DOCUMENT RESUME

ED 332 166 CS 010 588

AUTHOR	Costa, Arthur L., Ed.
TITLE	Developing Minds: A Resource Book for Teaching Thinking. Revised Edition, Volume 1.
INSTITUTION	Association for Supervision and Curriculum Development, Alexandria, Va.
REPORT NO	ISBN-87120-180-1
PUB DATE	91
NOTE	411p.; For volume 2, see CS 010 589. For previous edition, see ED 262 968.
AVAILABLE FROM	Association for Supervision and Curriculum Development, 1250 North Pitt St., Alexandria, VA 22314 (Stock No. 611-91026, $24.95).
PUB TYPE	Collected Works - General (020)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Cognitive Processes; *Comprehension; Concept Formation; Creative Thinking; *Critical Thinking; Curriculum Design; Curriculum Development; Curriculum Evaluation; Decision Making; Developmental Stages; Elementary Secondary Education; *Problem Solving; *Program Descriptions; Teaching Methods; *Thinking Skills

ABSTRACT

This eight-part book contains 69 articles which address topics related to helping students become effective thinkers. The articles are organized under these categories: (1) the need to teach students to think; (2) creating school conditions for thinking; (3) what is thinking? deciding on definitions; (4) a curriculum for thinking; (5) thinking pervades the curriculum; (6) teaching for thinking; (7) teaching strategies; and (8) assessing growth in thinking abilities. The book lists other resources for teaching thinking (in nine appendixes) which include a glossary of cognitive terminology, observation forms, checklists, questionnaires, evaluation instruments, suggestions for getting started, and questions for system planners. (PRA)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

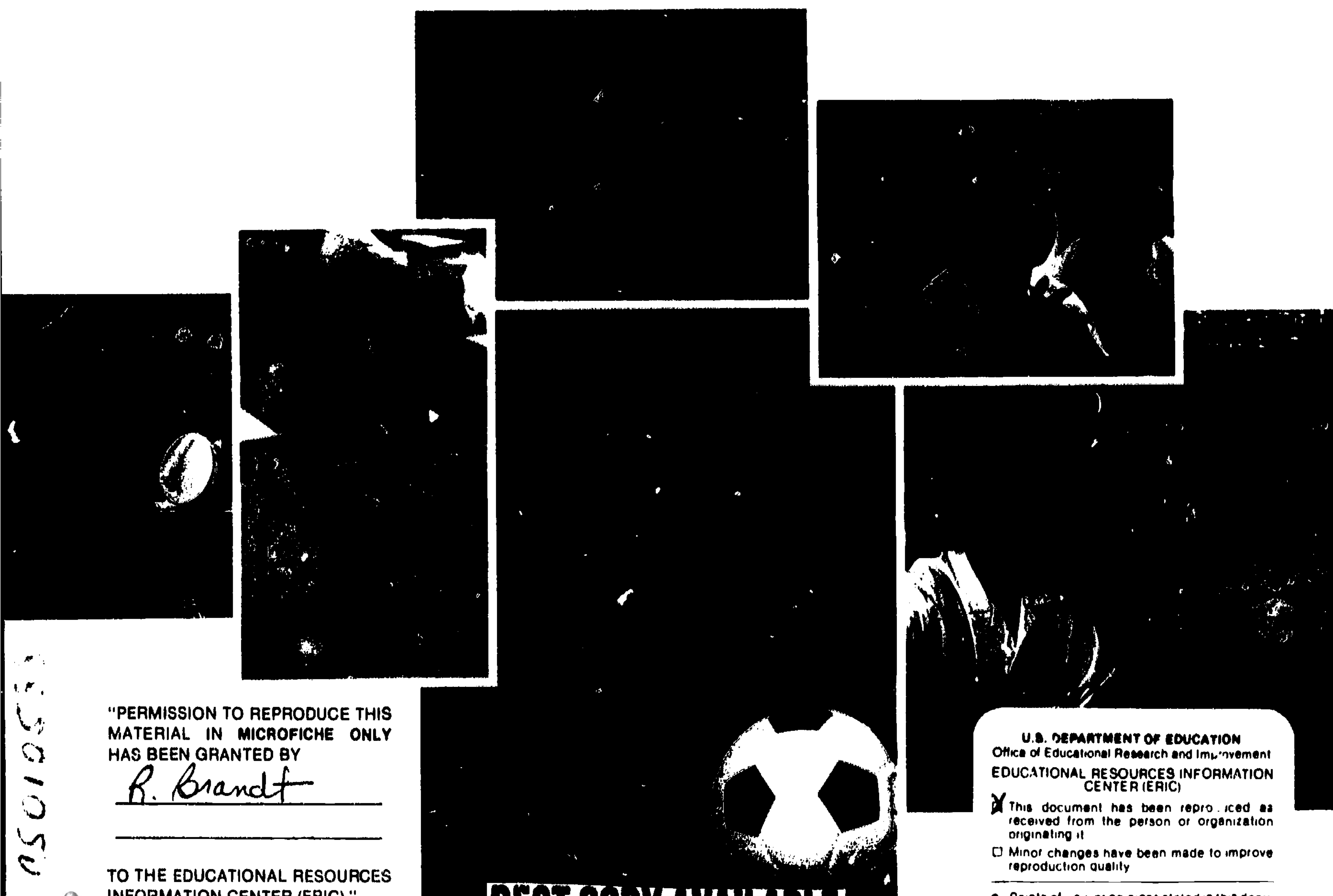
ED 332 166

Developing Minds

A RESOURCE BOOK FOR TEACHING THINKING

Revised Edition, Volume 1

Edited by
Arthur L. Costa



"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

R. Brandt

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

- [x] This document has been reproduced as received from the person or organization originating it
- [ ] Minor changes have been made to improve reproduction quality

- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy

BEST COPY AVAILABLE

ERIC

Developing Minds

A RESOURCE BOOK FOR TEACHING THINKING

Revised Edition, Volume 1

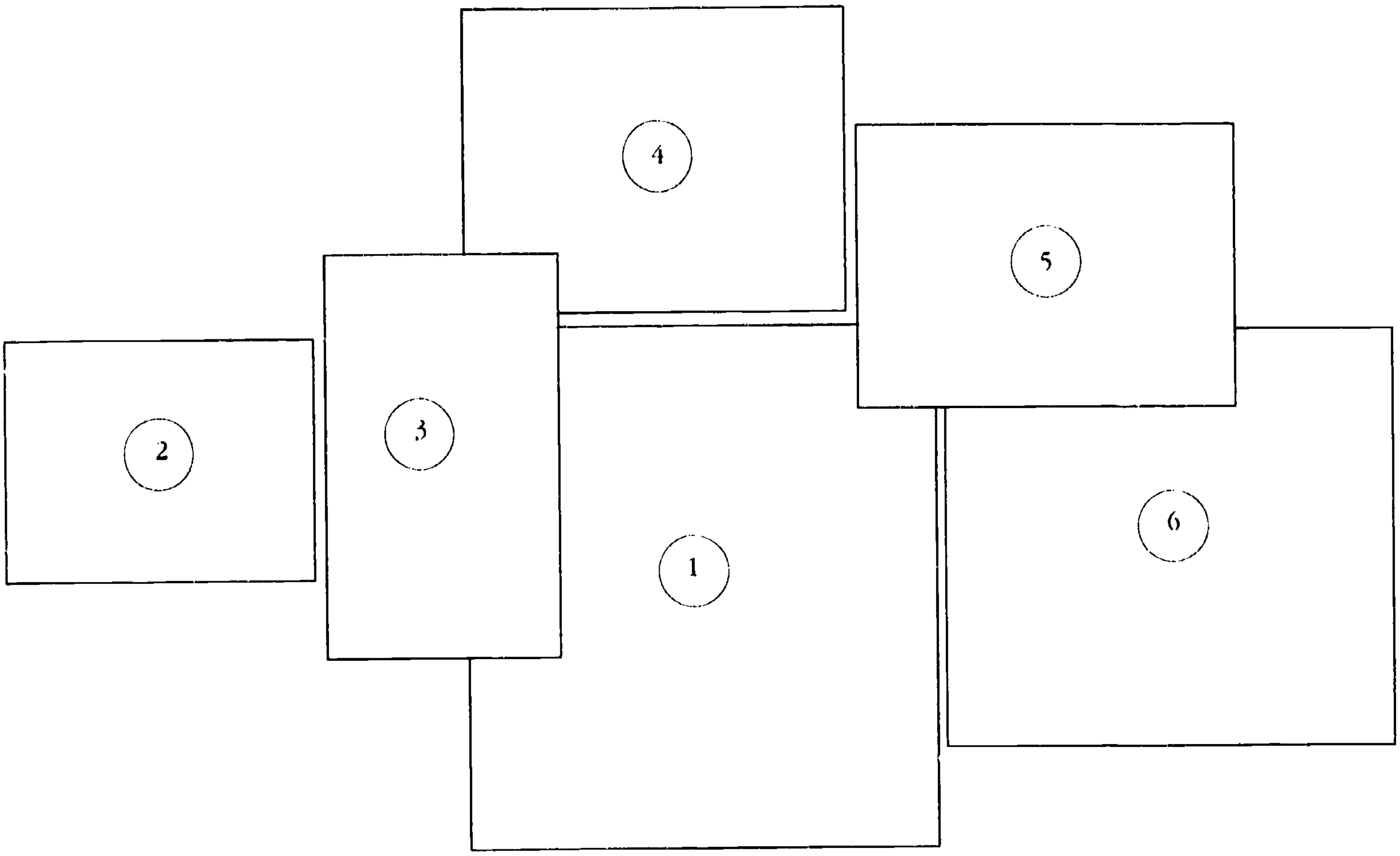
Edited by
Arthur L. Costa

ASCD

Association for Supervision and Curriculum Development
Alexandria, Virginia

CS010588

ERIC



Cover Photos: Photos 3–5 Copyright © by Susie Fitzhugh.

Copyright © 1991 by the Association for Supervision and Curriculum Development. All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without permission in writing from the publisher. The contents of this publication may, however, be reproduced if they are intended solely for nonprofit, educational use.

Ronald S. Brandt, *Executive Editor*
Nancy Modrak, *Managing Editor, Books*
Julie Houtz, *Senior Associate Editor*
Ginger Miller, *Associate Editor*
Carolyn Pool, *Associate Editor*
Cole Tucker, *Editorial Assistant*
Gary Bloom, *Manager, Design and Production Services*
Stephanie Kenworthy, *Assistant Manager, Production Services*
Keith Demmons, *Graphic Designer*
Valerie Sprague, *Desktop Typesetter*

ASCD publications present a variety of viewpoints. The views expressed or implied in this publication are not necessarily official positions of the Association.

Printed in the United States of America

Price: $24.95
ASCD Stock No.: 611-91026
ISBN: 0-87120-180-1

Library of Congress Cataloging-in-Publication Information:

Developing minds/edited by Arthur L. Costa.
p. cm.
Rev. ed. of: Developing minds, 1985, published in one volume.
Includes bibliographical references and index.
Contents: Vol. 1. A resource book for teaching thinking—v. 2. Programs for teaching thinking.
ISBN 0-87120-180-1 (v. 1): $24.95—ISBN 0-87120-181-X (v. 2): $10.95
1. Thought and thinking—Study and teaching. 2. Cognition in children.
LB1590.3.D48 1991
371.2'078—dc20 91-3069
CIP

Developing Minds

A Resource Book for Teaching Thinking

ERIC

Acknowledgments

"Exhilaration is that feeling you get just after a great idea hits you and just before you realize what's wrong with it."

WHEN I CASUALLY AGREED to edit *Developing Minds*, I didn't realize the immensity of the task. I knew I was in trouble when my patient wife, Nancy, met me at the airport upon my return from an extended meeting with the ASCD editorial staff: "Your computer missed you," she greeted, with a detectable ingredient of caustic sarcasm. To her and for her I am eternally grateful.

I seem to have been preparing almost my entire professional career for the production of this book. I want to thank my many mentors on whose interaction, inspiration, guidance, and knowledge I've drawn: Arthur Wells Foshay, Howardine Hoffman, Paul Brandwein, J. Cecil Parker, Larry Lowery, Frances Link, Reuven Feuerstein, J. Richard Suchman, Jerome Bruner, Jean Piaget, Hilda Taba, and Bruce Joyce, to mention only a few.

Gratitude should be expressed to ASCD's Executive Director, Executive Council, and Publications Committee for their proactive leadership, foresight, and realization of thinking skills as a high priority in which this organization should invest maximum and immediate efforts. I believe that ASCD has created a national awareness of intellectual development as a valued goal of education. It has been an awesome display of how an organization can move almost an entire profession.

I wish to express appreciation to the many contributors to this publication. They are a veritable "Who's Who" of outstanding contemporary cognitive educators. They have produced what I believe to be the most extensive, helpful, and scholarly publication on this topic to date. They've been patient with my prodding, determined with my deadlines, and agreeable to my editorial exclusions.

Finally, I wish to thank Arden Christian and the ASCD publications staff: Ron Brandt for his encouragement, thoughtfulness, and high standards; Nancy Modrak, Julie Houtz, Carolyn Pool, and Ginger Miller for their attention to detail; and Keith Demmons and Valerie Sprague for their artistry.

Arthur L. Costa
Granite Bay, California
1991

DEVELOPING MINDS
PREFACE TO THE REVISED EDITION

Arthur L. Costa

Modern education is competitive, nationalistic and separative. It has trained the child to regard material values as of major importance, to believe that his nation is also of major importance and superior to other nations and peoples. The general level of world information is high but usually biased, influenced by national prejudices, serving to make us citizens of our nation but not of the world.

—Albert Einstein

Much has happened since designing and publishing the first edition of *Developing Minds* in 1984–85. As I reflect on that original endeavor, I view it as an attempt to develop a broader awareness of the need for thinking to permeate the educational enterprise. In many ways we have succeeded in creating that awareness. This is evidenced by the increased numbers of schools and state departments of education that have developed or adopted programs of intellectual development. It is also seen in the fact that staff development efforts have prioritized the teaching of thinking, publishers have expanded the scope of instructional materials to include higher-order thought processes, and test producers have developed new assessment methods and technologies to determine students' thoughtful performance.

Certainly the flourishing concept of cognitive education has progressed rapidly during the past five years. As the last decade of the century unfolds, however, we are witnessing an even greater quest for intellectual fulfillment in the form of a universal revolution of the mind. As a result of instantaneous global communications, entire nations have become increasingly aware of other societies' artistic, technological, social, and economic progress. Comparing other nations' prosperity with their own existence has revealed to the peoples of underdeveloped nations the compelling effects of the applied intellect—creativity, problem solving, and reasoning skills in a climate of entrepreneurship, freedom, and collaboration. As a result, entire nations are renouncing their brief experiment with intellectual depression. They have embarked on a revolutionary demand for the installation of those cultural, societal, and environmental conditions that promote the fullest development of intellectual potential: greater involvement in creative problem solving; democratic decision making; and responsive interactions among the masses rather than having decisions made by an elite few and mandated from above. The eternal human quest for intellectual fulfillment has never been more pronounced. Machado's (1984) credo of every individual's inherent right to have his intellect developed is now manifest as a universal theme from Pretoria to the Kremlin, from the Brandenburg Gate to Tiananmen Square.

Based on the two truisms that schools are a reflection of society, and that modern society is becoming increasingly global, there is a quiet revolution taking place in education as well—a revolution of the mind. The restructured schools and effective classrooms based on collaborative learning, participative decision making, strategic teaching, and peer coaching are having a secondary effect: they are furthering the quest for the intellectual empowerment of the individual.

I strongly believe that this global quest for intellectual empowerment and the more microcosmic but concurrent educational pursuit of participative decision making are not happening coincidentally. The parallel patterns are far too obvious. Leaders of schools, corporations, and nations are heading toward a new state of mind—a new perception of their role and that of their organizations—from seeking power to empowering others; from controlling people to enabling them to be creative. Leadership, we are finding, is the desire to enhance the capability of others, whether it be in a classroom, boardroom, conference room, production plant, legislative chamber, or newsroom. Our goal is to leave other people in a better condition than they are in when we first encounter them. This may well become the central project—the strategic plan—of the world community of the 21st century.

ASCD is a professional organization dedicated to making the world a better place for future generations. I believe it is the most significant organization concerned with all youth and the realization that our children are our most precious resource; that through them we will realize a better tomorrow. Children are our legacy. And we know that the degree of civilization of any nation is equivalent to the degree of civilization of its youth.

While ASCD believes so strongly in developing a better future, we are simultaneously becoming aware of impending threats to our human futures. We are witnessing increased violence with more efficient weapons. The United States has an intolerably high rate of infant death and teenage suicide. During the year of publication of this book, three times more people will die of AIDS than did in all the Vietnam War. Increasingly, we are all at risk.

Because of changing demographics, we have more people drawing on social security and welfare with a smaller number of people contributing to such funds. We are seeing the emergence of a competitive world of mega-economies. The European Common Market will become operational in 1992; trading blocs are forming around the Pacific Rim and South America. Over 90 percent of foreign investment in the state of Hawaii is from Japan; nations are buying other nations. At the same time, we not only have the smallest number of people entering the work force, but those who are entering may be insufficiently educated to meet our country's need to participate in a global economy or to support the growing numbers of elderly and impoverished.

In the 20th century, the age of industrialization, we learned to be smart, to know lots of answers, to compete with each other, and to exploit the earth's resources. In the 21st century, we must learn how to reason, how to cooperate, and how to conserve our planet as a delicate, fragile ecosystem. The politics of the future will not be east versus west or capitalism versus communism. That debate is becoming rapidly moribund.

In 1991, we enter a new decade, are on the verge of a new century, and stand at the threshold of a new millennium. The young people in our schools today are the statespeople, leaders, parents, and teachers of the 21st century. We must teach them now how to secure our environment, how to regard our planet as a single organism, and how to live in harmony with each other.

The cooperative skills children learn in schools today will equip them with the empathy to build the multinational, multicultural, multilingual, global community of the next generation. The problem-solving skills they learn today will provide them the stamina to tackle the immense problems facing our ecological future. The communication skills they learn today will enable them to work in the emerging corporate world era. The closure of lessons today in which ambiguity and puzzlements are celebrated will equip them to face the uncertainty, confusion, and chaos of the future. Learning how to learn today will foster the continuance of learning throughout their lifetimes.

Jean Houston's quote, "Never has the vision of what human beings can be been more remarkable," is even more profound as we more clearly envision, more stridently demand, and more eagerly install those societal and noticeably similar educational conditions in which humanness is enhanced. The fullest development of the intellect today will allow our students and all the worlds' citizens to continue developing visions of ever more remarkable human beings.

This revised edition is dedicated to the development of that new form of intellect—a global intellect, with people who know how to live in a rational, humane, peaceful, and compassionate relationship with each other and the environment. If our schools fail, then our society and the greater global society will fail. Whatever it costs, the price of failure will be greater than the price of education. Our children are worth it; our planet is worth it. We must educate world citizens to walk the earth like human beings.

REFERENCE

Machado, L. A. (1984). *The Right to Be Intelligent.* New York: Pergamon Press.

Introduction

Nothing worse could happen to one than to be completely understood.

—Carl Jung

It takes much coaching for human movement to be performed with precision, style, and grace. It takes years of practice, concentration, and coaching to become a skilled gymnast or ice skater, for instance. Improvement is demonstrated by the increasing mastery of complex and intricate maneuvers performed repeatedly on command with sustained and seemingly effortless grace. The distinction between awkwardness and agility is obvious to even the most undisciplined observer.

Like strenuous movement, thinking is hard work. Similarly, we can assume that with proper instruction, human thought processes can become more broadly applied, more spontaneously generated, more precisely focused, more intricately complex, more metaphorically abstract, and more insightfully divergent. Such refinement also requires practice, concentration, and coaching. Unlike athletics, however, thinking is most often idiosyncratic and covert. Definitions of thought processes, strategies for their development, and assessment of the stamina required for their increased mastery are therefore illusive. Awkwardness and agility, therefore, are not as easily distinguished in thinking as they are in athletics.

Today there is a growing realization worldwide, by educators as well as the general public, that the level of a country's development depends on the level of intellectual development of its people. Indeed, Luis Alberto Machado (1980), the former Venezuelan Minister of Intellectual Development, reminds us that all human beings have a basic right to the full development of their intellect. Furthermore, recent research in education, psychology, and neurobiology supports the belief of many educators that our brain is our organ for learning and it must be engaged and transformed for learning to occur. Teaching thinking is an integral component of instruction in every school subject, and that achievement depends largely on the inclusion of those mental processes prerequisite to mastery of that subject.

Developing Minds: A Resource Book for Teaching Thinking and the companion volume, *Developing Minds: Programs for Teaching Thinking*, are dedicated to educators who believe that teaching is one of the most powerful mechanisms for developing intellectual prowess; that meaningful interaction with adults, peers, and the environment is essential in mediating the learner's intellectual development; that learning is a continual transformation of inner perceptions, knowledge, and experiences; and that all human beings have the potential to continually develop their intellectual powers throughout their lives. It is intended to help educational leaders— teachers, administrators, curriculum workers, staff developers, and teacher educators—infuse curriculum, instruction, and school organization with practices that more fully develop children's intellectual potentials.

Because the research in and development of cognitive education programs are progressing rapidly, this edition is *not* intended to be comprehensive. Rather, it is intended to serve as a practical resource to help initiate change, to validate the enhancement of intelligent behavior as a legitimate goal of education, to invite critical assessment of existing school practices for their contributions to children's intellectual growth, and to foster the expansion of thinking throughout the curriculum.

Practical Applications

Classification involves the separation of data and information into groups by commonalities and differences. The labels given to these groups should describe, as precisely as possible, their essential elements and attributes. Categorization, in contrast, involves a system of groupings: attributes of objects, events, and conditions are examined in determining to which predetermined group they should be assigned.

The categories for *Developing Minds* were formed by classifying numerous concerns; expressions of interest; identified needs; and questions posed by teachers, curriculum workers, administrators, staff developers, psychologists, and teacher educators. Thus, we hope this resource will give you practical assistance in initiating, improving, and evaluating your curriculum and instructional efforts to infuse thinking into your educational programs.

These resource books provide an organized space for information about curriculums intended to develop students'

ERIC

thinking abilities and instructional strategies. It offers the beginning of a categorization system into which additional helpful resources may be placed.

You should be alert to materials and resources that will help you develop instructional programs for thinking and, after examining their attributes, fit them into one of the categories provided. You may also wish to create new classifications.

We don't recommend reading these books from cover to cover. Regardless of your school or district situation, or the progress you may have already made in installing thinking skills instruction in your curriculum, these books will provide ideas, examples, definitions, and programs to give you an appropriate boost when you need one.

While we have gathered resources at the national level, you may wish to conduct a similar search of your own local resources. Talented people, innovative programs, and provocative media are available in most schools and communities. The process begins wherever you are.

On the day of its publication, *Developing Minds* will be obsolete—there will have been increases, new programs developed, additional research generated, and new articles and books written and published. You should expect these changes.

Although both volumes are copyrighted, most of their contents are contributions and descriptions of non-copyrighted ideas. You are therefore invited to duplicate those portions you find suitable for distribution to community groups, school staffs, boards of education, and so forth. We merely ask that you identify the source on all duplicated materials, and not use these materials for resale. For example, if you need a statement of philosophy or rationale to support your staff development or curriculum writing project, please duplicate or adapt the one contained in Part I. Give credit to the authors, Jay McTighe and Jan Schollenberger; then feel free to use it as a discussion starter for your own group. Our goal is to improve educational practices. We are using this book as a means of getting the word out.

Developing Minds is *not* a recipe book, nor does it provide easy answers. A curriculum for thinking, and therefore this revised edition, is intentionally unfinished. Its design is symbolic of the field of educational inquiry today—controversial, tentative, incomplete, and fascinating. Several chapters present alternative approaches, multiple definitions, and differing points of view. This is purposeful. Instructional leaders, working with other educators and interested community members, will strive for improvement by continuing to stimulate dialogue, gathering additional resources and data, clarifying meaning, synthesizing definitions, and searching for better ways of learning to think through education. Out of this confusion comes enlightenment. Thus the *process* of developing curriculum, improving instructional strategies, and assessing students' growth in thinking abilities is in itself a form of inquiry and should be an intellectually stimulating experience.

Arthur L. Costa

REFERENCE

Machado, L. A. (1980). *The Right to Be Intelligent.* New York: Pergamon Press.

PART I

The Need to Teach Students to Think

We must return to basics, but the "basics" of the 21st century are not only reading, writing and arithmetic. They include communication and higher problem-solving skills, and scientific and technological literacy—the thinking tools that allow us to understand the technological world around us

—Educating Americans for the 21st Century

• *Don't we already teach students to think?* Many educators believe that schools are already doing an adequate job of developing students' cognitive abilities.

• *Of course I teach thinking; why just yesterday I gave my students a lecture on the importance of thinking critically* Many teachers feel they are already doing an adequate job of educating the intellect.

• *Please . . . don't add anything more to the curriculum. We can't cover all that we're supposed to now!* Many administrators do not understand the place of thinking in the overall school day or the curriculum to be taught.

• *How does this new thinking skills curriculum in your schools meet the Economic Security Act—the Hatch Act? Is this one of the "sensitive subjects" I'm supposed to give my child permission to participate in?* Many parents don't understand the purposes of a cognitive curriculum.

• *I don't like those kinds of questions—they're too hard. Why don't teachers just tell us the answers they want us to have? Then we'll know if we're right so we can get a better grade in this class.* Many students don't realize that learning to think is the purpose of their education.

Even though *you* may be convinced, it is often necessary to persuade community groups, parents, other educators, and boards of education that resources should be devoted to educating the intellect. Part I of this resource book presents four statements of rationale that explain why there is a need to include thinking in the curriculum and why the development of students' intellectual abilities is a valid goal of education.

1

Why Teach Thinking? A Statement of Rationale

Jay McTighe and Jan Schollenberger

The level of the development of a country is determined, in considerable part, by the level of development of its people's intelligence. . . .

—Luis Alberto Machado

The goal of helping students become more effective thinkers is fundamental to American schooling and certainly not a new idea. John Dewey (1933) saw the development of an individual capable of reflective thinking as a prominent educational objective. In a 1937 report, the National Education Association's Educational Policies Commission included the following statement among its list of ten "imperatives": "all youth need to grow in their ability to think rationally, to express their thoughts clearly, and to read and listen with understanding" (National Education Association 1937).

The rationale for teaching thinking that we present in this chapter allows readers to examine their existing needs in this area. This rationale serves at least four purposes. First, it provides a clear picture of the problem for both educators and the public. Second, it offers well-founded reasons for considering change. Why should an individual teacher, school, or entire district bother to alter its approach without due cause? Third, it helps to structure the philosophy, goals and objectives, and form of improvement efforts. Finally, it identifies expected outcomes, which is necessary for the selection or development of appropriate instruments for assessment.

Our rationale is based on three significant factors that point to the need for teaching thinking: the *characteristics of present and future societies,* which can help us identify the skills that will be needed to develop *students' thinking capabilities* by modifying or creating new *teaching methods.*

Characteristics of Present and Future Societies

Societal demands for higher-order thinking are increasing. Employability studies document the need for a future work force capable of more sophisticated thinking than was generally required in the past. Such skills as independent analysis, flexible thinking, and collaborative problem solving are now considered basic requirements for many jobs. In *The Future World of Work,* The United Way of America (1988) predicts that "the greatest job growth over the remainder of the century will occur in areas that require high skill levels and demand creative thinking." In an "information age" characterized by the rapid expansion of knowledge and the emergence of increasingly sophisticated technologies, the ability to adapt quickly to change, along with the capacity and willingness to learn new skills on the job, assumes greater importance. Unfortunately, reports from business, industry, and the military express dissatisfaction with the skill level and adaptability of American workers, and these concerns are heightened by the challenges of increased global economic competition.

The requirements of the information age clearly affect educational goals and practices. The National Science Board Commission on Pre-College Education in Mathematics, Science, and Technology (1983) declared in its report, *Educating Americans for the 21st Century:*

> We must return to basics, but the basics of the 21st century are not only reading, writing, and arithmetic. They include communication and higher problem-solving skills, and scientific and technological

ERIC

literacy—the *thinking* tools that allow us to understand the technological world around us. . . . Development of students' capacities for problem-solving and critical thinking in all areas of learning is presented as a fundamental goal.

The Association for Supervision and Curriculum Development (1984) has also acknowledged the need for an expanded version of the basics in a resolution: "Further development and emphases are needed in teaching skills of problem solving, reasoning, conceptualization, and analysis, which are among the neglected basics needed in tomorrow's society."

Additional support for this view resulted from the work of a committee of leaders from various organizations and industries. In 1982 the Education Commission of the States directed this committee to identify those skills that would be considered basic for the future. They listed: "Evaluation and analysis skills, critical thinking, problem-solving strategies, organization and reference skills, synthesis, application, creativity, decision-making given incomplete information, and communication skills through a variety of modes" (Education Commission of the States 1982).

The rapid increase of available knowledge has particular significance for education. Content teachers frequently lament their inability to cover all the material in the content curriculums. The increased knowledge bases of many subjects quantitatively compound this task. It is clear that a different strategy is in order—one that emphasizes developing the lifelong *learning* and *thinking* skills necessary to acquire and process information within an ever-expanding field of knowledge.

According to Robert Ornstein of the Institute for the Study of Human Knowledge:

> Solutions to the significant problems facing modern society demand a widespread, qualitative improvement in thinking and understanding. We are slowly and painfully becoming aware that such diverse contemporary challenges as energy, population, the environment, employment, health, psychological well-being of individuals and meaningful education of our youth are not being met by the mere accumulation of more data or expenditure of more time, energy, or money. In view of the increasing pressures imposed on our society by these problems, many responsible thinkers have realized that we cannot sit back and hope for some technological invention to cure our social ills. We need a break-through in the *quality* of thinking employed both by decision-makers at all levels of society and by each of us in our daily affairs (Ornstein 1980).

Having identified the kinds of skills students need to develop now in order to function well in the future, it is imperative that we evaluate the capabilities that students currently possess.

Student Thinking Capabilities

An analysis of national assessment data on student achievement over the last decade reveals moderate improvement in performance in "basic skills" areas, especially for minority students. Unfortunately, when we examine student performance on those assessment tasks requiring more sophisticated thinking, such as inferential reading, persuasive writing, interpretation of data, and multistep problem solving, the results are disappointing. For example, in its analysis of trends in reading achievement, the U.S. Office of Educational Research and Improvement concluded that "while it appears that progress has been made in raising the share of students who acquire rudimentary, basic, and intermediate reading skills and strategies, no gains are evident at the higher levels of reading ability (Mullis and Jenkins 1990, p. 35)." This pattern is confirmed by the results of the most recent National Assessment of Educational Progress in reading: "Students at all three grade levels (3, 7 and 11) have particular difficulty with tasks that require them to elaborate upon or defend their evaluations and interpretations of what they have read. Continued attention to such skills must be a major priority in instruction (Applebee, Langer, and Mullis 1988, p. 6)."

Similar trends in mathematics, science, and writing are noted by the Nation's Report Card in these areas. *The Mathematics Report Card—Are We Measuring Up?* reports:

> The mathematical performance of students at ages 9, 13, and 17 has improved somewhat over the past eight years, yet a closer look at levels of proficiency indicates that most of the progress has occurred in the domain of lower-order skills (p. 49). . . . This picture reflects classrooms more concerned with students' rote use of procedures than with their understanding of concepts and developments of higher-order thinking skills (Dossey, Mullis, Lindquist, and Chambers 1988, p. 12).

The Science Report Card—Elements of Risk and Recovery confirms:

> The recent improvements occurred only in lower-level skills and basic knowledge. While average science proficiency is on the rise, students in the upper range of science proficiency did not show any improvement—nor are there increasing percentages of these students. Performance on moderately complex and specialized scientific tasks has not changed in almost a decade, and only a small number of students, merely 7 percent of 17-year-olds—demonstrate such higher-level skills (Mullis and Jenkins 1988, pp. 19–20).

Likewise, *The Writing Report Card, 1984–1988* reports:

> In both 1984 and 1988, a majority of the students at all three grade levels were able to write at least minimal responses to most of the persuasive tasks. Far fewer students, however, wrote at the adequate level, which required supporting points of view with evidence and reasoning (Applebee, Langer, Mullis, and Jenkins 1990, p. 40).

In order to increase writing performance, the report recommends that teachers stress the development of higher-order thinking skills in all areas of the curriculum; help students develop strategies for thinking about what they write; provide many opportunities for students to offer advice, convince others of their point of view, and defend their opinions; and respond to the ways in which they organize and present their ideas.

Such results are no surprise to teachers of all levels who express concern that students are unable to argue effectively, examine complex problems carefully, or write convincingly. These feelings are shared by parents, employers, and others who recognize the importance of thinking in today's world.

Thus it is necessary to also examine *why* students are falling short in this area. If teachers are to be charged with developing students' thinking skills, the first step is to look at the methods teachers currently use to find what they actually accomplish and to identify new techniques.

Today's Teaching Methods

While many teachers value thinking and employ methods that encourage its development, a number of studies indicate that these teachers do not constitute the norm.

The most widely publicized study of this problem was conducted by John Goodlad (1984) and reported in his book *A Place Called School.* This exhaustive study of American education involved observations of more than 1,000 classrooms in a variety of communities throughout the country. A summary of results showed that an average of 75 percent of class time was spent on instruction. Approximately 70 percent of this time involved verbal interaction—with teachers "out talking" students by a ratio of three to one. Observers noted that *less than* 1 percent of this "teacher talk" invited students to engage in anything more than mere recall of information (Goodlad 1983).

Fortunately, studies by Goodlad and others, results of national assessments of student achievement, and education reform reports, such as *A Nation At Risk* (National Commission on Excellence in Education 1983), have not gone unheeded by the education community. For example, the results of two recent polls offer encouraging signs of a growing awareness among educators of the need to focus greater attention on the development of student thinking abilities. A study of 672 high schools that was conducted by the Association for Supervision and Curriculum Development (Cawelti and Adkisson 1986) found that the majority of principals surveyed—66 percent— believed that the development of student thinking skills was "very important." Similarly, the 1989 Annual Gallup Poll of Teachers' Attitudes Toward the Public Schools (Elam 1989) revealed teachers' growing awareness of the importance of thinking skills. For example, 80 percent of the teachers polled in 1989, compared with just 56 percent in 1984, regarded "the ability to think—creatively, objectively, and analytically"—as the *highest* goal of education.

Recommendations for Schools

This increased awareness of the problem has stimulated a variety of responses at the national, state, and local levels. National and international conferences on thinking have introduced thousands of participants to available thinking skills programs and practices. Several states have introduced legislative initiatives to stimulate educational efforts to develop students' higher-order thinking abilities. Many school districts have established committees to examine promising practices, sponsored staff training programs, and adopted various thinking skills programs. And publishers of tests, textbooks, and resource materials have responded to this growing interest within the educational community.

In addition, an unusual consensus of opinion is reflected in statements by leading professional education organizations.

- In *Curriculum and Evaluation Standards for School Mathematics*, the National Council of Teachers of Mathematics (1988) states:

> Knowing mathematics means being able to use it in purposeful ways. To learn mathematics, students must be engaged in exploring, conjecturing, and thinking rather than only in rote learning of rules and procedures. Mathematics learning is not a spectator sport. When students construct personal knowledge derived from meaningful experiences, they are much more likely to retain and use what they have learned. This fact underlies teachers' new role in providing experiences that help students make sense of mathematics, to view and use it as a tool for reasoning and problem solving.

- The National Council of Teachers of English (1982) highlights thinking skills in the publication *Essentials of English* by affirming that:

> Because thinking and language are closely linked, teachers of English have always held that one of their main duties is to teach students *how* to think. Thinking skills, involved in the study of all disciplines, are inherent in the reading, writing, speaking, listening and observing involved in the study of English. The ability to analyze, classify, compare, formulate hypotheses, make inferences, and draw conclusions is essential to the reasoning processes of all adults. The capacity to solve problems, both rationally and intuitively, is a way to help students cope successfully with the experience of learning within the school setting and outside.

- In the National Council for the Social Studies publication, *Developing Decision-Making Skills*, Kurfman and Cassidy (1977) observe:

> Social studies classrooms have been dominated by attempts to transmit knowledge, often very specific knowledge, about people, places, dates, and institutional structure . . . There is no denying the importance of knowledge: the more capable we are of enjoying

experiences; the more we know, the more likely we are to make sound decisions. But, as the overall purpose of social studies, knowledge attainment is not a sufficiently broad purpose to guide program development or to inspire modern students. . . .

They propose:

Learning only easily testable fact-finding skills will prove increasingly inadequate for life in the modern world. Much more than fact-finding skills—that is, *higher-level thought processes*, useful knowledge, and clear values—are needed for students to function effectively (Kurfman and Cassidy 1977).

• In her article, "Striving for Excellence in Arts Education," Leilani Duke describes the ways in which thinking skills can and should be promoted through the arts:

The goal of education in the arts should be to foster the learning of higher order intellectual skills through presenting arts instruction as a compound discipline. Such an integrated approach includes (a) aesthetic perception, (b) production of performing skills, (c) arts criticism, and (d) arts history. Attending to aesthetic perception, children can learn to analyze, criticize, and interpret sensory properties. Through production and performing skills, they can learn how to translate abstract concepts into tangible, visual, auditory, or kinesthetic expressions. In developing critical skills, children can learn to make and support discriminatory judgments. They can learn to draw facts and inferences about man and society by studying the cultural and historical contexts from which the arts spring (Duke 1984).

Conclusion

The goal of developing school graduates with the ability to think critically is significant, yet it should not constitute the sole justification for improvement efforts. Since thinking is essential to all school subjects, its development should be considered *a means* as well as *an end.*

Finally, the fundamental requirements of our democratic society provide a powerful rationale for focusing on thinking. Democracy, as envisioned by our nation's founders, rests on an informed and intellectually able citizenry. Edward Glaser observes:

For good citizenship in a representative democracy is not just a matter of keeping within the law and being a good and a kind neighbor. In addition good citizenship calls for the attainment of a working understanding of our social, political, and economic arrangements and for the ability to *think critically* about issues concerning which there may be an honest difference of opinion (Glaser 1941, p. 5).

Effective thinking is particularly important for contemporary democracy as local, national, and international issues become increasingly complex. Additional sources attesting to this need and making recommendations could be cited; however, the message is clear—educators need to take renewed action to bring about qualitative improvements in student thinking.

References

Applebee, A., J. Langer, I. Mullis, and L. Jenkins. (1990). *The Writing Report Card, 1984–1988.* Princeton, N.J.: National Assessment of Educational Progress.

Applebee, A., J. Langer, and I. Mullis. (1988). *Who Reads Best?—Factors Related to Reading Achievement in Grades 3, 7, and 11.* Princeton, N.J.: National Assessment of Educational Progress.

Association for Supervision and Curriculum Development (ASCD). (May 1984). "ASCD 1984 Resolutions." *ASCD Update* 26, 4. Alexandria, Va.

Cawelti, G., and J. Adkisson. (August 1986). "ASCD Study Documents Changes Needed in High School Curriculum." *ASCD Curriculum Update*: 1–10.

Dewey, J. (1933). *How We Think.* Chicago: Henry Regenery Company.

Dossey, J., I. Mullis, M. Lindquist, and D. Chambers. (1988). *The Mathematics Report Card—Are We Measuring Up?* Princeton, N.J.: National Assessment of Educational Progress.

Duke, L. (January/February 1984). "Striving for Excellence in Arts Education." *Design for Arts in Education* 85, 3: 45–46.

Education Commission of the States. (1982). Denver, Colo.

Elam, S. M. (1989). "The Second Gallup Poll of Teachers' Attitudes Toward the Public Schools." *Kappan* 70, 10: 785–798.

Glaser, E. (1941). *An Experiment in the Development of Critical Thinking.* New York: Teachers College, Columbia University.

Goodlad, J. (1984). *A Place Called School.* New York: McGraw-Hill.

Goodlad, J. (March 1983). "A Study of Schooling: Some Findings and Hypotheses." *Phi Delta Kappan* 64, 7: 465–470.

Kurfman, D., and E. Cassidy (1977). *Developing Decision-Making Skills.* Arlington, Va.: The National Council for the Social Studies.

Mullis, I., and L. Jenkins. (1990). *The Reading Report Card, 1971–1988.* Washington, D.C.: Office of Educational Research and Improvement.

Mullis, I., and L. Jenkins. (1988). *The Science Report Card—Elements of Risk and Recovery.* Princeton, N.J.: National Assessment of Educational Progress.

National Commission on Excellence in Education. (1983) *A Nation at Risk: The Imperative for Educational Reform.* Washington, D.C.: U.S. Government Printing Office.

National Council of Teachers of English. (1982). *Essentials of English.* Urbana, Ill.

National Council of Teachers of Mathematics. (1988). *Curriculum and Evaluation Standards for School Mathematics—Executive Summary.* (1988). Reston, Va.

National Education Association, Educational Policies Commission. (1937). Report. Washington, D.C.

National Science Board Commission on Pre-College Education in Mathematics, Science, and Technology. (1983). *Educating Americans for the 21st Century.* Washington, D.C.

Ornstein, R. (1980). Institute brochure. Los Altos, Calif.: Institute for the Study of Human Knowledge.

United Way of America. (1988). *The Future World of Work: Looking Toward the Year 2000.* Alexandria, Va.

2

Educational Outcomes for a K–12 Curriculum

Sydelle Seiger-Ehrenberg

The principal goal of education is to create men who are capable of doing new things, not simply of repeating what other generations have done—men who are creative, inventive, and discoverers. The second goal of education is to form minds which can be critical, can verify, and not accept everything they are offered.

—Jean Piaget

Traditionally, elementary and secondary school curriculum has been derived from arbitrary selections of content from the "scholarly disciplines": history, geography, mathematics, biology, and so forth. Yet every significant statement of the goals of education has been expressed in terms of *desired outcome characteristics of the student*—"effective problem solver," "responsible citizen," and the like. What we've been saying, in effect, is that if students learn all the subject matter content we've included in the curriculum, they will somehow become the kind of people we want them to become.

The Institute for Curriculum and Instruction's (ICI) Curriculum Model is based on a different premise. It says, "If you want students to develop certain behavioral characteristics, start with those and focus the entire curriculum on achieving them. View the scholarly disciplines as sources of needed information, ideas, and procedures. Select and use content only as needed to achieve the desired student characteristics." By taking this approach, not only is the same basic content "covered," but all of it is learned in a *relevant context*, as it applies to achieving the desired outcome characteristics.

Copyright © 1978 by the Institute for Curriculum and Instruction.

The following is an introduction to the ICI Curriculum Model.[1] The Intended Outcome Statement is followed by a detailed analysis of its meaning.

Intended Outcome for Students

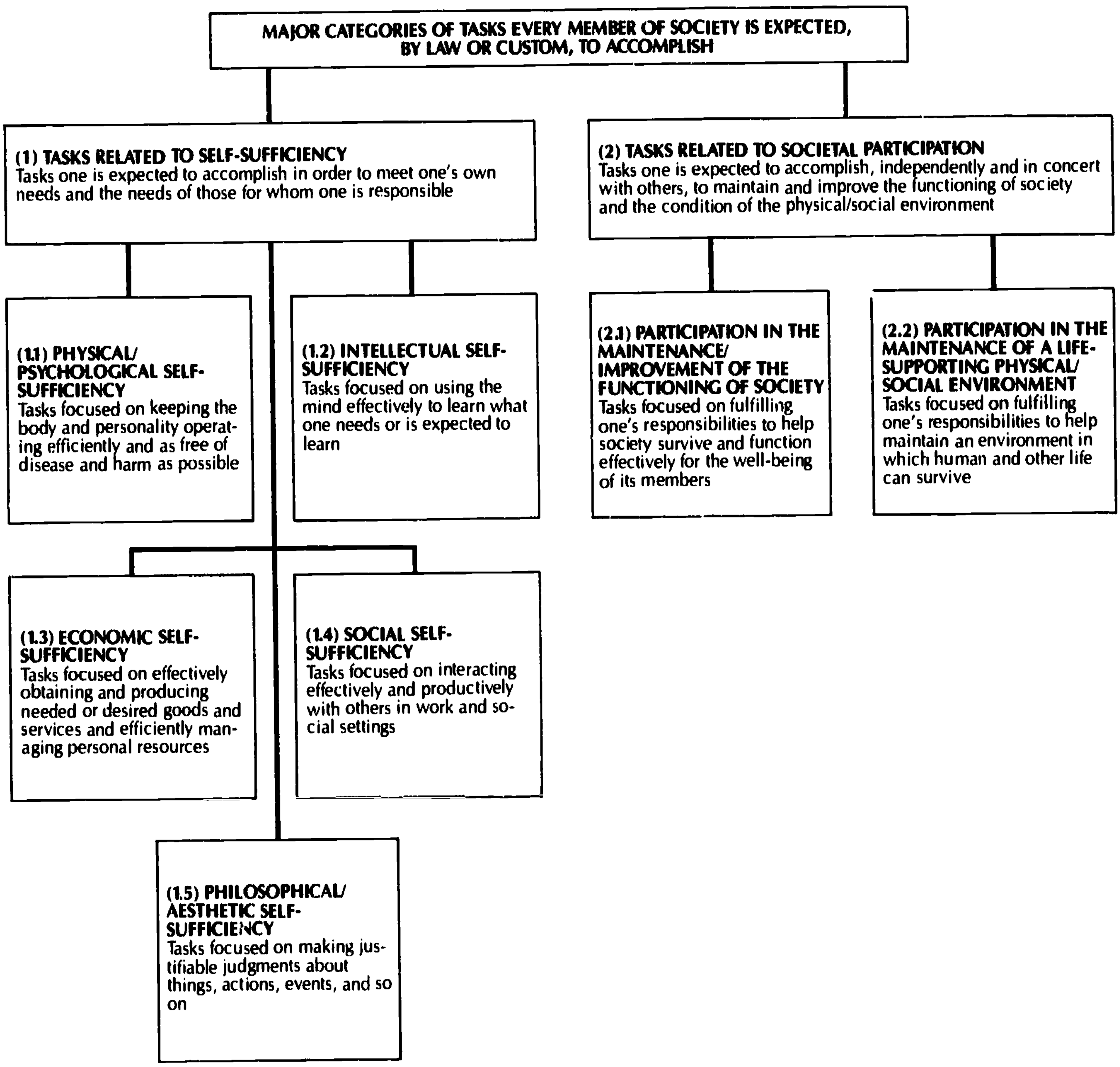
By the time students graduate from high school, they should be able to consistently and effectively take intelligent and ethical action to accomplish the tasks society legitimately expects of all its members and to establish and pursue worthwhile goals of their own choosing.

Consistently and Effectively Take Intelligent, Ethical Action

"Consistently" here means characteristically or without deviation, except under extraordinary circumstances. "Effectively" implies the ability to achieve desired results. "Intelligent, ethical action" refers to *planned behavior* undertaken as a result of having gone through a mental process such as:

- Clarifying what is to be achieved and why, the criteria and standards to be met and why.
- Obtaining sufficient valid, relevant, and reliable infoi mation to assess the current situation and deciding what, if anything, needs to be done.
- Analyzing alternative courses of action in terms of feasibility and possible short- and long-term consequences.
- Choosing the most appropriate, desirable courses of action considering what is to be achieved *and* the well-being of those involved.
- Making and carrying out the commitment to pursue one or more selected courses of action, evaluate the results and the way they were obtained, and accept and deal with

FIGURE 1
Areas of Societal Expectations

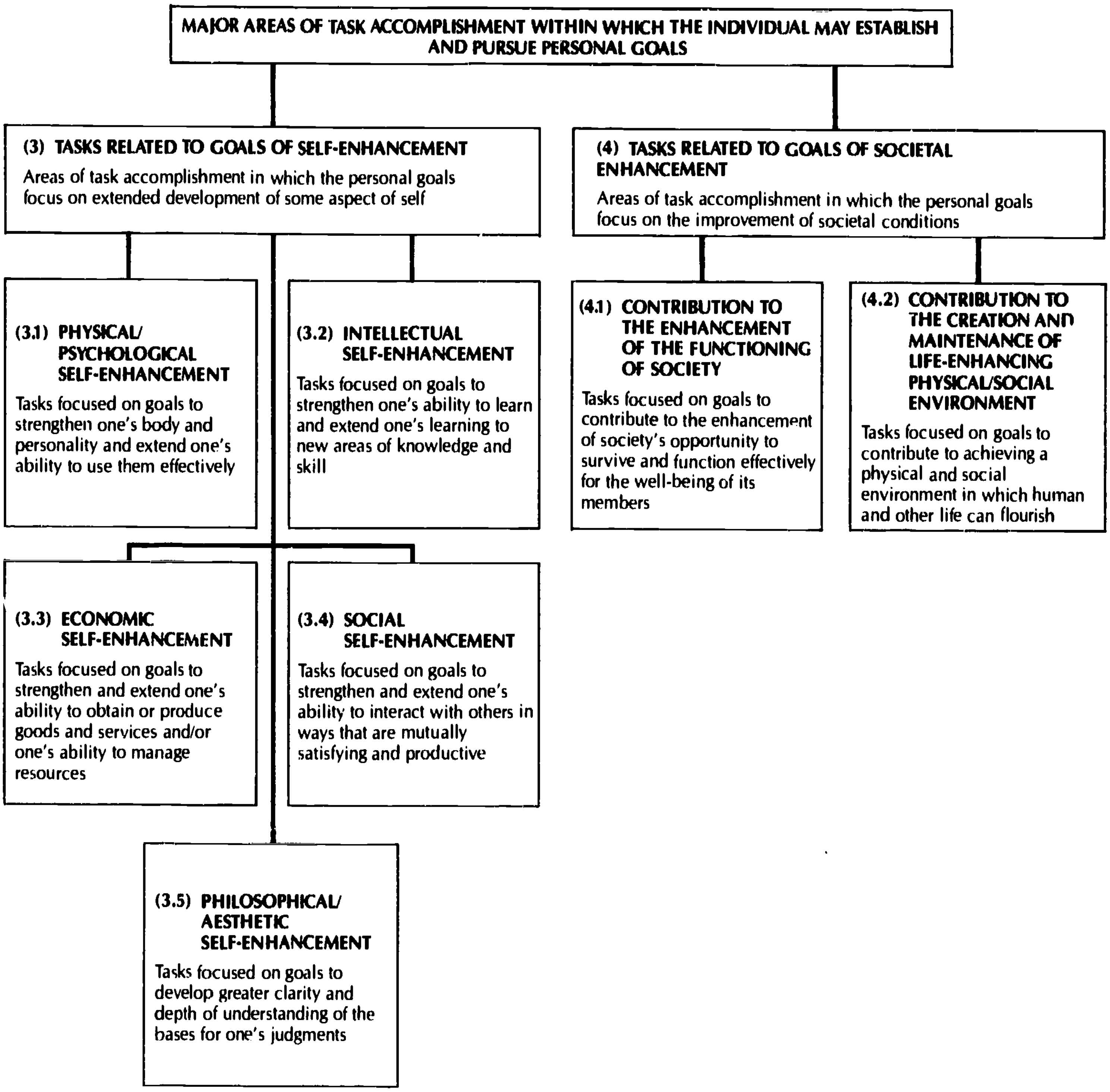


the consequences using the same rational, ethical procedures used to decide on the selected course of action.

"Intelligent," in effect, means using rational thought processes to arrive at a decision to act (or not act). It does *not* imply "unfeeling" or "uncreative," nor does it exclude the use of intuition. This concept of intelligence or rationality views feelings, attitudes, values, and ideas—from whatever source—as key factors to be consciously recognized and reckoned with in the decision-making or action process.

"Ethical" means taking into account, when deciding or acting, the well-being of those involved and making a commitment to take courses of action that are likely to contribute to (or at least will not detract from) the well-being of those affected and their opportunity to take intelligent, ethical action.

FIGURE 2
Areas of Personal Goals



Intelligent, ethical action *excludes*:

- *Irrationality*—choosing a course of action knowing it is likely to produce an undesired outcome (a person who is dieting decides to eat a rich dessert knowing it will add unwanted calories).
- *Irresponsibility or recklessness*—choosing a course of action without concern for the predicted consequences (an overweight person chooses to eat a rich dessert knowing it will add calories, but not caring whether or not he or she gains additional weight).
- *Impulsiveness*—choosing a course of action without giving any consideration to alternatives or possible consequences (an overweight person chooses to eat a rich dessert without thinking of either the calories or his or her weight).

• *Immorality*—choosing a course of action knowing it is likely to have injurious consequences for those involved (telling an overweight person who is dieting that the dessert you prepared is safe to eat because it was made with low-calorie substitutes, knowing that the dessert is really made with high-calorie ingredients).

• *Lack of integrity*—choosing a course of action knowing that it violates avowed principles (an overweight person who publicly claims to be on a very strict diet eats rich snacks on the sly and says that there must be something wrong with his or her glands or the diet because there is no weight loss).

Accomplish Tasks Society Legitimately Expects of All Its Members

"Society" refers to any identifiable group of people of which an individual may be considered to be a member. This includes the broad human community and therefore embraces tasks that *any* human being is expected to accomplish, by law or custom, regardless of the time or place (maintaining good health, caring for dependents, maintaining a safe physical environment). It also includes one's national group, cultural or subcultural group, age group, family group, and so on, and implies any tasks legitimately required of any member of those groups.

While many possible tasks might legitimately be expected of every member of society, Figure 1 categorizes the tasks used in this curriculum design, which apply to membership in *any* societal group, broad or narrow.

A corresponding concern is *how* these tasks are performed. In our society, we hold two broad expectations:

1. Tasks will be performed within the framework of both the letter and spirit of the law (or rules).

2. Where there is no explicit law or rule relating to a given situation, tasks will be performed in a manner consistent with the traditional customs, ethics, values, and mores of the society:

a. With empathy and goodwill toward others, like and different from oneself.
b. With consideration of the rights of others (without becoming a burden on society or inhibiting others' rights).
c. With effort to do one's best.
d. With integrity and honesty.
e. With intent to live a productive, useful life.
f. With willingness to accept responsibility for personal behavior.
g. With intent to protect, defend, and improve society and its institutions.

Establish and Pursue Worthwhile Goals

Implied here is that intelligent, ethical action will be taken (1) to select areas of interest or desired accomplishment and (2) to develop one's knowledge and skills to achieve desired goals. The qualifier "worthwhile" is somewhat redundant, because if such goals are identified through intelligent, *ethical* action, they are likely to be selected with consideration of and interest in the well-being of self and others. The word is included for emphasis.

Generally, personal goals, rather than being in areas different from the tasks expected of all members of society, are really *extensions* of them. They are based primarily on particular individual interests and abilities, rather than on societal expectations. An analysis of this context (Figure 2), therefore, is essentially the same as the previous one but with a slight change of focus from *required* task accomplishment to *self-selected* task accomplishment.

The most extreme implementation of the ICI Curriculum Model would require doing away with the traditional subjects of science, social studies, and so on, and replacing them with such subjects as Economic Self-Sufficiency, Intellectual Self-Enhancement, Participation in Functioning Society. A more moderate approach would be to retain the current subject areas but to use the student characteristics as the basis for selection of content and the way it is taught. For example, a high school biology course curriculum would be developed around the goal of students becoming prepared to contribute to the well-being of the living things in their environment. Students would be assessed accordingly—that is, they would be required to demonstrate that they have learned how to *use* certain knowledge and skills, rather than that they have simply acquired them. And isn't that, after all, what we *really* want curriculum to achieve?

NOTE

[1]The entire ICI Curriculum Model, too lengthy to include here, contains confirmation tasks, criteria, and standards for assessing student progress toward achievement of the intended outcome.

REFERENCE

Ehrenberg, S. D., and M. A. Lyle (1978). *A Strategy for Curriculum Design—The ICI Model.* Coshocton, Ohio: Institute for Curriculum and Instruction, pp. 44–50.

3

Thinking in Context: Teaching for Openmindedness and Critical Understanding

Shelley Berman

Solutions to the significant problems facing modern society demand a widespread, qualitative improvement in thinking and understanding. We are slowly and painfully becoming aware that such diverse contemporary challenges as energy, population, the environment, employment, health, psychological well-being of individuals and meaningful education of our youth are not being met by the mere accumulation of more data or the expenditure of more time, energy or money. In view of the increasing pressures imposed on our society by these problems, many responsible thinkers have realized that we cannot sit back and hope for some technological invention to cure our social ills. We need a breakthrough in the quality of thinking employed both by decision-makers at all levels of society and by each of us in our daily affairs.

—Robert Ornstein

Many programs teach thinking as a set of isolated skills. The skill-oriented thinking programs often assume that students will draw upon these skills to improve the way they think through a problem. Although these individual skills are useful in themselves, thinking is more than developing a collection of isolated skills; it is an integrative process that happens when one is confronted with a real problem. Building isolated skills does not necessarily mean that one will be able to think well in the context of a real situation. The debate surrounding these two approaches to teaching thinking is analogous to the whole-language versus basic skills debate surrounding the teaching of reading.

During the past eight years of working with teachers and students to develop students' critical thinking abilities and their openmindedness, Educators for Social Responsibility has developed what could be called a "whole-language" approach to thinking. What we want to encourage is a love of thinking, an ability to reflect on one's thinking and be open to new ideas, an interest in contributing one's thinking to help others and to improve society, and the courage to think through the most difficult and complex problems. Although there is merit and utility in teaching component skills, the art and love of thinking are best nurtured holistically in the context of meaningful problems.

The Vehicle for Teaching Thinking: Participation in Meaningful Problems

As an organization, ESR began by exploring the question of how we can best help students develop a sense of social responsibility—that is, a personal investment in the well-being of others and of the planet—and encourage their confidence that they can make a difference. We observed, and recent research confirmed, that young people are finding it increasingly difficult to assume a sense of social responsibility and to believe that they can create a better world (Bachman 1975–1986; People for the American Way 1989). The world's problems—destruction of the environment; issues of social injustice, hunger, and homelessness on a mass scale; the nuclear threat; drug abuse; and violence—seem overwhelming to them. Many feel powerless and are cynical about the future. They believe that the odds of solving these problems are slim, the personal costs of participation are high, the disappointments inevitable.

The powerlessness students feel is exacerbated by their lack of preparation in the thinking skills necessary to understand the complexity of these issues, their root causes, and the many divergent points of view about solutions. The result is that they often either withdraw from active participation in our society or fall prey to simple and inadequate solutions to complex problems. We found, however, that when we used a particular methodology with issues of real concern to students, students not only acquired these thinking skills, but also developed a sense of their own power to influence change.

The key qualities that made this methodology work were that the problems were meaningful to students and their decisions were translated into some form of action. Lawrence Kohlberg found this to be true in the area of moral development. After years of presenting students with fictional moral dilemmas in order to foster moral development, Kohlberg shifted to an approach he found far more effective—setting up "just communities" in schools where students confronted the real moral dilemmas of day-to-day school life (Kohlberg 1985). Similarly, the development of thinking skills is far more effective when students' thinking is challenged by real problems and real decisions. These can be classroom issues that are raised at a class meeting, curriculum content that is meaningfully related to the students' lives or to the larger society, or global issues about which students express concern.

A thinking skills curriculum is not a special add-on. It uses the opportunities already existing in the classroom and the curriculum, but uses them in a new way. The basic strategy is to involve students in making decisions about circumstances that affect their lives or the lives of others. For example, the classroom can provide an excellent context for decision making by involving students in the ongoing decisions involving classroom management—class rules or guidelines, classroom appearance, homework policies, and interpersonal behavior and conflict. Although this is most easily done through class meetings in the elementary grades, a number of high school teachers have had their students write a constitution for the class, thinking through the issues of rights and responsibilities, authority and power, and structure and discipline. They then use this constitution as a vehicle to think through problems that emerged throughout the year.

The curriculum also provides numerous opportunities. Several middle school math teachers who are working with ESR on new curriculum materials are experimenting with teaching thinking in mathematics by focusing on how numbers are used, and misused, in the political process and involving students in social issues where they can consider the implications of statistical data. Many science teachers have integrated the consideration of science-related social issues so that students can understand basic science concepts in the context of implications for society. In one elementary school, students had expressed concern about starvation in Africa, and this topic became the focus of the social studies curriculum for the year, with students not only studying Africa and hunger, but making decisions about how they could best help and what actions they would take.

This "thinking in context" gives students the opportunity to use their thinking purposefully and to experience the consequences of their decisions. Yet equally important to dealing with real problems and real decisions is the way we work with young people's thinking. Because ESR's focus has been holistic in nature, we have developed a methodology that teachers can use in their classrooms to nurture the ability to think clearly and independently. Because it is a "whole-language" approach, ESR's methodology is more about *how* we teach than *what* we teach. We believe that specific skill instruction as outlined in many of the other thinking skills programs can be useful within this larger context.

An Empowering Methodology

Underlying the methodology outlined below is a basic principle: **Students will feel more confident in their thinking and become more skilled when their thinking is valued and taken seriously, and when their thinking makes a difference by improving their own lives or by influencing or helping others.** The following nine strategies build on this principle and encourage students' confidence and empowerment. These strategies have been used by teachers to create an environment that effectively nurtures students' thinking abilities. Like the classroom and teaching changes that are entailed in cooperative learning, this approach to teaching takes time, attention, and practice. As we have learned from the work in cooperative learning, it is far easier to describe what needs to be done than it is to put this methodology into practice. To support the implementation of this approach, ESR has been providing individual teachers, schools, and school districts with inservice and summer institute opportunities.

Strategy 1: Create a Safe Environment

Students cannot develop their thinking abilities unless they feel safe. They need to know that they can share their feelings and their thoughts without being ridiculed. They need to know that they can take risks, and even make mistakes, without feeling embarrassed. This safety allows students to put their energy into exploration rather than spending it being overcautious, self-conscious, and defensive. A safe classroom does not mean a risk-free classroom. In fact, within the context of a safe environment, students can and should be encouraged to take risks.

There are many ways to create the experience of a safe classroom. Building a sense of the class as a community, providing clear structure and goals, acknowledging and affirming risk taking, and demonstrating that classroom conflicts can be resolved equitably are only a few of these. One of the best ways of creating an environment that provides safety but also encourages risk taking is to involve students in collaboratively setting guidelines for the class and monitoring how well the class is working together.

In my own classes, I begin the year by asking students, "What guidelines could we establish for ourselves that would not only make this a productive class, but would also make this a safe place for people to share what they are thinking and feeling, and a safe place for people to make mistakes and learn from them?" The guidelines that emerge are ones we continually refer to throughout the year to make sure that we have a trusting, supportive, and productive environment. The discussions that result as we monitor our work together provide opportunities for students to resolve conflicts, think through problem situations, participate in making decisions that have an impact on the classroom, assume responsibility for their own behavior, and build a sense of community and shared values.

Strategy 2: Follow Students' Thinking

Thinking skills develop as students make explicit their ways of thinking, hear alternative ways of thinking, and reflect on their thinking; therefore, the focus of our attention should not be on teaching students to think in a particular way, but on helping them explore and reflect on thinking processes they already use. As teachers, our challenge is to come to understand the way students are making sense of things, the logic they are using, and the sources of information they are drawing upon. As we understand these ways of thinking and make them explicit to a class, students can begin to choose those styles that seem most effective.

A 2nd grade teacher taught me a simple and effective way of following students' thinking that I later used in my high school social studies classes. She began each unit by asking students to brainstorm the answers to four questions —"What do you know about this? What do you think you know but are not sure about? Where did you get your information? What questions do you have?"—and then structured the unit around the questions the students indicated were most pressing for them. Teaching this way not only helped me understand my students better, but developed in them a respect for their knowledge, their thinking ability, and their power to guide their learning.

There are numerous ways that we can create an atmosphere that allows students to reflect on their own thinking. We can talk with them about how they can distinguish good thinking from poor thinking and work with them to set such standards as incisiveness, coherence, and openmindedness. We can have students keep thinking journals in which they note and reflect on their thinking. We can have reflective writing times in class. We can allow open-ended time in class for students to talk about their thoughts and reactions to the topic being considered. We can ask them to consider such self-reflective questions as, "How do we know what we know about this?" and "What are the biases in the way we are socialized and in what we are told about this?" In my classes, I set aside a time called "connections" to communicate that this is a time for people to talk about the connections they are making with the subject material and the insights they have been having about their own thinking processes. The goal of all these is to make the thinking process explicit and available for review and examination.

Strategy 3: Encourage Collaborative Thinking

We tend to think about thinking as an internal and individual process, yet we know from the studies of creativity and from the field of organizational development that new ideas often emerge out of collaborative processes. Vera John-Steiner (1985) found that individual creativity was built on the scaffolding of collegial interactions. Just as we need to teach students how to think clearly and independently, we need to teach them how to think collaboratively. Whether we use brainstorming, synectics, cooperative activities, or any of a variety of discussion techniques, we need to help students learn how to submit ideas for group consideration, build on each other's ideas, and come to consensus on the ideas that seem most productive, coherent, attractive, and so on. But we can also take the additional step of processing these conversations with students so that they can better understand how people contribute to the thinking of the group.

Strategy 4: Teach the Questions Rather than the Answers

Critical thinking skills rest on our ability to ask incisive and penetrating questions that get beneath the surface of a topic and reveal its complexity and subtlety. Developing this skill means paying close attention to students' questions and modeling questioning ourselves. We teach questioning by giving students the opportunity to articulate their questions. By talking about and categorizing these questions, the class then collectively hones them into broader and deeper questions. As mentioned in strategy 2, allowing students' questions to guide instruction is another powerful tool for teaching them how to ask good questions.

But we also need to help them ask the hardest questions, those that get at underlying assumptions, root causes, and internal contradictions, and those that ask students to examine their own beliefs and attitudes. If we encourage this deeper level of questioning, we will begin to hear students question things we often take for granted. Adolescents, especially, see the contradictions we have justified or ignored and ask us about the integrity of our beliefs and questions. They question beliefs and practices we may accept, such as nationalism, capitalism, religion, patriarchy, and the like. This questioning is not only natural but important because they are really attempting to create a coherent belief system for themselves. They are essentially asking if there is the possibility of living with integrity in their own lives. Although we should not dismiss any question, we do not need to answer all these questions. We can acknowledge the importance of the question and encourage students to explore it for themselves as deeply as possible.

Strategy 5: Teach About Interconnectedness

During the last two decades we have become far more conscious of our social and ecological interdependence. We have begun to see things less in a cause-effect or linear mode and more in a systems mode. Systems thinking[1] is a distinctly different way of thinking. It views situations holistically, examines the interconnections between parts of a system, and looks for interventions that can have a corrective influence on the system as a whole. Rather than focusing on one cause and one effect, it focuses on a continual stream of cause-effects, with effects becoming new causes in other parts of a loop that goes back on itself. Taking a systems perspective gives students an appreciation for interdependence and helps them explore problems much more comprehensively. They can also begin to see their role in the systems they are part of and appreciate more fully the consequences of their actions on others.

Strategy 6: Present and Have Students Enter Multiple Perspectives

One of the most important means of helping students reflect on their own thinking is to have them listen to and appreciate alternative perspectives. Entering the perspective of another is difficult, especially if it is in conflict with our own. In those situations we tend to listen in ways that discount other points of view. Imagine, for example, attending a series of lectures on a controversial topic. If the speakers present positions with which we agree, we tend to listen for the cogent arguments they present—almost as if we were building our own case in preparation for our next debate with a friend or colleague. When we listen to someone with whom we disagree, on the other hand, we listen for the flaws in logic, the misinformation, and the things left unsaid. By listening this way we only affirm our own positions.

Our challenge is to help students reach beyond the limits of their own experience and enter the experience of others. To accomplish this, ESR has adapted Peter Elbow's (1983) technique for teaching writing, called methodological belief. In the last four years, I have had the opportunity to use methodological belief in teaching about controversial issues. Prior to any criticism of various positions on the issue, I ask students to suspend their disbelief temporarily and to attempt to understand how advocates of each position view the problem. We then try to identify the truth in each position with which we can all agree. At first it is very difficult for students to allow themselves to try to appreciate positions with which, in reality, they disagree. With each successive perspective we take, however, the issues becomes more complex and the "right" answer less clear. Each position becomes a personal statement of the truth as one individual sees it. Examining each position from the perspective of the person holding it personalizes the position and makes it more available for consideration. The emphasis on looking for common agreements allows students to find some new paths to their own answers.

The work of William Perry (1968) on the forms of ethical and intellectual development and the work of Robert Selman (1980) on perspective taking are particularly revealing in how powerful and productive this effort can be. Perry, in his study of students confronted with multiple, competing perspectives, found that students moved from either/or thinking through relativism to a commitment to a point of view with an openness to change. Selman, who studies interpersonal perspective taking, found that by teaching perspective-taking skills students could move from egocentric and impulsive interpersonal negotiation strategies to mutual and collaborative strategies.

Entering the perspective of others compels us to tolerate ambiguity and to be continually open to change. This does not mean that we avoid taking positions, but that we take them knowing that we must allow for the possibility that we may be wrong. It does not mean that we lack criticalness or ethical standards, but that through our humility and openness we are able to evaluate and act in situations of social conflict with compassion and insight.

Strategy 7: Build on Sensibilities

When we place our primary focus on thinking, we tend to forget that thinking, feeling, and intuition are not separate but integrated. In fact, it is our feeling that something is wrong that often moves us to think about it. When teaching thinking to students we need to help them pay attention to intuition, to feelings, and to ethical considerations. We need to ask them not only how they think about something, but how it feels to them. We want to nurture a trust of that intuitive sense that something is or isn't right.

Strategy 8: Help Students Set Standards and Work from a Positive Vision of the Future

We need standards by which to measure the product of our thinking and we can help students construct these measures. In dealing with a conflict situation, students could consider the criteria for a good outcome. In dealing with a social or political issue, students could consider how people one hundred years from now would be affected by their recommendations. In dealing with a classroom decision, students could consider its impact on them years later or its impact on the school as a whole. These standards not only help students evaluate their own thinking, but help them consider and construct a positive vision of what they would like the future to be.

Strategy 9: Provide Students with Opportunities for Acting on Their Thinking

Thinking remains abstract until it is embodied in action. Through observing the impact of their actions, students experience the power and quality of their thinking. The feedback they get allows them to further refine their thinking. Student projects and presentations and students teaching other students what they have learned are typical ways that we can have students act on their own knowledge. If we are building a relationship between what we teach and the larger social and political environment, students can also be appropriately involved in taking actions on classroom, school, community, national, or global problems. This kind of social action/community service effort is empowering to young people because it calls on them to contribute their talents and care to helping others and creating a better environment for everyone.

These actions need to be learning opportunities integrated into the curriculum so that they can see and learn from the feedback they get. If students are tackling a classroom problem the actions they take may have a highly visible impact and offer them direct feedback. If, on the other hand, students choose to tackle such larger social or global issues as the environment or hunger, it is important that the actions they take be specific and concrete, possibly local in nature, so that they can track their impact. Above all, it is not appropriate for teachers to enlist students in their own positions or causes. Propagandistic education only leads to compliance, not conviction and commitment. The causes need to be ones that come from the concerns of the students and the actions need to be the result of their thinking and planning.

Not all actions will end well. Students will make mistakes. Sometimes the issue will be too large for them to see their impact. Yet in taking action, even in these circumstances, they begin to understand the complexity of problem situations and experience themselves as part of the larger network of people who are helping to create a better world.

Providing opportunities to contribute and have influence not only improves the quality of their thinking, but builds self-esteem and a sense of connection with the world around them. It demonstrates that their thinking is valued and that what they think can make a difference.

Qualities of Mind: Critique and Synthesis

In working with students' thinking ability, we have observed that students develop both critical understanding and openmindedness. We have come to identify these two elements as two complementary qualities of mind—critique and synthesis. I call these qualities of mind because each takes on a different frame of reference, approach, and attitude. Our goal in working with young people's thinking is to help them develop both of these qualities. And we can track our success by how well students are able to draw upon both of these qualities.

When we think of the critical thinker, it is very likely that we see an individual, at heart doubting, cautious, and logical, who approaches information with intelligent skepticism about the truth. The critical thinker stands apart from the world, evaluating, assessing, judging. The world appears polarized into competing ideas and interests, each of which is incomplete. Some of these ideas are right and some are wrong; and through the process of questioning, the critical thinker finds the inaccuracy and faulty logic in any position, as well as its valid points. The critical thinker discerns the truth by looking carefully through the close-up lens of logic.

The intelligence of critical thinkers is measured by their skill in dissecting arguments or "knowledge claims" in order to truly understand them, in searching for hidden meanings and assumptions, in comparing the arguments to what is known in order to examine their validity, and in making sure the information is logically consistent. Intelligence, in the critical mode of thinking, means discernment, discrimination, penetration, and precision in logical thought.

But there are vulnerabilities to the critical quality of mind. Because of its skepticism, it tends to question new information with far greater rigor than it questions already held positions and benefits. A classic example of this in classroom practice is, in fact, the formal debate—a superb tool for stimulating critical analysis. Each side submits its own best thinking and defends it against challenges. Each side searches for flaws and weaknesses in the other side's position. Yet in the end, each side usually remains as convinced of its original position as when it started. Through the process of debate, often the differences are highlighted and the issue is polarized. Each side stands in its solitary "rightness," closed to other alternatives. Each side has affirmed its strength in opposition to the other's point of view.

Critique is familiar to us. In fact, this skeptical and questioning attitude is the prominent one in our culture. Yet the skeptical side of thinking illuminates only part of the picture. By its nature, it encourages disbelief rather than empathy, debate rather than collaboration. It stresses the use of the close-up lens of logic rather than the wide-angled lens of vision and imagination.

The less familiar quality of mind, and therefore the more difficult to teach, is synthesis—the ability to draw connections and take larger and larger perspectives. It is a process that combines the disparate elements of a variety of positions or arguments into new and higher forms. It finds ways that ideas, elements within a system, or positions are interrelated. It looks for increasingly larger systems of organization and ways those systems affect one another. Rather than closing in on a narrowly focused critique, it seeks to broaden the focus and enlarge the vision.

Synthesis thinking focuses on interrelationships. The world is seen as a complicated network, open in nature and changing in character. Synthesis thinking assumes that all knowledge is limited. It assumes that each of us has a "window" on the truth and that we need to look through each other's windows as well as our own in order to broaden our understanding of that truth. Synthesis thinking seeks to find the value in each position or idea irrespective of its "rightness" or "wrongness." Essentially, synthesis thinkers look for common agreements as well as differences. They are open to new information, new points of view, and new experiences in order to enlarge their perspectives. Intuition, imagination, and an ability to conceptualize relationships among systems are important tools. The lens through which synthesis thinkers view the world is a wide-angled lens.

The critical and synthesis qualities, therefore, employ different but complementary skills. Critical thinking stresses logic, dissection, and organization along linear or hierarchical lines; synthesis stresses integrative, global, intuitive, and creative thinking. Critical thinking encourages skepticism; synthesis encourages openness to new and different ideas. Both can work together in judicious harmony. Through the methodology outlined above both are nurtured.

Putting the Methodology into Practice

Although many teachers already use some of these strategies, many find that this is a new approach to classroom instruction. Using it well means taking time to learn about and practice these strategies. It also means modeling critical questioning and openmindedness for students.

To help teachers become better able to use these strategies, ESR has created a wide range of professional development programs. These include in-depth inservice programs for schools or school districts, day-long seminars, and week-long summer institutes that are open to all educators. Because modeling is so important in learning, our professional development programs are structured to not only teach about these strategies, but to put them into practice in the course of the program. For more information on ESR's professional development opportunities, you can contact us at 23 Garden Street, Cambridge, MA 02138, (617) 492-1764.

The Context for Thinking

Just as the first strategy for developing thinking was to create a safe classroom environment, we have to realize that the structure and climate of our schools produce their own "hidden curriculum" that influences the cultivation of thinking skills. Are students' contributions to the school welcomed and valued? Do students participate in the problems and decisions of the school community? Does the curriculum of the school place the school in an ongoing relationship with the local community and the larger world? Is the faculty encouraged to think together and work together? Is the thinking of teachers valued and do teachers have an influence on school decision making? As I indicated earlier, students will feel more confident in their thinking and become more skilled when their thinking is valued and taken seriously, and when their thinking makes a difference by improving their own lives or by influencing or helping others. Likewise, teachers will teach thinking more effectively when their own thinking is valued and taken seriously. To effectively nurture thinking, we may need to change the way we think about our schools. Rather than see them as vehicles for producing some end product, we need to see them as participatory communities in themselves. They also need to be safe, collaborative environments.

A true community is a group of people who acknowledge their interconnectedness, have a sense of their common purpose, respect their differences, share in group decision making and responsibility for the actions of the group, and support each other's growth. Classrooms and schools can be communities of this kind, but it takes time, intention, and new forms of shared leadership. Schools that are healthy communities can more effectively foster thinking skills because they offer natural opportunities for "thinking in context."

Note

[1]For more information on systems thinking and the use of systems dynamics in education, contact Dan Proctor, Systems Dynamics Project, Boston Area ESR, 11 Garden Street, Cambridge, MA 02138.

References

Bachman, J. (1975–1986). *Monitoring the Future*. Ann Arbor: University of Michigan.

Elbow, P. (April 1983). "Critical Thinking is Not Enough." A speech delivered as the Reninger Lecture at the University of Northern Iowa. Available through ESR, 23 Garden Street, Cambridge, MA 02138.

Kohlberg, L. (1985). "The Just Community Approach to Moral Education in Theory and Practice." In *Moral Education: Theory and Application*, edited by M. Berkowitz and F. Oser. Hillsdale, N.J.: Lawrence Erlbaum.

John-Steiner, V. (1985). *Notebooks of the Mind*. Albuquerque, N.M.: University of New Mexico Press.

People for the American Way. (1989). *Democracy's Next Generation: A Study of Youth and Teachers*. Washington, D.C.: People for the American Way (2000 M St., NW, Suite 400).

Perry, W. G. (1968). *Forms of Intellectual and Ethical Development in the College Years*. New York: Holt, Reinhart and Winston.

Selman, R. (1980). *The Growth of Interpersonal Understanding: Developmental and Clinical Analysis*. New York: Academic Press.

Useful Resources for Thinking in Context

Berman, S., ed. (1984). *The Participation Series*. Cambridge, Mass.: Educators for Social Responsibility.

Berman, S., ed. (1983). *Perspectives: A Teaching Guide to Concepts of Peace*. Cambridge, Mass.: Educators for Social Responsibility.

Community Board Program. (1988). *Conflict Resolution: A Secondary School Curriculum*. San Francisco: The Community Board Program.

Kreidler, W. (1984). *Creative Conflict Resolution*. Glenview, Ill.: Scott Foresman.

Schniedewind, N., and E. Davidson. (1987). *Cooperative Learning, Cooperative Lives*. Dubuque, Iowa: William C. Brown.

Schniedewind, N., and E. Davidson. (1983). *Open Minds to Equality*. Englewood Cliffs, N.J.: Prentice-Hall.

4

Crossroads in American Education: A Summary of Findings from the Nation's Report Card

Arthur N. Applebee, Judith A. Langer, and Ina V. S. Mullis

Where there is no vision, the people perish.

—Proverbs

Since 1969, the National Assessment of Educational Progress (NAEP) has conducted regular surveys of student proficiency in a range of subjects. Some 1.4 million students from across the grades have participated in the assessments to date.[1]

Findings from recent NAEP assessments provide evidence of progress in students' academic achievement. Results from the 1984 and 1986 assessments indicate that, on the average, students' proficiency in reading has improved across time, and proficiency in writing, mathematics, and science has improved in recent assessments after earlier declines. Despite these positive signs, the remaining challenges are many. Not all ground lost during the 1970s and early '80s has been regained, and there was considerable concern even at the time of the first assessments about the quality of student learning. In addition, a closer examination of the NAEP data indicates that recent gains in student performance have occurred primarily at the lower levels of achievement. For example, students have improved in their ability to do simple computation, comprehend simple text, and exhibit knowledge of everyday science facts. But too few students develop the capacity to use the knowledge and skills they acquire in school for thoughtful or innovative purposes. And too few students learn to reason effectively about information from the subjects they study.

Overall, the NAEP data suggest that American education is at a crossroads. While academic achievement appears to be improving after years of decline, the continuing lack of growth in higher-level skills suggests that more fundamental changes in curriculum and instruction may be needed in order to produce more substantive improvements. The educational system in this country needs to extend its focus from the teaching and learning of skills and content to include an emphasis on the *purposeful use* of skills and knowledge.

Most teachers take a relatively traditional approach to instruction, relying heavily on classroom presentations, textbooks, and workbook- or teacher-prepared exercises. While such techniques have helped many students attain basic levels of proficiency in each subject area, they have not been as successful in helping students achieve higher levels of performance. For these qualitatively different gains to occur, the goals of instruction need to be reconsidered. Teaching decisions were once guided by a hierarchy suggest-

This chapter is an excerpt from *Crossroads in American Education*. The full report (No. 17-OV-01) can be obtained from the National Assessment of Educational Progress, Educational Testing Service, P.O. Box 6710, Princeton, NJ 08541 for $9.00 including shipping and handling.

ing that students must first learn the facts and skills and later learn to apply them. Yet many educators now recognize the limitations of this stepping-stone view of education. Education theory and research suggest a different pattern of generative teaching and learning, where learning content and procedures and how to use this learning for specific purposes occur interactively (Heath 1983; Langer and Applebee 1986; Vygotsky 1987). Students learn information, rules, and routines while learning to think about how they operate in the context of particular goals and challenges in their own lives. When students engage in activities that require them to use new learning, both their knowledge of content and skills and their ability to use them develop productively together.

For more thoughtful learning to occur, teachers need to orchestrate a broader range of instructional experiences than they presently use in order to provide students with opportunities to prepare for, review, and extend their new learning. Such activities might include, but not be limited to, the whole-class discussions, workbooks, and dittos that prevail today. Discussion teams, cooperative work groups, individual learning logs, computer networking, and other activities that engage students as active learners need to be added, and perhaps even predominate. To use these new approaches, teachers need to move away from traditional authoritarian roles and take on the role of guide. At the same time, they need to require that students cease being passive recipients of learning and become doers and thinkers instead. Some examples of this alternative mode of instruction can be found in current discussions of small-group problem-solving experiences, collaborative learning, activity-based learning, and instructional scaffolding (Cohen 1986; Langer and Applebee 1986; Resnick 1987).

Since tests and grades send messages to students about what is valued in their course work, the focus of tests also needs to shift. Instead of simply displaying their knowledge of facts and rules, students need to show that they can think about and use their knowledge. A number of alternative assessment procedures have been suggested. For example, in course work, portfolios of selected work, simulations, problems, or cases can be used as the basis for assessing students' knowledge and abilities.

In short, extensive modifications in curriculum and instruction may be required to expand the range of learning experiences available to students and to help them develop both content knowledge and the ability to reason effectively about what they know—skills that are essential if they are to take an intelligent part in the worlds of life and work. These modifications will undoubtedly be difficult, requiring changes in established procedures and traditions in the curriculum and in systems of evaluation. They will involve the reshaping of current notions of the goals of instruction, the roles of teachers and students, the language of instruction, the nature of instructional activities and materials, the signposts teachers use to know that they have been successful in their profession, and the evidence that policymakers, administrators, parents, and the general public use to know that schools are doing their job and students are learning.

Educators everywhere have the opportunity to use the NAEP results to great advantage—by reflecting on the deeply entrenched beliefs, policies, and behaviors that impede the very changes we wish to make and by setting a charted course for change.

NOTE

[1]Detailed information on sampling, number and types of items, and derivation of scales is presented in each subject area report. The *Crossroads* report is based primarily on the following NAEP reports: *The Reading Report Card, Progress Toward Excellence in Our Schools: Trends in Reading Over Four National Assessments, 1971–1984* (1985); A. N. Applebee, J. A. Langer, and I. V. S. Mullis, *The Writing Report Card: Writing Achievement in American Schools* (1986); J. A. Dossey, I. V. S. Mullis, M. M. Lindquist, and D. L. Chambers, *The Mathematics Report Card: Are We Measuring Up? Trends and Achievement Based on the 1986 National Assessment* (1988); I. V. S. Mullis and L. B. Jenkins, *The Science Report Card: Elements of Risk and Recovery* (1988). The following reports are also referenced: A. N. Applebee, J. A. Langer, and I. V. S. Mullis, *Writing Trends Across the Decade* (1986); A. N. Applebee, J. A. Langer, and I. V. S. Mullis, *Literature and U.S. History: The Instructional Experience and Factual Knowledge of High-School Juniors* (1987); M. E. Martinez and N. A. Mead, *Computer Competence: The First National Assessment* (1988).

REFERENCES

Cohen, E. (1986). *Designing Group Work: Strategies for the Heterogeneous Classroom*. New York: Teachers College Press.
Heath, S. B. (1983). *Ways with Words*. Cambridge: University Press.
Langer, J. A., and A. N. Applebee. (1986). "Reading and Writing Instruction: Toward a Theory of Teaching and Learning." *Review of Research in Education* 13: 171–94.
Resnick, L. (1987). *Education and Learning to Think*. Washington, D.C.: National Academy Press.
Vygotsky, L. (1987). *Thought and Language*. Cambridge: The MIT Press.

PART II

Creating School Conditions for Thinking

We should be teaching students how to think; instead we are primarily teaching them what to think.

—Jack Lochhead

To install thinking as a valid goal of education, the many components of the educational system must be tuned to work harmoniously. Years of experience with major efforts to improve educational practices demonstrate the ineffectiveness of change when these components are not "in sync." Materials of instruction, staff development, adopted curriculum, supervisory processes, evaluation measures, communiction with parents, and so forth, must all be aligned and focused on a common goal. Recent school effectiveness studies demonstrate the benefits when they are.

If teachers, parents, administrators, board members, and the community adopted thinking as a basic goal of education, the communitywide emphasis would be exhibited in several ways.

- Instructional materials would be developed and adopted based on their contributions to developing thinking.
- Teachers would be planning lessons together, coaching each other, collecting data for each other about their skills in teaching thinking, how they are getting better at it, and the effects on improved student thinking.
- School districts would examine their criteria for hiring new staff, their processes for selecting instructional materials, their communication and decision-making processes for determining how such policies and practices contribute to enhancing intellectual growth.
- Discipline, school organization, assessment, newsletters, and other communications as well as other such practices would be examined to determine their contribution to communicating thinking as a goal of educaiton.
- Supervisory personnel would be trained to recognize and evaluate the contributions of certain instructional practices to intellectual development.
- Staff development would be provided on how to describe, teach, and assess thinking.
- Problem solving would be discussed and debated in faculty, parent, and board meetings.
- Monies would be allocated to increase thinking skills programs.
- Community groups would complain that schools are not teaching enough thinking skills.
- Systems would be developed and installed to monitor and assess students' growth in thinking.
- Parent education would be provided to foster and support thinking at home.
- Incentives and rewards would be given to teachers, students, and administrators who excel in their use of intelligent behaviors.

In Part II, we examine some of these components.

5

A Call for Staff Development

James A. Bellanca

It must be remembered that the purpose of education is not to fill the minds of students with facts . . . it is to teach them to think, if that is possible, and always to think for themselves.

—Robert Hutchins

"I'd like you to give our faculty an inservice on thinking skills," the caller said. "This will be our inservice kickoff for the year."

Having received several similar phone requests in the past year, I interjected my questions. "When you say 'kickoff,' do you mean you're starting an extended inservice training program that will help your faculty develop new teaching methods?"

"Oh, no. We don't have time for that. We just want you to give one of those short, inspirational speeches for our first-day institute."

I needed more information. "Is there a reason you have selected the thinking skills topic?" I asked.

"Oh, yes. Our superintendent attended a conference and liked the thinking skills workshop best. Besides, a lot of the other curriculum directors in our area are talking about the importance of students' learning to think better."

A few more questions and my worst fears about faddish inservice were confirmed. "I'm sorry," I said. "I can't accept your invitation."

The caller's "Oh" was followed by a moment of silence. "Is there a special reason?" he asked.

"Yes," I responded. "There are several reasons. If you have the time, I'd be happy to outline them for you."

"Please do."

"First," I began, "in my nine years of working with the research on effective staff development, I've learned that most one-shot inservices are a waste of time and money—for me, for you, and for the teachers. I can sympathize with the teachers' need for energy builders and a district's need to introduce new ideas into a school, but the one-shot does not do that thoroughly or cost-effectively."

"But we have the superintendent's commitment. Surely that will motivate some faculty to adopt your ideas."

"Yes," I agreed. "The superintendent's support is essential. My concern is more basic."

"I don't know what you mean."

"Let me illustrate. I have a friend who is the superintendent of a 17-school district. She views her job as the district seer. She wants to predict the kind of education students in the district will need for success after graduation. She keeps her ear tuned closely to emerging issues, parental concerns, and educational developments. When a question of importance arises, such as 'Do our students know how to use computers?' or 'Are our reading scores up to snuff?' she avoids becoming what Naisbitt might call a 'fad maker,' an administrator who give a top-down, hastily conceived directive. Instead, she gathers principals and teachers together to study the issues and make a recommendation. She weighs that recommendation against other district priorities."

"But that could take months," objected the caller.

"I agree, and those months are necessary. If we are talking about meeting students' needs, we are talking about improving instruction. The one-shot inservice is planned quickly and as quickly forgotten. If we want to avoid reinforcing a 'This too shall pass' attitude about thinking skills, or any curriculum revision, the first requirement is the superintendent's commitment to a clear, well-conceived goal, not to a quick-fix fad."

"I don't see the distinction."

"Let me clarify. My friend is a good model. Recently she identified thinking skills as an important concern. She selected a task force and instructed this committee to assess what the district was already doing with thinking skills. Next, she outlined what she wanted within a set time, which was:

1. A recommendation on how the district could best improve students' thinking skills in the next three to five years.

2. A list of barriers that might impede progress.

3. Specific steps necessary to reach specific goals.

4. Timelines.

5. A proposed budget.

6. A description of responsibilities for everyone involved in implementing the process.

"In addition, she provided funds for the committee so that members could visit schools that had operational thinking skills programs, attend pertinent workshops, review materials, and gather other helpful information."

"That sounds expensive for a committee report."

"That may be true," I said, "especially if the committee recommends killing the idea. If not, consider the benefits."

"I see the point. She built in expertise on thinking skills, informed a committed leadership group, and brought about a strategic plan with definite implementation tactics—and probably spent less money than I would have paid for your inspirational speech."

"Exactly," I responded. "And that is why I resist one-shot inservices, however neatly packaged they might be. A district or school that studies the trend is ready to use its staff development money to cause *real and lasting improvement* in thinking skills; a district that rushes in on a whim gets hooked into the *fad*."

"I see," said the caller, "but I'm not sure what happens if the committee says 'Go.' "

"Then," I said, "it's time for some sales work. My friend, aided by her task force, devised a plan for the school board, the PTA, and local union leadership. She concentrated on three elements: what she wanted to see students doing differently after three years; what administrators and teachers would be doing differently; and what it would cost in time, resources, and money."

"The old bugaboos!"

"I prefer to call them the marketing realities of school improvement. If we want a solid, well-conceived, and successful thinking skills program, bearing the expense is an essential part."

"And time," said the caller.

"Yes," I added. "It takes well-spent time to build a good foundation. A good idea without a solid strategic plan will collapse."

"How much time are you proposing?"

"In the case I've been describing, about three hours work for the committee."

"Did their strategies work?"

"Yes, as they usuallay do. Even though the school board asked hard-money questions, as did union leaders."

"Can you be more specific? What was approved? Did the district get everything it requested?"

"I'll take the last question first," I said. "The committee didn't get all it requested. I've yet to see that happen. However, the substance of the recommendation remained intact."

"And what was that?"

"First, the plan focused on student outcomes. One example was 'Given the teachers' improved methods for developing thinking skills, the students would demonstrate significant gains on the New Jersey Test of Reasoning.'"

"Was there a reason for using that specific test?"

"Yes. While the committee described several assessment techniques, they knew the board would also want statistical measures. After reviewing several different instruments, the task force agreed that this test could be used to evaluate the measurable outcomes of their planned program."

"And those were . . ."

The Operating Philosophy

"The committee endorsed the premise that *all* students, even those in special education, could move toward intelligent thought, could solve increasingly complex problems, and could apply new skills to other content areas."

"What other bases did the committee establish?"

"Two others. First, the committee set the expectation that *all* staff—administrators, teachers, and support persons—could improve their own capabilities as thinkers and teachers of thinking. Second, they were convinced that a clear, schoolwide purpose, understood by all, was important to this project."

"I agree. One or two enthusiasts working alone does not make a winning team."

"That is why this basic operating philosophy is important. They didn't want thinking skills to be another 'addition' to the curriculum. They wanted to see thinking skills integrated into what was already being done, and they wanted staff development to support this approach."

"What did they propose?"

"First, a K–12 curriculum that included a hierarchy of thinking skills."

"Can you give me an example?"

"Yes," I replied. "In the primary grades, the curriculum would introduce students to observing, sequencing, patterning, finding likenesses and differences, grouping, naming, attribute shifting, basic predicting, and goal setting. In middle school, the curriculum would reinforce the basic thinking skills by moving the youngsters from concrete examples to more abstract concept formation; teachers would introduce problem identification, cause-effect analysis, solution design, and outcome prediction. In high school, the curriculum would call for students to practice their skills, master a variety of problem-solving processes, and tackle rudiments of inductive and deductive logic."

"But haven't schools always taught these skills and processes?"

"Indirectly, yes. But for the most part assessment data showed that only individual teachers here and there recognized what mental operations students were using—whether, for example, they were identifying patterns or identifying likenesses. The students used the skills, but they were often unaware of *how* they arrived at their conclusions."

"Is that so wrong?"

"It's not wrong, only limiting. When students are not aware of how they are thinking, they cannot formalize the skill; they can only react to a situation. They cannot elicit the principle governing the situation. As a result, they seldom transfer thinking skills learned in one context, such as math, to other subject areas. Worse yet, they fail to develop the concepts about thinking that could help them improve how well they think."

"Thinking about thinking? That is called metacognition, isn't it?"

"Yes. And labeling is an important first step in preparing students to think about their thinking."

"That seems sensible. What I don't understand is why you listed so few skills processes."

"You have a sharp eye. The list was restricted purposefully."

"Why?"

"The committee was looking for quality, not quantity. It saw no benefit in adding a host of skills to be covered. To prevent both the overload factor and the curriculum race syndrome, the committee argued for selected skills to be well taught at each grade level, carefully reinforced, and thoroughly transferred."

"How do you mean 'well taught'?"

Questioning Skills as Prerequisites

"We hear much talk about students acquiring *higher-level thinking* skills. We know this occurs most successfully when a teacher uses *higher-order teaching* skills. For instance, asking students questions that demand complex responses—not just the simple recall of information—requires sophisticated teaching skills. Teachers must use very refined questioning skills to draw out and extend responses, especially from reluctant learners."

"Are you saying, then, that every teacher must be a skilled questioner?"

"If we expect every student to become a capable thinker, yes. The teacher's questioning skills are a prerequisite to better thinking."

"I am familiar with a variety of prepackaged thinking skills programs. Do they demand such skilled teaching?"

"Not all do. The poorest are no more than glossy mimeo worksheets. When a teacher floods the room with worksheets, the students may fill in the blanks and boxes without much thought, play games, or dawdle the time away. The best programs recognize that the development of thinking skills and the mastery of problem-solving processes depend on how teachers set up the activity and guide the discussion that follows. Whether the curriculum is prepackaged or devised by the district, the teacher's skill in asking questions and explicitly teaching thinking skills will determine the degree of the program's success."

"That seems so obvious."

"In theory, yes; in practice the purple plague of mindless, duplicated worksheets is more common."

"In other words, you are saying that just as it takes more skill to cook a souffle than a hamburger, it takes more skill to lead an inquiry lesson than it takes to teach a direct-instruction lesson."

"Yes. As long as you understand that the best teachers do both well, I would argue that good inquiry teaching is more difficult."

Measures of Success

"Suppose we structure the type of inquiry program you describe. Will we increase student achievement by the end of the year?"

"Probably not. One year is too short a time for such results. However, you could easily measure increased teacher knowledge, skill, and use of inquiry in the classroom—increased student participation, more thoughtful student behavior, and a greater value accorded thinking by all. By assessing those elements first, you could predict meaningful achievement increases in two or three years."

"That gives me a sense of relief."

"How so?"

"I was trying to think how we could do what you are suggesting. I'm now seeing the difference between the quick fix and mastery curriculum. You're asking us to integrate a formal thinking skills program. It would highlight a limited number of essential skills, emphasize transfer of those skills, and train teachers to spend more time helping students to apply their new skills and less time 'covering' material."

"Precisely. Most traditional curriculums give short shrift to teaching for transfer. Rather than introducing a multitude of thinking skills in each grade, it is more practical in each grade to introduce no more than six micro-thinking skills.

More time should be spent helping students transfer the skills to their content areas and practicing previously learned skills by positive reinforcement and metacognitive discussion."

"I see. You value depth over breadth in teaching skills."

"Yes. Rather than an empty emphasis on coverage, I want each teacher to focus on an outcome—the students' use of the skill."

"You are saying, then, that teaching for transfer, along with inquiry skills, is a mark of the more skilled teacher?"

"Yes, and so is the teacher's ability to use metacognitive strategies."

"I understand the term metacognition, but what are metacognitive strategies?"

"They are teaching strategies, used regularly and consistently by the teacher, that promote metacognition. Art Costa outlined the most productive metacognitive strategies in *Educational Leadership* (Costa 1984)."

"Can you give me some examples?"

"Yes. When teachers explain to students that the lesson objective is a specific thinking skill, ask extending questions, or have students map their thinking patterns, they are promoting metacognition."

"Those procedures don't sound difficult."

"They aren't. The challenge comes in the teachers' discipline and finesse in causing students to examine how they think."

"Discipline?"

"Yes. Discipline is required to design a lesson that not only covers course content, such as science or literature, but integrates thinking skills, too. Planning this lesson will require that teachers take time to isolate the desired level of thinking, model the thinking skill, structure the thinking experience, question so that all students are involved, and encourage transfer of the skill to other academic areas."

"Can you give an example?"

"Yes. Suppose that Mrs. Fuller intends to introduce induction to her composition students. Her curriculum guide provides the Sherlock Holmes Mystery Student activity. In this activity, she plans a series of 'what if' questions. Knowing that she has some students who need extra focus time, she structures her questions using small-group whip-a-round. Every student in each group will answer at least twice. She'll follow this with a random report from each group. Each new idea will be listed on the board, and she'll ask students to attempt generalizations about the specific ideas. This will lead to her explanation and definition of induction and the posting of her objective: 'You will apply the inductive process to the writing of an essay about induction.' Because she knows that this is a complex objective, she encourages student questions."

"I see what you mean about time and discipline. I have teachers who would resist having to go to all that trouble."

"And that is why I would also argue they will have less success than Mrs. Fuller in teaching students how to think."

"Let me play the devil's advocate for my teachers by asking, 'Why not just give the definition and explain with some examples? The capable thinkers will get it; the others won't anyway.'"

"Ah, but remember our original expectation. Our intention is to improve the thinking capacity of all students. That cannot happen if we take the easy route of doling out information for the few. Furthermore, I'd question how well even the best students increase their capacity to think by memorizing definitions and examples. Mrs. Fuller took great care to motivate every student not just to memorize facts, but actually to start thinking inductively. She structured the Sherlock Holmes activity to keep it going. Only when she was sure her students knew where they were going and why did she give precise instructions for the activity. In groups of three, students searched for planted clues around the classroom. After ten minutes, each group pooled its finds and formed hunches about the items. As students reported their hunches, Mrs. Fuller extended the thinking with clarifying and probing questions. Gradually, groups began to exchange clues, searching for patterns until they finally discovered the answers."

"That must have taken a lot more time than a lecture."

"You don't know the half of it—Mrs. Fuller continued with a metacognitive discussion. She asked each group to recall the thinking steps used to reach the final conclusion. She asked the groups to contrast the patterns; and as they listed their patterns on the blackboard, she helped them recognize the differences in the approaches each had used, places where thinking hit dead ends, and processes that lead to the sound conclusions they ultimately drew. She concluded the lesson by asking each student to use the 'Thinking Journal' to compose a personal definition of induction along with an 'I learned' statement."

"And that was the end?"

"Of that two-period lesson, yes. Mrs Fuller followed the basic lesson with shorter practices—another Sherlock Holmes activity to accompany a short story, another activity for a magazine article, and a third using the students' world history text. Each of the practice lessons was designed to promote transfer of the concept introduced in the first lesson. What could have more utility than transfer through related coursework? After the social studies lesson, Mrs. Fuller finally pulled all the pieces together with a biology text assignment and take-home newspaper assignment. The latter also served as the test, which revealed how well she had succeeded with *all* the students."

Hierarchy of Teaching Skills

"Now I understand your emphasis on the more advanced skills needed to teach thinking skills. However, I wouldn't know where to begin to develop my staff."

"First, think about a hierarchy of teaching skills."

"Similar to the hierarchy of thinking skills?"

"Yes. First, there are the skills needed by a teacher to be effective with basic instruction: classroom management, lesson design, and learning theory."

"The methods of effective teaching."

"Yes. The concepts and methods that researchers have confirmed as the basics of quality instruction. However, they are only a starting point."

"What's next on your hierarchy?"

"Next is what I call the enabling behaviors. These are the teaching skills that enable all students to increase the quantity of active thinking in the classroom."

"What are some examples?"

"First, I'd go to the research. There I'd find wait time, equal distribution of student responses, selective reinforcement, equal cueing and encouragement, and the other strategies leading to equal opportunity to respond to questions."

"To promote the quantity of thinking, you are suggesting an approach similar to the Teacher Expectations and Student Achievement (TESA) behaviors."

"Yes, these enabling behaviors are simple but powerful tools that get amazing results. Without these enablers, the classroom is not a hospitable environment for good inquiry."

"Beyond basic teaching skills and enabling behaviors, what?"

"Quality. I'd move up a step in our teaching hierarchy to the metacognitive and transfer strategies. From there, I want to see the teacher helping students acquire more complex thinking skills, use the skills to develop more abstract concepts, and apply the skills for analytic and creative problem solving."

"If our district develops a thinking skills curriculum of this hierarchy of teaching skills, what should follow?"

"First, a needs assessment would identify the basic, enabling, and advanced skills each teacher uses successfully. A written test and classroom observations take care of this. Next, you would use the needs data to teach any additional skills needed."

"That sounds easy enough."

"Don't be fooled. I can predict two difficulties. First, your teachers are used to the one-shot inservice. Second, you have always encouraged your teachers to identify and correct their own problems. They may balk at a focused program. If you want to model the 'thinking' approach, the design of your workshop will differ radically from past practices. The approach I recommend determines needs based on district priorities, observations, and in a sense, required inservice over an extended period of time."

"I see no problem there. Our district is committed to the idea of personal and school improvement. Also, I wouldn't gain any support for any ideas by asserting that there is something wrong with our teachers. I'd want an incentive program to concentrate on individual and school improvement rather than punitive measures, and as I see it, your hierarchy of teaching skills allows for an infinite scale of improvement. In contrast with the proscriptive repair of the 'medical model'—something's really wrong—the hierarchy of teaching skills presents improvement in a more positive light."

"I like your analysis."

Workable Workshop Design

"On the other hand, I'm not clear what you mean by a *radically* different workshop design. Our teachers are impatient with any workshop that doesn't produce immediate results."

"The way to do that is through the workshop design that 'walks its talk.' "

"Walks its talk?"

"Yes. Adults learning new ways to instruct students will grasp the content best from a model that demonstrates exactly what it teaches."

"Be more specific."

"Surely. Imagine that your desired outcome for the workshop is to have teachers identify situations in which they might use the enabling skills. Let me picture for you a design that will accomplish this objective." I then described the design shown on Figure 1.

"That is a very thorough and active design. I notice that the lesson not only teaches about the enablers, but demonstrates their use and promotes transfer."

"You are right on target. Moreover, this design allows for the trainers to introduce behavior coaching and peer support teams."

"What do you mean?"

Sustaining Workshop Momentum

"If you are familiar with the best practices on effective staff development, you will recall that chances for the teachers to adopt newly learned skills increase dramatically if they observe each other using the skills and discuss their mutual experiences."

"Yes, but our teachers resist anyone coming into their classrooms to observe."

FIGURE 1
Workshop Design Utilizing Enabling Skills

Focus: 1. "How many teachers remember the Lone Ranger?"
"Who can recall his horse's name? His companion's name?"
"How is the story line of that serial similar to TV soaps such as *Dallas*?"

2. "Explain how soap opera writers use the morphological grid to motivate their own divergent thinking."

Objective: To motivate divergent thinking so that we will explore new combinations of ideas.

Task: Develop a modern soap opera.

Instructions: 1. You are members of a TV production team assigned to develop a new soap opera for the networks. Observe your grid:

	Male Lead	*Female Lead*	*Third Party*	*Action*	*Scene*	*Result*
1)						
2)						
3)						
4)						
5)						
6)						
7)						
8)						
9)						
10)						

2. All brainstorm, column by column.

3. Take the last six digits of a randomly selected phone number and check the items.

4. In groups of three, use the elements to create a story line. Read select examples.

Objective: Apply the above process.

Task: Each group creates a grid similar to the one above for the following task areas:
1) Writing a short story.
2) Discovering a new ______________________.
3) Applying the scientific method.
4) Solving a math problem.
5) Promoting a new college loan program.
6) Building a house.

Instructions: Identify the variables (no more than six) for the top line of the grid. For instance, you might have the following variables for creating a lesson design: *Objective, Information, Activity, Discussion, Closure.*

Discussion: In your classroom, list some ways you might use the grid to promote divergent thinking among students. What are some other ways to promote divergent thinking? What are the advantages of using this approach with students? Disadvantages? How can divergent thinking help your students?

Closing Activity: Select one example from the discussion above and prepare a lesson for students. Use all the design elements previously learned in this workshop.

"I would, too, if the norms were the same as you have described in your system. Change the norms from the medical model you dislike. The positive improvement model you described earlier replaces 'We're going to fix up your bad teaching' with 'Let's help each other get even better.' "

"I guess I can't argue that point, but it won't be easy."

"Quality staff development is never easy."

"Did all this really work in your friend's district?"

"Yes, with a great deal of thought, planning, and hard work. The committee suggested that grade-level teams already working on curriculums receive the first training on thinking skills. In the first semester, they used the district's scheduled inservice time plus their monthly committee time for workshops in the enabling behaviors, microskills, and problem-solving models. The workshops included guided practice, peer feedback, and specific lesson planning to use new skills. With principals' help, team members scheduled peer observations and feedback sessions between each workshop."

"How did that work?"

"Very well. In addition to giving the teams a deeper understanding of the skills, a cadre was prepared to pilot the new curriculum and prepare assessment tools for colleagues. Also, each individual's development program was personalized. Thinking skills training, matched to individual needs, recognized what teachers already could do and thus did not teach skills to teachers who already had them. The old inoculation approach gave way to focused training, and both time and dollars were saved. Each teacher's program included input, cooperative practice, observation, feedback, and coaching so that teachers could achieve their own desired improvement targets."

"This all sounds great, but this exact model may not work in our district."

"I agree. Each district, even each building, is unique. Rather than slavishly copying any example of a thinking skills program, it's important that you follow a problem-solving process that adjusts your needs to your district's goals."

"To paraphrase *My Fair Lady*, I think I've got it."

"Let me check it out with you."

Looking Back, Looking Ahead

"First, we need to establish district goals for thinking skills instruction. The goals should clarify our definition, our assumptions, and our expectations.

"Second, we must identify the specific micro-thinking skills for each grade and build a cohesive thinking skills curriculum. We could use a leadership committee to do this.

"Next, we need to design lessons to teach each microskill. If we emphasize teaching the microskills with guided practice that helps students apply them, we will do better than if we overpack a curriculum stressing massive content coverage.

"Fourth we need to ascertain each teacher's ability to use the teaching behaviors that heighten student mastery of thinking skills.

"Fifth, we must design multilevel staff development programs that ensure that all faculties blend the basic instructional skills, the enablers, and the metacognitive and transfer strategies into their content lessons.

"Last, we must add coaching and clinical supervision to ensure high transfer of thinking skills instruction into classroom practices. Our instructional lessons should model the inductive approach, allowing extensive time for focused questioning, metacognitive analysis, and activities to promote transfer."

"That is a thorough summary. You have identified the main points I wanted to make."

"Thank you. I'll happily trade my one-shot mentality for your better process, a sound thinking skills program based on systematic staff development."

REFERENCE

Costa, A. (November 1984). "Mediating the Metacognitive." *Educational Leadership* 42, 3: 57–62.

6

Effective Staff Development Practices for Higher-Order Thinking

Joseph Onosko and Robert B. Stevenson

Commitment to a mission! That is the crucial key to peak performance.

—Charles Garfield

Teachers have been urged to devote more attention to enhancing students' ability to reason, to create, to solve problems—in short, to think. Staff development can encourage and instruct teachers in this endeavor. We know from long experience, however, that traditional one- and two-day workshops that present packaged materials and programs have little substantial impact (Fullan 1982). Instead, research seems to indicate that if fundamental change is to occur, teachers require more intense, ongoing technical assistance (Fullan 1985; McLaughlin and Marsh 1978; Stevenson 1987).

The key question is what kinds of assistance are most likely to help teachers promote higher-order thinking? To answer this question, we decided to interview authorities with extensive experience in helping high school teachers increase their emphasis on higher-order thinking.

Following a national search in which more than 100 respected staff developers were nominated, 25 persons were selected to participate. Their professional affiliations included colleges and universities, state and local education agencies, as well as schools and special projects. In two written questionnaires and two lengthy telephone interviews, participants discussed in detail their most effective staff development effort to improve teachers' ability to promote higher-order thinking. In most of these programs, teachers' training time was equivalent to at least six eight-hour days.

Five Effective Strategies

Although diverse perspectives were offered, staff developers commonly mentioned five strategies for promoting higher-order thinking:

1. *Help teachers analyze and develop a conceptualization of thinking.* By working toward an articulated conception of thinking, teachers can be stimulated to reconsider their instructional goals. For example, an understanding of the characteristics and dispositions of good thinkers can move teachers from a rigid emphasis on content acquisition to a more balanced approach that acknowledges the importance of thinking processes and skills. In addition, the conceptualization that emerges provides a common language for teachers to discuss their efforts with colleagues.

2. *Model specific instructional strategies for promoting student thinking.* Modeling instructional strategies (whether in workshops, on videotape, or in teachers' classrooms) enables teachers to see specific alternatives to traditional methods such as lecture and recitation. When strategies are demonstrated with students (especially the teacher's own), teachers gain confidence not only in the specific strategies used, but also in their students' ability to engage in higher-order thinking.

3. *Provide opportunities for teachers to practice and discuss instructional strategies.* Demonstrating and discussing lesson presentations among peers allows teachers to

ERIC

receive constructive feedback and recognition. Demonstrations can take place in teachers' own classrooms or in workshops where fellow participants role-play students, or teachers can bring videotapes of their classroom teaching to workshop sessions. Given the traditional isolation and lack of adult interaction in teachers' work, these opportunities are important for fostering collegiality and commitment to a common goal.

4. *Provide time for teachers to discuss workshop ideas and techniques and to formulate classroom applications.* Discussion time enables participants to review newly introduced ideas and techniques, brainstorm applications to their own classrooms, and later share their experiences in trying out the ideas and techniques in their own classrooms. Dialogue and reflection are essential if teachers are to successfully incorporate new ideas into their own practices.

5. *Engage teachers in higher-order thinking, such as authentic problem solving, in their subject areas.* Encourage teachers to reflect on and analyze their own thinking in trying to solve a challenging problem, either individually or in small groups. Such problems might include mental puzzles, controversial public issues, or simulated decision-making exercises. The intent is to stimulate teachers' enthusiasm for thinking as an instructional goal, develop self-confidence in their own ability to think, and help them become more conscious of the kinds of thinking they wish to promote.

Exemplary Programs

The following descriptions of two exemplary staff development programs illustrate more concretely how the strategies and activities recommended by our authorities were put into practice.

Program 1

This program was implemented in a district with two high schools over a three-year period. Six full-day workshop sessions were held the first year, involving 16 teachers and 2 administrators. In addition, the developer observed and discussed two lessons with each teacher. During the summer after year one, workshop participants and the developer met to focus on specific district needs, set up long-range strategies and goals, and prepared a budget to meet those needs. In the second year, the staff developer encouraged teacher ownership of the change effort by leading the first four workshop sessions with 16 new teachers, and then observed as four teachers from the previous year conducted the remaining two sessions. Classroom observations of teachers and follow-up discussions continued in the second year.

In the final year, the developer conducted five full-day sessions with instructional supervisors from the district, while the previously trained district teachers assumed full command of the six teacher workshop sessions with a third group of 16 peers. For each session, substitute teachers were hired to cover the classes of workshop participants. Teachers who served as workshop leaders received a summer stipend for their planning efforts and were occasionally freed from classroom assignments to prepare for an upcoming workshop session.

Over the course of intervention, the developer tried to (a) foster teachers' metacognition, problem solving, and critical thinking; (b) heighten teachers' awareness of students' thinking; (c) develop teachers' conception of thinking; (d) model instructional strategies that promote thinking; (e) have teachers conduct thinking oriented lessons with students; (f) modify administrators' "commanding mode" of supervision; and (g) create greater collegiality and interdependence between teachers.

The developer defined metacognition, presented research showing its importance, and modeled for teachers the way he thought through certain problems. To minimize teacher defensiveness and facilitate openness in sharing ideas, he invited criticism of his own thinking and at times intentionally exhibited flawed thinking. He assigned paired problem-solving tasks in which teachers shared their thinking with a peer. He also presented and discussed classroom strategies to promote students' metacognition, problem solving, and critical thinking.

To heighten their awareness of students' thinking and to develop their conceptions of thinking, teachers read Glatthorn and Baron's (1985) "The Good Thinker." Teachers were to look for the suggested attributes in their students and then, in the following workshop session, discuss their observations. Other articles from the conceptual literature on thinking were read and discussed. Teachers were asked to administer the Cornell Thinking Test Level X and an ideational fluency test (e.g., if it never stopped snowing what would happen?) to their students and then analyze the results. The test items themselves and discussion of results were used by teachers to help them identify specific needs and conceptualize instructional goals.

Between workshop sessions, teachers designed and conducted thinking oriented lessons in their classrooms. Successes and failures were discussed during workshops, explanations were offered for failed attempts, and suggestions were made for future efforts. Later in the year, teachers brought audiotaped lessons to workshop sessions. In small groups, teachers listened to lessons, analyzed them, and made suggestions for improvement. On a voluntary basis near the end of the year, teachers brought videotaped lessons to workshop sessions for observation and review. In addition, throughout the year the staff developer observed two live or videotaped lessons of each workshop participant and spent a minimum of one hour in post-observation discussion. In some cases, the teacher and developer reviewed the lesson on videotape during the debriefing; otherwise, tapes were left for teachers' later viewing.

Finally, in five full-day sessions with administrators and supervisors, the staff developer discussed observation and lesson debriefing objectives and techniques and general ways to ensure the continued success of the thinking program. The developer also observed supervisors in their post-observation discussions with teachers. Supervisor and developer then met separately to discuss the supervisor's approach

Program 2

This intervention also began with support from the district administration. The ultimate goal was to deepen students' understanding of the various subject areas by infusing the instruction of thinking skills and the promotion of dispositions into the curriculum. The central strategy was to help teachers think more critically about their subjects and teaching by offering a conceptual understanding of thinking and classroom techniques to promote students' thinking.

The developer worked individually for three days with a district teacher who had attended the developer's national training program in critical thinking the previous summer and who was to serve as the district facilitator during and after the developer's six workshop sessions in the fall. A group of 24 teachers were released from their classroom assignments every other Thursday during a two-month period to attend the all-day sessions. Teams of two teachers represented each of the district's schools and were later to serve as facilitators trainers in their respective buildings during the summer and following academic year. Three follow-up sessions took place in the spring (one full-day and two half-day) to help prepare the 24 workshop participants for their future infusion efforts and to allow them to discuss their own efforts at instruction for thinking since the fall sessions.

The six fall workshop sessions challenged teachers to execute a thinking skill (and in the process to observe a method of instruction), analyze it through readings and follow-up discussions, practice the skill as students would be asked to do, and, finally, develop an action plan for teaching the skill to their own students prior to the next workshop. Skills highlighted included making inferences recognizing assumptions, identifying sound versus fallacious reasoning, drawing conclusions, identifying an argument's structure, seeking evidence, and using language precisely. In two of the sessions, discussion also focused on the importance of cultivating dispositions important to effective thinking (i.e., reflectiveness, flexibility, intellectual curiosity, confidence in one's thinking, persistence, a thirst for reasons, respect for other viewpoints) and issues and methods in the assessment of critical thinking. In the final fall session, each teacher made a 15-minute presentation to the group (followed by 10 minutes of discussion/critique) illustrating an application of a strategy to develop and enhance students' critical thinking. This could be a demonstration lesson, a description of a sample lesson to be used in their own upcoming training efforts, or the presentation of audio-visual materials designed for classroom use.

The following summary of a workshop on "analyzing arguments" shows the kinds of activities that occurred during each of the six training sessions. Teachers began the day by discussing their classroom efforts in teaching the previous session's skill training on sound versus fallacious reasoning. Successes and failures were analyzed, and suggestions were made for future efforts. Teachers then rearranged themselves in groups of five to six for a small-group task on analyzing arguments. They were to identify which of the passages on a handout were arguments and which were other types of information or statements. For each passage identified as an argument, they were to identify premises and conclusions. During small-group discussion, teachers could refer to a previously assigned reading by Nickerson (1986) that outlined elements of an argument. The activity concluded with the developer reading aloud a current newspaper editorial and teachers identifying premises and conclusions and evaluating the merits of the editorial's argument based on the supporting reasons offered. The teachers and the developer then completed similar activities for identifying and evaluating supporting premises and assessing an argument's validity by determining whether conclusions follow logically from the premises. The day's work concluded with teachers devising ways to incorporate the analysis of arguments into their instructional plans for the coming week.

The workshop session offered teachers a conceptual understanding of argument analysis through the Nickerson reading and the classroom activities. While placed in the role of thinker (i.e., identifying an argument's premises, conclusions, and reasons), teachers also observed instructional techniques used by the developer to promote thinking. Finally, teachers were able to talk with one another at the end of the session to assimilate workshop ideas and brainstorm methods of implementation into their own classes. Teachers knew that the ensuing session would begin with a debriefing regarding their own efforts to teach analysis of argument.

* * *

The five strategies we have outlined represent th e kinds of ongoing assistance needed to help teachers develop the technical skills for promoting higher-order thinking. As our developers emphasized, however, there are substantial organizational barriers to successful long-term change in teachers' practices. The two programs summarized above illustrate some of the organizational forms of support (e.g., long-term district commitment to the effort, release time to develop and attend workshops, paid summer planning time) that are essential for successful interventions. In other words, not only are improvements required in staff development practices, but organizational changes are also needed to facilitate and support a professional culture that encourages rather than suppresses teaching for higher-order thinking.

REFERENCES

Fullan, M. (1982). *The Meaning of Educational Change.* New York: Teachers College Press.

Fullan, M. (January 1985). "Change Processes and Strategies at the Local Level." *Elementary School Journal* 85: 391–421.

Glatthorn, A., and J. Baron. (1985). "The Good Thinker." In *Developing Minds: A Resource Book for Teaching Thinking.* 1st ed. Alexandria, Va.: Association for Supervision and Curriculum Development.

McLaughlin, M. W., and D. D. Marsh (1978). "Staff Development and School Change." *Teachers College Record* 80, 1: 69–94.

Nickerson, R. S. (1986). *Reflections on Reasoning.* Hillsdale, N.J.: Lawrence Erlbaum.

Stevenson, R. B. (1987). "Staff Development for Effective Secondary Schools: A Synthesis of Research." *Teaching and Teacher Education,* 3, 3: 233–248.

7

Teaching For, Of, and About Thinking

Arthur L. Costa

Ron Brandt's editorial in the September 1984 issue of *Educational Leadership* is one of the most helpful organizers for the teaching of thinking that I've found. He discusses a balanced, three-part program, which I interpret as follows.

Teaching FOR Thinking

Many authors and psychologists believe that children learn to think long before they come to school and that educators need to create the conditions for their natural, human inclination to think to emerge and develop. Indeed, Hart (1975) believes that schools are "brain incompatible." In their studies of creativity, Ghiselin (1955) and Gardner (1982) find that what young children do prior to entering school and what practicing scientists and artists do is more similar than anything that goes on in between.

Teaching for thinking simply means that teachers and administrators examine and strive to create school and classroom conditions that are conductive to children's thinking. This means that:

1. Teachers *pose problems, raise questions*, and intervene with paradoxes, dilemmas, and discrepancies that students can try to resolve.

2. Teachers and administrators *structure* the school environment for thinking—value it, make time for it, secure support materials, and evaluate growth in it.

3. Teachers and administrators *respond* to students' ideas in such a way as to maintain a school and classroom climate that creates trust, allows risk taking, and is experimental, creative, and positive. This requires listening to students' and each other's ideas, remaining nonjudgmental, and having rich data sources.

4. Teachers, administrators, and other adults in the school environment *model* the behaviors of thinking that are desired in students.

Accomplishing all of the above alone would go far in encouraging students to use their native intelligence. However, there's more. Students haven't learned to think yet.

Teaching OF Thinking

Most authors and developers of major cognitive curriculum projects agree that direct instruction in thinking skills is imperative. Beyer, de Bono, Feuerstein, Lipman, and Whimbey would probably agree on at least one point: the teaching of thinking requires teachers to instruct students directly in the process of thinking. Even Perkins (1981) believes that creativity can be taught—by design.

This does not mean that a curriculum program must be purchased, inserviced, and installed. While this is surely a viable option and should be considered, there are other ways of teaching students thinking skills: analyzing the subject areas or skills being taught in the normal curriculum for their prerequisite cognitive abilities and then teaching those skills directly, for example. The act of decoding in reading requires analysis, comparison, making analogies, inferring, synthesizing, and evaluating. Teaching of thinking, therefore, means that these cognitive skills are taught *directly* as part of the reading (decoding) program.

Critical thinking skills might be taught directly during a social studies unit on the election process. Steps in problem solving might be taught directly during math and science instruction. The qualities of fluency and metaphorical thinking might be taught directly during creative writing, and so forth. Creating conditions for thinking and teaching it directly

FIGURE 1
Staff Development Matrix for Thinking Skills

Levels of Skill Development	**I. Teaching For Thinking:** Creating school and classroom conditions conducive to full cognitive development	**II. Teaching Of Thinking:** Instructing students in the skills and strategies directly or implementing one or more programs	**III. Teaching About Thinking:** Helping students become aware of their own and others' cognitive processes and their use in real-life situations and problems
A. Awareness Developed by lectures, readings, witnessing demonstrations, and so on	I A	II A	III A
B. Knowledge and Comprehension Developed by modeling, practicing, comparing, discussing, interacting	I B	II B	III B
C. Mastery of Skills Developed by practicing with feedback and coaching	I C	II C	III C
D. Application Developed by extended use across subject areas, varieties of groups, demonstrations; critique and dialogue with others	I D	II D	III D
E. Trainer of Trainers Developed by creating, conducting, and critiquing inservice strategies; observing the training of other trainers	I E	II E	III E

are excellent procedures, but what about the application? Nothing yet has been taught about the transference of these thinking skills beyond the context in which they were learned. Students may be able to identify the steps in the problem-solving process and correctly distinguish between classification and categorization, but do they have any inclination to use these skills in real-life situations? There's more.

Teaching ABOUT Thinking

Teaching about thinking can be divided into at least three components: brain functioning, metacognition, and epistemic cognition.

1. *Brain functioning*. Neurobiological research has shed light on how our brains work. Teaching about thinking would include investigating such curiosities as: How do we think? How does memory work? What causes emotions? Why do we dream? How do we learn? How and why do mental disorders occur? What happens when part of the brain is damaged? Restak's *The Brain* (1979), Ornstein and Thompson's *The Amazing Brain* (1984), and Russell's *The Brain Book* (1979) are sources of information. The public television series entitled "The Brain" is also an excellent resource and is available for use in schools.

2. *Metacognition*. Being conscious of our own thinking and problem solving while thinking is known as metacognition. It is a uniquely human ability occurring in the neocortex of the brain. Good problem solvers plan a course of action before they begin a task, monitor themselves while executing that plan, back up or adjust the plan consciously, and evaluate themselves upon completion.

Metacognition in the classroom might be characterized by having discussions with students about what is going on inside their heads while they're thinking; comparing different students' approaches to problem solving and decision making; identifying what is known, what needs to be known, and how to produce that knowledge; or having students think aloud while solving problems.

FIGURE 2
I. Teaching FOR Thinking

Intersection	Competencies of Teachers
I A	Is aware of different levels of questions and various ways of organizing the classroom for instruction. Can describe alternative ways of responding so as to maintain and extend students' thinking.
I B	Plans lessons to incorporate levels of questions, response behaviors, and classroom organization for thinking. Seeks assistance, advice from others in methods and materials for teaching thinking.
I C	Invites others to observe a lesson, then to give feedback about questioning skills, classroom organization, and response behaviors Volunteers to do the same for colleagues.
I D	Incorporates thinking skills across subject areas. Devotes maximum time to teaching for thinking. Shares ideas and materials with colleagues. Strives to model rational thinking processes in own behavior.
I E	Conducts inservice for colleagues. Videotapes own lessons and shares with colleagues. Plans, conducts, and evaluates staff development strategies. Analyzes school and classroom conditions for their conduciveness to and modeling of thinking. Works to improve them.

FIGURE 3
II. Teaching OF Thinking

Intersection	Competencies of Teachers
II A	Is aware of various programs intended to teach thinking directly. Is aware of definitions and distinctions among various thinking skills and strategies.
II B	Employs lessons intended to directly teach thinking skills. Incorporates thinking skills into content areas. Attends training in a curriculum program intended to teach thinking directly.
II C	Invites others to observe and give feedback about lessons in which thinking is taught directly. Applies knowledge learned in training programs to instruction. Devotes two to three hours per week to teaching thinking directly.
II D	Distinguishes among several major curriculums intended to teach thinking. Diagnoses students' cognitive deficiencies and provides experiences to remediate them. Analyzes the cognitive skills prerequisite for students to master school subjects, and incorporates instruction in those skills.
II E	Develops and implements inservice training in one or more of the major curriculum programs. Trains others in the development of lesson plans incorporating direct instruction of thinking skills and strategies. Surveys and recommends adoption of instructional materials that enhance thinking skills.

Metacognitive instruction would include learning how to learn; how to study for a test; how to use strategies of question asking before during, and after reading. It might include knowing how you learn best—visually, auditorily, or kinesthetically—and what strategies to use when you find yourself in a situation that does not match your best learning modality.

Metacognition is discussed more extensively later in this book. See also Costa 1984.

3. *Epistemic cognition*. Epistemology is the study of how knowledge is produced. In the curriculum it might include studying the lives, processes, and works of great composers, artists, scientists, and philosophers. Epistemological questions for discussion include:

- How does what scientists do differ from what artists do?
- What are the procedures of inquiry used by anthropologists as they live with and study a culture?
- What goes on inside a maestro's mind as he or she conducts an orchestra?
- What was it about Mozart's genius that allowed him to hear a total musical composition before writing it down?
- What process do poets use to create?
- Why can't we use processes of scientific inquiry to solve social problems?

FIGURE 4
III. Teaching ABOUT Thinking

Intersection	Competencies of Teachers
III A	Is aware of differences in modality strengths, learning styles, and brain functioning. Can define such terms as metacognition and epistemology.
III B	Attempts metacognitive discussions with students. Discusses how the brain works. Selects materials on brain functioning and biographies of famous scientists and artists in an attempt to intrigue students.
III C	Invites colleagues to observe a lesson involving a philosophical/epistemological discussion and seeks feedback as to ways to improve. Reads and attends courses and lectures, watches video programs on philosophy, cognition, brain functioning, and so on. Di cusses differences in learning strengths and modalities with students.
III D	Selects materials and conducts lessons in which comparisons are made of strategic reasoning, knowledge production, and creativity. Discusses with students such topics as artificial intelligence, the analysis of propaganda, and strategies of learning. Models metacognition overtly in the presence of students.
III E	Develops, conducts, and evaluates inservice strategies for colleagues for instruction on brain functioning, learning style differences, and metacognition. Develops curriculum incorporating materials and learning activities intended to have students learn to think and learn about thinking. Designs assessment tools and techniques to gather evidence of students' growth in intelligent behaviors.

Epistemic cognition is the study and comparison of great artists, scientists, and scholars and the differential processes of investigation, inquiry, and creativity that underlie their productivity. Lipman's Philosophy for Children program is especially well suited for this. Other resources include Perkins' *The Mind's Best Work* (1981), Madigan and Elwood's *Brainstorms and Thunderbolts: How Creative Genius Works* (1983), and Gardner's *Art, Mind, and Brain* (1982).

Installing a Program for Thinking

Installing a program of teaching for thinking does not happen overnight. It takes time, patience, and practice. Joyce and Showers (1988) have created a helpful paradigm for thinking about the steps and sequences in staff development efforts. They suggest a series of stages and levels of concern through which teachers proceed during the change process. Their procedure includes inservice techniques that help teachers raise their skill development levels in using new skills and behaviors.

The matrix for staff development presented in Figure 1 combines two components—*teaching for, of, and about thinking* and *the levels of skill development*. Figures 2, 3, and 4 provide examples of teacher competencies, skills, and knowledge as indicators of what might be included at each intersection in the matrix. Please consider these examples merely as helpful starting points to which you can add your own indicators of competence.

REFERENCES

Brandt, R. (September 1984). "Teaching of Thinking, for Thinking, About Thinking." *Educational Leadership* 42, 1: 3.

Costa, A. L. (November 1984). "Mediating the Metacognitive." *Educational Leadership* 42, 3: 57–62.

Gardner, H. (1982). *Art, Mind, and Brain*. New York: Basic Books.

Ghiselin, B., ed. (1955). *The Creative Process*. New York: Mentor Books.

Hart, L. (1975). *Human Brain and Human Learning*. New York: Longman.

Joyce, B., and B. Showers. (1988). *Student Achievement Through Staff Development*. New York: Longman.

Madigan, C., and A. Elwood. (1983). *Brainstorms and Thunderbolts. How Creative Genius Works*. New York: Macmillan.

Ornstein, R., and R. F. Thompson. (1984). *The Amazing Brain*. Boston: Houghton Mifflin.

Perkins, D. (1981). *The Mind's Best Work*. Cambridge, Mass.: Harvard University Press.

Restak, R. (1979). *The Brain: The Last Frontier*. New York: Warner Books.

Russell, P. (1979). *The Brain Book*. New York: E. P. Dutton.

8

The Principal's Role in Enhancing Thinking Skills

Arthur L. Costa

Principals are the gatekeepers of change. Unless they support a project it seldom works.

—Berman and McLaughlin (1975)

School effectiveness research supports what many educators intuitively know: the principal has a strong influence on the curriculum implemented, the instructional strategies employed, and thus, on student achievement.

Nationwide efforts to infuse thinking skills into the curriculum, to include them in instructional strategies, and to assess schools' success in teaching thinking are capturing the attention and energies of boards of education, curriculum committees, and departments of education. Obviously, the role of principals in this endeavor is critical. Their behaviors are symbolic for staff members, students, and the community.

This chapter clarifies the principal's role and suggests how principals can exert their crucial influence in enhancing students' full intellectual functioning and development. Principals can approach this goal by (1) creating intellectually stimulating school conditions for staff and students, (2) using available resources to support a cognitive curriculum, and (3) modeling rational practices.

Creating Intellectually Stimulating School Conditions

If teachers are expected to teach for thinking, they need an environment in which their intellectual processes are stimulated. One role of the principal, therefore, is to create a school atmosphere that invites teachers' highest intellectual functioning (Sprinthall and Theis-Sprinthall 1983). There are many ways principals can create intellectually stimulating environments. For instance, they can:

1. *Involve teachers, parents, and students in decision making.* Teachers in effective schools have opportunities to participate in making decisions that affect them. Mandates from above are among the greatest deterrents to thinking. Principals must encourage, facilitate, and protect teachers' rights to:

- Pursue self-studies,
- Develop goals,
- Plan personal staff development,
- Prioritize which thinking skills to emphasize,
- Select their own instructional materials,
- Invent methods to determine their own effectiveness,
- Determine indicators of student growth, and
- Share and suggest solutions to problems.

As teachers participate in making decisions that affect them, the likelihood that those processes will infiltrate their classrooms greatly increases.

2. *Employ collegial supervision rather than evaluation.*Collegial supervision Value judgments about teachers' competencies, potentials, and ideas detract from motivation and produce stress (Lepper and Greene 1978). Under stress, the brain's creative, analytical functions are extinguished and replaced with conformity (MacLean 1978). To build trust and to challenge teachers to become experimental hypothesis makers, principals will withhold value judgments and view the teaching/learning process as a continual, problem-solving, creative method of inquiry. Supervision then becomes "brain compatible" (Hart 1983; Costa and Garmston 1985).

3. *Avoid recipes.* It is tempting to describe and evaluate the act of teaching in "five steps, four factors, and seven

variables," but teaching by number is as creative as painting by number. Obviously, the processes of teaching and learning the strategies of higher-level thinking are complex and require concentrated time and effort. Participants must find the richness in this complexity and avoid looking for simplistic answers.

4. *Explicate the dream.* Principals of effective schools have a vision of what their schools can become. They constantly assess all programs, each decision, and every new direction in order to help achieve that vision. In their pursuit of excellence, they strive to be thoughtful, rational, innovative, and cooperative. In addition, they seize every opportunity to articulate, refine, and magnify this vision by:

- Openly discussing it with the faculty, community, fellow administrators, and central office staff;
- Illuminating instruction that illustrates it;
- Finding materials that are consistent with it; and
- Organizing classrooms to better achieve it.

Not only do these activities help clarify principals' intuitive perceptions, they also make a strong public statement about their values.

5. *Constant reminders.* "Thought is Taught at Huntington Beach High" emblazons one school's memo pads. "The HOTS [Higher-Order Thinking Skills] Committee will meet in the teachers' room at 3:30" resounds from another school's loudspeaker. A brightly painted banner exclaiming "Thinkers Do It Thoughtfully" decorates one wall of the teachers' room as a not-so-subtle souvenir of their commitment to plan and teach thinking skills. Lesson plan books list Bloom's taxonomical levels of thinking on the covers. "Just a Minute, Let Me Think" is the slogan on the bulletin board in yet another school's foyer. In a staff lounge, a butcher paper scope-and-sequence chart displays skill activities entered by each teacher at each grade level for each subject area. These are but a few of the many innovative ways principals strive to keep their staff members thinking about thinking.

Using Available Resources to Support Thinking

Resources are usually defined in terms of time, space, energy, and money. How principals allocate these limited resources is yet another significant expression to staff members, students, and the community of their value systems.

Most obvious is the principal's commitment of financial resources for thinking skills programs: purchasing materials, hiring consultants to assist the faculty in curriculum and staff development, sending staff members to conferences and workshops, and hiring substitutes to facilitate peer observation. Securing financial grants from local industries, philanthropic organizations, and national, state, and local education agencies is one way to increase this often limited resource.

Because time and energy are an administrator's most precious commodities, parceling them out wisely is crucial to their effectiveness. Administrators should make time to do the following:

1. *Monitor instructional decision making.* Once the staff has defined how to effectively teach thinking, administrators can assess its use by looking at the instructional decisions teachers make, such as:

- Planning lessons that include cognitive objectives,
- Sequencing teaching strategies according to levels of thought,
- Selecting instructional materials that stimulate problem solving,
- Organizing the classroom for discussion of ideas,
- Developing learning activities that provoke thinking, and
- Evaluating student growth in thinking abilities.

In these ways, administrators convey to teachers that instruction is the primary mechanism for improving thinking; if instruction is improved, thinking will improve correspondingly.

2. *Coordinate the curriculum.* Possessing a broad curriculum purview, principals are in a good position to effectively monitor the relationship between teachers' instructional decisions and the district's philosophical goals. They can search for the ever-increasing complexity and abstraction of thinking required in learning activities at each grade level, coordinate resources with other schools in the district or community, and evaluate the long-range cumulative effects of cognitive instruction.

3. *Use faculty time to think and discuss thinking.* Too often, precious faculty meeting time is relegated to managerial tasks and information transmission. Discussing thinking at a faculty meeting, or in department- or grade-level meetings, is time well spent. Agenda items can include inviting teachers to:

- Report what they have learned from thinking skills courses, staff development activities, or research;
- Describe successes and problems in teaching for thinking;
- Discuss which thinking skills to focus on this year;
- Demonstrate instructional techniques that provoke thinking;
- Compare how they include thinking in each subject area;
- Describe how children increase the complexity of their intellectual skills throughout their development;
- Review and select materials to enhance thinking;

- Discuss ways to support each other's teaching with concurrent instruction (thinking across the curriculum);
- Invent alternative ways to assess students' growth in thinking abilities; and
- Relate school goals to district priorities.

4. *Secure parental support.* Parents probably have the greatest effect on children's abilities and inclinations for mental development. Concerned parents model thinking; their language engages differential cognitive structures. For students whose parents don't provide this mediation, thinking skills instruction is remedial.

Principals are the primary link between schools and the community. They have the opportunity to involve parents in decision making, interpret school programs to the community, and educate parents in their dominant role as mediators of their children's cognitive development.

Some parents believe that schools should teach only the basics. They may judge modern education in terms of their experience as students—during a time when the value of thinking was not necessarily recognized. Principals can help parents enhance their aspirations for their children by stressing that reasoning is a basic skill for survival in the 21st century: cognitive processes are prerequisite to mastery in all school subjects, critical thinking skills are essential to success on college entrance exams, and career security and advancement are dependent on innovation, insightfulness, and cooperation.

Many parents realize reasoning is the fourth "R," and there is a definite trend toward increased parental concern for children's cognitive development (Gallup 1984). By stimulating parents' interest in school and learning, environmental issues, time and money planning, and so on, principals can involve parents in helping to improve their children's thinking skills.

Time and energy invested in parental education pay high dividends. Elementary school administrators may wish to involve their school psychologists and nurses in enhancing parental effectiveness. Secondary and college-level school administrators may consider including parenting classes in their curriculum. Possible offerings include instruction in such cognitively related understandings as:

- Promoting language development,
- Experiential stimulation,
- Parent-child communication skills,
- Good nutrition,
- Child growth and development,
- Rational approaches to discipline,
- Supervising homework,
- Providing home environments conducive to cognitive development, and
- Modeling appropriate adult behaviors.

5. *Enhance personal thinking skills.* If any time and energy remain, principals themselves may wish to participate in staff development activities and learn more about cognitive education by:

- Learning to distinguish among the many programs available,
- Considering what to look for in teacher-student classroom interaction,
- Studying how to apply criteria to the selection of instructional materials,
- Learning more about brain functioning, and
- Improving the cognitive skills associated with problem solving, creativity, research, and cooperative planning.

Modeling Rational Behavior

Imitation is the most basic form of learning. Another leader, George Washington, is credited with saying, "Actions, not words, are the true criterion" (*Social Maxims: Friendship*, c. 1790). Thus, when problems arise in the school, the community, or the classroom, the principal must be seen solving those problems in rational, thoughtful ways. If not, the principal may unknowingly undermine the very goals of curriculum to which commitment is sought. Evaluation of a teacher's or program's effectiveness may be performed by the very person who is rendering the program ineffective. Principals should emulate those rational competencies desired in students and taught by teachers through:

1. *Withholding impulsivity.* Principals work in an environment that's a lot like a popcorn popper: new problems pop up quickly. Consequently, it's easy to become tense, fatigued, and cognitively overloaded. Effective principals develop self-awareness and biofeedback strategies to combat stress and handle irritating problems with patience, rationality, and poise.

2. *Demonstrating empathy for others.* Empathy is one of the highest forms of mental development. Behaving empathically requires overcoming one's own egocentricity, detecting another's subtle emotional and physical cues, and perceiving a situation from another's point of view—a complex set of cognitive processes. When dealing with parents, staff members, colleagues, and students, the administrator who demonstrates empathy models the most potent intellectual process.

3. *Metacognition.* Metacognition is our ability to formulate a plan of action, monitor our own progress along that plan, realize what we know and don't know, detect and recover from error, and reflect on and evaluate our own thinking processes. Administrators demonstrate metacognition when they publicly share their planning strategies, admit their lack of knowledge but describe means of generating

that knowledge, and engage others in deliberating, monitoring, and evaluating problem-solving strategies.

Metacognition seems to be an attribute of effective problem solvers. Administrators can model effective problem solving by demonstrating awareness of their own problem-solving abilities, discussing them, and inviting comments and evaluation (Costa 1984).

4. *Cooperative decision making.* Democratic principals realize that their intellectual power multiplies when they draw on the power of others, and they value group thinking for the decisions their staff members face. Cooperative decision making requires the ability to:

- Withhold judgment,
- Cope with ambiguity,
- Think flexibly,
- Think tentatively,
- Evaluate alternatives,
- Seek consensus,
- Take another person's point of view, and
- Employ hypothetical, experimental thinking.

These are the same attributes of critical thinking and problem solving that we want teachers to instill in students.

5. *Believing that all children can think.* School effectiveness research indicates that teachers' and administrators' expectancies of student performance correlate with achievement. In cognitive education programs, too, our expectancies become apparent. In many schools, children with low IQ scores are believed to be incapable of higher-level thought. Other schools employ thinking programs only for the gifted. And some children are "excused" from thinking because of the supposed inadequacies of home environment, culture, socioeconomic level, or genetic makeup. Indeed, those students who are reluctant to think—who recoil from mental activity because it's "too hard"—are the ones who need it most.

Modern cognitive theorists reject the notion of a static and unchanging IQ. Rather, they adopt a dynamic theory of multiple intelligences that can be nurtured and developed throughout a person's life. Administrators must demonstrate the belief that, with proper mediation and instruction, *all* human beings can continue to increase their intellectual capacities (Gardner 1983; Feuerstein 1980; Whimbey and Whimbey 1975).

REFERENCES

Berman, P., and M. McLaughlin. (1975). "Federal Programs Supporting Educational Change." In *The Findings in Review*, Vol. IV. Santa Monica, Calif.: The Rand Corporation.

Costa, A. (November 1984). "Mediating the Metacognitive." *Educational Leadership* 42, 3: 57–62.

Costa, A., and R. Garmston (February 1985). "Supervision for Intelligent Teaching." *Educational Leadership* 42, 5: 70–80.

Feuerstein, R. (1980). *Instrumental Enrichment.* Baltimore: University Park Press.

Gallup, G. (September 1984). "The 16th Annual Gallup Poll of the Public's Attitudes Toward the Public Schools." *Phi Delta Kappan* 66, 1: 23–28.

Gardner, H. (1983). *Frames of Mind.* New York: Basic Books.

Hart, L. (1983). *Human Brain, Human Learning.* New York: Longman.

Lepper, M., and D. Greene. (1978). *The Hidden Costs of Rewards.* Hillsdale, N.J.: Lawrence Erlbaum.

MacLean, P. (1978). "A Mind of Three Minds: Educating the Triune Brain." In *Education and the Brain*, 77th Yearbook of the National Society for the Study of Education, edited by J. Chall and A. Mirsky. Chicago: University of Chicago Press.

Sprinthall, N., and L. Theis-Sprinthall. (1983). "The Teacher as an Adult Learner: A Cognitive Developmental View." In *Staff Development*, 82nd Yearbook of the National Society for the Study of Education, edited by G. Griffin. Chicago: University of Chicago Press.

Whimbey, A., and L. Whimbey. (1975). *Intelligence Can Be Taught.* New York: E. P. Dutton.

9

Preparing Teachers to Teach Thinking

David S. Martin

The Need

The move to more formally incorporate the Teaching of Thinking into elementary and secondary schools in the United States is now approaching ten years of age. It has originated to a large degree from the emphasis of educators themselves as opposed to government initiatives; it is not fundamentally based within subject matter, although in recent years some subject area groups have incorporated these ideas; and the critical element is *explicit* discussion of cognitive and metacognitive processes within most of the thinking skills program.

Many, but not all, of the thinking skills programs require some form of teacher training, but most of the training has been within the *in-service* category. Preservice teacher education programs, on the other hand, have as a group been slow to respond to the need for explicit preparation of teachers of thinking in order to meet the need created by the thinking skills movement in the field. Yet, with the impending retirement of many teachers within the next 10 years, together with expectations by school districts that new teachers be able to implement thinking skills programs already installed within their school systems, teacher preparation institutions have a special obligation to incorporate this aspect of preparation into their programs in some form. The most recent reports of the National Assessment of Educational Progress, indicating that American youth are still woefully deficient as a group in higher-level problem-solving processes, only serves to underline the importance of formal teacher preparation in this area. Let us examine the responses of the teacher education community, and then identify important actions and issues to be addressed in the near future.

This chapter was originally published as "Preparing Thinking Teachers," *Teaching Thinking and Problem Solving* 11, 3 (May–June 1989). Francine Beyer, Editor. Reprinted by permission.

A Short History of Teacher Education and the Preparation of Teachers of Thinking

Just as the distinction between teaching for thinking, teaching of thinking, and teaching about thinking is useful in elementary and secondary education, it is also useful in teacher education. Many programs for many years have taken seriously the mission of preparing teachers to teach *for* thinking in terms of emphasizing the incorporation of challenging questions and certain kinds of special activities within the social studies and science curricula, among others. However, preparation of teachers to teach thinking as an overt part of the curriculum or to teach students to explicitly focus on their own mental processes (teaching *of* thinking and teaching *about* thinking, respectively), has not been a regular part of the teacher preparation curriculum. In addition, the preparation of teachers to involve specific thinking skills programs within their curriculum has also not been a part of the *preservice* program.

Beginning in the early 1980s, the Association Collaborative for Teaching Thinking (ACTT) was formed, consisting of representatives of numerous professional organizations in education, and among them was representation from the American Association of Colleges of Teacher Education (AACTE). This representation become one of the first formal recognitions by the teacher preparation community that the teaching of thinking is important. Representatives of AACTE were among those developing a set of standards for the preparation of teachers of thinking, which is now available from the ACTT on request or from the author of this chapter; the standards propose that the National Council on the Accreditation of Teacher Education assess teacher preparation programs for the explicit degree to which their programs prepare teachers in five areas:

1. The teacher and the teacher educator who effectively teach thinking will demonstrate an attitude of thoughtful consideration of the problems, topics, and issues of their professional experiences.

2. The teacher and teacher educator indicate that they have an active working knowledge of the methods of effective inquiry utilizing all levels of thinking.

3. The teacher educator and students in the teacher education program demonstrate skill in applying the methods of inquiry to classroom teaching.

4. The teacher educator and the teacher trainee provide repeated explicit opportunities for their respective students to reflect on, analyze, and apply higher-order thinking operations to real world issues and problems, as well as to subject matter.

5. Teacher education institutions maintain an actively supportive climate which promotes the exercise, application, teaching, and learning of thinking dispositions and cognitive operations.

To date NCATE has not officially adopted those standards.

In the Fall of 1987, the AACTE then called a special task force meeting to discuss directions for the association in regard to the preparation of teachers of thinking; this meeting brought together 12 persons representing Psychology, Teacher Education Faculty, and other related fields. One result of that meeting was a cosponsored conference involving 65 teacher educators in early 1988, who examined possible models for including thinking skills programs as a part of the teacher education program.

Later in 1988 a full one-week seminar took place for teacher educators representing eight different institutions, to look in-depth at models for program revision and course revision in teacher preparation programs; this seminar was a part of a large annual institute at the University of Massachusetts at Boston, on the general thinking skills theme. From this event the beginnings of a mail network resulted, as well as a special Resolution for the entire AACTE organization.

That resolution, calling for all programs in teacher education to incorporate preparation for teaching thinking, was passed by a large margin at the 1989 Annual Conference of the AACTE. Parallel to that event was the proposal of a Special Study Group within the AACTE to enable interested institutions of teacher preparation to exchange ideas and models on the implementation of thinking skills within teacher education. That study group is currently in the process of forming and establishing by-laws.

The impression thus far may be that teacher education has only paid lip-service to the thinking skills movement, and that all of the above actions are merely paper activities. However, some specific implementations and models are already in force and will explained below. Let us first, however, look at the further rationale for the place of thinking skills within the teacher education curriculum.

Cognitive Education and the Teacher Education Knowledge Base

One of the five major new standards of the National Council on the Accreditation of Teacher Education relates to the knowledge base in teacher education. We now know a great deal about the ways in which children improve their cognitive skills, as well as the pedagogical techniques which are most likely to promote thinking in students. For example:

1. Asking questions that demand "why" and "how" response.

2. Identifying the specific strategies used in solving a problem and *labeling* those strategies (metacognition).

3. Reflecting with students explicitly on the cognitive processes used to solve a problem.

4. In the context of regular subject matter, reminding students of cognitive strategies which can be applied.

5. Setting an appropriate "disposition" for thinking in the classroom by establishing an acceptant tone during discussions.

In addition to this body of research is a separate but related body—the investigation of teaching itself as a cognitive activity. The work of Morine-Dershimer (1982) established methods for researching the thinking of teachers. The need for the teacher to diagnose the cause of student difficulty and to prescribe beyond trial and error was observed by Carbone (1980). In addition, Renner (1975) demonstrated positive cognitive growth in teacher trainees as the result of preservice training in methods of teaching science using well-structured reasoning activities.

Clark and Yinger (1979) and others have studied teaching as a cognitive activity; Clark and Lampert (1986) provide an excellent summary of those aspects of the research on teacher thinking which belong in the knowledge base for teacher education. The work of Peterson (1988) is now conceptualizing how teacher and student cognitions and knowledge can mediate effective teaching. We see a current call for a "*paradigm* shift" in research on teacher education, away from the process-product approach (Shulman 1986) and towards a cognitive paradigm which examines the effects of the thinking and decision-making that teachers do while interacting with students (Clark and Peterson 1986; Peterson, Swing, and Stoiber 1986).

Therefore we fortunately have sufficient information while conducting needed further research to include a significant place for cognitive education within the knowledge base segment of teacher education.

Models

But the knowledge base alone is not sufficient for preparing active teachers of thinking. The infusion of thinking skills must cut *across* the curriculum into not only course work, but also practicum work as well. Several programs are in effect or are concretely proposed at this time and are illuminating to examine.

For example, at least one model for this kind of infusion exists for teacher educators to adapt or adopt—the Critical Thinking in the Schools/Teacher Education Project at Montclair State College in New Jersey. Using a collaborative, multi-disciplinary approach with attention to the theoretical aspects of thinking across the disciplines and the implications for teaching and learning at the college level, College faculty from all disciplines work on issues related to teaching for critical thinking. A key element is the identification of clinical schools as suggested by the Carnegie Forum on Education and the Economy's report, *A Nation Prepared: Teachers for the 21st Century* (1986). College faculty conduct workshops with the faculty of the Clinical Schools to create a school climate that is receptive to critical thinking. Faculty have also revised their courses and approaches at every level to incorporate teaching for critical thinking; and a course, Teaching for Critical Thinking, has been introduced into the teacher education professional sequence.

Another model (Martin 1984a, 1984b) would first require faculty development of the teacher education faculty in a systematic program of cognitive skill development. Following that stage, each of the components of the teacher education program (foundations, curriculum, methods, and practicum) would share the responsibility for incorporating certain particular cognitive skills; for example, the foundations courses in educational psychology would emphasize not only the knowledge base about cognition, but would also *teach* the cognitive skill of analysis in some depth since that skill is applicable on an adult level to the diagnostic activities which a teacher must carry out; the curriculum course would, among other emphasis, teach future teachers on an adult level the skills of logical reasoning as applied to different theories about curriculum. Then an emphasis in the practicum experience would be on supervised synthesis and the application of a variety of cognitive skills by expecting student teachers to incorporate them in the context of their curriculum.

Several other university programs for preparing teachers of thinking should be noted. A special fifth-year program for K–8 preservice teachers leading to certification, is also administered by the Institute for the Advancement of Philosophy for Children, with a focus on the teaching of thinking; the University of Massachusetts at Boston has a special master's degree in thinking skills for experienced teachers; and, the preservice preparation program at the university of Virginia integrates "reasoning skills" across a block of methods courses in areas such as social studies, science, and math.

From these models, it is pleasing to note that some teacher educators have grasped well the notion that thinking skills cannot be a separate thread (just as it should not be within the school curriculum) but instead should be infused. Clearly, wider implementation of these models and experimentation with other models is necessary at this time, and all educators who care about thinking skills must support and encourage the teacher education profession to pursue these experiments now.[1]

Immediate Action

In addition to the development of full programs in the teaching of thinking within teacher preparation curricula, individual teacher education faculty may take measures within their own courses to foster the teaching of thinking as well. For example, some techniques would include the following:

1. Broaden course objectives to include certain higher-level cognitive skills which are relevant to the discipline of the course (e.g., in a course on the philosophy of education, one course objective could become the ability to take a position on an issue and defend it logically in front of one's peers)

2. Build into the activities of the course a number of activities in which students identify some relevant cognitive skill (such as logical defense of a position), apply it during the course, reflect on the cognitive strategies used, and discuss specific techniques for applying those strategies to teaching children.

3. Include in the course the view of the *structure* of the discipline as well as its content.

4. During the activities of the course, employ higher-order questioning during all class discussions.

5. Connect those activities with parallel observation experiences in school classrooms; for example, in the philosophy of education course if one skill is defending a logical position, then when students observe in the classroom in the teacher education program, they would observe for the ways in which the model teacher asks children to defend their positions in discussions.

6. Revise course assessment tools to include not only memory and comprehension of course ideas, but also higher-level analysis, reasoning, and *manipulation* of course ideas.

In addition, we propose that the readers of this issue make it a part of their professional agenda to offer assistance to teacher education programs through *partnerships* between school professionals who are experienced in thinking skills education and university teacher education programs.

Needed Research

For the near future, some important research questions about the relationship between teacher education and thinking skills remain to be investigated. They would include looking at the following questions:

1. Which principles from cognitive education at the school level are applicable to *adult* education for higher-level cognitive skills with preservice teachers as learners?

2. To what degree will the incorporated cognitive skills *embedded* into methods courses in the teacher education program *transfer* into the student teaching *experience*?

3. What effects will infused cognitive education elements in teacher education coursework have on the student teacher's view of classroom reality when he or she meets it in the practicum experience?

4. What teaching strategies for the preservice teacher are most effective in relating cognitive skills to curriculum content?

5. What is the interaction between specific demographic variables in learners and the success of a thinking skills program carried out by a student teacher?

6. What methodological variables make a measurable difference in raising the thinking levels of students in a practicum situation by a student teacher?

7. What is the impact of cognitive education on the child's view of the student teacher who is implementing a thinking skills program, as compared with the view of student teachers who are not implementing such a program?

8. What types of assessment will comprehensively identify and be sensitive to the effects of thinking-skills programs on the teaching of student teachers in general and specifically on their success in implementing thinking skills programs with their own students?

9. What is the effect on the student teacher's self-concept as a teacher as the result of implementing a program in the teaching of thinking?

10. What is the influence on the student teacher by a Cooperating Teacher who is an excellent teacher of thinking?

These questions will undoubtedly lead to additional questions and related sub-questions in the future.

Thus, the teacher education community has *begun* to attend to the thinking skills movement, but much remains to be done to build the implementation on a full level to equal what is evidently happening in this direction in schools today. Only when we have full preparation at the preservice level of a new *corps* of teachers prepared to actively teach thinking can we be certain that the thinking skills movement will become a permanent part of the American Curriculum.

NOTE

[1]For further reading on teacher education and higher-order thinking skills, particularly about teaching methods for improving student cognition and about various models for changing teacher education programs in this direction, see Martin (1989).

REFERENCES

Carbone, P. F., Jr. (May–June 1980). "Liberal Education and Teacher Preparation." *Journal of Teacher Education* 31, 3: 7–12.

Carnegie Forum on Education and the Economy. (1986). *A Nation Prepared: Teachers for the 21st Century.* New York: Carnegie Corporation.

Clark, C. M., and M. Lampert. (Sept.–Oct. 1986). "The Study of Teacher Thinking and Implications for Teacher Education." *Journal of Teacher Education* 37, 5: 27–31.

Clark, C. M., and P. L. Peterson. (1986). "Teachers'Thought Processes." In *Handbook of Research on Teaching*, edited by M. C. Wittrock. New York: Macmillan.

Clark, C. M., and R. J. Yinger. (1979). "Teacher Thinking." In *Research in Teaching: Concepts, Findings, and Implications*, edited by H. J. Walberg and P. L. Peterson. Berkeley, Calif.: McCutchan.

Martin, D. S. (May/June 1989). "Restructuring Teacher Education Programs for Higher-Order Thinking Skills." *Journal of Teacher Education* 40, 3: 2–8.

Martin, D. S. (1984a). "Can Teachers Become Better Thinkers?" *Occasional Paper No. 12.* Oxford, Ohio: National Staff Development Council.

Martin, D. S. (1984b). "Infusing Cognitive Strategies into Teacher Preparation Programs." *Educational Leadership* 42, 3: 68–72.

Morine-Dershimer, Greta. (March 1982). *Tying Threads Together: Some Thoughts on Methods for Investigating Teacher Thinking.* New York: American Education Research Association.

Peterson, P. L. (June/July 1988). "Teachers' and Students' Cognitional Knowledge for Classroom Teaching and Learning." *Educational Researcher* 17, 5: 5–14.

Peterson, P. L., S. R. Swing, and K. D. Stoiber. (1986). *Learning Time vs. Thinking Skills: Alternative Perspectives on the Effects of Two Instructional Interventions.* Program Report 86-6. Madison: Wisconsin Center for Education Research.

Renner, J. W. (1975). "Determination of Intellectual Levels of Selected Students: Final Report to National Science Foundation." Document 75-SP-0517. Washington, D.C.: National Science Foundation.

Shulman, L. S. (1986). "Paradigms and Research Program in the Study of Teaching: A Contemporary Perspective. In *Handbook of Research on Teaching*, edited by M. C. Wittrock. New York: Macmillan.

10

Parents' Influence on Their Children's Thinking

Irving E. Sigel

Some people think that it is holding on that makes one strong. Sometimes it's letting go.

—Sylvia Robinson

It goes without saying that parents play a significant role in the development of children's cognitive development. Parents contribute to a child's intellectual development through their contribution to the child's genetic makeup and the home environment that is mapped onto the child's basic competence. Much has been written about the role of inheritance in intellectual development, especially with regard to intelligence quotient (IQ) (Plomin 1986; Scarr and McCartney 1983). In this chapter, I focus on parents' role as teachers of their children and show how they contribute to the development of their children's thinking skills.

Definition of Thinking

To set the stage for thinking about thinking, and to differentiate it from IQ (which is merely a score on a test), let me clarify what I mean by thinking. Thinking involves a number of mental processes that are employed in the service of solving problems. This type of thinking is referred to as *direct thinking*, as distinguished from fantasy, daydreaming, or reverie.

Thinking is usually differentiated from intelligence. Intelligence refers to ability or competence, whereas thinking comprises skills for analysis, synthesis, evaluation, problem solving, reflectivity, categorization, and different types of reasoning (including deductive, inductive, syllogistic, and analogic). Researchers and test developers have been able to differentiate each of these processes and have in fact created tests for each of them. This indicates that they are all separate, identifiable skills. However, all of these processes can be classified under the rubric of thought. Hence, when one speaks of thinking or thinking skills, it is important to designate which particular process is being discussed. The feature common to all these labels is the employment of mental activities in problem solving.

Thinking involves not only the processes identified above, but content as well: when we think, we think something about something. Thought has content, which takes the form of symbols. These symbols can be words, pictures, signs, or sounds—all of which are knowledge. For example, when we think about a book we have read, we may think of it in words, in images, or in combinations of the two. When we think of geographical distances, we may think in terms of numbers or spaces.

All thought involves symbols. Symbols are representations of experience. The symbol stands for the real event. When we imagine a future activity, we are symbolizing or representing that activity in our minds, in our imaginations.[1] Thought requires the use of symbols, and it is this quality of thinking that forms the focus of this essay.

To put the role of parental influence in context, I briefly present some generalizations about how the family environment affects the child's cognitions and academic achievement. I then present some of our research on how parents influence their children's symbolic thinking.

General Overview of Parental Influences on Children's Intellectual Development

Over the past two decades there has been a resurgence of interest in the role of parents and the family in influencing children's overall intellectual development and academic achievement. Such topics as IQ, school performance, and attitudes toward self and others have been the targets of interest.

The search for parental influence on these child characteristics has led to the study of such parental sources of influence as: beliefs (McGillicuddy-DeLisi 1982; Miller 1988); values (Kohn 1969); parenting styles and attributes (Grolnick and Ryan 1989; Hess and McDevitt 1984; Marjoribanks 1979); attitudes (Parsons, Adler, and Kaczala 1982); and parent personality characteristics (Cowan and Cowan 1990). In addition to these psychological aspects of parental influence, attention has also been directed to family configurations as sources of influence. Specifically, factors of family size, birth order, and spacing of births (Zajonc 1976) have been related to children's IQ.

In spite of differences in concept and method, these studies show that a child's developing intellectual functioning and subsequent academic achievement are influenced to some degree by each of these factors. Studies focusing on parental values and beliefs report that children whose parents conform to social convention do less well on problem-solving and thinking tasks than do children whose parents are more progressive and democratic. Children who come from impoverished homes where parents have little education do less well on intellectual assessments and school performance than children from more privileged homes (Gottfried 1984; White 1982). Birth order does make a difference, especially when birth order spacing is taken into account: the larger the spacing between births with middle-class children, the greater the intellectual performance of each child. In contrast, in working-class families, the closer the spacing the better the performance (McGillicuddy-DeLisi and Sigel 1990). A series of studies shows that children whose parents are depressed (especially the mothers) are less well adjusted and perform less well on intellectual assessments (Kochanska in press). Parents who show negative attitudes regarding their children's academic competence have a negative influence on the children's accomplishment (Parsons et al. 1982).

These studies point to the significance of a complex set of factors that combine to create a pattern of parental and family influences. Among the many factors that emerge as sources of influence are the parents' behavior and methods of communication with their children. This topic forms the core of the following discussion.

Parents as Communicators and Teachers

Parents communicate their feelings, beliefs, attitudes, and values to their children through their actions. What parents say, what they do, and how and when they engage their children are factors that contribute to the children's thinking skills, as well as their attitudes toward intellectual activity.

Parents interact with their children as initiators, by, for example, asking children something or telling them to do or not to do something. Children can also initiate by asking their parents for certain actions. Each responds to the other, so that there is mutual influence. We refer to this as a bi-directional model of parent-child interaction. In this report, however, I discuss only the parents as the source of influence.

For the past 15 years my colleagues and I have interviewed and observed parents and teachers interacting with children from preschool age to preadolescence.[2] The guiding hypothesis in these studies is that parents, by their very communication strategies, affect the intellectual functioning of their children. To explain the basis for this assertion I must briefly describe the theory from which this idea sprung and show the relationship between parental actions and behavior and children's thinking.

To think, as defined above, requires demonstrating competence to work with symbols and to understand some basic rules about them. We refer to this as *representational competence.* All the knowledge we have in our minds is in some form of representation. Mathematical knowledge, for instance, is represented by numbers and by symbols that represent mathematical operations such as addition or subtraction. *Representation*, in this context, refers to the internalization of experience and the transforming of the experience into some type of symbol system.

The competence aspect refers to the understanding of the rule that experience can be transformed into symbols and still retain the core meaning. A three-dimensional automobile and a picture of that automobile, while differing in the way they are presented, still retain their automobile identity. I call this awareness *the conservation of meaning*, since the object retains its identity in spite of differences in appearance. I argue that representational competence and the conservation of meaning are prerequisites for the understanding of pictures, maps, graphs, and other designs.

Three intellectual functions become possible when the individual is representationally competent: (1) anticipation, which involves planning and predicting for future events, (2) hindsight, which encompasses two mental processes—reconstruction of past events (short- or long-term) and reorganization of those past experiences in the service of representing the here and now and possible future events (planning and predicting), and (3) transcendence of the ongoing present, which encompasses those processes that reflect abstraction or the transformation of ongoing experiences into symbols (Sigel 1986). Each of these thinking functions involves symbols.

A person who is representationally competent understands how knowledge is represented and expressed in planning, anticipation, and reconstruction of the past, and integrates this understanding in the service of the present. Representational competence is a necessary condition for thinking and problem solving. These processes function in interrelated ways. For example, when one enters a new city, one might mentally retrieve previous encounters with new locations and employ the same strategies used during those encounters to cope with the new situation. Think of a child looking at a map of the world and a globe. Does the child realize that these are but two ways of representing the earth? Representational competence is indicated when the child is aware of this fact. Another example of representational competence is when an individual knows that + means *add* or *and*, and that it signifies addition. Individuals differ in the degree to which they understand this rule and this is what I believe accounts in part for differences in performance in most problem-solving and intellectual assessments (Sigel in press).

The fundamental ability to engage in representational thinking is built into our nervous system. Without this inherent ability, it would have been impossible to develop symbolic thought. Although the ability to engage in representational thinking is universal, competence varies as a function of social experience. The social experiences that foster representational competence are referred to as *distancing strategies*, which are essentially cognitive demands that force children to separate self cognitively from the present behavioral environment. In so doing, the children have to engage in representational thinking. Distancing strategies are usually verbal, but they can also be expressed by manipulating the physical environment, such as changing the spatial arrangements in a room. Any actions that create some type of discrepancy between what the child is doing or intends to do, instigates representational thinking. The distancing strategies that parents use early in a child's life lay down a considerable basis for subsequent representational competence (Sigel 1986).

Levels of distancing strategies. Distancing strategies differ in the level and type of cognitive demands they place on children. A large number of strategies used by parents have been identified. Three levels of demand were identified. Levels of demands were based on the level of distance—from the immediate available stimulus situations to the most inferential and abstract. Low-level strategies incorporate the ongoing present where the stimuli might be present but does not activate separation from the ongoing. Low-level demands include: "What color is the shoe?" "What is your name?" and "How many apples do you see on the table?" Medium-level strategies involve interaction with objects, events, or individuals that facilitate the thinking process. Examples of medium-level demands include: "Which of these two cups is larger?" or "Can you tell me about your trip to the farm?" High-level strategies involve demands to infer, to generalize, to abstract. In essence, these demands employ mental processes without access to objects and places in the environment. Examples of high-level demands include: "How would you go about planning your next birthday party?" or "Are there any other ways you might draw the house?"

The form of the strategies might be questions or statements. High-level strategies are most often open-ended questions, whereas low-level strategies tend to be closed-ended and make minimal demands to represent the experience.

Effect of distancing strategies on children's thinking. On the basis of observations of the way parents functioned as teachers in our laboratory at the Educational Testing Service, we are convinced that the way parents interact with their children in a teaching-type situation (an everyday affair for most parents of young children) does influence the children's abilities to deal with symbols. The effect of these strategies on the children depends on their developmental level, the level of cognitive demand, whether it is a question or a statement, and the children's attention and involvement.

The pattern of results obtained in studies of parental distancing strategies and performance on standard tests of intelligence show that parents' use of low-level demands (Level 1) was related to lower test scores. There was also evidence that parents' high-level demands had a positive effect on children's performance.

The results of our studies with preschool children on tasks requiring representational competence are clear. The frequency of low-level strategies correlates with poor performance on tasks of memory for sentences, static memory, and understanding of sequencing. On the other hand, children who experience high frequencies of high-level distancing do well on anticipation, seriation, and ordering tasks. Likewise, children whose parents use authoritative, didactic teaching strategies that do not encourage independent thinking—exploring and discovering for oneself—do less well on problem-solving tasks requiring reflective thinking, memory for stories, and standard intelligence tests. Thus, parents' verbal engagement with their children, making high-level cognitive demands, has a positive effect on their children's thinking and problem-solving abilities. Incidentally, we found the same kind of relationships with children and their preschool and elementary school teachers. Children with teachers who use didactic strategies, closed questions, and do not follow up on their questions with "cognitive demands" to think, to plan, and to anticipate outcomes, seem to do less well in their academic subjects—at least as judged by teachers.

Although little attention was paid to the role of affect and parent sensitivity in this discussion, I want to conclude with a caveat. The use of inquiry with high-level distancing strategies has to be geared to the child's understanding level and comfort state. Our results also point out that parents who accept their children's ideas and engage them in conversation with follow-up comments and questions enhance their children's representational competence.

To summarize, there seems to be a lot of evidence that parents' attributions, beliefs, and values about children's academic and problem-solving skills do relate to the children's performance. However, the missing link in these findings is how these beliefs, attitudes, values, and attributions are expressed. The strategies parents use do influence children's representational competence. Didactic, closed-ended questions and statements have a negative influence on children's representational competence, whereas open-ended questions with the cognitive demands to reflect, to think of alternatives, to form one's own ideas, to plan, and to reconstruct memories in the service of solving a problem, are all conducive to enhanced representational competence.

The message is clear: When parents recognize that children are thinkers and treat them accordingly, children are empowered to develop representational competence.

Notes

[1]Although some writers distinguish between signs and symbols, for the sake of the discussion here I will use the word symbol to cover all types of internal representations, since these are representations of some other event, object, person, or idea.

[2]The results for the older children are not yet available, but preliminary analysis suggests that the level of distancing strategy parents use with preschoolers has some carryover for the children's performance on school achievement tests.

References

Cowan, P. A., and C. P. Cowan. (1990). "Becoming a Family: Research and Intervention." In *Methods of Family Research: Biographies of Research Projects (Vol. 1): Normal Families*, edited by I. E. Sigel and G. H. Brody. Hillsdale, N.J.: Lawrence Erlbaum.

Gottfried, A. W., ed. (1984). *Home Environment and Early Cognitive Development: Longitudinal Research.* New York: Academic Press.

Grolnick, W. S., and R. M. Ryan. (1989). "Parent Styles Associated with Children's Self-regulation and Competence in School." *Journal of Educational Psychology* 81, 2: 143–154.

Hess, R. D., and T. M. McDevitt. (1984). "Some Cognitive Consequences of Maternal Intervention Techniques: A Longitudinal Study." *Child Development* 55, 6: 2017–2030.

Kochanska., G. (In press). "Maternal Beliefs as Long-term Predictors of Mother-Child Interaction and Report." *Child Development.*

Kohn, N. L. (1969). *Class and Conformity: A Study in Values.* Homewood, Ill.: Dorsey Press.

Marjoribanks, K. (1979). *Families and Their Learning Environments: An Empirical Analysis.* London: Routledge and Kegan Paul.

McGillicuddy-DeLisi, A.V. (1982). "The Relationship Between Parents' Beliefs about Development and Family Constellation, Socioeconomic Status, and Parents' Teaching Strategies." In *Families as Learning Environments for Children*, edited by L. M. Laosa and I. E. Sigel. New York: Plenum.

McGillicuddy-DeLisi, A. V., and I. E. Sigel. (1990). "Family Environment and Children's Representational Thinking." In *Development of Literacy* (Vol.6), edited by S. Silvern. Greenwich, Conn.: JAI Press.

Miller, S. A. (1988). "Parents' Beliefs about Children's Cognitive Development." *Child Development* 59, 2: 259–285.

Parsons, J. E., T. F. Adler, and C. M. Kaczala. (1982). "Socialization of Achievement Attitudes and Beliefs: Parental Influences." *Child Development* 53, 2: 310–321.

Plomin. R. (1986). *Development, Genetics, and Psychology.* Hillsdale, N.J.: Lawrence Erlbaum.

Scarr, S., and K. McCartney. (1983). "How People Make Their Own Environments: A Theory of Genotype Environment Effects." *Child Development* 54, 2: 424–435.

Sigel, I. E. (1986). "Early Social Experience and the Development of Representational Competence." In *Early Experience and the Development of Competence*, edited by W. Fowler. New Directions for Child Development, No. 32. San Francisco, Calif.: Jossey-Bass.

Sigel, I. E. (In press). "Representational Competence: Another Type?" In *Criteria for Competence: Controversy in the Assessment of Children's Abilities*, edited by M. Chandler and M. Chapman. Hillsdale, N.J.: Lawrence Erlbaum.

White, K. R. (1982). "The Relation Between Socioeconomic Status and Academic Achievement." *Psychological Bulletin* 91, 3: 461–481.

Zajonc, R. B. (1976). "Family Configuration and Intelligence." *Science* 192, 4: 227–236.

11
The School as a Home for the Mind

Arthur L. Costa

Whatever the mind of man can conceive and believe, it can achieve.

—Paul H. Dunn

A quiet revolution is taking place across America in corporate offices, industrial factories, government offices—and in schools as well. It is a revolution of the intellect, placing a premium on our greatest natural resource, the human mind. Increasingly, those attributes of a climate conducive to intellectual growth and self-fulfillment are becoming universally recognized and accepted. The conditions that maximize creativity are being described, understood, and replicated (Perkins 1983; Kohn 1987; Deal 1987; Brandt 1988; McClure 1988; and Saphier 1987). The new paradigm of industrial management emphasizes an environment in which growth and empowerment of the individual are the keys to corporate success. Pascarella writes in *The New Achievers* (1984):

> Management is heading toward a new state of mind—a new perception of its own role and that of the organization. It is slowly moving from seeking power to empowering others, from controlling people to enabling them to be creative. . . . As managers make a fundamental shift in values . . . the corporation undergoes a radical reorientation to a greater world view.

Many educators have advocated similar school conditions for years, believing that a climate that maximizes human potential can be developed, monitored, and sustained. These conditions are equally applicable at all levels of the educational organization: classrooms, schools, and school districts.

Shaping Teachers' Thinking

Many factors influence teachers' thinking as they make decisions about curriculum, instruction, and content. Their own cultural background, cognitive style, and professional values and beliefs about education all subconsciously enter their daily decision making. Knowledge of students' needs and perceptions of students' abilities and backgrounds influence teacher judgments about when to teach what to whom. The available resources for instruction—tests, materials, equipment, textbooks, time, and space—all have an impact on teachers' instructional planning.

Less obvious influences on teacher thought, but vastly more compelling, are the norms, culture, and climate of the school setting. Hidden but powerful cues emanate from the school environment. They signal the institutional value system that governs the operation of the organization (Saphier and King 1985). Similarly, classroom cues signal a hidden, implicit curriculum that influences student thinking as well.

Recent efforts to bring an intellectual focus to our schools most likely will prove futile unless we create a school environment that signals the staff, students, and community that development of the intellect is of prime importance as the school's goal. While efforts to enhance the staff's instructional competencies, develop curriculum, revise instructional materials and testing procedures, and pilot and adopt published programs are important components in implementing cognitive education, it is crucial that the school climate in which teachers make their decisions be aligned with the goals of full intellectual development. According to Jack Frymier (1987):

In the main, the bureaucratic structure of the workplace is more influential in determining what professionals do than are personal abilities, professional training, or previous experience. Therefore, change efforts should focus on the structure of the workplace, not on the teachers.

Unfortunately, schools can be intellectually depressing, not only for students but for teachers as well. John Goodlad (1984) found that:

- Teachers are extremely isolated. They perform their craft behind closed doors and have little time within rigid daily schedules to meet, plan, observe, and talk with each other.
- Teachers often lack a sense of power and efficacy. Some believe they are at the bottom of the hierarchy while the decisions and evaluations affecting them are being made "up there" someplace.
- The complex, intelligent act of teaching is often reduced to formulas or series of steps and competencies, the uniform performance of which supposedly connotes excellence in the art and elegance of teaching.
- Information about students achievement is for political, evaluative, or coercive purposes; it neither involves nor instructs the school staff members in reflecting on, evaluating, and improving curriculum and instruction.
- Educational innovations are often viewed as mere "tinkering" with the instructional program. There are so many of them, and their impact is so limited, that teachers sometimes think, "If I do nothing, this, too, shall pass." Instead of institutionalizing change, traditional practices and policies so deeply entrenched in the educational bureaucracy remain static. Testing, reporting, securing parent understanding and support, teacher evaluation, scheduling, school organization, and discipline procedures are seldom revised to harmonize with the overall innovation.

When such a dismal school climate exists, teachers understandably become depressed. Their vivid imagination, altruism, creativity, and intellectual prowess may soon succumb to the humdrum dailiness of unruly students, irrelevant curriculum, impersonal surroundings, and equally disinterested coworkers. Under such conditions, the likelihood that teachers will value the development of students' intellect is marginal.

Toward the School as a Home for the Mind

Teachers are more likely to teach for thinking in an intellectually stimulating environment. When the conditions in which teachers work signal, promote, and facilitate their intellectual growth, they will gradually align their classrooms and instruction to promote students' intellectual growth as well. As teachers teach students to think, become more aware of conditions that promote student thinking, and become more powerful thinkers themselves, they will demand and create school climate conditions that are intellectually growth-producing as well. Thus, respect for intelligent behavior grows to pervade all levels of the institution.

Three climate conditions, in particular, facilitate intellectual growth: (1) all participants share a common vision of the school as a home for the mind, (2) the process of thinking is the content of curriculum and instruction, and (3) schools and classrooms are interdependent communities. These conditions provide a sharper image of a climate for thinking in schools and classrooms that are dedicated to becoming homes for the mind.

A Common Vision

If your vision statement sounds like motherhood and apple pie and is somewhat embarrassing, you are on the right track.

—Peter Block

Effective organizations are characterized by a deep sense of purposefulness and a vision of the future. Members at all levels share a commitment to that vision, a sense of ownership, and an internal responsibility for performance (Harmon 1988). This shared vision is evident in several ways.

Faith in Human Intellectual Potential

In a school that is a home for the mind, there is an inherent faith that all people can continue to improve their intellectual capacities throughout life; that learning to think is as valid a goal for the "at-risk," the handicapped, the disadvantaged, and the foreign-speaking as it is for the "gifted and talented"; and that all of us have the potential for even greater creativity and intellectual power. Students, teachers, and administrators realize that learning to use and continually refine their intelligent behavior is the purpose of their lifelong education. Such a belief is expressed in many ways.

Thinking is valued not only for all students and certified staff, but, as in Worthington, Ohio, for the classified staff as well. A principal of a "thinking school" in Davis, California, reported that a newly hired custodian constantly asked her to check on how well he was cleaning the classrooms and to tell him whether he was doing an adequate job. She decided to help him develop a clear mental image of what a clean classroom looked like and then worked to enhance his ability to evaluate for himself how well the room he cleaned fit that image.

School staff members continue to define and clarify thinking as a goal and seek ways to gain assistance in achieving it. Their commitment is reinforced when they are able to report and share progress toward installing thinking in their schools and classrooms. The superintendent of Manheim Township in Lancaster, Pennsylvania, reviews with site administrators their long-range goals and progress toward including the development of intelligent behaviors in the school's mission. In classrooms in Wayzata, Minnesota, students keep journals and periodically report new insights about their own creative problem-solving strategies.

Philosophy, Policies, and Practices

The vision is also expressed in the district's board-adopted mission statement, purposes, and policies. In Hopkins, Minnesota, enhancing intelligent behavior is explicitly stated in the school district's adopted philosophy and mission. District policies and practices are constantly scrutinized for their consistency with and contribution to that philosophy. Evidence of their use as criteria for decision making is examined. Furthermore, procedures for continuing to study, refine, and improve districtwide practices encourage schools to keep growing toward more thoughtful practice

Personnel practices, for example, reflect the desire to infuse thinking. Job specifications for hiring new personnel include skills in teaching thinking. Teachers are empowered to make decisions that affect their jobs. Supervision, evaluation, and staff development practices enhance the perceptions and intellectual growth of certified staff and honor their role as professional decision-makers (Costa and Garmston 1985; Costa, Garmston, and Lambert 1988).

Selection criteria for texts, tests, instructional materials, and other media include their contribution to thinking. Counseling, discipline, library, and psychological services are constantly evaluated for their enhancement of and consistency with thoughtful practice.

In schools and classrooms, discipline practices appeal to students' thoughtful behavior. Students participate in generating rational and compassionate classroom and school rules and continually strive to evaluate their own behavior in relation to those criteria (Curwin and Mendler 1988).

Protecting What's Important—Saying "No" to Distractions

Sometimes our vision of the desired school is temporarily blurred or obscured. We are distracted from our intellectual focus by fads, bandwagons, other educational "panaceas," and by pressures from public and vocal special-interest groups. Our purposes may be temporarily clouded by politically and financially expedient decisions. We must ignore all of these distractions as irrelevant to our central issue.

On the other hand, we need to encourage philosophical discussion because it gives voice to alternative views. Considering other perspectives—as expressed in such books as Bloom's *Closing of the American Mind* (1987), Ravitch and Finn's *What Do Our 17-Year-Olds Know?* (1987), and Hirsch's *Cultural Literacy* (1987)—creates tensions, honors divergent thinking, and expands and refines our vision. Such discussion encourages staff members to include modes of thinking and inquiring in their definition of literacy. Discussion strengthens the staff's commitment to the principle that to learn anything—to gain cultural literacy or basic skills—requires an engagement of the mind.

Knowing that thinking is the important goal, all inhabitants of the school believe that their right to think will be protected. District leaders keep this primary goal in focus as they make day-to-day decisions. Teachers' rights to be involved in the decisions affecting them are protected, as are the rights of those who choose not to be involved in decision making.

Since change and growth are viewed as intellectual processes, not events, we value the time invested in ownership, commitment, and learning.

Communications

Embedded in an organization's communications are expressions of what it prizes. Pick up any newspaper and you see a reflection of society's values in its major sections: sports, business and finance, and entertainment.

As a school becomes a home for the mind, the vision increasingly pervades all of its communications. In Palmdale, California, and Pinellas Park, Florida, report cards, teacher conferences, and other progress reports include indicators of the growth of students' intelligent behaviors: questioning, metacognition, flexibility of thinking, persistence, listening to others' points of view, and creativity (Costa 1985b).

Growth in students' thinking-abilities is assessed and reported in numerous ways, including teacher-made tests, structured observations, and interviews. Students maintain journals to record their own thinking and metacognition; they share, compare and evaluate their own growth of insight, creativity, and problem-solving strategies over time. Parents, too, look for ways in which their children are transferring intellectual growth from the classroom to family and home situations. In Westover Elementary School in Stamford, Connecticut, portfolios of students' work show how their organizational abilities, conceptual development, and creativity are growing. Test scores report such critical thinking skills as vocabulary growth, syllogistic thinking, reasoning by analogy, problem solving, and fluency.

Parents and community members in Sorento, Illinois, receive newspaper articles, calendars, and newsletters informing them of the school's intent and ways they can engage children's intellect (Diamandis and Obermark 1987/1988). "The Rational Enquirer" is the name given to the Auburn (Washington) School District's Thinking Skills network newsletter. In Verona and Waukesha, Wisconsin, parents attend evening meetings to learn how to enhance their children's intelligent capacities and behaviors (Feldman 1986).

Mottoes, slogans, and mission statements are visible everywhere. "LINCOLN SCHOOLS ARE THOUGHT-FULL SCHOOLS" is painted on one district's delivery trucks for all to see. In the Plymouth-Canton (Michigan) Public Schools, the superintendent distributes bookmarks reminding the community that thinking is the schools' goal, and "THOUGHT IS TAUGHT AT HUNTINGTON BEACH HIGH" is emblazoned on the schools' note pads. "MAKING THINKING HAPPEN" is printed on Calvin Coolidge Elementary School's letterhead in Shrewsbury, Massachusetts. "THINKING SPOKEN HERE" is a constant classroom reminder of Stockton, California, history teacher Dan Theile's explicit goals for students. "WE'RE TRAINING OUR BRAINS" is the motto on buttons proudly produced, sold, and worn by the special education students at Jamestown, Pennsylvania, Elementary School. "THE UNITED MIND WORKERS" was adopted as the name of the staff at Bleyl Junior High near Houston, Texas.

Tangible Support

How teachers, school administrators, and other leadership personnel expend their valuable and limited resources—time, energy, and money—signals the organization's value system. The Hanford (California) School Board provides a profound example of this point. The board requires elementary school principals to spend 50 percent of their time in curriculum and instructionally related activities. To ensure that this happens, administrative assistants were hired to provide support for principals.Personnel practices

The school that is becoming a home for the mind allocates financial resources to promote thinking. Irvine, California schools hired a full-time thinking skills resource teacher. Substitutes are hired so that teachers can be released to visit and coach each other. Staff members and parents are sent to workshops, courses, conferences, and inservice sessions to learn more about effective thinking and the teaching of thinking.

Instructional materials and programs related to thinking are purchased, and time is provided for planning, training teachers to use the materials, and gathering evidence of their effectiveness. Consultants discuss and report new learnings about intellectual development and implications for program improvement. Vignettes and "critical incidents" are recorded, described, and analyzed as indicators of students' application of critical and creative thinking skills and dispositions.

Administrators use their time and energy to visit classrooms, where they learn more about thinking and coach thinking skills instruction. Teachers spend time planning lessons and observing each other teach for thinking. Time in classrooms, as well, is allocated to thinking skills and talking about thinking.

Thus, we see that all members of the school community—students, teachers, administrators, classified personnel, board members, and parents—share a common vision of the school as a home for the mind. They continually work to sharpen that image, to clarify their goals, and to align daily practices with that vision of the future.

Process as Content

In the school that is becoming a home for the mind, development of the intellect, learning to learn, knowledge production, metacognition, decision making, creativity, and problem solving are the subject matter of instruction. Content is selected because of its contribution to process and thus becomes a vehicle for thinking processes.

Problem Solving, Decision Making, and Open Communication

Being committed to the improvement of intellectual growth, everyone in the school is willing to discuss their strategies for improving school climate, interpersonal relationships, and the quality of their interactions and problem solving. Students and school personnel practice, evaluate, and improve their listening skills of paraphrasing, empathizing, and clarifying and understanding.

At school board, administrative, and faculty meetings, decision-making processes are discussed, explained, and adopted. Process observers are invited to give feedback about the group's effectiveness and growth in decision-making, consensus-seeking, and communication skills.

Each group member's opinions and questions are respected. Disagreements are stated without fear of damaging relationships. Debates and critical assessment of alternative points of view are encouraged. Responsibility for "errors, omissions, and inadequacies" is accepted without blaming others. Responses are given and justified, and new ideas are advanced without fear of criticism or judgment. Group members' differing priorities, values, logic, and philosophical beliefs become the topics of analysis, dialogue, understanding, and further questions.

Continuing to Learn—Expanding the Knowledge Base

Knowledge about thinking and the teaching of thinking is vast, complex, uncertain, and incomplete (Marzano, Brandt, Hughes, Jones, Presseisen, Rankin, and Suhor 1987). We will never know it all, nor would we wish to reduce thinking to a simplistic, step-by-step lesson plan (Brandt 1987). In a school that is a home for the mind, the inhabitants continually expand their knowledge base: gaining more content, learning more about learning, and thinking more about thinking. They add to their repertoire of instructional skills and strategies, seeking greater diversity rather than conformity.

Knowing that the school's mission is to develop the intellect, teachers increasingly strive to invest thoughtful learning, craftsmanship, metacognition, and rigor into curriculum and instruction. They expand their repertoire of instructional skills and strategies to develop a wide range of reasoning, creative, and cooperative abilities in students.

Teachers increase their knowledge of the sciences, math, and humanities because it helps them ask more provocative questions that invite inquiry and critical thinking. A wider knowledge base supports the transfer of concepts across several subject areas and encourages appreciation for the disciplined methodologies of the great thinkers throughout history.

Teachers draw from their growing repertoire of knowledge about instructional techniques and strategies to make decisions based on goals, students' characteristics, and the context in which they are working. They vary their lesson designs according to students' developmental levels, cognitive styles, and modality preferences (Jones 1987).

While students expand their range of intelligent behaviors, teachers and administrators improve their own thinking skills and strategies by pursuing course work in philosophy, logic, and critical thinking. Thinking skills include not only knowing how to perform specific thought processes (Beyer 1985) but also knowing what to do when solutions to problems are not immediately known; study skills and learning-to-learn, reasoning, problem-solving, and decision-making strategies are important (Marzano and Arredondo 1986). Teachers and administrators learn about their own cognitive styles and how to cooperate with and value others who have differing styles. They learn how to cause their own "creative juices" to flow through brainstorming, inventing metaphor, synectics, and concept mapping.

Modeling

Thinking is probably best learned through imitation and emulation of good thinkers. Adults in the school that is becoming a home for the mind try to model the same qualities and behaviors they want students to develop. Teachers and administrators share their metacognitive strategies in the presence of students and others as they teach, plan, and solve problems (Jones 1987).

Staff members restrain their impulsiveness during emotional crises. They listen to students, parents, and each other with empathy, precision, and understanding. They reflect on and evaluate their own behaviors to make them more consistent with the core value that thoughtful behavior is a valid goal of education.

The School as a Community

Humans, as social beings, mature intellectually in reciprocal relationships with other people. Lev Vygotsky (1978) points out that the higher functions actually originate in interactions with others.

> Every function . . . in cultural development appears twice: first, on the social level, and later on the individual level; first between people (interpyschological), and then inside (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals.

Together, individuals generate and discuss ideas, eliciting thinking that surpasses individual effort. Together and privately, they express different perspectives, agree and disagree, point out and resolve discrepancies, and weigh alternatives. Because people grow via this process, collegiality is a crucial climate factor.

Collegiality

The essence of collegiality is that people in the school community are working together to better understand the nature of intelligent behavior. Professional collegiality at the district level is evident, such as in Grosse Pointe, Michigan, when administrators form support groups to assist and coach each other; when teachers and administrators from different schools, subject areas, and grade levels form networks to coordinate efforts to enhance intelligent behavior across all content areas and in district policies and practices. Committees and advisory groups assess staff needs, identify and locate talent, and participate in district-level prioritizing and decision making. They support and provide liaison with school site efforts; plan districtwide inservice and articulation to enhance teachers' skills; and develop an aligned, coordinated, and developmentally appropriate curriculum for students.

Selection committees for instructional materials review and recommend adoption of materials and programs to enhance students' thinking. Through districtwide networks, teachers share information and materials and teach each other about skills, techniques, and strategies they have found to be effective. The staff at Tigard, Oregon, call this "Think Link".

In schools, teachers plan, prepare, and evaluate teaching materials. In St. Paul, Minnesota, teachers visit each other's classrooms frequently to coach and give feedback about the relationship between their instructional decisions and student behaviors. In Chugiak, Alaska, high school teachers are members of "instructional skills teams." Together they prepare, develop, remodel, and rehearse lessons. They then observe, coach, and give feedback to each other about their lessons.

Teachers and administrators continue to discuss and refine their vision of the school as a home for the mind. Definitions of thinking and the teaching and evaluation of students' intellectual progress are continually clarified. Child-study teams keep portfolios of students' work and discuss each student's developmental thought processes and learning styles. Teams explore instructional problems and generate experimental solutions. Faculty meetings are held in classrooms where the host teacher shares instructional practices, materials, and videotaped lessons with the rest of the faculty. Teacher teams sequence, articulate, and plan for continuity, reinforcement, and assessment of thinking skills across grade levels and subject areas.

An Environment of Trust

People are more likely to engage and grow in higher-level, creative, and experimental thought when they are in a trusting, risk-taking climate (Kohn 1987). MacLean's (1978) concept of the triune brain illuminates the need for operating in an environment of trust. For the neomammalian brain (the neocortex) to become fully engaged in its functions of problem solving, hypotheses formation, experimentation, and creativity, the reptilian brain (R-complex) and the paleomammalian brain (limbic system) need to be in harmony. Under stress or trauma, the more basic survival needs demanded by the reptilian brain and the emotional security and personal identity required by the paleomammalian brain can override and disrupt the more complex neocortical functioning.

Because higher-order thinking is valued as a goal for everyone in the school, the school's climate is monitored continually for signs of stress that might close down complex and creative thinking. Risk-taking requires a nonjudgmental atmosphere where information can be shared without fear that it will be used to evaluate success or failure.

A climate of trust is evident when experiments are conducted with lesson designs, instructional sequences, and teaching materials to determine their effects on small groups of students (or with colleagues before they're used with a group). Various published programs and curriculums are pilot-tested, and evidence is gathered over time of the effects on students' growth in thinking skills. Teachers become researchers when alternative classroom arrangements and instructional strategies are tested and colleagues observe students interactions.

Appreciation and Recognition

Whether a work of art, athletic prowess, acts of heroism, or precious jewels, what is valued in society is given public recognition. Core values are communicated when people see what is appreciated. If thinking is valued, it, too, is recognized by appreciation expressed to students and to teachers and administrators as well.

Students are recognized for persevering, striving for precision and accuracy, cooperating, considering another person's point of view, planning ahead, and expressing empathy. Students applaud each other for acts of ingenuity, compassion, and persistence. The products of their creativity, cooperation, and thoughtful investigation are displayed throughout the school.

Teachers at Wasatch Elementary School in Salt Lake City give a "Blue Ribbon Thinking Award" to students who display intelligent behaviors. Similarly, teachers in East Orange, New Jersey, give certificates for "good thinking."

One form of appreciation is to invite teachers to describe their successes and unique ways of organizing for teaching thinking. In faculty meetings, teachers share videotaped lessons and showcase the positive results of their lesson planning, strategic teaching, and experimentation.

Schools within the district receive banners, flags, trophies, or certificates of excellence for their persistence, thoughtful actions, creativity, cooperative efforts, or meritorious service to the community. Some schools have even established a "Thinkers Hall of Fame."

Sharing, Caring, and Celebrating

Thinking skills are pervasive in schools that value thinking. They are visible in the traditions, celebrations, and everyday events of school life.

Staff members are often overheard sharing humorous anecdotes of students who display their thought processes.

("I saw two 7th grade boys on the athletic field yesterday ready to start duking it out. Before I could get to them, another boy intervened and said, 'Hey, you guys, restrain your impulsivity.'")

Teachers and administrators share personal, humorous, and sometimes embarrassing anecdotes of their own problems with thinking (tactics for remembering peoples' names, finding their car in the parking lot, or solving the dilemma of locking the keys in the car).

At career days, local business and industry leaders describe what reasoning, creative problem-solving, and cooperative skills are needed in various jobs. At school assemblies, students and teachers are honored for acts of creativity, cooperation, thoughtfulness, innovation, and scholarly accomplishments. Academic decathlons, thinking and science fairs, problem-solving tournaments, dialogical debates, invention conventions, art exhibits, and musical programs all celebrate the benefits of strategic planning, careful research, insightfulness, sustained practice, and cooperative efforts.

The Ultimate Purpose: Enhancing Student Thinking

A common vision, process as content, and the school as a community are not ends in themselves. We must constantly remind ourselves that the reason we construct our schools is to serve our youth.

As the cornerstones and building blocks of school climate are gradually cemented into a sturdy foundation, teachers will in turn create a classroom with corresponding climate factors that recognize and support growth in students' intelligent behaviors.

The vision of education as the development of critical thinking abilities is evident as students deliberate and persevere in their problem solving, as they work to make their oral and written work more precise and accurate, as they consider others' points of view, as they generate questions, and as they explore the alternatives and consequences of their actions. Students engage in increasingly rigorous learning activities that challenge the intellect and imagination. Such scholarly pursuits require the acquisition, comprehension, and application of new knowledge and activate the need for perseverance, research, and increasingly complex forms of problem solving.

Since such processes of thinking as problem solving, strategic reasoning, and decision making are explicitly stated as the content of lessons, they become the "tasks that students are on." The metacognitive processes engaged in while learning and applying the knowledge are discussed. Thus, students' thinking becomes more conscious, more reflective, more efficient, more flexible, and more transferable.

Collegiality is evident as students work together cooperatively with their "study-buddies," in learning groups, and in peer problem solving. In class meetings, students are observed learning to set goals, establish plans, and set priorities. They generate, hold, and apply criteria for assessing the growth of their own thoughtful behavior. They take risks, experiment with ideas, share thinking strategies (metacognition), and venture forth with creative thoughts without fear of being judged. Value judgments and criticisms are replaced by accepting, listening, empathizing with, and clarifying each other's ideas (Costa 1985a).

* * *

The Greeks had a word for it: paideia. The term, popularized by Adler's *Paideia Proposal* (1983), is an ideal concept we share: a school in which learning, fulfillment, and becoming more humane are the primary goals for all students, faculty, and support staff. It is the Athenian concept of a learning society in which self-development, intellectual empowerment, and lifelong learning are esteemed core values and all institutions within the culture are constructed to contribute to those goals.

References

Adler, M. J. (1983). *The Paideia Proposal: An Educational Manifesto.* New York: Macmillan.

Beyer, B. (April 1985). "Teaching Critical Thinking: A Direct Approach." *Social Education* 49, 4: 297–303.

Bloom, A. (1987). *The Closing of the American Mind.* New York: Simon and Schuster.

Brandt, R. (September 1988). "On the High School Curriculum: A Conversation with Ernest Boyer." *Educational Leadership* 46, 1: 4–9.

Brandt, R. (October 1987). "On Teaching Thinking Skills: A Conversation with B. Othanel Smith." *Educational Leadership* 45, 2: 35–39.

Costa, A. (1985a). "Teacher Behaviors That Enhance Thinking." In *Developing Minds: A Resource Book for Teaching Thinking*, edited by A. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Costa, A. (1985b). "How Can We Recognize Improved Students Thinking?" In *Developing Minds: A Resource Book for Teaching Thinking*, edited by A. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Costa, A., and R. Garmston (February 1985). "Supervision for Intelligent Teaching." *Educational Leadership* 42, 5: 70–80.

Costa, A., R. Garmston, and L. Lambert (1988). "Teacher Evaluation: A Cognitive Development View." In *Teacher Evaluation: Six Prescriptions for Success*, edited by S. Stanley and J. Popham. Alexandria, Va.: Association for Supervision and Curriculum Development.

Curwin, R., and A. Mendler (1988). *Discipline with Dignity.* Alexandria, Va.: Association for Supervision and Curriculum Development.

Deal, T. (1987). Presentation made at the 1987 ASCD Annual Conference, New Orleans, La.

Diamandis, L., and C. Obermark (December 1987/January 1988). *Bright Ideas—A Newsletter for Parents: Critical Thinking Activities for Kindergarten Children* 2, 2. Sorento, Ill.

Feldman, R. D. (November 11, 1986). "How to Improve Your Child's Intelligent Behavior." *Woman's Day.*

Frymier, J. (September 1987). "Bureaucracy and the Neutering of Teachers." *Phi Delta Kappan* 69, 1: 9–14.

Goodlad, J. (1984). *A Place Called School: Prospects for the Future.* New York: McGraw-Hill.

Harmon, W. (1988). *Global Mind Change.* Indianapolis, In.: Knowledge Systems, Inc. Published in cooperation with the Institute of Noetic Sciences, Sausalito, Calif.

Hirsch, E. D. (1987). *Cultural Literacy.* Boston, Mass.: Houghton Mifflin.

Jones, B. F. (1987). "Strategic Teaching: A Cognitive Focus." In *Strategic Teaching and Learning: Cognitive Instruction in the Content Areas.* Edited by B. F. Jones, A. S. Palinscar, D. Ogle, and E. Carr. Alexandria, Va.: Association for Supervision and Curriculum Development.

Kohn, A. (September 1987). "Art for Art's Sake." *Psychology Today* 21: 52–57.

MacLean, P. (1978). "A Mind of Three Minds: Educating the Triune Brain." In *Education and the Brain,* edited by J. Chall and A. Mirsky. Chicago: University of Chicago Press.

McClure, R. (1988). *Visions of School Renewal.* Washington, D.C.: National Education Association.

Marzano, R., and D. Arredondo (1986). *Tactics for Thinking.* Alexandria, Va.: Association for Supervision and Curriculum Development.

Marzano, R., R. Brandt, C. Hughes, B. F. Jones, B. Presseisen, S. Rankin, and C. Suhor. (1987). *Dimensions of Thinking.* Alexandria, Va.: Association for Supervision and Curriculum Development.

Pascarella, P. (1984). *The New Achievers.* New York: Free Press.

Perkins, D. (1983). *The Mind's Best Work: A New Psychology of Creative Thinking.* Cambridge, Mass.: Harvard University Press.

Ravitch, D., and C. Finn. (1987). *What Do Our 17-Year-Olds Know?* New York: Harper and Row.

Saphier, J. (1987). *Strengthening School Culture.* Presentation made at the 1987 ASCD Annual Conference, New Orleans, La.

Saphier, J., and M. King. (March 1985). "Good Seeds Grow in Strong Cultures." *Educational Leadership* 42, 6: 67–74.

Vygotsky, L. (1978). *Society of Mind.* Cambridge, Mass.: Harvard University Press.

PART III

What Is Thinking? Deciding on Definitions

> *Nothing worse could happen to one than to be completely understood.*
>
> —Carl Jung

CRITICAL THINKING

One of the major tasks of improving or installing a thinking skills program is deciding what thinking is.

Schools should have a somewhat common vision of what it is they are striving for in order to teach it.

CREATIVE THINKING

LATERAL THINKING

If you don't know what it is you're teaching for, how can you measure it? How do you know if kids are getting better at it?

Isn't BLOOM'S TAXONOMY enough?

HIGHER-LEVEL THINKING

The field of cognitive education today is fraught with different interpretations. The purpose of this part of this resource book is

NOT to provide you with the definition. Rather, it is intended to stimulate discussion. From these several definitions, you must adapt, modify, and decide which definition is most appropriate to your situation:

METACOGNITION

There is not unanimity.

REMEDIAL THINKING

There is confusion.

INTELLIGENCE

But the decision on definition is part of the inquiry process. That makes the process consistent with the product.

Just what do human beings do when they behave intelligently?

REASONING

12

Thinking Skills: Meanings and Models Revisited

Barbara Z. Presseisen

It is not best that : e should all think alike; it is difference of opinion which makes horse races.

—Mark Twain

Of the many tasks that confront educators in planning for thinking skills in the curriculum, few are more critical than determining what is meant by thinking or developing a model of the thinking process.

Currently, there is a great deal of interest in improving student thinking abilities, but there is also a great deal of confusion about what thinking is, the kinds of experiences or programs that advance it, and the implications of such efforts for school personnel and policies. This chapter provides a glossary of working definitions of thinking skills and some practical models to help form a taxonomy to explain the working relationships among different levels and different kinds of thought processes.

Definitions of Essential Thinking Skills

Thinking is generally assumed to be a cognitive process, a mental act by which knowledge is acquired. Although cognition may account for several ways that something may come to be known—as in perception, reasoning, and intuition—the current emphasis in thinking skills is on *reasoning* as a major cognitive skill. Consider, for example, the following definitions of thinking:

- "The mental derivation of mental elements (thoughts) from perceptions and the mental manipulation/combination of these thoughts" (Cohen 1971, p. 5).
- "The mental manipulation of sensory input to formulate thoughts, reason about, or judge" (Beyer 1984a).
- "The extension of evidence in accord with that evidence so as to fill up gaps in the evidence: and this is done by moving through a succession of interconnected steps which may be stated at the time, or left till later to be stated" (Bartlett 1958, p. 75).

Several interesting aspects underlie these definitions of thinking. Thinking processes are related to other kinds of behavior and require active involvement on the part of the thinker. Notable products of thinking—thoughts, knowledge, reasons—and higher processes, like judging, problem solving, or conducting critical analyses, can also be generated. Complex relationships are developed through thinking, as in the use of evidence over time. These relationships may be interconnected to an organized structure and may be expressed by the thinker in a variety of ways. If anything, these definitions indicate that thinking is a complex and reflective endeavor as well as a creative experience. Such meanings are highly reminiscent of Dewey's original 1910 writing (see Dewey 1933).

Current literature on thinking presents multiple lists of cognitive processes that can be considered thinking skills. It is dangerous to confuse one level of thinking with another in terms of its power or significance. Beyer (1984b) stresses the importance of defining skills accurately and suggests reviewing the work of researchers like Bloom, Guilford, and Feuerstein to find useful definitions. Clear definitions, Beyer maintains, do not confuse distinctly different processes like inquiry and simple recall. Furthermore, consistent with other

This revised chapter is based on work funded by the Office of Educational Research and Improvement (OERI), U.S. Department of Education. The opinions do not necessarily reflect the position of the Department of Education, and no official endorsement by OERI should be inferred.

researchers of cognitive processes, Beyer distinguishes between lower, essential skills and complex, multiple-process strategies. For example, there is great difference between picking identical examples of a particular insect and finding the antidote to the sting of the same insect. One task involves the basic processes of identification and comparison; the other requires multiple, sophisticated, replicable, and sequential steps of problem solving.

What are the basic essential skills of thinking? Nickerson (1981) suggests that no one taxonomy exists. Educators would be wise, he advises, to select abilities that represent what they want students to be able to do and incorporate these particular skills into their curriculums and school programs. Researchers' lists can be the basis of such selections, and a number of such resources are now available for practitioners to use (Marzano, Brandt, Hughes, Jones, Presseisen, and Suhor 1988). Consider, for example, the categories of skills suggested by Bloom, Englehart, Furst, Hill, and Krathwohl (1956) and Guilford (1967).

Bloom's Taxonomy	*Guilford's Structure of Intellect*
Knowledge	Units
Comprehension	Classes
Application	Relations
Analysis	Systems
Synthesis	Transformations
Evaluation	Implications

Each of Bloom's cognitive categories includes a variety of thinking skills and indicates the kind of behavior students are to perform as the objectives or goals of specific learning tasks. For example:

- *Knowledge*: Define, recognize, recall, identify, label, understand, examine, show, collect.
- *Comprehension*: Translate, interpret, explain, describe, summarize, extrapolate.
- *Application*: Apply, solve, experiment, show, predict.
- *Analysis*: Connect, relate, differentiate, classify, arrange, check, group, distinguish, organize, categorize, detect, compare, infer.
- *Synthesis*: Produce, propose, design, plan, combine, formulate, compose, hypothesize, construct.
- *Evaluation*: Appraise, judge, criticize, decide.

Some of these tasks are also evident in Guilford's six categories. For example:

- Recognizing a particular object is a *units* skill.
- Showing a group of similarly colored or shaped objects is a *classes*-based task.
- Forming a geometric structure out of six matchsticks is a *systems* task.

In both researchers' work, there are some unstated dimensions to the thinking skills sequence. Tasks generally move from simpler to complex operations, from more observable and concrete to abstract dimensions, and from an emphasis on working with known materials toward creating or inventing new, previously unknown approaches or materials. Guilford is interested in both convergent and divergent operations, and his ultimate goal is a thorough exposition of the nature of intelligence.

Since the initial work of Bloom and Guilford, a greater concern for the developmental appropriateness of tasks or thinking skills has emerged. Hudgins' (1977) study of thinking and learning emphasizes Piaget's research on the development of thinking processes as the child grows intellectually. This research assumes that there is a regular sequence to children's cognitive development, but not precisely in direct age correlates. Piaget (1970) suggests that youngsters first entering school are mostly "preoperational" or dominated by their perceptions. Gradually, and depending on the quality of their mental interactions, students develop systematic explanations or concrete rules for resolving conflicting situations or explaining diverse phenomena; they form conceptualizations. By their early teens, most students develop the ability to perform higher forms of cognitive operations: they learn to vary interpretations or descriptions in abstract form and to construct formal explanations of cause and effect. Somehow, says Hudgins, the scope of thinking skills expressed in a K–12 curriculum needs to relate to this developmental and cumulative sequence, as well as to the empirical research it represents. The relationship of particular subject matter to the specific skills to be learned also may be of developmental consequence.

One troubling note in the development of educators' interest in teaching thinking to America's students is that many students do *not* learn to think effectively (Presseisen 1988). They do not become proficient in the essential, or basic, thinking skills. Some students fail to complete their schooling and either are pushed out or drop out of school before graduation. Others continue through the system, but fail to learn to use their minds independently or are unable to perform the higher-order thinking skills associated with adult behavior. This is a population "at risk." Whether they have failed to be "mediated," as Feuerstein (1980) would suggest, or whether they cannot master the tasks of complex information demands, as Sternberg (1983) sees the problem, these students face great obstacles in a world that increasingly requires them to think.

Another issue regarding essential thinking skills is the concern for various models of thinking that are available to the learner, such as types of symbol systems. Much school learning involves linguistic or verbal abilities as well as quantitative, numerical reasoning. Spatial or visual depictions of mental processing are becoming more significant to instruction, especially with the advent of video technologies in the classroom. How do these different modalities or modes of thinking influence cognitive development? How can different approaches to learning be incorporated into instruction so that skill development is enhanced for every youngster, regardless of cultural background or socioeconomic well-being? Today these are open research questions in teaching thinking.

The testing of basic cognitive ability also reflects a field currently in flux. Although lower level skills of memory and recall are still part of nearly every standardized test battery, there is general agreement among researchers that more complex cognitive operations and creative relationships, like metaphors and analogies, are equally important to assess. Differing modalities appear on student tests. For example, the *Developing Cognitive Abilities Test* (1980) is designed around a content format that uses Bloom's Taxonomy and a three-mode organization of content—verbal, quantitative, and spatial—for students in grades 3–12. Other emergent thinking assessments, including statewide testing, now stress performance rather than mere information acquisition and emphasize the *use* of thinking skills in various modalities within an integrative content approach (Baron, Forgrove, Rindone, Kruglanski, and Davey 1989). Formats of continuous progress and the gradual building of portfolio collections of student work are yet other proposed directions for assessing students' thinking in essential skills (Wolf 1989).

Ideally, then, there are a host of candidates for a basic thinking skills taxonomomy. In planning a curricular sequence, teachers should consider the developmental level of the learners, the mode of presenting information to them, the subject matter involved, and the testing program to assess mastery. At least five categories of thinking skills merit consideration. Figure 1 presents a model of such a first-order, operational taxonomy. This is not the only model of a list of essential skills; the list in a popular framework presents an alternative design, including 21 core skills in 8 categories (Marzano et al. 1988, p. 69). What is important is that educators develop and use a common design to link essential skills to higher-order, more complex operations.

FIGURE 1

A Model of Thinking Skills: Basic Processes

CAUSATION—*establishing cause and effect, assessment:*
- Predictions
- Inferences
- Judgments
- Evaluations

TRANSFORMATIONS—*relating known to unknown characteristics, creating meanings:*
- Analogies
- Metaphors
- Logical inductions

RELATIONSHIPS—*detecting regular operations:*
- Parts and wholes, patterns
- Analysis and synthesis
- Sequences and order
- Logical deductions

CLASSIFICATION—*determining common qualities:*
- Similarities and differences
- Grouping and sorting, comparisons
- Either/or distinctions

QUALIFICATIONS—*finding unique characteristics:*
- Units of basic identity
- Definitions, facts
- Problem/task recognition

FROM SIMPLE TO COMPLEX DEVELOPMENT

Complex Thinking Processes

The five categories suggested in Figure 1 are essential thinking skills. The complex processes involved in thinking skills programs—the "macro-process strategies"—are based on the essential skills, but use them for a particular purpose. Cohen (1971, p. 26) distinguishes processes that rely on external stimuli and seek to be productive, such as making judgments or problem resolution, from processes that depend about equally on external and internal stimuli and seek to be creative. He suggests at least four different complex thinking processes:

- *Problem Solving*—using basic thinking processes to resolve a known or defined difficulty; assemble facts about the difficulty and determine additional information needed; infer or suggest alternate solutions and test them for appropriateness; potentially reduce to simpler levels of explanation and eliminate discrepancies; provide solution checks for generalizable value.
- *Decision Making*—using basic thinking processes to choose a best response among several options; assemble information needed in a topic area; compare advantages and disadvantages of alternative approaches; determine what additional information is required; judge the most effective response and be able to justify it.
- *Critical Thinking*—using basic thinking processes to analyze arguments and generate insight into particular meanings and interpretations; develop cohesive, logical reasoning patterns and understand assumptions and biases underlying particular positions; attain a credible, concise, and convincing style of presentation, mode, or argument.
- *Creative Thinking*—using basic thinking processes to develop or invent novel, aesthetic, constructive ideas or

products, related to percepts as well as concepts, and stressing the initiative aspects of thinking as much as the rational. Emphasis is on using known information or material to generate the possible, as well as to elaborate on the thinker's original perspective or design.

These complex processes obviously draw on and elaborate on the underlying essential skills. Certain of the essential skills may be more significant to one complex process than to others, but current research has not necessarily clarified a discrete understanding of such relationships. What seems most important is that young learners develop competence in the essential skills during the early years of schooling, and then—in middle or junior high school—are introduced to the more complex processes in specific content matter that is fairly closely related to the use of such skills.

Middle school or early junior high school is an appropriate time for introducing instruction about higher-order skills or complex thinking processes. The adolescent learner's growing cognitive capacities offer ripe opportunities for the challenge of more complex thinking (Presseisen 1982). Elementary students can benefit from early exposure to varied thinking processes and to different media of presentation, but probably can only approach more complex sequences as they gain experience and apply similar skills in multiple content areas. Beyer (1984c) suggests that an effective thinking skills curriculum will introduce only a limited number of skills at a particular grade level, will teach these across all appropriate content areas, and will vary the media and content of presentation. Subsequent grades should enlarge the thinking skills base and provide additional, and more elaborate, applications of skills already introduced.

Some complex thinking processes may be more relevant to certain subject areas than to others. For example, problem-solving thinking skills seem ideal for mathematics or science instruction. Decision making may be useful for social studies and vocational studies; critical thinking may be more relevant for the debate team, language arts class, and problems of democracy or American government courses. Creative thinking might enhance all subjects, as well as be particularly meaningful to art, music, or literature programs. Most important, the goals of the specific complex-process and objectives for learning in the particular subject area should be parallel and reinforcing.

Figure 2 presents a suggested model of complex thinking processes. The relationship of any one process to the underlying essential skills is tentatively drawn and is relative to the skills presented in Figure 1. Other potential complex processes might be examined in terms of how they compare to the four strategies presented relative to underlying characteristics and ultimate outcomes.

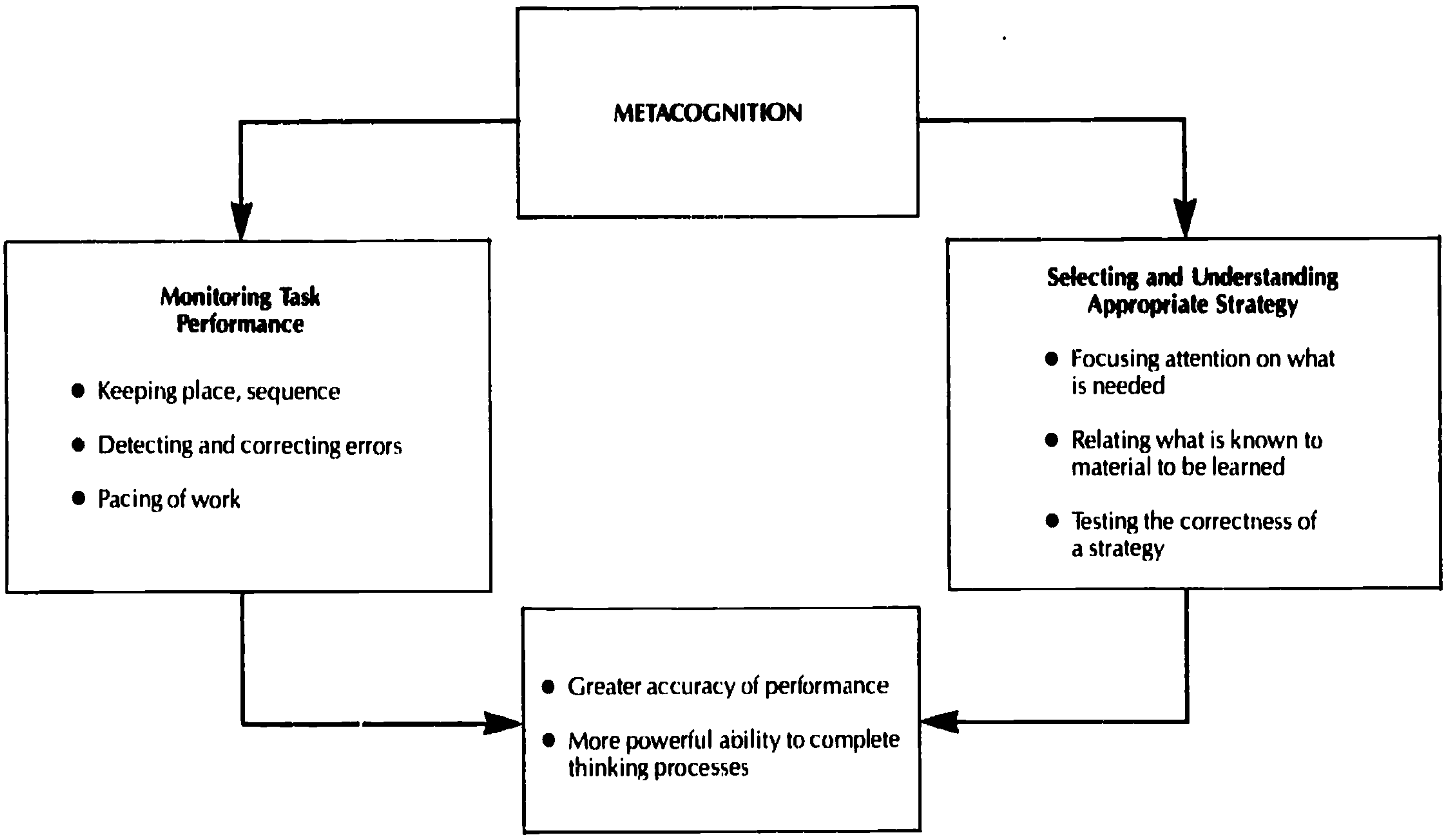
Metacognition and Thinking

A useful taxonomy of thinking must somehow account for metacognitive aspects of the current thinking skills movement. According to Flavell (1976, p. 232), " 'Metacognition' refers to one's knowledge concerning one's own cognitive processes and products." Learners must actively monitor their use of thinking processes and regulate them according to their cognitive objectives. Henle (1966) considers such regulation the essence of autonomous self-education. Costa (1983) suggests that this ability to "know what we know and what we don't know" is a uniquely human trait, but not

FIGURE 2
A Model of Thinking Skills: Complex Processes

HIGHER-ORDER SKILL	**PROBLEM SOLVING**	**DECISION MAKING**	**CRITICAL THINKING**	**CREATIVE THINKING**
Task	Resolve a known difficulty	Choose a best alternative	Understand particular meanings	Create novel or aesthetic ideas/products
Essential Skills Emphasized	Transformations Causation	Classifications Relationships	Relationships Transformations Causation	Qualification Relationships Transformations
Yields	Solution Generalization (potentially)	Response	Sound reasons, proof, theory	New meanings, pleasing products

FIGURE 3
A Model of Metacognitive Thinking Skills



necessarily one that all adults acqu 'e. He proposes metacognitive skills as a key attribute of formula thinking or higher-process skills instruction and stresses that the teacher's classroom methodology must constructively deal with metacognition. Other researchers maintain that metacognitive skills are also significant factors in developing subject-skilled performers.

One of the most salient characteristics of metacognition is that it involves growing consciousness. One becomes more aware of the thinking processes themselves and their specific procedures, as well as more conscious of oneself as a thinker and performer. As learners acquire understanding of what the various thinking processes are, they can better understand and apply them. Thus, some researchers (see Beyer 1983) suggest that, initially, thinking skills be taught directly and in relatively content-free situations.

Metacognitive thinking has two main dimensions. The first is task oriented and relates to monitoring the actual performance of a skill. The second dimension is strategic; it involves using a skill in a particular circumstance and being aware of getting the most informative feedback from carrying out a particular strategy. Figure 3 elaborates on these dimensions.

Monitoring task performance requires learners to watch their own activities. Students cannot tell if they are at the right place if they are not aware of the assigned task and the directions for completing it. They might be advised to discriminate subgoals of a task and relate them to ultimate objectives. In mathematics problems involving reading, for instance, students might identify addition or subtraction as an appropriate operation before actually determining a final answer. Detecting errors while working may involve checking or proofreading, rereading passages, or recalculating or retranslating material. Allocating time across work or checking coverage in qualitative dimensions ("Is my outline extensive enough?") are aspects of pacing the completion of an assignment. The metacognitive thesis is that any and all of these behaviors can enhance the success of particular task performance. Often these same behaviors are also characteristic of sound study skills programs.

In terms of selecting appropriate strategies to work by, metacognitive theory suggests that the first order of learning is to recognize the particular problem and determine what information is needed to resolve it and where to obtain it. Through such consideration, the student comes to recognize the limitations of the learning and the ultimate boundaries of the solution being sought. Sternberg (1984) considers these the "executive processes" of sound reasoning. Flavell (1976, p. 234) refers to the various aspects of information retrieval in learning to think—remembering, monitoring, and updating information—and draws parallels between classroom learning and experiences involving thinking in the world outside school. Henle (1966, p. 57) suggests that recognizing what is understood and to what degree ultimately helps learners to come to terms with the power of their own thoughts. Consider, for example, the importance of knowing the difference between a wild guess, an informed guess, a hypothesis, an intuition, and a fact. Finally, testing the accuracy of a strategy provides an opportunity to apply varying sets of evaluative criteria and to determine if, in fact, the right approach is being employed. The learner has an opportunity to assess the initial selection of strategy, as well as to develop insight into a potentially better choice. A more holistic understanding of strategy and the development of fluency or competence in a particular strategy are involved in this type of learning. From the metacognitive viewpoint, the thinker becomes more autonomous as these skills are developed and refined.

Conation and the Importance of Affect and Environment

Researchers have recently emphasized the influence of the more affective aspects of thinking on students' cognitive performance (e.g., McCombs and Marzano 1989). Conation, the *striving* to think clearly, including *disposition*—the inclination to develop and use attitudes and practices over time—may be crucial to the fostering of thoughtful learners. Metacognitive understanding assumes a relationship between "skill and will" that enables a problem solver to stick to a task, to persevere in searching for an adequate solution, and to check if an answer continues to fit. Ennis (1986) has developed a list of important dispositions that are essential to the acts of critical thinking and analytical pursuit, and he emphasizes the importance of developing these personal inclinations throughout a lifetime. Beyer (1984a) stresses the significance of learning such behaviors through modeling in the classroom and with guided practice inspired by a cognizant coach.

Recently, the research of the Soviet psychologist Lev Vygotsky has begun to show its influence on the development of a theory of teaching and schooling (Wertsch 1985). Taking social and behavioral views of human development, a number of social scientists propose that higher-order thinking develops out of social interaction; they emphasize the importance of context and interaction in cognitive instruction (Tharp and Gallimore 1988). The conditions of the classroom as a supportive environment for learning, as well as the teacher's role as a thoughtful mediator and model of thinking *and* disposition, become key aspects of this emergent theory. These researchers emphasize the need for user-friendly settings for learning, particularly for children from multicultural backgrounds. At the same time, these researchers state, the environment should be carefully planned for gradual and steady cognitive improvement.

The Vygotskian model is not without relevance to learning to think in specific contexts, as well. "Hands-on learning," an approach parallel to the Russian researcher's "zone of proximal development," has special meaning for learning to appreciate the interplay of concrete experience and theoretical abstraction. By manipulating objects in science classes, for example, students may test their own hypotheses, as well as those of their classmates, while the teacher seeks to communicate about the principles or concepts of the discipline itself. Such social interaction in the classroom, coupled with discovery and evaluative feedback, provides for the mediation of learning. Research seems to indicate that both metacognition and conation contribute to the real transfer of knowledge. Students experience the excitement of the creation of knowledge. This excitement is not only contagious, but also has a long-term influence on a student's personal learning behavior and the understanding of such behavior.

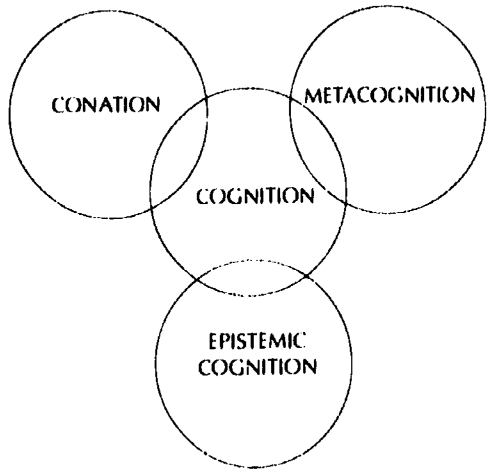
Toward a Common Understanding

When we focus on what we mean by thinking, we need to consider the various levels of thought that humans are capable of. The complexity of the cognitive process becomes evident. A four-part model has been generated by this examination:

- *Cognition*—the skills associated with essential and complex processes.
- *Metacognition*—the skills associated with the learner's awareness of his or her own thinking.
- *Epistemic Cognition*—the skills associated with understanding the limits of knowing, as in particular subject matter and the nature of the problems that thinkers can address.
- *Conation*—the striving to think clearly, including personal disposition, which is the inclination to develop and use attitudes and practices over time.

Figure 4 depicts this global view of thinking.

FIGURE 4
A Global View of Thinking



Once this four-part taxonomy is considered, educators can examine the kinds of material available to them for enhancing thinking instruction in the classroom. They may also become aware of the need to devote attention to relating thinking to current school programs and to teachers' understanding of what thinking is and what it means to student development and classroom instruction. The supportive nature of the school's environment and the quality of interaction in the classroom also become concerns of cognitive instruction. How to assess student achievement in the various abilities related to thinking is also a prominent issue.

Without a common understanding of what we mean by thinking, we cannot even begin to address the extensive problems associated with the development of students' higher cognitive performance.

REFERENCES

Baron, J. B.; P. D. Forgione, Jr.; D. A. Rindone; H. Kruglanski; and B. Davey. (1989). *Toward a New Generation of Student Outcome Measures: Connecticut's Common Core of Learning Assessment.* Hartford: Connecticut State Department of Education.

Bartlett, F. C. (1958). *Thinking: An Experimental and Social Study.* London: Allen and Unwin.

Beyer, B. K. (November 1983). "Common Sense About Teaching Thinking Skills." *Educational Leadership* 41, 3: 44–49.

Beyer, B. K. (February 1984a). "Practical Approaches to Teaching Thinking Skills in Every Classroom." Program presented at a National Curriculum Study Institute of the Association for Supervision and Curriculum Development, San Francisco.

Beyer, B. K. (March 1984b). "Improving Thinking Skills—Defining the Problem." *Phi Delta Kappan* 65, 7: 487.

Beyer, B. K. (April 1984c). "Improving Thinking Skills—Practical Approaches." *Phi Delta Kappan* 65, 8: 559.

Bloom, B. S., ed.; M. D. Englehart, E. J. Furst, W. H. Hill, and D. R. Krathwohl. (1956). *Taxonomy of Educational Objectives, Handbook I: Cognitive Domain.* New York: David McKay.

Cohen, J. (1971). *Thinking.* Chicago: Rand McNally.

Costa, A. L. (July–August 1983). "*Mediating the Metacognitive.*" *Human Development 26.*

Developing Cognitive Abilities Test, Teacher's Manual. (1980). Glenview, Ill.: Scott, Foresman.

Dewey, J. (1933). *How We Think.* Boston: D.C. Heath.

Ennis, R. H. (1986). "A Taxonomy of Critical Thinking Dispositions and Abilities." In *Teaching Thinking Skills: Theory and Practice,* edited by J. B. Baron and R. J. Sternberg. New York: W. H. Freeman.

Feuerstein, R. (1980). *Instrumental Enrichment: An Intervention Program for Cognitive Modifiability.* Baltimore: University Park Press.

Flavell, J. H. (1976). "Metacognitive Aspects of Problem Solving." In *The Nature of Intelligence,* edited by L. B. Resnick. Hillsdale, N.J.: Lawrence Erlbaum.

Guilford, J. P. (1967). *The Nature of Human Intelligence.* New York: McGraw-Hill.

Henle, M. (1966). "Cognitive Skills." In *Learning About Learning: A Conference Report,* edited by J. S. Bruner. Washington, D.C.: U.S. Department of Health, Education, and Welfare.

Hudgins, B. B. (1977). *Learning and Thinking: A Primer for Teachers.* Itasca, Ill.: F. E. Peacock.

Marzano, R. J., R. S. Brandt, C. S. Hughes, B. F. Jones, B. Z. Presseisen, and C. Suhor. (1988). *Dimensions of Thinking: A Framework for Curriculum and Instruction.* Alexandria, Va.: Association for Supervision and Curriculum Development.

McCombs, B. L., and R. J. Marzano. (September-October 1989). "Integrating Skill and Will in Self-Regulation." *Teaching Thinking and Problem Solving* 11: 1–4.

Nickerson, R. S. (October 1981). "Thoughts on Teaching Thinking." *Educational Leadership* 39, 2: 21.

Piaget, J. (1970). "Piaget's Theory." In *Carmichael's Manual of Child Psychology, Volume I,* edited by P. H. Mussen. New York: John Wiley and Sons.

Presseisen, B. Z. (1982). *Understanding Adolescence: Issues and Implications for Effective Schools.* Philadelphia, Pa.: Research for Better Schools, Inc.

Presseisen, B. Z., ed. (1988). *At-Risk Students and Thinking: Perspectives from Research.* Washington, D.C., and Philadelphia, Pa.: National Education Association Publications and Research for Better Schools, Inc.

Sternberg, R. J. (February 1983). "Criteria for Intellectual Skills Training." *Educational Researcher* 12, 2: 6–12, 26.

Sternberg, R. J. (January 1984). "What Should Intelligence Tests Test? Implications of a Triarchic Theory of Intelligence for Intelligence Testing." *Educational Researcher* 13, 1: 5–15.

Tharp, R. G., and R. Gallimore. (1988). *Rousing Minds to Life: Teaching, Learning, and Schooling in Social Context.* New York: Cambridge University Press.

Wertsch, J. V., ed. (1985). *Culture, Communication, and Cognition: Vygotskian Perspectives.* New York: Cambridge University Press.

Wolf, D. P. (April 1989). "Portfolio Assessment: Sampling Student Work." *Educational Leadership* 46, 7: 35–39.

13
The Good Thinker

Allan A. Glatthorn and Jonathan Baron

Thought alone is eternal.

—Owen Meredith

Schools that are planning to teach critical thinking are surrounded by what seems to be a bewildering variety of programs. It would be helpful to have a theory of critical thinking that would allow educators to assess the theoretical soundness and effectiveness of such programs. In this chapter we describe one such theory and discuss its implications for educational practice.

Baron's Model of the Good Thinker

The model proposed by Baron (1985) is based on a philosophical argument in the tradition of Dewey (1933), but is consistent with empirical evidence as well. Before we describe it in detail, we would like to point out two important features.

First, it is a model of *conscious* thinking. In conscious thinking, we are aware of thinking; we can follow instructions about its processes and evaluate our use of those processes. In unconscious thinking, much of the thinking work is taken over by subconscious processes. Baron's model focuses on conscious thinking because only conscious thinking can be influenced directly by pedagogical interventions.

Second, it is a *general* model that provides insight into several types of thinking; it is not domain- or discipline-specific. It presents a picture of, for instance, how a mechanic diagnoses a problem with a car engine and how a principal chooses a method to improve school attendance. In essence, the model involves several closely related processes or phases.

- *Thinking begins with a state of doubt about what to do or believe.* As Dewey (1933) noted, all conscious thought has its genesis in uncertainty; the individual is confronted with a problematic situation.
- *We usually have a goal in mind when the doubt arises, but we may search for new goals, subgoals, or a reformulation of the original goal.* The goal is the state we wish to achieve, such as a new insight or an effective solution. Implicit in each goal is a question that we want to answer: "What is wrong with the car?" "What methods will increase attendance?"
- *We search for possibilities.* Possibilities are possible answers to the question implicit in the goal. They are the alternate routes or options to solution. Each possibility has a strength—a measure of the value we accord that possibility. The strength is a subjective assessment of the closeness of the solution to the goal, and is always determined from our personal perspective, not from an outsider's viewpoint. While we may be influenced by the views of others, it is our own assessment of strength that makes the difference.
- *We search for evidence relative to the possibilities.* Evidence is needed to evaluate possibilities. We search for arguments, scenarios, analogies, and facts that bear on the possibilities.
- *We use the evidence to revise the strengths of the possibilities.* Each piece of evidence has a subjective weight for each possibility. We may either overreact or minimize this weight.
- *We decide that the goal is reached and conclude the search.* At a certain point we terminate the search for goals, possibilities, and evidence, deciding that further searching would be counterproductive.

The most important components of the model are the three search processes—the search for goals, the search for possibilities, and the search for evidence. At times these searches are active—we exclude all other conscious activities. At other times they are inactive—we postpone judgment while pursuing other activities. Note also that while the processes are presented here in a linear form, they do not all occur consciously in every thought sequence and are ordinarily not used in a linear order.

Common Types of Thinking

When we examine the types of thinking that are essential to certain activities, we need to ask whether there is too much or too little thinking (relative to a range that would be optimal for the thinker's rational goals), but we usually cannot ask whether thinking occurs at all. There are nine types of thinking.

Diagnosis is troubleshooting, for which we use our hypothesis about the source of the problem. The evidence may consist of the results of tests we have performed. The goal is usually fixed. "My car stalls at corners—what's going wrong?"

Hypothesis testing is the process of forming and testing theories, just as scientists test theories. During hypothesis testing, the goal is often changed. Scientists frequently discover the real question while trying to answer some other question.

Reflection is the search for general principles or rules based on evidence gathered largely from memory: "What general principle might explain why teachers often ignore curriculum guides?" "What are the rules for simplifying algebraic expressions?" We search for possible answers, new questions, and evidence that supports the possible answers. Here the search for evidence is under considerable control; we might direct our memories to provide evidence either for or against a given possibility. Philosophers and other scholars spend most of their time reflecting. It is a major component of Lipman's "Philosophy for Children" program (Lipman, Sharp, and Oscanyon 1980).

Insight is the "eureka" phenomenon. Solutions come suddenly and with certainty. In insight problems it is only the search for possibilities (possible answers or approaches) that seems under control; the search for and use of evidence are usually immediate. In this sense, insight problems are atypical of most thinking.

Artistic creation is also an important type of conscious thinking. The possibilities are the components of the work itself, such as the images in a poem, the colors in a painting, or the movements in a dance. The weight of the evidence for a given possibility is the artist's critical reaction to the evidence itself. In creative tasks the search for goals is under full control and is usually crucial for success.

Prediction is similar to reflection, but the search for goals may not be as controllable. The evidence usually consists of memories of past situations and analogous cases.

Decision making is a type of thinking in which the possibilities are courses of actions or plans. The evidence usually consists of imagined consequences. Decision making may be one of the most important types of thinking, since it includes the selection of strategies for other mental tasks.

Behavioral learning involves learning about the effects of one's conduct. When we learn behaviorally, we try to accomplish tow goals—to learn about the situation (for example, to learn how to cook) and to obtain success with the task at hand (to produce an edible meal). Often these goals compete. Repeating some action that has worked in the past might result in success, but it might also preclude the experimentation that is needed for learning. The same issues come up when we learn specific heuristics for problem solving or writing.

Learning from observation includes all cases in which we learn about the environment through observation alone, without voluntary experimentation. In this sense, most language learning is a type of learning from observation, as are most types of culturally transmitted knowledge. In this type of thinking, the search for evidence is not controllable at all.

Good Thinking vs. Bias

Without corrective intervention, there are two general biases that may occur. First, we might search too little, give up too soon, or be too satisfied with the first possibilities, evidence, and goals that enter our minds. We tend to do this because the cost of thinking—time, effort, and lost opportunity—is immediate, but the benefits of thinking—increased knowledge and better decision—are usually in the future. Thus, learning to think well is a problem of self-control, just like saving money.

The second bias is that we may not be sufficiently self-critical. We might seek evidence that supports, rather than conflicts with, out initial ideas, and we might ignore contrary evidence or fail to try to think of alternatives. This bias allows us to stop thinking early. Thus the first bias reinforces the second.

Both biases are difficult to correct without help, for those of us who are not self-critical or who give up early will never have a chance to experience the beneficial effects of better thinking. Of course, there are people who think too much or are too self-critical. But according to the theory, those people are victims of too much education.

Good Thinking vs. Poor Thinking

This model helps us make some valid and useful distinctions between good and poor thinking. Here we wish to distance ourselves from those who equate good thinking with a long list of discrete mental operations and those who describe poor thinking in terms of several logical errors. We argue for the analysis summarized in Figure 1. This analysis enables researchers and educators to focus attention on a smaller number of critical attributes. For clarity, Figure 1 contrasts good thinkers with poor thinkers; however, we do not mean to suggest that individuals should be so categorized. A person can be, for example, a good thinker in financial matters and a poor thinker in personal matters.

Given this caveat, we begin by noting that there are some general traits that characterize good thinkers. Good thinkers are willing to think, and may even find thinking enjoyable. They can carry out searches when necessary and suspend judgment. They value rationality, believing that thinking is useful for solving problems, reaching decisions, and making judgments. Poor thinkers, in contrast, need certainty, avoid thinking, must reach closure quickly, are impulsive, and rely too heavily on intuition.

These traits are predictably manifested throughout the three searches. When searching for goals, good thinkers are deliberative and take the time necessary to reflect on several possible goals; poor thinkers are impulsive and choose one of the first goals that come to mind. Like scientists, good thinkers can identify new goals while working on others; they can put aside the original question when a more basic one appears. Poor thinkers are reluctant to change goals, believing that changing one's course is a mark of weakness.

When searching for possibilities, good thinkers again manifest deliberateness; they can wait to find additional possibilities; and they are open to multiple options, since most problems permit several solutions. Poor thinkers prefer to consider only a few possibilities—"There are only two sides to every question"—or, even worse, only one.

When searching for and using evidence, the differences are marked. Good thinkers deliberately search for evidence that opposes the favored possibilities, as well as evidence that supports them. Poor thinkers, on the other hand, search only for confirming evidence. Good thinkers use evidence, whether or not it supports the favored possibilities; poor thinkers ignore negative evidence. Psychologists who have

FIGURE 1
Good Thinking vs. Poor Thinking

ASPECT:	THE GOOD THINKER:	THE POOR THINKER:
General Traits	• Welcomes problematic situations and is tolerant of ambiguity.	• Searches for certainty and is intolerant of ambiguity.
	• Is sufficiently self-critical; looks for alternate possibilities and goals; seeks evidence on both sides.	• Is not self-critical and is satisfied with first attempts.
	• Is reflective and deliberative; searches extensively when appropriate.	• Is impulsive, gives up prematurely, and is overconfident of the correctness of initial ideas.
	• Believes in the value of rationality and that thinking can be effective.	• Overvalues intuition, denigrates rationality; believes that thinking won't help.
Goals	• Is deliberative in discovering goals.	• Is impulsive in discovering goals.
	• Revises goals when necessary.	• Does not revise goals.
Possibilities	• Is open to multiple possibilities and considers alternatives.	• Prefers to deal with limited possibilities; does not seek alternatives to an initial possibility.
	• Is deliberative in analyzing possibilities.	• Is impulsive in choosing possibilities.
Evidence	• Uses evidence that challenges favored possibilities.	• Ignores evidence that challenges favored possibilities.
	• Consciously searches for evidence against possibilities that are initially strong, or in favor of those that are weak.	• Consciously searches only for evidence that favors strong possibilities.

studied the persistence of irrational beliefs attribute such persistence to this bias in searching for and using evidence (see, for example, Nisbett and Ross 1980; Baron 1985).

Fostering Good Thinking: The Classroom Climate

Our goal as educators is to foster the development of the "good thinker" attributes while helping students understand the limitations of contrary dispositions and behaviors. One fundamental approach is to provide a classroom climate conducive to and supportive of the attributes of good thinking. The model suggests three crucial elements.

A spirit of inquiry. The classroom where thinking is fostered is one where inquiry is valued. The teacher admits uncertainty: "We're not really sure how evolution works." "I'm not sure about my interpretation of the poem—I continue to see other things in it." The teacher welcomes intellectual challenges: "You're right in raising that issue—I need to re-think that matter." The teacher also emphasizes education in all subjects as an exploration into the unknown, as well as teaching what is known. And the teacher repeatedly conveys his or her own belief in the value of thinking. Intuition is valuable, but intelligent people look beyond their hunches.

An emphasis on problem finding. Most classrooms are places where answers are sought and solutions are valued. In a thinking-centered classroom, students are taught and encouraged to find problems, to wonder, and to speculate. The unthinking person observes graffiti and either smiles or frowns. The thinking person wonders: "Why is graffiti in Europe so often political—and in the United States, more commonly scatological?" The teacher nurtures the problem-finding attitude by encouraging students to ask questions, not just answer them: "Here are some data about income distribution in the United States—what questions could we ask?" "We'll be studying family life in Israel—what questions would you like to have answered?"

A more deliberative pace. Many classrooms seem to encourage impulsiveness—the teacher asks a question, expects an immediate answer, and calls on the first student who waves a hand. Such rapid-fire recitations are useful in several ways. They facilitate assessment of student knowledge permit rehearsal of facts, and keep students attentive; yet they can be counterproductive when thinking is the focus. Students need time to deliberate—to reflect about alternative possibilities, to weigh the evidence, and to come to a tentative conclusion. One useful way to reinforce such deliberation has been suggested by David N. Perkins (personal communication 1984): wait until all students have raised their hands before calling on anyone; then call on three and discuss the differences in their answers.

Whenever possible, examinations should allow time for reflection and discourage guessing. Some students will refuse to learn to think, despite strong encouragement, unless they are convinced that thinking will improve their grades. It is inconsistent to encourage thinking in the classroom and discourage it on tests.

Teaching Good Thinking: Methods That Might Work

We will not pretend that we have worked out all the pedagogical implications of the model; much more research and development need to be done. However, our review of previous research on teaching thinking and our educational analysis of Baron's model lead us to believe that certain approaches might be effective.

1. *Teach thinking in all subjects, wherever appropriate.* Evidence suggests that such multidisciplinary approaches are more effective than single courses in critical thinking. The model is sufficiently general in scope that it can be used in a variety of school subjects: the student designing a bookcase in industrial arts and the student interpreting a poem in English class are both engaged in thinking—or can be if the task is presented in a manner that encourages thinking. Of course, there are important differences that should be emphasized: evidence sought to support a given bookcase design is quite different from that offered for a particular interpretation of a poem. Students need to understand both the general model and its particular applications. In some cases, prepared materials designed with thinking in mind may be helpful, but materials alone will not be effective.

2. *Present students with case studies of good thinkers.* Students can learn a great deal by studying detailed examples of good thinkers at work. They can see the model at work and understand why the processes are used differently in each course. They can understand that good thinking is not limited to a given sex, to a particular social class or ethnic group, or to scientific endeavors. They can see that the best thinkers are often wrong, and the path to truth is often tortuous and uncertain. Watson searching for the DNA helix, Frost struggling with a poem, and Boorstin trying to find patterns in the discoverers are all examples of imperfect humans engaged in exciting quests.

3. *Present students with subject-related problems that require them to use the processes.* Not all learning should be discovery learning; there is a time for presenting formulas, explaining concepts, and conveying information. But in each subject the teacher should develop a unit of study in which

the students occasionally use the model—first with teacher coaching and then on their own. Some subjects, such as language arts, can be presented primarily from a thinking vantage point.

4. *Focus selectively on the relationships of the important search processes to particular subjects.* We do not argue here for the teaching of discrete skills; however, there is educational merit in giving selective attention to setting goals, searching for possibilities, and weighing evidence as occasions present themselves in the classroom—"The present goal of our foreign policy seems to be one of expanding our sphere of influence. What other goals might we have?" "Recent research suggests that cancers are virus-related. What other possibilities might be investigated?" "The manufacturer reports that this medicine is more effective than aspirin. How reliable is that evidence? What type of evidence might be more helpful?"

5. *Provide appropriate opportunities for applying the model to personal decision making.* Most educators agree that children and adolescents need help with personal decision making. The model has direct application to a variety of personal issues, such as moral choices, consumer decisions, and career options. In appropriate subjects, students could be taught how to apply the model to these and other types of personal decisions.

We do not claim that this model is the best, nor do we guarantee that its methods will be effective. We know, however, that the model is sound in theory and consistent with available evidence. And we believe that the classroom climate and teaching methods we have suggested have a good chance of helping students become better thinkers.

References

Baron, J. (1985). *Rationality and Intelligence.* New York: Cambridge University Press.

Dewey, J. (1933). *How We Think: A Restatement of the Relation of Reflective Thinking to the Educative Process.* Boston: Heath.

Lipman, M., A. M. Sharp, and F. S. Oscanyon (1980). *Thinking in the Classroom.* 2nd ed. Philadelphia, Pa.: Temple University Press.

Nisbett, R., and L. Ross (1980). *Human Inference: Strategies and Shortcomings of Social Judgments.* Englewood Cliffs, N.J.: Prentice-Hall.

14

Goals for a Critical Thinking Curriculum

Robert H. Ennis

There are two ways to slide easily through life; to believe everything or to doubt everything. Both ways save us from thinking.

—Alfred Korzybski

This chapter presents an overall content outline for a critical thinking curriculum. It does not incorporate decisions about grade level, sequence, repetition in greater depth, emphasis, or infusion in subject matter areas (which might be exclusive or overlapping), though such decisions must be made to fit particular school situations.

WORKING DEFINITION: Critical thinking is reasonable, reflective thinking that is focused on deciding what to believe or do.

Critical thinking so defined involves both dispositions and abilities:

A. Dispositions
   1. Seek a clear statement of the thesis or question.
   2. Seek reasons.
   3. Try to be well informed.
   4. Use credible sources and mention them.
   5. Take into account the total situation.
   6. Try to remain relevant to the main point.
   7. Keep in mind the original or basic concern.
   8. Look for alternatives.
   9. Be open-minded.
      a. Consider seriously other points of view than one's own ("dialogical thinking").
      b. Reason from premises with which one disagrees—without letting the disagreement interfere with one's own reasoning ("suppositional thinking").
      c. Withhold judgment when the evidence and reasons are insufficient.
   10. Take a position (and change a position) when the evidence and reasons are sufficient to do so.
   11. Seek as much precision as the subject permits.
   12. Deal in an orderly manner with the parts of a complex whole.
   13. Use one's critical thinking abilities.
   14. Be sensitive to the feelings, levels of knowledge, and degree of sophistication of others.[2]

B. Abilities

   Elementary Clarification.
   1. Focusing on a question
      a. Identifying or formulating a question
      b. Identifying or formulating criteria for judging possible answers
      c. Keeping the situation in mind
   2. Analyzing arguments
      a. Identifying conclusions
      b. Identifying stated reasons
      c. Identifying unstated reasons
      d. Seeing similarities and differences
      e. Identifying and handling irrelevance
      f. Seeing the structure of an argument
      g. Summarizing
   3. Asking and answering questions of clarification and challenge, for example:
      a. Why?
      b. What is your main point?
      c. What do you mean by . . . ?
      d. What would be an example?

Copyright © 1990 by Robert H. Ennis

FIGURE 1
An Application of Critical Thinking in Real Life

The Charges of Murder and Voluntary Manslaughter, as Presented to Jurors at a Trial in the State of Illinois

The Charge of Murder

To sustain the charge of Murder, the State must prove the following propositions:

First: That the Defendant performed the acts that caused the death of the victim, or

Second: That when the Defendant did so, she intended to kill or do great bodily harm to the Victim, or she knew that her acts would cause death or great bodily harm to the Victim, or she knew that her acts created a strong probability of death or great bodily harm to the Victim, and

Third: That the Defendant was not justified in using the force that she used.

If you find from your consideration of all the evidence that each of these propositions has been proved beyond a reasonable doubt, then you should find the Defendant guilty.

If, on the other hand, you find from your consideration of all the evidence that any of these propositions has not been proved beyond a reasonable doubt, then you should find the Defendant not guilty.

The Charge of Voluntary Manslaughter

To sustain the charge of Voluntary Manslaughter, the State must prove the following propositions:

First: That the Defendant intentionally or knowingly performed the acts that caused the death of the Victim, and

Second: That when the Defendant did so, she believed that circumstances existed that would have justified killing the Victim, and

Third: That the Defendant's belief that such circumstances existed was unreasonable, and

Fourth: That the Defendant was not justified in using the force that she used.

If you find from your consideration of all the evidence that each of these propositions has been proved beyond a reasonable doubt, then you should find the Defendant guilty.

If, on the other hand, you find from your consideration of all the evidence that any of these propositions has not been proved beyond a reasonable doubt, then you should find the Defendant not guilty.

e. What would not be an example (though close to being one)?
f. How does that apply to this case (describe case, which might well appear to be a counter-example)?
g. What difference does it make?
h. What are the facts?
i. Is this what you are saying: __________?
j. Would you say some more about that?

Basic Support:

4. Judging the credibility of a source; criteria (that are often not necessary conditions):
   a. Expertise
   b. Lack of conflict of interest
   c. Agreement among sources
   d. Reputation
   e. Use of established procedures
   f. Known risk to reputation
   g. Ability to give reasons
   h. Careful habits
5. Observing and judging observation reports; criteria (that are often not necessary conditions):
   a. Minimal inferring involved
   b. Short time interval between observation and report
   c. Report by observer, rather than someone else (that is, the report is not hearsay)
   d. Records are generally desirable. If report is based on a record, it is generally best that:
      (1) The record was close in time to the observation.
      (2) The record was made by the observer.
      (3) The record was made by the reporter.
      (4) The statement was believed by the reporter, either because of a prior belief in its correctness or because of a belief that the observer was habitually correct.
   e. Corroboration
   f. Possibility of corroboration
   g. Conditions of good access
   h. Competent employment of technology, if technology is useful
   i. Satisfaction by observer (and reporter, if a different person) of credibility criteria

Inference:

6. Deducing and judging deductions
   a. Class logic
   b. Conditional logic
   c. Interpretations of statements
      (1) Negation and double negation
      (2) Necessary and sufficient conditions
      (3) Other logical words: "only," "if and only if," "or," "some," "unless," "not both," and so on
7. Inducing and judging inductions
   a. Generalizing
      (1) Typicality of data: limitation of coverage
      (2) Sampling
      (3) Tables and graphs
   b. Inferring explanatory conclusions and hypotheses
      (1) Types of explanatory conclusions and hypotheses
         (a) Causal claims
         (b) Claims about beliefs and attitudes of people

(c) Interpretations of authors' intended meanings
(d) Historical claims that certain things happened
(e) Reported definitions
(f) Claims that something is an unstated reason or unstated conclusion
(2) Investigating
(a) Designing experiments, including planning to control variables
(b) Seeking evidence and counterevidence
(c) Seeking other possible explanations
(3) Criteria; given reasonable assumptions:
(a) The proposed conclusion would explain the evidence (essential)
(b) The proposed conclusion is consistent with known facts (essential)
(c) Competitive alternative conclusions are inconsistent with known facts (essential)
(d) The proposed conclusion seems plausible (desirable)

8. Making and judging value judgments
a. Background facts
b. Consequences
c. Prima facie application of acceptable principles
d. Considering alternatives
e. Balancing, weighing, and deciding

Advanced Clarification:

9. Defining terms and judging definitions; three dimensions:
a. Form
(1) Synonym
(2) Classification
(3) Range
(4) Equivalent expression
(5) Operational
(6) Example and nonexample
b. Definitional strategy
(1) Acts
(a) Report a meaning
(b) Stipulate a meaning
(c) Express a position on an issue (including "programmatic" and "persuasive" definition)
(2) Identifying and handling equivocation
(a) Attention to the context
(b) Possible types of response:
(i) "The definition is just wrong" (the simplest response)
(ii) Reduction to absurdity: "According to that definition, there is an outlandish result"
(iii) Considering alternative interpretations: "On this interpretation, there is this problem; on that interpretation, there is that problem
(iv) Establishing that there are two meanings of a key term, and a shift in meaning from one to the other
(v) Swallowing the new definition
c. Content

10. Identifying assumptions
a. Unstated reasons
b. Needed assumptions: arguments reconstruction,

Strategy and tactics:

11. Deciding on an action
a. Define the problem
b. Select criteria to judge possible solutions
c. Formulate alternative solutions
d. Tentatively decide what to do
e. Review, taking into account the total situation, and decide
f. Monitor the implementation

12. Interacting with others
a. Employing and reacting to "fallacy" labels (including)
(1) Circularity
(2) Appeal to authority
(3) Bandwagon
(4) Glittering term
(5) Name calling
(6) Slippery slope
(7) Post hoc
(8) Non sequitur
(9) Ad hominem
(10) Affirming the consequent
(11) Denying the antecedent
(12) Conversion
(13) Begging the question
(14) Either/or
(15) Vagueness
(16) Equivocation
(17) Straw person
(18) Appeal to tradition
(19) Argument from analogy
(20) Hypothetical question
(21) Oversimplification
(22) Irrelevance
b. Logical strategies
c. Rhetorical strategies

d. Presenting a position, oral or written (argumentation)
   (1) Aiming at a particular audience and keeping it in mind
   (2) Organizing (common types: main point, clarification, reasons, alternatives, attempt to rebut prospective challenge.. summary—including repeat of main point).

NOTES

[1]For an elaboration of the ideas in this set of proposed goals, see R. H. Ennis "Rational Thinking and Educational Practice," in *Philosophy and Education* (80th Yearbook of the National Society for the Study of Education, Part I), edited by J. F. Soltis (Chicago: NSSE, 1981); R. H. Ennis, "A Conception of Rational Thinking," in *Philosophy of Education 1979*, edited by Jerrold Coombs (Bloomington, Ill.: Philosophy of Education Society, 1980); and R. H. Ennis, *Critical Thinking*, (Englewood Cliffs, N.J.: Prentice Hall, in press). A note on terminology: "rational thinking" as used in the first two items, is what I mean here by "critical thinking." In deference to popular usage and theoretical considerations as well, I have abandoned the more narrow, appraisal-only sense of "critical thinking" that I at one time advocated.

[2]Item 14 under "Dispositions" is not, strictly speaking, a critical thinking disposition. Rather, it is a social disposition that is desirable for a critical thinker to have.

15

What Philosophy Offers to the Teaching of Thinking

Barry K. Beyer

Much of what is written and done about the teaching of thinking reflects the influence of psychology. This is hardly surprising. In recent years, psychologists have taken major strides toward a fuller understanding of how we generate, process, store, and retrieve information and knowledge. Furthermore, because the training of educators often includes study in psychology or some subject closely related to it, we seem quite receptive to what psychologists have to tell us.

As important as psychology is in improving student thinking, however, it provides only one perspective for analyzing and understanding thinking. Philosophy offers another equally valuable, but too often ignored, perspective. Philosophy neither competes with nor negates the findings of psychology, but goes beyond them, adding unique insights into the cognitive processes we use to establish meaning.

Essentially, psychology offers insights into process, into *how* thinking occurs and thus how thinking procedures might be effectively taught. Philosophy, on the other hand, offers substance: it offers insights into *what* ought to be included in any worthwhile thinking skills program. If we fail to include insights from *both* psychology and philosophy in teaching thinking, we are likely to restrict ourselves to a one-dimensional understanding of thinking and to seriously limit our efforts to improve student thinking. I wish here to call attention to what philosophy offers about thinking that psychology does not so that these important dimensions of thinking can be incorporated into our classroom curriculums and teaching.[1]

Philosophy *Is* Thinking

Probably no discipline has more to do with thinking than does the discipline of philosophy, for philosophy and thinking are inextricably interwoven. Experts define philosophy as inquiry based on logical reasoning—it is the love and pursuit of wisdom (Morris 1973, p. 985). Unlike other disciplines, which generally apply thinking in specific contexts to particular data or problems, philosophy *is* thinking, the thinking that underlies all assertions, claims, and principles. It is the only discipline that has thinking as both its *subject* and its *method* of inquiry.

Philosophers study, apply, and evaluate rules and standards for thinking and for judging the substance of thinking. By focusing on the *standards* of good thinking, philosophy brings to us a different—and philosophers think more sophisticated—conception of thinking.

At the risk of oversimplifying a complex discipline, I would suggest that six concepts in philosophy have immediate relevance to improving student thinking. A brief analysis may clarify how each can contribute to classroom efforts to improve this thinking.

Reasoning. Reasoning, the most distinctive feature of philosophy, is the systematic inferring of information according to rules of logic so as to demonstrate or ascertain the validity of a claim or an assertion. It is the process by which we draw conclusions from observations or invent hypotheses and beliefs. The use of reasoning gets us from given, perhaps fragmentary, evidence to a conclusion. Indeed, we reason for many purposes, including the need to

---

This chapter originally appeared in Barry K. Beyer, "What Philosophy Offers to the Teaching of Thinking," *Educational Leadership* 47, 5 (February 1990): 55–60. Copyright © 1990 by Barry K. Beyer. All rights reserved.

find unstated assumptions, to distinguish the relevant from the irrelevant, to justify claims, to determine the validity of others' claims, and so on.

Reasoning usually presents itself in the form of arguments, or sequences of statements presented to demonstrate the truthfulness of some assertion. This, for example, is an argument: "It's my turn to use the hall pass. I'm done with my work, and everyone else who has finished has already used it." By itself, the assertion "it's my turn to use the hall pass" is not an argument; it is simply a claim with no supporting reasons.

Argumentation can be thought of as a structure within which the various skills and dispositions of thinking are exercised. Levels of argumentation, from the simple to the complex, include recognizing arguments, analyzing arguments, evaluating arguments, and producing arguments.

Argument recognition consists of the ability to distinguish a communication that presents a claim with one or more supporting reasons from a communication that simply describes or explains. *Argument analysis*, as defined by philosophers Michael Scriven, Steven Toulmin, and others, involves examining a communication to identify (1) the claim (what the author is trying to make one believe or accept), (2) the stated reasons that are invoked to support this claim, and (3) the stated and unstated premises or assumptions that underlie the given reasons (the claimant may not prove or even state these but oft-times implicitly asks that they be accepted as true) (Scriven 1976, pp. 39–45; Toulmin, Ricke, and Jarik 1984). In *argument evaluation*, the extent to which the argument works or does not work is judged. In *argument making*, lines of valid reasoning must be produced to support an assertion. This generative process applies argument analysis and evaluation, as well as other cognitive skills.

The abilities to recognize, analyze, judge, and formulate valid arguments through the application of reasoning and rules of logic are central to critical thinking.

Critical judgment. Philosophical thinking is critical thinking, which means a willingness (indeed, a predisposition) and an ability to scrutinize and evaluate thinking—one's own as well as others'—to determine truth, accuracy, or worth, and to construct logical arguments to justify claims or assertions (Paul 1984b, 1987). Such thinking is called critical because it judges according to prescribed criteria, not because it is negative or accusatory. The results of critical thinking can be positive or negative, depending on whether or not the criteria are met.

Critical thinking is discriminating, disciplined, and questioning. We often naively assume that the opposite of critical thinking is creative thinking, but its actual opposite, as Matthew Lipman points out, is *un*discriminating, *un*disciplined, and *un*questioning thought—in short, the gullible acceptance of claims without careful analysis of their bases in evidence, reasons, and assumptions (Lipman 1987).

One of the most essential aspects of critical thinking is critical judgment, which to philosophers means the inclination to evaluate objectively rather than to accept blindly (Lipman 1988). Philosophers examine reasoning to judge the extent to which it meets accepted standards of reasonableness and logic (Paul 1984b, 1987). Critical judgment consists of applying appropriate criteria to any sort of communication—an oral statement, a written document, a film, a painting, an action, or an event.

Philosophers have identified many specific critical judgment skills that good thinkers are able to execute. These include, for example, the ability to make logical inferences, to identify logical fallacies, and to judge the logical consistency of arguments.

Because critical thinking is concerned with what is reasonable to accept, critical judgments must also be made about the accuracy and reliability of information in the premises of arguments and in the evidence offered in support of claims. Matthew Lipman, Robert Ennis, and Richard Paul have identified a number of critical thinking skills that can be employed to judge the quality of such reasoning (Ennis 1962; Paul, Binker, Jensen, and Kreklau 1987). Among the skills they believe all of us should master are:

- determining the credibility of a source,
- distinguishing the relevant from the irrelevant,
- distinguishing facts from value judgments,
- identifying and evaluating unstated assumptions,
- identifying bias,
- identifying point of view,
- evaluating evidence offered in support of a claim. (Beyer 1985)

For philosophers, being able to think means being able to execute these and other thinking operations within the context of searching for truth. For Lipman, reasoning at the lowest level means being able to execute each of these critical judgment skills. The highest level of reasoning demands the ability to combine these skills in a concerted, simultaneous fashion for highly sophisticated purposes (Lipman 1984, 1987).

Criteria. Philosophy, as Lipman and others frequently point out, is unlike other disciplines in that it provides criteria for judging the *quality* of thinking (Lipman 1988). More important, philosophers continuously submit these criteria to intensive critical analysis in an effort to devise the best criteria to use in their search for truth.

To examine the claims and arguments with which we are bombarded (and which we ourselves devise), we must understand and be able to apply criteria for determining the reasonableness of given claims and arguments. Experts generally agree, for example, on the criteria for identifying bias, the criteria that a line of reasoning must meet to be considered valid, and the criteria that a written document must meet to be considered credible. For instance, to be considered credible, an author must be recognized as expert on the subject, must have a reputation for accuracy, and must have no vested interest in distorting the truth in what has been written (Ennis 1985a, 1985b). The criteria used in critical thinking are a knowledge dimension unique to this kind of thinking.

Philosophers have formulated (or, some would say discovered) rules of reasoning that have come to constitute logic. These rules serve as guidelines for producing reasoned arguments as well as criteria for judging the quality—the reasonableness—of any claim or argument. One such rule, for example, is often expressed as:

1. If A, then B.
2. If B, then C.
3. Therefore, if A, then C.

Translated into an everyday example, such a statement might read:

1. If Jane gets a 90 on this exam, she gets an A as her average in this course for this semester.
2. If Jane gets an A average for this course for this semester, she makes the honor roll for this semester.
3. Therefore, if Jane gets a 90 on this exam, she makes the honor roll for this semester.

This argument is perfectly logical according to this rule, which holds that the truth of premises 1 and 2 *necessarily* leads to a true conclusion (as stated in number 3).

Logic, it should be noted, deals not with the substance of what is said, but with its structure, with the rules of how to put statements together so that one leads invariably to the next. These rules help us determine the validity of conclusions in terms of the reasons upon which they are based. Generating and judging valid arguments calls for knowledge of the rules of logic as well as the skills and inclination to apply them. Critical thinkers think critically about the criteria and standards on which thinking is based and use these standards to judge thinking and its products.

Point of view. When philosophers think about the substance of thinking, they focus not only on its elements, process, and structure, but also on the context in which thinking occurs. One important feature of this context is the point or points of view taken, represented, or expressed by the individuals involved.

The phrase *point of view* means different things to different people. To some, it simply means one person's opinion. For philosophers, however, it is a much more complicated and sophisticated concept. In terms of critical thinking, a point of view is the position from which one views things; that position, in turn, is a product of one's accumulated experience (Paul 1987). An individual standing on the rim of the Grand Canyon, for example, sees a different scene than does one standing along the riverbed at the bottom of the canyon. Although both observers see the Grand Canyon, each sees it from a different point of view. Furthermore, what is viewed differently is interpreted differently, according to each viewer's prior knowledge, interests, motives, assumptions, biases, predilections, and similar variables. So, in examining ideas, events, or experiences, different individuals often see altogether different aspects of the subject, depending on where they are and where they have been. Only when different viewpoints are put together is the whole comprehensible.

Full understanding of an explanation or a description requires an understanding of the point of view that produced it. Thus, detecting points of view and taking them into account are important aspects of philosophical thinking, as is the ability to look at a subject from different points of view. It should be noted, however, that the rules of logic are valid for all persons regardless of their points of view.

Dialogue. One major method by which individuals exercise their critical thinking abilities is dialogue. Dialogue has been defined as an interchange among two or more individuals or points of view on a given topic, claim, or subject in an effort to ascertain the truth (Lipman 1984; Paul 1987). Such an interchange involves giving and analyzing evidence, reasoning logically, identifying assumptions, looking at consequences, and representing differing points of view. This dialogue may be conducted between or among people, or it may even be carried on by an individual through critical self-reflection.

Asking and answering questions is one way that dialogue is stimulated, directed, and critically evaluated. Of course, not all questions call for critical thinking. Some simply call for a literal report of what some source has asserted or what appear to be the attributes of an object, a scene, a process, or a claim. Questions that require critical thinking, on the other hand, call for sustained efforts to reason and to evaluate reasoning. Such questions require respondents to clarify statements, define terms, and judge the relevance, accuracy, and nature of statements (Lipman 1984; Paul 1984, 1987). A typical line of questioning that activates critical thinking might include the following questions:

- Why is your claim true?
- What reasons or evidence can you give for saying what you said?
- If that is so, what is likely to follow?
- What are you assuming? If that is so, aren't you also assuming that . . . ?
- What are other ways of looking at this?

This line of questioning (sometimes called Socratic questioning) provides an opportunity, a stimulus, and a guide for applying critical thinking. The process probes the thinking by which an individual makes and justifies assertions. Socratic questioning does not teach anyone how to *do* critical thinking, but it provides a device for *exercising* critical thought. Engaging in dialogues guided by questions like these moves a thinker closer to understanding a particular claim or topic and to ascertaining what is true. Many philosophers assert that the ability to think rationally is thereby enhanced.

Dispositions. Some philosophers emphasize that thinking is much more than simply technique or skill, that in addition to criteria, rules, and procedures, critical thinking is a particular mental set that calls for distinct, habitual ways of behaving. These ways—called dispositions by Ennis, passions by Paul—constitute the spirit, or affective dimension, of critical thinking, making it much less mechanistic than it is customarily portrayed to be.

Paul asserts that skilled thinkers are driven by a passion for getting to the bottom of things, are devoted to seeking the truth rather than to self-aggrandizement, are inclined to ask probing questions about why things are believed to be as they are asserted to be, are persistent in thinking their way through perplexing problems, and are deeply averse to sloppy, ambiguous thinking (Paul 1987).

Ennis claims that skilled thinkers are also disposed to continually seek more information, to use credible sources, to volunteer and seek reasons and evidence in support of claims, to suspend judgment, to examine issues from different points of view, and to be willing to change their positions when evidence and reasoning warrant (Ennis 1962, 1985a).

Notice the words used to describe these operations: *drive, devoted, persistent, disposed, seek,* and *be willing.* These attributes of dispositions, which reflect emotions and feelings, show that while critical thinking is objective, it is hardly value-free. Critical thinkers attach great value to seeking understanding, determining worth, and searching out truth. The continuing persistent disposition to know what is true motivates critical thinking and guides it by basing its execution on a clear underlying value.

Philosophy and Teaching Thinking

Of course, philosophers deal with concepts other than the six just highlighted. Some, such as matters of free will and determinism, do not seem especially relevant to efforts to improve critical thinking or its teaching.

Others may be relevant but are at the moment receiving little attention from philosophers interested in furthering the teaching of critical thinking. One of these is reasoning about moral and ethical issues and principles. Another is the analysis and conceptualization of concepts such as ***truth***, *fairness*, and *equality*, which are central to our democratic way of life. Indeed, the conceptual repertoire of philosophy is one of the treasure houses of the humanities. Only a portion of these riches has yet been uncovered or applied to the teaching of thinking.

Regardless of the kind of "thinking curriculum" educators might develop, it should include at the very least the six basic concepts of philosophy outlined here. Moreover, no matter which cognitive skills are selected as learning objectives, reasoning—inductive, deductive, analogical—ought to be included, for this skill is foundational to all thinking, including recall.

Critical judgment and the specific operations by which it is carried out should also be included because of the crucial role they play in generating and evaluating the hypotheses, theories, and conclusions that thinking produces.

In addition, any viable thinking skills curriculum should provide instruction in the criteria by which we judge the worth, accuracy, and truth of our own thoughts and those of others, especially the rules of reasoning, the principles of logic, and the evaluative criteria used in critical thinking. Identifying, analyzing, and evaluating point of view should be included among those concepts.

Finally, to be worthwhile and effective in producing skillful thinkers, a K–12 thinking skills curriculum should attend to the methods philosophers use to stimulate and guide thinking as well as to the dispositions that support and motivate this thinking.

Such a curriculum should employ dialogue and structured, *student-generated* critical thinking questioning, not simply as devices for exercising thinking, but as frameworks for instruction and as devices for guiding practice and application following instruction. The values and attitudes that support critical thinking should also be explicit goals of instruction, for such dispositions, as much as skill with cognitive operations and critical knowledge, carry thinking forward.[2]

Those of us who want to improve student thinking ignore these six *qualitative* attributes of philosophic thinking at some peril. Unfortunately, in our desire to infuse thinking skills into the K–12 curriculum, many of us have been focusing almost exclusively on information-processing skills and cognitive strategies (such as decision making, problem solving, and creative thinking) to the exclusion of reasoning and the other thinking skills and dispositions associated with philosophy. We should do more.

If we do not begin to incorporate the concepts of philosophy into programs to improve thinking, we run the risk of producing form without substance, technique without purpose, performance without measures of quality. If we do incorporate what philosophy has to offer, however, we can enable students to claim, as Descartes did, "I think, therefore I am."

NOTES

[1]A small number of philosophers, deeply committed to the teaching of thinking, have made cogent efforts to refine, clarify, and interpret aspects of philosophy that relate to thinking. Three who have made especially noteworthy contributions are Matthew Lipman, Robert Ennis, and Richard Paul.

From Lipman's incisive interpretations of critical thinking came his ingenious invention of very specific classroom approaches for teaching children to sharpen their thinking skills and dispositions (see Lipman 1980).

Ennis's ground-breaking analyses of the nature of critical thinking and his exploration of ways to assess it have made an immense contribution to our understanding of this complex mental phenomenon (see Ennis 1962, Ennis 1987).

Paul's analysis and advocacy of philosophical thinking have inspired appreciation of philosophy as a tool for improving thinking (see Paul 1984).

The points in this paper distill the work of Lipman, Ennis, and Paul, as well as that of Steven Toulmin, John Chafee, Vincent Ruggerio, Tony Blair, Ralph Johnson, and Philip Percorino. Along with their thoughts and claims are insights I have derived from applying their ideas to the teaching of writing.

[2]For detailed approaches to developing such a curriculum, see, for example, Beyer 1988.

REFERENCES

Beyer, B. K. (April 1985). "Critical Thinking—What Is It?" *Social Education* 49, 4: 270–276.

Beyer, B. K. (1988). *Developing a Thinking Skills Program* Boston: Allyn and Bacon.

Ennis, R. (Winter 1962). "A Concept of Critical Thinking." *Harvard Educational Review* 32, 1: 81–111.

Ennis, R. (1987). "A Taxonomy of Critical Thinking Dispositions and Abilities." In *Teaching Thinking Skills: Theory and Practice*, edited by J. Baron and R. Sternberg. New York: W. H. Freeman.

Ennis, R. (October 1985a). "A Logical Basis for Measuring Thinking Skills." *Educational Leadership* 43, 2: 46.

Ennis, R. (Winter 1985b). "Critical Thinking and the Curriculum." *National Forum* 65, 1: 28–31.

Lipman, M. (September 1984). "The Cultivation of Reasoning through Philosophy." *Educational Leadership* 42, 1: 51–55.

Lipman, M. (September 25, 1987). "What Is the Thinking Skills Movement Doing to American Schools?" Address at the Conference on Thinking and Education of the Virginia Department of Education, Williamsburg, Va.

Lipman, M. (Septembe. 1988). "Critical Thinking—What Can It Be?" *Educational Leadership* 46, 1: 38–43.

Lipman, M., and A. M. Sharp. (1980). *Philosophy in the Classroom*. 2nd ed. Philadelphia, Pa.: Temple University Press.

Morris, W., ed. (1973). *American Heritage Dictionary of the English Language*. Boston: American Heritage Publishing Company and Houghton Mifflin.

Paul, R. (1987). "Dialogical Thinking: Critical Thought Essential to the Acquisition of Rational Knowledge and Passions." In *Teaching Thinking Skills: Theory and Practice*, edited by J. Baron and R. Sternberg. New York: W. H. Freeman.

Paul, R. (Winter 1984a). "The Critical Thinking Movement: A Historical Perspective." *National Forum* 65, 1: 2–3, 12.

Paul, R. (September 1984b). "Critical Thinking: Fundamental to Education for a Free Society." *Educational Leadership* 42, 1: 4–14.

Paul, R., A. J. A. Binker, K. Jensen, and H. Kreklau. (1987). *Critical Thinking Handbook: 4th–6th Grades*. Rohnert Park, Calif.: Center for Critical Thinking and Moral Critique.

Scriven, M. (1976). *Reasoning*. New York: McGraw-Hill.

Toulmin, S., R. Rieke, and A. Jarik. (1984). *An Introduction to Reasoning*. 2nd ed. New York: Macmillan.

16

Teaching Critical Thinking in the Strong Sense

Richard W. Paul

. . . no abstract or analytic point exists out of all connection with historical, personal thought: . . . Every thought belongs, not just somewhere, but to someone, and is at home in a context of other thoughts, a context which is not purely formally prescribed. Thoughts . . . are something to be known and understood in these concrete terms.

—Isaiah Berlin, *Concepts and Categories* (New York: Viking, 1979), xii.

Though there has now been considerable discussion and much work on the goal of cultivating student thinking, in many ways we still have a long way to go. There is still insufficient appreciation of the global shift that a genuine cultivation of student thinking requires. It is still common to find administrators and teachers who believe that the cultivation of thinking is an automatic by-product of content coverage or simply a matter of assembling the right bag of tricks to pass on to teachers. It is also common to find significant misconceptions about the nature of the mental structures essential to disciplined, self-directed, rational thought. Finally, very few educators are aware of the pitfalls of most established approaches to thinking, one of the biggest of which is an inadvertent emphasis on what I have called "weak-sense" thinking.

The Dangers and Pitfalls of a Weak-Sense Approach

There are three groups of mental structures essential to the development of a moral, open-minded thinker: (1) proficient micro-skills, such as the ability to recognize a vague sentence, a questionable assumption, a contradiction or inconsistency, an inference or implication; (2) refined macro-abilities, such as the ability to read and write critically, engage in the give-and-take of discussion and debate, evaluate sources of information, or create and explore arguments and theories; and (3) traits of mind, which are the intellectual virtues and moral commitments that transform thinking from a *selfish, narrow-minded foundation* to a *broad, open-minded foundation*. Figure 1 shows the dimensions of critical thought that these three mental structures encompass. Many programs suffer from misconceptions at the micro-skill and macro-ability level, but virtually *all* programs suffer from a lack of appreciation of the need to specifically teach for the traits of mind essential to *strong critical thinking*.

The time has now come, I believe, to address this problem. Current methods, as I have suggested, often inadvertently encourage thinking merely in a "weak" sense. The most fundamental and questionable assumption of many present approaches is that thinking can be successfully taught as a battery of technical skills mastered more or less one by one without serious attention to intellectual values and standards, or to matters of character and motivation. The result is that those students who develop thinking skills typically use those skills merely to advance their interests, to gain advantage, to win arguments, to get ahead, but *not* to reason in a more open- or broad-minded way. An alternative

Copyright © 1990 by Richard W. Paul.

FIGURE 1

The Elements of Critical Thought

Cognitive Strategies—Micro-Skills
- Comparing and contrasting ideals with actual practice
- Thinking precisely about thinking: using critical vocabulary
- Noting significant similarities and differences
- Examining or evaluating assumptions
- Distinguishing relevant from irrelevant facts
- Making plausible inferences, predictions, or interpretations
- Giving reasons and evaluating evidence and alleged facts
- Recognizing contradictions
- Exploring implications and consequences

Cognitive Strategies—Macro-Abilities
- Refining generalizations and avoiding oversimplifications
- Comparing analogous situations: transferring insights to new contexts
- Developing one's perspective: creating or exploring beliefs, arguments, or theories
- Clarifying issues, conclusions, or beliefs
- Developing criteria for evaluation: clarifying values and standards
- Evaluating the credibility of sources of information
- Questioning deeply: raising and pursuing root or significant questions
- Analyzing or evaluating arguments, interpretations, beliefs, or theories
- Generating or assessing solutions
- Analyzing or evaluating actions or policies
- Reading critically: clarifying or critiquing texts
- Listening critically: the art of silent dialogue
- Making interdisciplinary connections
- Practicing Socratic dis ussion: clarifying and questioning beliefs, theories, or perspectives
- Reasoning dialogically: comparing perspectives, interpretations, or theories
- Reasoning dialectically: evaluating perspectives, interpretations, or theories

Affective Strategies—Traits of Mind
- Thinking independently
- Developing insight into egocentricity or sociocentricity
- Exercising fair-mindedness
- Exploring thoughts underlying feelings and feelings underlying thoughts
- Developing intellectual humility and suspending judgment
- Developing intellectual courage
- Developing intellectual good faith or integrity
- Developing intellectual perseverance
- Developing confidence in reason

and more realistic approach is available. Teachers can come to abandon the idea that thinking can be taught as a battery of atomic technical skills. They can come to recognize the significance of the motivations and values that underlie a person's thinking. With an appropriate orientation and long-term staff development, teachers can begin to take seriously the pitfalls of present instruction and can learn a "strong-sense" approach to teaching critical thinking.

A Strong-Sense Approach To Critical Thinking: The Intellectual Virtues

In any strong approach to thinking, the affective dimension is given a special emphasis. We teach, then, for particular traits of mind, for mental structures that lay a foundation for moral *as well as intellectual reflection. We develop student micro-skills and macro-abilities in the context of intellectual standards and values. There are nine traits that I consider essential to strong thinking:*

1. Independence of Mind: the disposition and commitment to autonomous thinking, thinking for oneself. Unfortunately, the human mind does not instinctively value autonomy of thought. Many of our beliefs are acquired at an early age, when we have a strong tendency to form beliefs merely because we want to believe or because we are rewarded for believing. To develop independence of thought, students must learn to question what is presented to them as true. They must learn to analyze issues for themselves, and to reject unjustified authorities at the same time that they recognize the contributions of justified authorities. They must thoughtfully form their own principles of thought and action, determine for themselves when information is relevant, when to apply a concept, and even when to make use of a skill. They must learn how to resist intellectual manipulation.

2. Intellectual Curiosity: the disposition to wonder about the world. Unfortunately, most people tend to lose their curiosity at an early age. Critical thinkers need to be curious about their environment. They need to seek explanations for apparent discrepancies and speculate about the causes of these discrepancies. They need to develop an interest in how they came to be the persons they are. They need to wonder about the nature and direction of their lives. They need to appreciate the mystery of human life, of how we have come to be such a paradoxical species, of how we can be capable of such high thought and such low action. They need to be curious about language, about how it works, about how we live in and through it. They need to be perplexed about how we can deceive ourselves so often, how we can know so much about ourselves and still fail to grasp our contradictions and inconsistencies.

3. Intellectual Courage: the consciousness of the need to face and fairly address ideas, beliefs, or viewpoints toward which we have strong negative emotions and to which we have not given a serious hearing. Intellectual courage is connected with the recognition that ideas commonly considered dangerous or absurd are sometimes rationally justified (in whole or in part) and that conclusions and beliefs inculcated in us are sometimes false or misleading. To determine for ourselves which is which, we must not passively and uncritically accept what we have "learned" or been taught. Intellectual courage comes into play here because inevitably we will come to see some truth in ideas that may be considered dangerous and absurd, and distortion or falsity in some ideas strongly held in our social group. We need courage to be true to our own thinking in such circumstances. The pressure to conform can be great. The penalties for nonconformity can be severe.

4. Intellectual Humility: the awareness of the limits of our knowledge, including sensitivity to circumstances in which our native egocentrism is likely to function self-deceptively, and sensitivity to the biases, prejudices, and limitations of our viewpoint. Intellectual humility is based on the recognition that we should not claim more than we actually know. It does not imply spinelessness or submissiveness. It implies the lack of intellectual pretentiousness, arrogance, or conceit. It implies insight into the foundations of our beliefs knowing what evidence we have, how we have come to believe, what further evidence we might need to examine or seek out.

5. Intellectual Empathy: the consciousness of the need to imaginatively put ourselves in the place of others in order to genuinely understand them. This requires explicit consciousness of our egocentric tendency to identify truth with our immediate perceptions or long-standing thoughts or beliefs. This trait correlates with the ability to reconstruct accurately the viewpoints and reasoning of others and to reason from premises, assumptions, and ideas other than our own. This trait also correlates with the willingness to remember occasions when we were wrong in the past despite an intense conviction that we were right and, therefore, with the ability to imagine our being similarly deceived in a case at hand.

6. Intellectual Integrity: the recognition of the need to be true to the intellectual and moral standards implicit in our judgments of the behavior or views of others; to be consistent in the intellectual standards we apply; to hold ourselves to the same rigorous standards of evidence and proof to which we hold our antagonists; to practice what we advocate for others; and to honestly admit discrepancies and inconsistencies in our own thought and action.

7. Intellectual Perseverance: the consciousness of the need to pursue intellectual insights and truths in spite of difficulties, obstacles, and frustrations--and a willingness to do so; firm adherence to rational principles despite the irrational opposition of others; a sense of the need to struggle with confusion and unsettled questions over an extended period of time to achieve deeper understanding or insight.

8. Faith in Reason: confidence that, in the long run, our own higher interests and those of humankind at large will be best served by giving the freest play to reason, by encouraging people to come to their own conclusions by developing their own rational faculties; faith that, with proper encouragement and cultivation, people can learn to think for themselves, to form rational viewpoints, draw reasonable conclusions, think coherently and logically, persuade each other by reason, and become reasonable persons, despite the deep-seated obstacles in the native character of the human mind and in society as we know it.

9. Fair-mindedness: the consciousness of the need to treat all viewpoints alike, without reference to our own feelings or vested interests, or the feelings or vested interests of our friends, community, or nation. This implies that we adhere to intellectual standards without reference to our own advantage or the advantage of our group.

The Interdependence of the Intellectual Virtues

Let us now consider the interdependence of these traits, how hard it is to deeply develop any one of them without also developing the others.

Consider intellectual humility. To become aware of the limits of our knowledge we need the courage to face our own prejudices and ignorance. To discover our own prejudices, we must in turn often empathize with and reason within points of view toward which we are hostile. And to do this, we must typically persevere over a period of time, for learning to empathically enter a point of view against which we are biased takes time and significant effort. That effort will not seem justified unless we have the faith in reason to believe we will not be "tainted" or "taken in" by whatever is false or misleading in the opposing viewpoint. Furthermore, merely believing we can survive serious consideration of "alien" points of view is not enough to motivate most of us to consider them seriously. We must also be motivated by an intellectual sense of justice. We must recognize an intellectual responsibility to be fair to views we oppose. We must feel obliged to hear them in their strongest form to ensure that we do not condemn them out of our own ignorance or bias. At this point, we come full circle back to where we began: the need for intellectual humility.

Or let us begin at another point. Consider intellectual good faith or integrity. Intellectual integrity is clearly difficult to develop. We are often motivated—generally without admitting to or being aware of this motivation--to set up inconsistent intellectual standards. Our egocentric or sociocentric side readily believes positive information about those we like and negative information about those we dislike. We tend to believe what justifies our vested interest or validates our strongest desires. Hence, we all have some innate tendency to use double standards, which is of course paradigmatic of intellectual bad faith. Such thought often helps us get ahead in the world, maximize our power or advantage, and get more of what we want.

Nevertheless, we cannot easily operate explicitly or overtly using a double standard. We must, therefore, avoid looking at the evidence too closely. We cannot scrutinize our own inferences and interpretations too carefully. Hence, a certain amount of intellectual arrogance is quite useful. I may assume, for example that I know just what you're going to say (before you say it), precisely what you are really after (before the evidence demonstrates it), and what actually is going on (before I have studied the situation carefully). My intellectual arrogance makes it easier for me to avoid noticing the unjustifiable discrepancy in the standards I apply to you and those I apply to myself. Of course, if I don't have to empathize with you, that too makes it easier to avoid seeing my duplicity. I am also better off if I don't feel a keen need to be fair to your point of view. A little background fear of what I might discover if I seriously considered the consistency of my own judgments also helps. In this case, my lack of intellectual integrity is supported by my lack of intellectual humility, empathy, and fair-mindedness.

Going in the other direction, it will be difficult to maintain a double standard between us if I feel a distinct responsibility to be fair to your point of view, understand this responsibility to entail that I must view things from your perspective in an empathic fashion, and conduct this inner inquiry with some humility regarding the possibility of my being wrong and your being right. The more I dislike you personally or feel wronged in the past by you or by others who share your way of thinking, the more pronounced in my character must be the trait of intellectual integrity in order to provide the countervailing impetus to think my way to a fair conclusion.

Teaching For the Affective and Moral Dimension of Critical Thinking

There are a wide variety of ways that we can teach for those traits of mind essential to strong critical thinking. Here I mention only a few of them.

Teaching For Intellectual Independence

A critical education respects the autonomy of the student. It appeals to rationality. Students should be encouraged to discover information and use their knowledge, skills, and insights to think for themselves. Merely giving students "facts" or telling them the "right way" to solve a problem interferes with students' critiquing and modifying preexisting beliefs with new knowledge.

Rather than ask students to simply "discuss" ideas in their texts, the teacher can ask them to brainstorm ideas and argue among themselves, for instance, about problems and solutions to problems. Before reading a section of text that refers to a map, chart, time-line, or graph, students could first read and discuss what it shows. Students could develop their own categories instead of being provided with them. In English class, "Types of Literature" lessons could be redesigned so that students group and discuss writings they have read, entertaining different ways to classify them. In science class, students could first explain how they categorize animals, and then compare their categories to those used by scientists.

When a text tries to do too much of the students' thinking for them, it can be examined in depth: "Why does the text tell you this? Why do the authors think this (concept, skill, procedure, step) is important? What is the author's point of view? How does it compare with your point of view?"

Written assignments should provide many opportunities for students to exercise independent judgment: in gathering and assembling information, in analyzing and synthesizing it, and in formulating and evaluating conclusions. We could have students discuss different ways to organize their points in essays, rather than provide them in advance with different essay structures.

In science, students could put their own headings on charts or graphs they make, or decide through discussion what kind of graph would be most illuminating: "What information do we have? How can we record it so we can see what it means? What kind of graphs should we make? Why? What is that kind used for? Is that what our data are like?"

Students could review material themselves, rather than rely on the text for summaries and review questions. The teacher could routinely ask students, "What do you believe are the most important points covered in the passage (chapter, story, etc.)?"

When discussing specific countries and periods of history, students could look at and discuss political, population distribution, physical, historical, linguistic, or land-use maps before reading their texts. In general, there is a need for teachers to seek out and treat student thinking on all subjects as important and worthy of consideration.

Teaching For Intellectual Curiosity

We can teach for intellectual curiosity most effectively by modelling it in all that we do. In standard instruction, where everything is more or less laid out in advance as "true,"

ERIC

this typically is not done. The textbook and the teacher usually play the role of authority, of providing answers not questions, of dispelling curiosity rather than cultivating it.

If the teacher abandons the dogmatism of standard didactic teaching, however, and adopts a "Let's-see-if-we-can-figure-these-things-out-for-ourselves" attitude, then curiosity can be rekindled. Through Socratic questioning, the teacher can wonder aloud in front of the class about the meaning and truth of even the most fundamental ideas and concepts.

By slowing down the pace of coverage, the teacher can, by wondering aloud in front of the students, provide an opportunity for curiosity to develop in a variety of directions: "What does democracy really mean? Yes, it is government of the people, but what does that really mean? Is your family run democratically? Is our classroom? Is the playground? Do we really know what democracy means?

"What about freedom, or love, or friendship, or trust? Do we know what these words mean? Do we know what these things are? Are we interested, curious, to find out?"

In virtually every subject area we can cultivate student curiosity by treating much of what we take for granted as an object of wonder. We can work to impress upon students' minds how little, rather than how much, we know. True, we have a lot of information. But how much knowledge do we have? How much do we really know? How much do we merely accept because someone else, or some book, said so?

Teaching For Intellectual Courage

Intellectual courage is fostered through a consistently open-minded atmosphere. Students should be encouraged to honestly consider or doubt any belief or established view. Students who disagree with or doubt their peers or the text should be given support. The teacher should raise probing questions about unpopular ideas that students have hitherto been discouraged from considering. The teacher should model intellectual courage by playing devil's advocate.

Texts, on the rare occasions when the question is discussed, typically seem to suggest that standing up for our beliefs is fairly easy. This is not helpful. Rather, students should discuss such questions as these: Why is it hard to go against the crowd? If everyone around you is sure of something, why is it hard to question it or disagree? When is it good to do so? When might you hesitate? When should you hesitate? How does it feel when you question your group's beliefs? Why? Why do people often get mad when they are questioned, doubted, or disagreed with? Should they? Is this attitude compatible with freedom of thought? Is it hard to question your own beliefs? Why?

Of course, students who have been habitually praised for uncritically accepting others' claims may feel the rug pulled out from under them when first expected to think for themselves. They should be emotionally supported in these circumstances and encouraged to express the natural hesitancy, discomfort, or anxiety they may experience. They should be encouraged to recognize that all of us must work our way through fear of rejection by others. The willingness to consider unpopular beliefs develops by degrees. Teachers should, therefore, exercise discretion, beginning first with mildly unpopular, rather than extremely unpopular, beliefs.

If, during the course of the year, an idea or suggestion that at first sounded "crazy" has proven valuable, students could be reminded of it, discuss it at length, and compare it with other events: "How did this idea seem at first? Why? What made you change your mind about it? Have you had other similar experiences? Why do unpopular ideas seem crazy or stupid at first?"

Teaching For Intellectual Empathy

Since intellectual empathy correlates with the ability to reconstruct accurately the viewpoints and reasoning of others and to reason from premises, assumptions, and ideas other than our own, a major focus of our effort should be in developing activities and assignments in which students must reason within points of view other than their own. There are unlimited opportunities for doing this in virtually all classes and subjects.

First of all, the social and human disciplines routinely admit to multiple points of view: history, sociology, psychology, anthropology, literature, economics, and business. When we teach these subjects, we can help our students discover some of the major differing perspectives and devise activities that require them to reason within them.

Second, students themselves inevitably internalize what they learn within their own individual point of view. In classroom discussions, students have a responsibility to understand each other; therefore, teachers should conduct discussions in such a way that students must enter empathically into one another's perspectives and demonstrate some ability to reason in the perspective of the other (student). This is true even in mathematics and the hard sciences, where students tend to retreat from thought into the mindless shelter of following procedures and formulas.

Teaching For Intellectual Humility

Texts and testing methods inadvertently foster intellectual arrogance. Most text writing says, "Here's the way it is. Here's what we know. Remember this, and you'll know it.

too." Behind student learning, there is often little more thought than "It's true because my textbook said it's true." This often generalizes to "It's true because I read it somewhere."

Teachers can encourage the habit of exploring the basis for beliefs by taking advantage of any situation in which students are not in a position to know. When materials call on students to make claims for which they have insufficient evidence, the teacher should encourage students to remember what is said in the materials but also to suspend judgment as to its truth. The teacher might first ask for the reasons for the claim and have students probe their strength. Students can be encouraged to explain what they would need to learn to be more certain. For example, they might discuss how reasonable people respond to gossip or the news on TV: They hear what is said, remember what they have heard, but do not automatically believe it.

In exposing students to concepts within a field, we can help students see how all concepts depend on other, more basic concepts and how each field of knowledge depends on fundamental assumptions that need to be examined, understood, and justified. We can help students discover experiences in their own lives that help support or justify what a text says. We should always be willing to entertain student doubts about whether what a text says is true.

We can model intellectual humility by demonstrating a willingness to admit the limits of our own knowledge and of human knowledge generally. Routinely qualify statements: "I believe," "I'm pretty sure that," "I doubt," "I suspect," "Perhaps," "I'm told," "It seems," and so on.

Students should discuss such experiences as having a bad first impression, then learning they were wrong; feeling certain of something, then later changing their minds; thinking they knew something, then realizing they didn't.

The teacher can ask students to brainstorm questions they have after studying. Students could keep question logs during the course of research projects, periodically recording their unanswered questions. We should emphasize the fact that only when we do have questions are we really learning. When we have no questions, when nothing seems doubtful or unclear, we are probably not truly coming to terms with our subject.

Teaching for Intellectual Integrity

Texts often inadvertently encourage the natural split between "school belief" and "real-life belief" and between verbal or public belief and belief that guides action. There is an old saying to the effect that "it is a good prophet who follows his own teaching." And sometimes parents say, "Do as I say, not as I do." There is often a lack of integrity in human life. Hypocrisy and inconsistency are common. As educators, we need to highlight the difficulties of being consistent in an often inconsistent world.

As teachers, we need to be sensitive to our own inconsistencies in the application of rules and standards, and we need to help students explore their own. Peer groups often pressure students to judge "in-group" members less critically than "out-group" members. Students need opportunities to honestly assess their own participation in such phenomena. When evaluating or developing criteria for evaluation, have students assess both themselves and others, noting their tendency to favor themselves.

Language arts texts often have students roundly criticize characters without taking into account the difficulties of living up to worthy ideals. Students should be encouraged to give more realistic assessments: "Would you have done otherwise? Would it have been easy? Why or why not? Why do so few people do this?"

Social studies texts often judge other societies more harshly than they do our own. Students should examine their texts' consistency in evaluation. The teacher may have to help students recognize this problem by posing questions: "What did that country do? Why? Has our government ever done the same or a similar thing? Why? What justification was given? Was it right? Why do we often criticize in others what we accept in ourselves?"

Teaching For Intellectual Perseverance

Critical thinking is reflective and recursive; that is, we often go back in our thoughts to previous problems to reconsider or re-analyze them. Intellectual perseverance can be developed by reviewing and discussing the kinds of difficulties inherent to previous problems worked on, exploring why it is necessary to struggle with them over an extended period. Studying the work of great inventors or thinkers through biography can also be of useful, since students can discuss why long-range commitment was necessary for such work to be successful. In time, students will see the value of pursuing important ideas at length.

We should take the time to design long-term projects that require perseverance. We should help students to develop the skills of breaking down complex problems into simpler components, so they will come to see how complex problems can be solved over time. We should encourage students to become reflective about their long-term problems, helping them to make sense of why some problems take a long time to solve--even under the best of conditions. For example, when Thomas Edison was asked whether he was frustrated by all the time he had wasted before he found a successful way to make a light bulb, he replied, "It wasn't wasted. I discovered thousands of ways of how *not* to make a light bulb!" We could have students discuss experiences of their own that parallel Edison's.

Texts will often label a problem hard to solve, but simply leave it at that. To help students develop the sense that a problem is not hopeless even though the solution is not immediately clear or simple, you could divide the class into groups and have them discuss various ways in which the problem could be approached, seeing if they can break the problem down into simpler components. Devoting considerable time to problem analysis is necessary to develop students' confidence in their ability to tackle difficult problems and recognize when a long-term commitment will be necessary. Students will not develop intellectual perseverance unless they develop confidence in their ability to successfully analyze and approach problems.

Teaching For Fair-mindedness

Teachers can encourage students to think fair-mindedly when disputes or problems arise, when the class is discussing controversial issues, or even when evaluating the reasoning of story characters with divergent perspectives. In fact, whenever there are multiple points of view and students are attracted to one rather than another of those viewpoints, teachers have an excellent opportunity to encourage fair-mindedness by ensuring that all students learn to reason sympathetically within points of view with which they disagree.

When disputes between students arise in the course of the day, the teacher can ask students to state each other's positions, giving both a chance to correct any misunderstanding of their positions. The teacher can then ask students to explain why their fellow student might see things differently: "What is Sue angry about? Why does that make her mad? Sue, is that right?"

Students can be encouraged to consider evidence and reasons for positions with which they don't agree, as well as for those with which they do agree. For example, students could be asked to consider positions from their parents' or siblings' points of view: "Why doesn't your mother want you to . . . ? Why does she think it's bad for you (wrong, etc.)? What does she think will happen? Why?"

Although texts often have students consider a subject or issue from a second point of view, discussion is typically brief rather than extended, and little or nothing is done to help students integrate insights gained by considering multiple perspectives. If students write a dialogue about an issue from opposing points of view, or contrast a story character's reasoning with an opposing point of view, or role-play discussions, we should take the opportunity to have students directly compare, and empathize with, different conflicting perspectives.

When the class is discussing different cultures the teacher can encourage students to consider why people believe such different things and why they tend to think our own ways and beliefs are right and "true." You might select some beliefs of other cultures that contrast with common beliefs in our culture and organize discussions in which students try to figure out why others do not believe as we do and why they might not be persuaded to change their beliefs when exposed to ours. As a result, students will slowly come to appreciate the wisdom behind some of the beliefs of others while they come to recognize the bias behind some of our beliefs, and they will slowly become more fair-minded.

The Importance of Intellectual Discipline

Educational reform that focuses on explicit consciousness of the comprehensive need for fair-minded thinking offers us hope for the gradual elevation of human life and practices from the selfish to the humane. Only when we raise children to think critically, as a matter of course, about their use of language, the information they take in, the nature of propaganda that surrounds them, the multiple prejudices assumed to be self-evident truths; only when we educate children to probe the logical structure of thought, to test proposed knowledge against experience, to scrutinize experience from alternative perspectives; only when we reward those who think for themselves, who display intellectual independence, courage, humility, and faith in reason; only then do we have a real chance that children will eventually become free and morally responsible adults and hence help eventually to create, through their example and commitments, genuinely free and moral societies.

Fair-minded thinking is increasingly an imperative in everyday life. Skilled narrow-minded thinking is increasingly a serious threat to our well-being. From the poisoning of the air, the water, and the ground to the spread of life-threatening diseases, the human species is increasingly at risk. For the first time in our history, it is imperative that we take true intellectual discipline and the "fitness" of our minds seriously. We must create new conditions in school and society under which the intellectual virtues long ignored—independence of mind, intellectual curiosity, intellectual courage, intellectual humility, intellectual perseverance, intellectual integrity, faith in reason, and fair-mindedness—can develop. We must learn to be comfortable with, indeed to value, for the first time, well-justified self-criticism. We must, for the first time, begin to devote as much time to intellectual habits as we now do to physical ones and admit, finally, that rationality and openness of mind are not automatic or "natural" states that can be left to themselves to emerge and flourish. To begin to do this, we must reconceptualize the nature of teaching and learning in every context of school life. We must focus directly on the traits of mind essential to fair-minded thought. We must teach thinking for the first time in a *strong* sense.

RECOMMENDED READINGS

Paul, R., A. J. A. Binker, and D. Weil. (1990). *Critical* Thinking Handbook: K–3: A Guide For Remodelling Lesson Plans in Language Arts, Social Studies, and Science. Rohnert Park, Calif.: Foundation For Critical Thinking, Sonoma State University.

Paul, R., A. J. A. Binker, K. Jensen, and H. Kreklau. (1990). *Critical Thinking Handbook: 4–6th Grades: A Guide For Remodelling Lesson Plans in Language Arts, Social Studies, and Science.* Rohnert Park, Calif.: Foundation For Critical Thinking, Sonoma State University.

Paul, R., A. J. A. Binker, D. Martin, C. Vetrano, and H. Kreklau. (1989). *Critical Thinking Handbook: 6–9th Grades: A Guide For Remodelling Lesson Plans in Language Arts, Social Studies, and Science.* Rohnert Park, Calif.: Center For Critical Thinking and Moral Critique, Sonoma State University.

Paul, R., A. J. A. Binker, D. Martin, C. Vetrano, and H. Kreklau. (1989). *Critical Thinking Handbook: High School: A Guide For Redesigning Instruction.* Rohnert Park, Calif.: Center For Critical Thinking and Moral Critique, Sonoma State University.

Paul, R. (1990). *Critical Thinking: What Every Person Needs To Survive in A Rapidly Changing World.* Rohnert Park, Calif.: Center For Critical Thinking and Moral Critique, Sonoma State University.

Paul, R. (May 1988). "Ethics Without Indoctrination," *Educational Leadership* 45, 8: 10–19.

17

What Creative Thinking Is

D. N. Perkins

Creativity is the encounter of the intensively conscious human being with his world.

—Rollo May

Creativity is a messy and myth-ridden subject. Many of our casual beliefs have prevented an adequate understanding of creative thinking and have thwarted efforts to nourish its development in schools, businesses, and homes. Before addressing what creativity is, it's useful to examine two things creativity is not: a single, distinctive ability, and a matter of talent.

Intelligence as measured by IQ is one possible explanation for creativity in terms of ability. However, within a profession, creative achievement correlates poorly with IQ (Barron 1969; Wallach 1976a, 1976b). Another ability theory of creativity implicates "ideational fluency"—the ability to produce a large number of appropriate and unusual ideas efficiently. Although plausible, this theory has not withstood empirical testing. Correlations between ideational fluency measures and various biographical measures of real-world creative accomplishment are unimpressive (Crockenberg 1972; Mansfield and Busse 1981; Wallach 1976a, 1976b). Various other ability theories of creativity also fall short empirically or logically (Perkins 1981, ch. 9).

The second myth, that creativity depends on great talent in a particular field, conflicts with everyday experience. It's not unusual to find individuals with great *technical* talent in a field who are not notably creative. Moreover, identifying creativity with great talent suggests that we recognize as creative only the major innovators like Beethoven or Einstein. But, clearly, creativity is a matter of degree: it can be modest as well as grand. Moreover, if we only think of creativity on the grand scale, we miss opportunities to foster modest creative achievements that can provide both practical payoffs and personal rewards.

Creative Thinking: A Definition

Creative thinking is thinking patterned in a way that tends to lead to creative results. This definition reminds us that the ultimate criterion of creativity is output. We call a person creative when that person consistently gets creative results, meaning, roughly speaking, original and otherwise appropriate results by the criteria of the domain in question.

There is no obvious reason that creative results should depend on a single trait like ideational fluency. The pattern of creative thinking is not simple and neat—not just a matter, for instance, of generating ideas and selecting among them. Rather, the pattern involves a number of components that contribute to the creative outcome. These components can be categorized according to six general principles of creative thinking.

1. *Creative thinking involves aesthetic as much as practical standards.* Creative people strive for originality and for something fundamental, far-reaching, and powerful. For instance, Einstein's contributions were shaped substantially by his intense commitment to parsimonious theories lacking any element of arbitrariness; the same aesthetic led him to view quantum mechanics with distaste, despite his own early contributions to the development of the theory (Holton 1971–72).

Creative results do not just bubble up from some fecund swamp in the mind. Creative individuals tend to value stated qualities and try quite straightforwardly to achieve them. Getzels and Csikszentmihalyi (1976) have documented this trend in creative student artists. Various studies have identified similar explicit commitments in creative scientists (Helson 1971; Mansfield and Busse 1981; Pelz and Andrews 1966; Roe 1952a, 1952b, 1963; Perkins 1981).

This chapter is an excerpt from D. N. Perkins, "Creativity by Design." *Educational Leadership* 42, 1 (September 1984): 18–24.

2. *Creative thinking depends on attention to purpose as much as to results.* Creative people explore alternative goals and approaches early in an endeavor, evaluate them critically, understand the nature of the problem and the standards for a solution, remain ready to change their approach later, and even redefine the problem when necessary.

For an apt example of the latter, NASA scientists during the early days of the space program tried to solve the problem of heat of re-entry by devising a substance that could withstand the heat. They failed in their quest and had to abandon this definition of the problem. Their ultimate solution—the ablative heat shield that burns away as the space vehicle penetrates the atmosphere, taking the heat with it—turned upside down the original goal of finding a heat-resisting substance. The attention creative artists give to choosing what work to undertake has been documented by Getzels and Csikszentmihalyi (1976) for student artists. Skilled practitioners' understanding of problems has been extensively demonstrated for problem solving in science and mathematics. In brief, experts perceive problems in terms of possible solution paradigms, whereas novices perceive the same problems in terms of superficial features. (Chi, Feltovich, and Glaser 1981; Larkin 1983; Larkin, McDermott, Simon, and Simon 1980; Schoenfeld and Herrman 1982).

3. *Creative thinking depends on mobility more than fluency.* As noted earlier, efforts to relate measures of ideational fluency to real-world creative achievement have been disappointing. Instead, when difficulties arise, creative people may make the problems more abstract or more concrete, more general or more specific. They may use analogies—as Charles Darwin did when he arrived at the notion of natural selection by reading Malthus on population growth and contemplating the intense struggle that would result from human overpopulation—or they may project themselves into different roles—the viewer of a painting rather than the painter, the user of an invention rather than the inventor.

Clement (1982, 1984) has documented the role of analogy in skilled solving of math and physics problems. Working backwards from answer to solution is a widespread tactic in skilled problem solving (Newell and Simon 1972). Reformulating a problem in various ways is one tactic used in Schoenfeld's successful demonstrations of teaching mathematical problem solving (Schoenfeld 1982; Schoenfeld and Herrman 1982). These sorts of mobility are, of course, features of high competence as much as of creativity.

4. *Creative thinking depends on working at the edge more than at the center of one's competence.* Creative people maintain high standards, accept confusion, uncertainty, and the higher risks of failure as part of the processes, and learn to view failure as normal, even interesting, and challenging. An anecdote about Mozart illustrates performance under pressure. Mozart supposedly wrote the overture to *Don Giovanni* in a blitz effort the night before the opera opened. Although the orchestra performed it opening night without rehearsal, the overture was well received. Of course, many artists have taken risks of another sort, venturing well beyond the accepted canons of taste. Many works now considered notable received a dim reception from a public accustomed to more conventional styles, as happened, for instance, with Stravinsky's *Rite of Spring* and Manet's *Luncheon on the Grass* and *Olympia*.

The career of Marie Curie presents a striking case of persistent research conducted under sometimes appalling conditions (Perkins 1981, ch. 8; Reid 1974). Of course, dedication to success and stamina to withstand setbacks are characteristics of many sorts of achievement, not just creative achievement.

5. *Creative thinking depends as much on being objective as on being subjective.* Creative people consider different viewpoints, set final or intermediate products aside and come back to them later so that they can evaluate them with more distance, seek intelligent criticism, and subject their ideas to practical and theoretical tests.

Evidence on the relevance of criticism and the willingness to seek it out comes from my own studies of the practices of professional and amateur poets (see Perkins 1981, ch. 4). Contrary to the popular image of poets as utterly private individuals, many routinely sought feedback from colleagues. Moreover, these poets produced poetry judged by a panel of critics to be better than those who did not seek criticism.

6. *Creative thinking depends on intrinsic, more than extrinsic, motivation.* Creative people feel that *they*, rather than other people or chance, choose what to do and how to do it. They perceive the task as within their competence (although perhaps close to its edge); view what they are undertaking as worthwhile in itself, not just a means to an end; and enjoy the activity, its setting, and its context.

Numerous studies discussed by Amabile (1983) argue the importance of intrinsic motivation. In one study she biased the attitudes of a group of poets by asking them to list their reasons for writing before they composed haikus. The instructions for one group of poets led them to mention pragmatic reasons, such as holding a job as a professor, whereas the instructions for the second group produced a list of intrinsic reasons, such as writing for the sake of the art or for self-exploration. Remarkably, this simple preliminary activity produced a (presumably temporary) set that influenced the quality of the haikus the poets wrote immediately thereafter. As rated by judges who did not know which poets had received which treatments, the haikus produced by the intrinsic group ranked considerably higher.

In summary, it seems reasonable to say that the more these six principles guide one's thinking, the more creative it will be. However, not all the principles specifically reflect creativity as much as intellectual competence or motivation in general. For example, the ability to grasp the nature of a problem quickly is characteristic of skilled problem solvers, whether notably creative or not. The willingness and even desire to work at the edge of one's competence is striking in champion athletes, who may or may not be particularly creative. Other characteristics, on the other hand, are specifically associated with creative performance, such as attention to purpose or an emphasis on originality.

The creative pattern of thinking is an interesting mix of strategies, skills, and attitudinal factors. For instance, attention and effort are allocated in certain ways—to purposes, to transformations of the problem, to gathering and processing feedback, to the originality and other aesthetic qualities of the product. At least to some extent, such allocational patterns can be viewed as strategies that teachers might directly encourage in students. On the other hand, there are aspects of skill involved, such as the ability to quickly grasp the nature of a problem. By and large, only considerable experience in the domain in question will impart such expertise. Finally, an individual would not maintain creative behavior without some commitment to aesthetic principles, without an involvement in the problem for its own sake, without pleasure in pushing a problem into different patterns, and so on.

How Education Falls Short

There are many books and courses designed to teach creativity, but the case for their effectiveness is thin. A review by Mansfield, Busse, and Krepelka (1978) examined the literature on several courses for definitive evidence of gains and transfer. In general, the results were disappointing. Some undramatic gains occurred on tasks close to the training task; transfer was little in evidence.

The six characteristics of creative thinking discussed earlier help to explain why brief, special-purpose instruction may have little impact on creativity. Most such instruction focuses on strategies for creative thinking. These strategies probably help, but creativity benefits from skill as well.

The skills described in the six principles of creative thinking require extensive practice in a particular field. Although extreme competence may not be necessary, indeed may even be counterproductive, moderate skill seems essential. Thus, some efforts to impart creative problem solving may falter not so much because they fail to give enough emphasis to the creative side of the matter but because they do not provide sufficient guidance and experience on the competence side.

Moreover, attitudes as well are critical to creative thinking. They cannot be taught directly, any more than one can teach students to like Shakespeare. Teaching creativity must involve exposing students to the flavor and texture of creative inquiry and hoping they get hooked.

Another problem with special-purpose programs is the very limited time usually invested. We seem to assume that normal education equips students with the knowledge base for a creative pattern of thinking and that they need only a few quick tips about how to marshal existing knowledge and know-how to creative ends. Experience does not bear this out.

The deeper difficulty may be that schooling in general works against the creative pattern of thinking. Accordingly, instruction designed to foster creativity has to make up for the shortcomings of normal instruction. While the usual reasons—that schooling is too "right answer" oriented and has little tolerance for the maverick—are relevant, they are part of a much more pervasive syndrome. The six general principles of creative thinking yield a good map of the problem.

1. *Attention to aesthetics.* Outside of literature and the arts, conventional schooling pays little attention to the aesthetics of the many products of human inquiry that are addressed—for instance, scientific theories, mathematical systems, historical syntheses. How often, for example, do teachers point out the beauty of Newton's laws or the periodic table? How often do they highlight the originality of thinking of history as shaped by geography rather than skillful and willful leaders, or the originality of proving a theorem by *reductio ad absurdum* rather than by constructive proof? Likewise, how often do teachers comment on the aesthetics of students' work in math and science?

2. *Attention to purpose.* Most assignments are so narrow that students have little opportunity to generate, or even select among, different purposes. The treatment of scientific theories, for instance, often concentrates on the result to the exclusion of the broader purposes of explanation and understanding that motivated their initial development. For example, what range of phenomena spurred Newton to develop his laws, and where, historically, did that concern come from? How do Newton's laws affect our everyday lives? Some instruction in physics gives full play to such questions, but much does not.

3. *Mobility.* Most school problems are so narrow and convergent that, except for "working backwards," mobility doesn't count for much. Mobility applies most when a task presents major choices—for instance, selecting a problem,

revising a problem, choosing between empirical and theoretical methods (or, in a more humanistic context, choosing to treat a writing assignment either discursively or as a dialogue or drama), or trying to distill from one's knowledge a particular thesis to defend. For the most part, school problems lack the elbow room for exercising mobility.

4. *Workin ; at the edge of one's competence.* Especially gifted students may become discouraged if they do not find school challenging enough. But perhaps the broader difficulty is this: school does not challenge students to be creative. If they have the motivation, students can work at the edge of their competence in other directions—by precision, remembering all the facts, solving textbook problems—but not so much in the direction of creative accomplishment.

5. *Objectivity.* Schools typically do highlight objectivity, although not always very successfully in the arts.

6. *Intrinsic motivation.* It's no news that conventional schooling does not do a very good job of fostering intrinsic motivation Teachers, understandably discouraged by inattentive students and an often unsupportive society, often project an offhand or mechanical attitude toward knowledge and teaching. Students pick this up and project it back, continuing the vicious circle. Also, textbooks usually give little play to the most interesting features of subject areas. Finally, students have few opportunities to select the problems they address or the direction their instruction takes.

In summary, conventional schooling gets a mixed report card for its influence on creative thinking. Most of the problems trace back to two pervasive practices: Schooling generally presents knowledge as a given, rather than as the product of a creative effort to accomplish something. And schooling generally poses to students tasks that do not exercise or even allow creative effort.

REFERENCES

Amabile, T. M. (1983). *The Social Psychology of Creativity.* New York: Springer-Verlag.

Barron, F. (1969). *Creative Person and Creative Process.* New York: Holt, Rinehart, and Winston.

Chi, M., P. Feltovich, and R. Glaser. (1981). "Categorization and Representation of Physics Problems by Experts and Novices." *Cognitive Science* 5: 121–152.

Clement, J. (1982). "Analogical Reasoning Patterns in Expert Problem Solving." In *Proceedings of the Fourth Annual Conference of the Cognitive Science Society.* Ann Arbor: University of Michigan.

Clement, J. (April 1984). "Non-Formal Reasoning in Experts' Solutions to Mathematics Problems." Paper presented at the annual meeting of the American Educational Research Association, New Orleans.

Crockenberg, S. B. (1972). "Creativity Tests: A Boon or Boondoggle for Education?" *Review of Educational Research* 42, 1: 27–45.

Getzels, J., and M. Csikszentmihalyi. (1976). *The Creative Vision: A Longitudinal Study of Problem Finding in Art.* New York: John Wiley and Sons.

Helson, R. (1971). "Women, Mathematicians and the Creative Personality." *Journal of Consulting and Clinical Psychology* 36: 210–220.

Holton, G. (Winter 1971-72). "On Trying to Understand Scientific Genius." *The American Scholar* 41: 95–110.

Larkin, J. (1983). "The Role of Problem Representation in Physics." In *Mental Models,* edited by D. Gentner and A. S. Stevens. Hillsdale, N.J.: Erlbaum.

Larkin, J., J. McDermott, D. Simon, and H. Simon. (1980). "Modes of Competence in Solving Physics Problems." *Cognitive Science* 4: 317–345.

Mansfield, R. S., and T. V. Busse. (1981). *The Psychology of Creativity and Discovery.* Chicago: Nelson-Hall.

Mansfield, R. S., T. V. Busse, and E. J. Krepelka. (1978). "The Effectiveness of Creative Training." *Review of Educational Research* 48, 4: 517–536.

Newell, A., and H. Simon. (1972). *Human Problem Solving.* Englewood Cliffs, N.J.: Prentice-Hall.

Pelz, D. C., and F. M. Andrews. (1966). *Scientists in Organizations: Productive Climates for Research and Development.* New York: John Wiley and Sons.

Perkins, D. N. (1981). *The Mind's Best Work.* Cambridge, Mass.: Harvard University Press.

Reid, R. (1974). *Marie Curie.* New York: Saturday Review Press.

Roe, A. (1952a). "A Psychologist Examines 64 Eminent Scientists." *Scientific American* 187, 5: 21–25.

Roe, A. (1952b) *The Making of a Scientist.* New York: Dodd, Mead and Co.

Roe, A. (1963). "Psychological Approaches to Creativity in Science." In *Essays on Creativity in the Sciences,* edited by M. A. Coler and H. K. Hughes. New York: New York University.

Schoenfeld, A. H. (1982). "Measures of Problem-Solving Performance and of Problem-Solving Instruction." *Journal for Research in Mathematical Education* 13, 1: 31–49.

Schoenfeld, A. H., and D. J. Herrman. (1982). "Problem Perception and Knowledge Structure in Expert and Novice Mathematical Problem Solvers." *Journal of Experimental Psychology: Learning, Memory, and Cognition* 8, 5: 484–494.

Wallach, M. A. (1976a). "Psychology of Talent and Graduate Education." In *Individuality in Learning,* edited by Samuel Messick and Associates. San Francisco: Jossey-Bass.

Wallach, M. A. (1976b). "Tests Tell Us Little About Talent." *American Scientist* 64: 57–63.

18

Dimensions of Thinking: A Framework for Curriculum and Instruction

Robert J. Marzano, Ronald S. Brandt, Carolyn Sue Hughes, Beau Fly Jones, Barbara Z. Presseisen, Stuart C. Rankin, and Charles Suhor

Dimensions of Thinking (Marzano et al. 1988) is a framework meant to describe the various types of thinking that should be addressed within any comprehensive effort to teach thinking. It is a consequence of plans made at an ASCD-sponsored conference in May 1984 at the Wingspread Conference Center in Racine, Wisconsin, hosted by the Johnson Foundation. ASCD had called the meeting to ask interested educators how they might contribute to the burgeoning interest in teaching thinking. Out of that conference was formed the Association Collaborative for Teaching Thinking. The Collaborative recommended that a comprehensive framework be developed that would help educators understand the complexities and subtleties of teaching thinking. In effect, a framework was needed that identified the various aspects or dimensions of thought so that educators could identify the specific aspects of thinking reinforced by specific programs.

After a review of the research and theory, five dimensions or aspects of thought were identified. These dimensions should be read as general organizers for types of thinking—categories of thought. The five dimensions of thinking are:

- metacognition
- critical and creative thinking
- thinking processes
- core thinking skills
- content area knowledge.

Dimension 1: Metacognition

Although frequently discussed, metacognition is easily misunderstood. At a very basic level, metacognition simply means being aware of one's own thinking. However, current research and theory indicate that metacognition involves at least two components: (1) knowledge and control of self, and (2) knowledge and control of process (Paris, Lipson, and Wixson 1983).

Knowledge and Control of Self

Knowledge and control of self involves commitment, attitudes, and attention. Intuitively, most teachers recognize that students' commitment to academic tasks is a major determinant of their success. What is not intuitively recognized, however, is that commitment is a volitional act, not a by-product of circumstances; human beings can and do generate commitment by choice. This implies that one of the first aspects of knowledge and control of self involves monitoring commitment to the task at hand.

Closely related to commitment are the attitudes one brings to the task. A learner approaches a task with certain attitudes about the value of the task, his or her ability to perform the task, and the value of effort. If a learner does not possess effective attitudes, the learning situation will be adversely affected. Consequently, an important aspect of knowledge and control of self is being aware of the attitudes one brings to a task and cultivating those attitudes that are most conducive to learning.

The final aspect of knowledge and control of self involves attention. As with commitment, attention is commonly thought of as a reaction to a stimulus. If something is interesting, then it is attended to. If it is not interesting, little attention is effected. Attention, however, can also be controlled by the learner. That is, the learner can be attentive even in uninteresting situations. A third aspect of knowledge and control of self, then, is monitoring one's attention level and generating attention when necessary.

Knowledge and Control of Process

Knowledge and control of process, the second component of metacognition, involves evaluation, planning, and regulation. Evaluation includes assessing the current state of progress within a process—taking your mental temperature: "Do I understand what I just read? Do I understand the legend in this map?" Evaluation occurs throughout a process and is both the beginning and the end point for a task. It also includes assessing the extent to which adequate resources are available and goals and subgoals have been attained.

Planning involves deliberately selecting strategies to fulfill specific goals. Basically, students must know an array of specific procedures related to a task and select the most appropriate procedure at any given point. Finally, regulation involves checking progress toward goals and subgoals and then changing behavior if necessary.

An emphasis on metacognition in the classroom means that students must first be given control over classroom tasks and held responsible for their performance on those tasks. The notion of the teacher as a disciplinarian is, therefore, greatly diminished. Students need to learn to develop and foster self-control as a means to attaining better academic progress. Student self-control is considered as important and deserving of direct attention as any academic goal; indeed, the achievement of academic goals is directly dependent on self-control. This view echoes the message of the work world to education: that one of the important skills for students entering the work force is knowledge and control of themselves so that they can work autonomously and effectively with others in sometimes difficult situations.

Critical and Creative Thinking

Although critical thinking is commonly thought of as evaluative and creative thinking as generative, the two actually complement each other and work together. All good thinking involves both quality assessment and the production of novelty. Critical thinkers generate ways to test assertions; creative think‹ ‹ examine the newly generated thoughts to assess their validity and utility. The difference is not of kind but of degree and emphasis.

The moral for educators is to avoid implying that critical thinking and creative thought are opposite ends of a single continuum. Instead, school programs and practices should reflect the understanding that highly creative thinking is often highly critical and vice versa. This does not mean, however, that specific elements cannot be identified for both critical and creative thought.

The elements commonly associated with critical thinking can be subdivided into two major types: skills and dispositions. Ennis (1985) has developed a comprehensive list of critical thinking skills that includes: focusing on a question, analyzing arguments, and judging the credibility of a source. In addition to these rather specific skills, critical thinking also involves dispositions—general ways in which situations are approached. Again, Ennis has developed a comprehensive list that includes being open-minded, trying to be well informed, and taking into account the total situation.

The components of creative thinking can also be subdivided into skills and dispositions. Skills of creative thinking include such cognitive operations as generating alternatives and thinking laterally. Additionally, they include such dispositions as working at the edge rather than the center of one's competence, operating from an internal rather than an external locus of control, and reframing ideas.

To facilitate critical and creative thinking in the classroom means that instruction must be structured in such a way as to overtly reinforce both. Teachers can facilitate critical thinking by:

- conducting discussions and debates on controversial subjects;
- having students role-play historical incidents in which protagonists held conflicting views;
- having students attend community meetings or watch television programs that express different viewpoints;
- having students write letters to the editor expressing their opinions on a current local issue;
- having older students analyze newspaper articles and other material to find examples of apparent bias;
- having students read and discuss literature that reflects values and traditions different from theirs.

Perkins' (1986) "knowledge as design" is a powerful classroom tool for creative thinking. Using knowledge as design, students are helped to see the artifacts in their environment as designs created by people in response to a need. From this standpoint, a screwdriver, Boyle's law, and the Bill of Rights are all structures devised to accomplish a particular purpose. Perkins (1984) proposes that to make sense of the world and to produce designs of their own, students can ask four questions about any piece of knowledge:

- What is its purpose?
- What is its structure?
- What are model cases of it?
- What are arguments that explain and evaluate it?

It is in answering these questions in an open but thoughtful manner that the dispositions of creativity can be exemplified and reinforced.

The Thinking Processes

Another major dimension of thinking is the set of mental operations called processes. Thinking processes such as concept formation, decision making, research, and composing are commonly rich, multifaceted, and complex, involving the use of several thinking skills. As explained in the next section, thinking skills are simpler cognitive operations such as observing, comparing, or inferring. Thinking processes are broader in scope, more "macro," and take a longer time to complete.

There are eight thinking processes in the Dimensions of Thinking framework:

- Concept formation
- Principle formation
- Comprehension
- Problem solving
- Decision making
- Research
- Composition
- Oral discourse

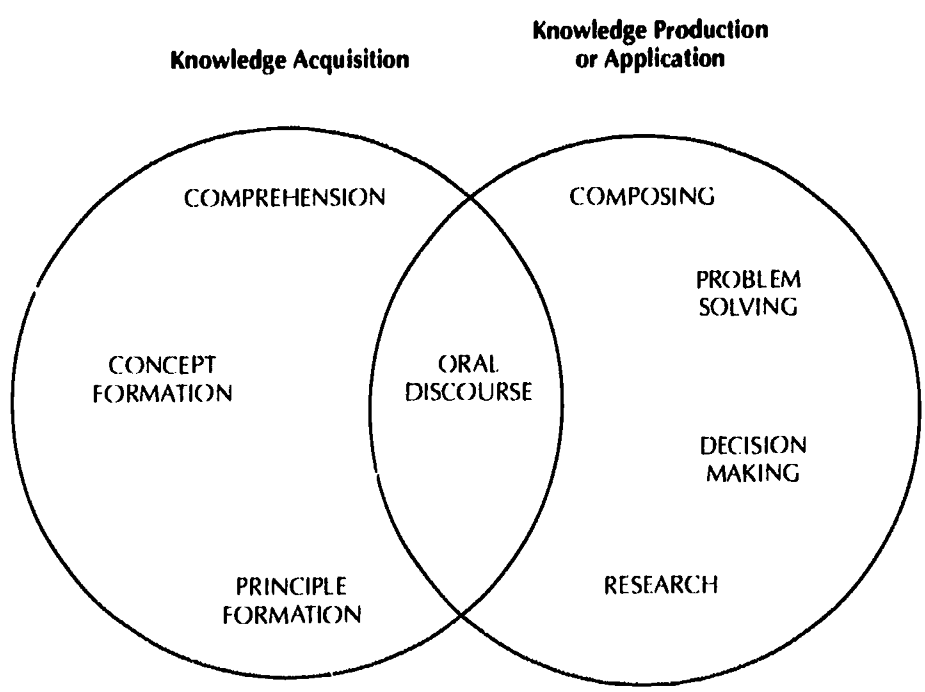
Although these processes are described linearly below, they do not occur in a lock-step manner (e.g., concept formation occurs before principle formation, and so on). Rather, the processes interact in a dynamic and iterative way.

The first three processes—concept formation, principle formation, and comprehension—are more directed toward knowledge acquisition than the other five. Concept formation is a foundation for the other processes. For example, when students encounter new content, they must establish the essential concepts before they can comprehend more densely organized information. Similarly, principle formation and comprehension are the basis for the other processes—for example, when a student invokes previously learned principles to solve a problem.

The next four processes—problem solving, decision making, research, and composition—often build on the first

FIGURE 1

Thinking Processes



three because they involve the production or application of knowledge. Finally, oral discourse is a process for both acquiring and producing knowledge. Figure 1 depicts the interrelationships among the processes.

Given that concept formation, principle formation, and comprehension help build a foundation for learning any discipline, an approach to curriculum planning that incorporates thinking processes can begin by listing answers to these questions:

- What concepts might we want students to develop in this course?
- What principles might students need to understand the relationships in this course?
- What other information might students need to comprehend in relationship to this course?

Since every conceivable concept or principle in any one course cannot be taught, educators must make choices. That is, they need to select the most important information, concepts, and principles around which to build curricular units.

Although students and teachers use knowledge acquisition processes to build a foundation for learning any content area, the knowledge is useful only to the degree that students can apply the knowledge or produce new knowledge. Therefore, educators need to design opportunities for students to use their knowledge to compose, to solve problems, to make decisions, or to conduct research for discovering new knowledge. Each unit in the curriculum should provide structured opportunities to use at least one of these processes, and in planning the overall curriculum, educators should provide a balanced menu of opportunities for students to use the various processes for producing or applying knowledge.

Finally, students and teachers should use oral discourse as a means of implementing or effecting all the other thinking processes. That is, language is a basic tool for learning in the classroom. All the other thinking processes use it during their execution. For example, using oral discourse, students can verbalize the similarities among examples of a concept, brainstorm ideas for a written composition, and discuss the merits of alternative solutions to a problem. Because the thinking processes are complex and require significant classroom time, educators need to develop curriculums that incorporate opportunities for students to use thinking processes to learn more effectively.

Core Thinking Skills

While the thinking processes are complex, macro-level mental operations, the core skills are micro-level operations used in the "service of" the process. That is, as an individual engages in a thinking process, she will use a number of the core skills.

Although a comprehensive list of skills is probably indeterminate, there is a finite set that is frequently used in the execution of the various thinking processes. These "core skills" are listed in Figure 2.

FIGURE 2

Core Thinking Skills

Focusing Skills
1. Defining problems
2. Setting goals

Information Gathering Skills
3. Observing
4. Formulating questions

Remembering Skills
5. Encoding
6. Recalling

Organizing Skills
7. Comparing
8. Classifying
9. Ordering
10. Representing

Analyzing Skills
11. Identifying attributes and components
12. Identifying relationships and patterns
13. Identifying main ideas
14. Identifying errors

Generating Skills
15. Inferring
16. Predicting
17. Elaborating

Integrating Skills
18. Summarizing
19. Restructuring

Evaluating Skills
20. Establishing criteria
21. Verifying

The focusing skills come into play when an individual senses a problem, an issue, or a lack of meaning. They enable the learner to attend to selected pieces of information and ignore others. The information gathering skills are used to bring to consciousness the substance or content to be used during the processing of information. Remembering skills are activities that the learner consciously engages in to store information in long-term memory and to retrieve it. Organizing skills are used to arrange information so it can be understood or presented more effectively. The learner uses these skills to impose structure on information by matching similarities, noting differences, or indicating sequences. Analyzing skills are used to clarify existing information by examining parts and relationships. Through analysis, the learner distinguishes components, attributes, assumptions, or reasons. Generating skills involve using prior knowledge to add information beyond what is given. Generation is essentially a constructive process, as connections among new ideas and prior knowledge are made. Integrating skills involve putting together the relevant parts or aspects of a solution, principle, or composition. Finally, evaluation skills involve assessing the reasonableness and quality of ideas.

Although the Dimensions of Thinking framework lists separate thinking skills, this in no way implies that thinking skills should be taught in isolation. Rather, the thinking skills should be reinforced when appropriate to the accomplishment of a learning goal.

Content Area Knowledge

The final major dimension of thinking is content area knowledge. Simply stated, all of the previous dimensions —metacognition, critical/creative thinking, the thinking processes, and the core skills—are meant to be used as one gains content area or domain specific expertise. This last dimension implies that the teaching of thinking cannot be separated from learning content. Consequently, the teaching of thinking must be an integral part of classroom instruction. As students learn content, their metacognitive knowledge and control of both self and process should be reinforced. Students should be using the skills and dispositions of critical and creative thinking to deepen and enrich their understanding of content. Finally, the thinking processes should be used as a major organizer for classroom tasks and the core thinking skills as tools for their effective execution.

Ultimately, it can only be through the integration of the first four dimensions of thinking and the fifth dimension—content knowledge—that the teaching of thinking will become a meaningful part of education.

REFERENCES

Ennis, R. H. (1985). Goals for a Critical Thinking Curriculum. In *Developing Minds: A Resource Book for Teaching Thinking*. edited by A. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Marzano, R. J., R. S. Brandt, C. S. Hughes, B. F. Jones, B. Z. Presseisen, S. C. Rankin, and C. Suhor. (1988). *Dimensions of Thinking: A Framework for Curriculum and Instruction*. Alexandria, Va.: Association for Supervision and Curriculum Development.

Paris, S. G., M. Y. Lipson, and K. K. Wixson (October 1983). Becoming a Strategic Reader. *Contemporary Educational Psychology* 8: 293–316.

Perkins, D. N. (Sept. 1984). Creativity by Design. *Educational Leadership* 42, 18: 18–25.

Perkins, D. N. (1986). *Knowledge as Design*. Hillsdale, N.J., Lawrence Erlbaum.

19

Dimensions of Learning: An Integrative Instructional Framework

Robert J. Marzano and Debra J. Pickering

I think—therefore I am.

—René Descartes

I think that I think, therefore I think I am.

—Ambrose Bierce

Dimensions of Learning (Marzano, Pickering, and Brandt 1990; Marzano et al. in press) is an adaptation of ASCD's comprehensive framework entitled Dimensions of Thinking (Marzano et al. 1988) (see description in this volume). While Dimensions of Thinking is a framework for organizing the theory and research on the teaching of thinking, Dimensions of Learning is an integrative framework for instructional planning and decision making. It is integrative in the sense that it involves the use of instructional strategies from a number of currently popular programs and practices such as cooperative learning, the teaching of thinking, the Hunter model, TESA, and so on. It facilitates planning and decision making in that it provides teachers with a framework with which they can identify the specific type of thinking reinforced or cued by specific teacher actions. This is one of the basic assumptions of, and foundations for, the Dimensions of Learning program—namely, that almost every teacher action reinforces or cues a specific type of student thought. To illustrate, if the teacher asks a question about a particular fact that students were exposed to, the teacher's action (the question) signals to students that they must perform the mental act of recall. If the teacher asks students to evaluate the information in an editorial, the teacher's behavior signals another type of student thinking—evaluative thought. The teacher directly and indirectly fosters certain types of thinking by her actions or lack thereof. Consequently, if teachers want to foster students' cognitive development, they can and should plan their actions to elicit certain types of student thought.

What, then, are the types of thinking that should be fostered in the classroom? Within the Dimensions of Learning program, five types of thinking are described. They are referred to as five dimensions of learning.

Dimension 1: Thinking Needed to Develop a Positive Attitude Toward Learning

One of the most important things the study of human learning has taught us is that students do not approach classroom learning in a vacuum. Rather, they bring to classroom tasks a set of attitudes that directly affect their performance. To a great extent, these attitudes set students up for success or failure, since positive attitudes enhance performance and negative attitudes diminish performance.

One of the first types of thinking necessary, for effective learning, then, is that which establishes an appropriate attitudinal environment. Specifically, the learner must have appropriate attitudes about self and others, self and climate, and self and task. Ideally, this means the learner believes that (1) she is accepted by both teacher and peers; (2) the classroom is a safe, orderly, and relatively comfortable place; and

ERIC

(3) classroom tasks are personally relevant and understandable and she has the skills to accomplish them.

Armed with an awareness of this first dimension of learning, a teacher can plan specific behaviors that reinforce these attitudes and perceptions in students. This planning can be facilitated by asking and answering the following questions:

Self and Others

- What can I do to help students feel accepted by me, the teacher?
- What can I do to help students feel accepted by each other?
- What can I do to help build a sense of community in my classroom?

Self and Climate

- What can I do to establish a sense of safety in my students?
- What can I do to establish a sense of orderliness in my students?
- What can I do to establish a sense of comfort in my students?

Self and Task

- What can I do to foster a sense of success in my students?
- What can I do to focus students' energy and attention?
- What can I do to make classroom tasks valuable and relevant to students?

As a result of asking and answering these questions, a teacher might identify specific behaviors that reinforce student thinking relative to the first dimension of learning. For example, a teacher might reinforce effective attitudes about self and others by providing equal response opportunities for students (so that students have a sense of acceptance by the teacher) and by using cooperative and collaborative instructional techniques (so that students develop a sense of community and peer support). To develop effective attitudes about self and climate, a teacher might greet students at the door or arrange the classroom to accommodate different styles of learning. Finally, the teacher might reinforce effective attitudes about classroom tasks by structuring activities for high success and communicating to students a sense of confidence in their ability.

Dimension 2: Thinking Needed to Acquire and Integrate Knowledge

Types of thinking that help learners acquire and integrate new knowledge are also important to effective learning. When learning new information, the learner must first assimilate the information into her existing knowledge base by: (1) constructing meaning, (2) organizing, and (3) storing or practicing.

Constructing meaning, as the term implies, involves using what is already known to make sense of what is to be learned. There are many strategies, most developed from the research and theory on reading comprehension, that can help students construct meaning. Using the K-W-L strategy (Ogle 1986), for example, the learner initially identifies what she already knows about the topic (what I already know = K) and what she would like to know (what I want to know = W). She then reads (or listens to, or observes) the information and determines what she learned (what I learned = L). This strategy involves the learner in actively constructing meaning for new information.

Organizing knowledge involves making distinctions between the different types of information important to a lesson (e.g., facts, time sequences, causal networks, problems/solutions, episodes, concepts, principles). Making these distinctions is at the core of effective learning. Since much of the information presented to students orally and in writing can be organized in a variety of ways, it's important, from the learner's perspective, to organize information in a way that is consistent with the teacher's preferred method of organization. If the teacher has not identified her preferred method of organization prior to presenting information, instruction will, by definition, lack focus and impose a great burden on the learner—namely, that of figuring out how to organize the content to meet the implicit but unstated expectations of the teacher.

Finally, storing information involves representing it in long-term memory in such a way as to make it easily accessible at later dates or practicing it to the extent that it can be performed automatically. This involves such activities as verbal rehearsal, use of imagery, use of mnemonics, use of mass and distributed practice, and so on.

The second dimension of learning implies that teachers should plan for lessons by asking and answering the following questions before presenting or exposing students to content:

- What important information do I want students to know?
- Within that information, what are the important facts? time sequences? causal networks? problem/solutions? episodes? concepts? principles?
- What will I do to help students construct meaning for this important information?
- What will I do to help students organize this information?
- What will I do to help students store this information?
- What will I do to help students practice this skill?

Dimension 3: Thinking Needed to Extend and Refine Knowledge

Knowledge, once acquired and integrated with existing knowledge, does not remain static. Over time it is changed, sometimes in unpredictable ways. For example, research indicates that students' early ideas of science concepts are commonly more like an Aristotelian view of the physical world than a Newtonian view (Vosniadou and Brewer 1987). It is only after experiencing information in new and unusual ways that students refashion simplistic concepts into highly developed ideas.

A third dimension of learning, then, is the type of thinking that aids in the extension and refinement of knowledge. For this model, eight major extending and refining operations have been identified. These are summarized in Figure 1.

FIGURE 1

Extending and Refining Operations

Comparing: Identifying and articulating similarities and differences between two items.

Classifying: Grouping items into definable categories based on their attributes.

Inducing: Inferring unknown generalizations or principles based on observation or analysis.

Deducing: Inferring unknown consequences and necessary conditions from given principles and generalizations.

Analyzing Errors: Identifying and articulating mistakes in one's own thinking or in that of others.

Constructing Support: Building a system of evidence or a proof for an assertion.

Abstracting: Identifying and articulating the underlying theme or general pattern for information.

Analyzing Value: Identifying and articulating the worth of information for you and for others.

Each of the mental operations listed in Figure 1, when applied as a knowledge extension and refinement activity, engages the learner with content in a way that inevitably causes the learner to change that content in some way. For example, whenever you compare two or more elements in detail, even if you know them fairly well, you invariably learn something new about them as a result of the act of comparison. In a social studies class, students might compare different forms of government (e.g., democracy, republic, and monarchy) to discover distinctions about which they were previously unaware. Similarly, the process of making deductions about future events or states based on known principles or situations invariably helps you better understand those principles or situations. In a science class, students might make deductions about whales based on known principles about mammals to refine and extend their knowledge about mammals and whales.

The third dimension of learning implies that teachers should plan for lessons by systematically asking and answering the following questions:

In terms of important classroom content, what will I do to help students

- compare the information?
- classify the information?
- make inductions about the information?
- make deductions about the information?
- analyze errors within the information?
- construct support for or against the information?
- make abstractions about the information?
- analyze values relative to the information?

Dimension 4: Thinking Needed to Make Meaningful Use of Knowledge

Ultimately learning must involve the meaningful use of knowledge. Meaningful use, by definition, involves a goal orientation. Something is meaningful to you if it fits within one or more of your goals. We should note here that the extending and refining operations listed in Figure 1 are not commonly the focus of personal goals. For example, you don't usually compare for the purpose of comparing and you don't abstract simply for the purpose of abstracting. There are some cognitive operations, though, that are generally goal directed. More precisely, there are a set of operations that are frequently the vehicles for accomplishing goals. These are briefly described in Figure 2.

To illustrate, scientific inquiry is typically a vehicle for accomplishing goals, specifically those dealing with understanding physical and psychological phenomena and then using that understanding to make predictions about future phenomena. For example, a student might use scientific inquiry to understand the principles underlying a reader's reaction to certain types of adjectives in an essay. The student could then use that knowledge to predict how readers will react to specific types of essays.

Composing is a vehicle for accomplishing the goal of creating something new. Problem solving is a vehicle for achieving the goal of changing some incomplete or unacceptable situation. Decision making is a vehicle for achieving the goal of selecting between alternatives. Oral discourse is a vehicle for achieving the goal of clarifying and discovering fine distinctions within information.

FIGURE 2

Processes Involving the Meaningful Use of Knowledge

Oral Discourse: The act of discussing a topic using specified conventions that add clarity to and provide new insights into the topic of discussion.

Composing: The act of creating a new product using known information.

Problem Solving: The act of obtaining a content-related goal for which some obstacle is in the way.

Decision Making: The act of selecting among alternatives that appear to be equal.

Scientific Inquiry: The act of identifying underlying principles relative to a physical or psychological phenomenon, making predictions based on those principles, and then systematically testing the accuracy of those predictions.

The goal-oriented nature of the processes listed in Figure 2 implies that students should be allowed and expected to engage in self-selected, personally relevant tasks in which they systematically use one or more of the processes listed in Figure 2. For example, in a history class, a student might choose to compose an essay describing the events that led to the Cuban missile crisis. Another student, however, might decide to use decision making to analyze Kennedy's reasons for blockading the Soviet missile-bearing ships. Finally, another student might talk with a group of students to clarify some of the issues surrounding the events leading to the blockade. In short, the classroom tasks that most powerfully change existing knowledge are those that involve the processes listed in Figure 2 and are selected and orchestrated by students themselves.

To facilitate such a use of knowledge, the teacher should ask and answer such questions as:

- What will I do to help my students select meaningful tasks involving classroom content?
- What will I do to help my students use the following processes within the tasks they select: oral discourse? composing? problem solving? decision making? scientific inquiry?

Dimension 5: Thinking Needed to Develop Desirable Habits of Mind

It is a common misconception that higher-order thought is complex thought, that the more complex a task is, the higher the level of cognition required. Although intuitively it seems that the complexity of a task dictates whether it is higher or lower in order, very complex tasks can often be done with relatively little effort or thought. Consider the complexity involved in reading this chapter. For years researchers and theorists have agreed that the act of reading is

Dimensions of Learning

Developers:	R. J. Marzano, D. J. Pickering, D. E. Arredondo, G. J. Blackburn, D. L. Davis, R. W. Ewy.
Goal:	Provide a comprehensive instructional planning framework that integrates the teaching of thinking into content area instruction using aspects of the major instructional models currently available.
Cognitive skills addressed:	• Thinking needed to develop a positive attitude toward learning. • Thinking needed to acquire and integrate knowledge. • Thinking needed to extend and refine knowledge. • Thinking needed to make meaningful use of knowledge. • Thinking needed to develop desirable habits of mind.
Assumptions:	• Teaching thinking is reinforced by overt teacher behaviors. • For the teaching of thinking to be effective, it must be part of instructional planning. • For the teaching of thinking to be effective, it must be based on a comprehensive framework of human learning.
Intended audience:	K–12
Process:	Teachers plan and carry out content area instruction in such a way as to reinforce thinking along five major dimensions of learning.
Time:	Instruction in specific, cognitive strategies is built into classroom instruction as needed.
Available from:	Association for Supervision and Curriculum Development, 1250 N. Pitt Street, Alexandria, Virginia 22314-1403

one of the most complex cognitive operations, yet no literate adult would consider the act of reading a chapter or article a higher-order task. Literate adults have developed the complex process of reading to such a level of proficiency that they can perform it with little conscious thought. This level of proficiency is called *automaticity*. Some theorists assert that the vast majority of (or perhaps all) complex processes can be developed to the point of automaticity (Anderson 1983). In short, what is complex for the novice is relatively easy for the expert.

Higher-level thought, then, must involve mental "habits" that make even somewhat mundane tasks challenging and nonautomatic. Within the Dimensions of Learning model, three types of mental habits that facilitate higher-level learning have been identified: (1) those that make learning critical, (2) those that make learning creative, and (3) those that make learning self-regulated.

Mental habits that make learning more critical in nature include:

- Being clear and seeking clarity
- Being accurate and seeking accuracy
- Being open-minded
- Taking a position and defending it
- Being sensitive to the level of knowledge and feelings of others
- Avoiding impulsivity

Ennis (1985) and Costa (1985) note that it is these types of behavior that are at the core of critical thinking. To illustrate, the learner might notice her tendency to answer questions without much forethought and afterwards, she may consciously control her impulsivity. Or the learner might consciously strive to communicate in a clear fashion, checking to see that others have understood her communication.

Mental habits that make learning more creative in nature have been identified by Amabile (1983) and Perkins (1984). They include:

- Engaging intensely in tasks even when answers or solutions are not apparent
- Pushing the limits of one's knowledge and abilities
- Generating and following one's own standards of evaluation
- Generating new ways of viewing situations outside the boundaries of standard conventions

For example, the learner might notice that he tends to "coast" through projects, expending as little energy as possible. To correct or override this tendency, the learner might "push" himself within a certain project, trying to go beyond and explore the limits of his own competence.

The third category of mental habits that facilitate higher-level learning is those that make learning self-regulated—under the conscious control of the learner. Such habits are derived from the research and theory in metacognition and self-efficacy (Brown 1978; Flavell 1976). Some of these are:

- Being aware of one's own thinking
- Planning
- Being sensitive to feedback
- Using available resources
- Evaluating the effectiveness of one's thinking

For example, the learner might make a specific plan of action for a classroom project. As the learner implements her plan, she might occasionally note if she is getting closer to or further from her goal and then make corrections as needed.

The final dimension of learning, then, is habits of mind that make learning critical, creative, and self-regulated. Like the attitudes and perceptions that establish the environment for learning, the habits of mind must be fostered in a direct and conscious way. The teacher might reinforce them by noting and encouraging the use of specific habits or by appointing classroom "observers" to identify and acknowledge their use.

To plan for developing the dispositions in students, it is helpful for the teacher to ask and answer the following questions:

Critical Thinking

What will I do to help my students

- be clear and seek clarity?
- be accurate and seek accuracy?
- be open-minded?
- take a position and defend it when warranted?
- be sensitive to others?
- avoid impulsivity?

Creative Thinking

What will I do to help my students

- engage intensely in tasks even when answers aren't apparent?
- push the limits of their knowledge and ability?
- generate and follow their own standards?
- generate new ways of viewing situations?

Self-Regulation

What will I do to help my students

- be aware of their own thinking?
- plan?
- be sensitive to feedback?
- use available resources?
- evaluate the effectiveness of their own thinking?

Implications

The Dimensions of Learning framework is currently being field-tested and refined by the Mid-continent Regional Educational Laboratory and the Association for Supervision and Curriculum Development. Eighteen districts representing 10 states and 2 countries have committed to a two-year field test of this program. The results to date indicate that even the most effective teachers rarely go beyond Dimensions 1 and 2 in their instructional planning. That is, teachers set a positive attitudinal environment for learning and do an effective job of helping students acquire and integrate information; however, they rarely engage students in tasks that help them extend and refine knowledge (Dimension 3) or use it in meaningful ways (Dimension 4). Rarer still is planned instruction geared toward systematic reinforcement of the dispositions of critical thought, creative thought, and self-regulation (Dimension 5).

Use of the dimensions as a planning framework, however, can change this. When teachers use the framework, they tend to systematically plan for and engage students in tasks that reinforce the types of thinking described in Dimensions 3, 4, and 5. Student engagement in these tasks in turn increases students' abilities to use the types of thought described in Dimensions 3, 4, and 5.

References

Amabile, T. M. (1983). *The Social Psychology of Creativity*. New York: Springer-Verlag.

Anderson, J. (1983). *The Architecture of Cognition*. Cambridge, Mass.: Harvard University Press.

Brown, A. L. (1978). "Knowing When, Where and How to Remember: A Problem of Metacognition." In *Advances in Instructional Psychology*, vol. 1, edited by R. Glaser. Hillsdale, N.J.: Lawrence Erlbaum.

Costa, A. (1985). "How Can We Recognize Improved Student Thinking?" In *Developing Minds: A Resource Book for Teaching Thinking*, edited by A. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Ennis, R. H. (1985). "Goals for a Critical Thinking Curriculum." In *Developing Minds: A Resource Book for Teaching Thinking*, edited by A. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Flavell, J. H. (1976). "Metacognitive Aspects of Problem Solving. In *The Nature of Intelligence*, edited by L. B. Resnick. Hillsdale, N.J.: Lawrence Erlbaum.

Marzano, R. J., R. S. Brandt, C. S. Hughes, B. F. Jones, B. Z. Presseisen, C. S. Rankin, and C. Suhor. (1988). *Dimensions of Thinking: A Framework for Curriculum and Instruction*. Alexandria, Va.: Association for Supervision and Curriculum Development.

Marzano, R. J., D. J. Pickering, D. E. Arredondo, G. J. Blackburn, D. L. Davis, and R. W. Ewy, (in press). *Dimensions of Learning: An Integrative Instructional Framework*. Alexandria, Va.: Association for Supervision and Curriculum Development.

Marzano, R. J., D. J. Pickering, and R. C. Brandt. (1990). Integrating Instructional Programs through Dimensions of Learning. *Educational Leadership* 47, 5: 17–24.

Ogle, D. (1986). K-W-L: A Teaching Model That Develops Active Reading of Expository Text. *The Reading Teacher* 39: 564–576.

Perkins, D. N. (Sept. 1984). Creativity by Design. *Educational Leadership* 42, 18 : 18–25.

Vosniadou, S., and W. F. Brewer. (1987). Theories of Knowledge Restructuring in Development. *Review of Educational Research* 51, 1: 51–67.

20

The Search for Intelligent Life

Arthur L. Costa

Presented in the preceding chapters of Part III are a variety of definitions of thinking skills and abilities. After reading so many points of view, perhaps your confusion has only increased. What follows, however, is yet another attempt to clarify the purposes for teaching thinking.

I believe that time and energy devoted to clarifying are well spent. If we know what our outcomes are, we can more readily select or construct learning experiences that contribute to them and determine what student behaviors indicate that those goals are being achieved. I suggest that the goals of cognitive education should be the achievement of those dispositions, attitudes, or inclinations that are characteristic of intelligently behaving human beings.

Some Assumptions About Intelligent Behaviors

In teaching for thinking, we are interested not only in what students know but also in how students behave when they don't know. Intelligent behavior is demonstrated when we are confronted with questions and problems for which we don't know the immediate answer. We want students to use what they learn to solve all kinds of problems—new and old.

By definition, a problem is any stimulus, question, task, phenomenon, anomaly, discrepancy, or perplexing situation. We want to focus on student performance under challenging conditions that demand strategic reasoning, insightfulness, perseverance, creativity, and craftsmanship to resolve complex problems.

Gathering evidence of the performance and growth of intelligent behavior is difficult through standardized testing. It really requires "kid-watching": observing students as they try to solve the day-to-day academic and real-life problems they encounter in school, at home, on the playground, alone, and with friends. By collecting anecdotes and examples of written, oral, and visual expressions, we can see students' increasingly voluntary and spontaneous performance of these intelligent behaviors.

The Search for Intelligent Behaviors

Just what do human beings do when they behave intelligently? In their research in effective thinking and intelligent behavior, Feuerstein, Rand, Hoffman, and Miller (1980), Glatthorn and Baron (1985), Sternberg (1984), Perkins (1985), and Ennis (1985) found that effective thinkers share identifiable characteristics. These characteristics have been identified in successful mechanics, teachers, entrepreneurs, salespeople, parents—people from all walks of life.

Below are 14 characteristics of intelligent behavior that teachers and parents can teach and observe. This list is not meant to be complete, but rather suggestive of the goals for which we are striving. As we think and study more about intelligent behavior we will undoubtedly discover additional characteristics.

1. Persistence

Failed in business 1831
defeated for legislature 1832
again failed in business 1833
elected to legislature 1834
defeated for Speaker 1838
defeated for elector 1840
defeated for Congress 1843
elected to Congress 1846
defeated for Congress 1848
defeated for Senate 1855
defeated for vice-president 1858
defeated for Senate 1858
elected president of the United States in 1860

—Abraham Lincoln

People who behave intelligently try to stick to a task until it is completed. They don't give up easily. For instance, when asked how he was able to discover the law of universal gravitation, Sir Isaac Newton disarmingly replied, "By thinking on it continuously." Some students, however, when they can't immediately find the answer to a problem, crumple their papers and throw them away, saying, "I can't do this, it's too hard," or they make up an answer to get the task over with as quickly as possible. They lack the ability to analyze a problem, to develop a system, structure, or strategy of problem attack. I overheard one student, when challenged with a provocative problem, say, "I don't do thinking!"

Students demonstrate growth in thinking abilities by increasing their use of alternative strategies of problem solving. They collect evidence to indicate their problem-solving strategy is working, and if one strategy doesn't work, they know how to back up and try another. They realize that they must reject their theory or idea and employ another. They have systematic methods of analyzing a problem, knowing ways to begin, knowing what steps must be performed, and what data need to be generated or collected. This is what is meant by perseverance.

2. Decreasing Impulsivity

By the time I think about what I'm going to do, I already did it.
—Dennis the Menace

When it is important to do so, intelligent people think before they act. They deliberately form a vision of a product, a plan of action, a goal, or a destination before they begin.

In school, however, students often blurt out the first answer that comes to mind. Sometimes they shout an answer, start to work without fully understanding directions, work without an organized plan or strategy for approaching a problem, or make immediate value judgments about an idea—criticizing or praising it—before fully understanding it. They take the first suggestion given or operate on the first idea that comes to mind rather than consider alternatives and consequences of several possible solutions.

As students become less impulsive, we can observe them clarifying goals, planning a strategy for solving a problem, exploring alternative problem-solving strategies, and considering the consequences of actions before they begin. They use fewer trial-and-error tactics, gather information before they begin a task, take time to reflect on an answer before giving it, make sure they understand directions before starting a task, and listen to alternative points of view.

3. Listening to Others—With Understanding and Empathy

The way of being with another person which is termed empathic means temporarily living in their life, moving about in it delicately, without making judgments. To be with another person in this way means that for the time being you lay aside the views and values you hold for yourself in order to enter the other's world without prejudice. A complex, demanding, strong yet subtle and gentle way of being.
—Carl Rogers

Some psychologists believe that the ability to listen to other people, to empathize with and to understand their point of view, is one of the highest forms of intelligent behavior. Being able to paraphrase other people's ideas; detecting indicators (cues) of their feelings or emotional states in their oral and body language (empathy); accurately expressing other people's concepts, emotions and problems—all are indications of listening behaviors (Piaget called it "overcoming ego-centrism").

Some students ridicule other students' ideas. They are unable to build on, consider the merits of, or operate on another person's ideas. We know students are developing better listening skills when we observe them attending to another person and demonstrating an understanding of, or empathy for, another person's idea or feeling by accurately paraphrasing it, building on it, clarifying it, or giving an example of it. When students say, "Peter's idea is . . ., but Sarah's idea is . . .," or "Let's try Shelley's idea and see if it works," or "Let me show you how Gina solved the problem, then I'll show you how I solved it," then we know students are listening to and internalizing others' ideas and feelings.

4. Cooperative Thinking—Social Intelligence

Getting along well with other people is still the world's most needed skill. With it . . . there is no limit to what a person can do. We need people, we need the cooperation of others. There is very little we can do alone
—Earl Nightingale

Humans are social beings. We congregate in groups, find it therapeutic to be listened to, draw energy from one another, and seek reciprocity. In groups, we contribute our time and energy to tasks that we would quickly tire of when working alone. In fact, one of the cruelest forms of punishment we can inflict is solitary confinement.

Humans who behave intelligently realize that all of us together are more powerful than any one of us. Probably the foremost of intelligent behaviors for the post-industrial society will be a heightened ability to think in concert with others. As the world population steadily grows and we find ourselves living together in increasingly closer proximity, we will become ever more conscious that the earth is a closed ecological system and that sensitivity to the needs of others is paramount to human survival.

Problem solving has become so complex that no one person can go it alone: No one has access to all the data needed to make critical decisions; no one person can consider as many alternatives as several people. But working in groups requires the ability to justify ideas and to test the feasibility of solution strategies on others. Indeed, there are not many decisions any of us makes without having to consider their effects on others.

Children do not necessarily come to school knowing how to work effectively in groups. They may exhibit competitiveness, narrowmindedness, egocentrism, ethnocentrism, or criticism of others' values, emotions, and beliefs.

Listening, consensus seeking, giving up an idea to work on someone else's, empathy, compassion, group leadership, knowing how to support group efforts, altruism—all are behaviors indicative of intelligent human beings.

5. Flexibility in Thinking

To raise new questions, new problems, to regard old problems from a new angle requires creative imagination and makes real advances.

—Albert Einstein

Intelligent people can approach a problem from a new angle using a novel approach. DeBono (1970) refers to this as *lateral thinking*.

Some students have difficulty in considering alternative points of view or dealing with several sources of information simultaneously. *Their* way to solve a problem seems to be the only way. They may decide that *their* answer is the only correct answer. They are more interested in knowing the correctness of their answer than in being challenged by the process of finding the answer. They are unable to sustain a process of problem solving over time, so they avoid ambiguous situations; they have a need for certainty rather than an inclination to doubt. Their minds are made up and they resist being influenced by data or reasoning that contradicts their beliefs.

As students become more flexible in their thinking they can be heard considering, expressing, or paraphrasing another person's point of view or rationale. They can state several ways of solving the same problem and can evaluate the merits and consequences of alternative courses of action. When making decisions, they will often use such words as "however," "on the other hand," or "if you look at it another way." Although they gradually develop a set of moral principles to govern their own behavior, they are willing to change their mind if presented with a convincing argument. Working in groups, they often resolve conflicts through compromise, express a willingness to experiment with another person's idea, and strive for consensus.

6. Metacognition—Awareness of One's Own Thinking

When the mind is thinking it is talking to itself.

—Plato

Some people are unaware of their own thinking processes while they are thinking. When asked, "How are you solving that problem?" they may reply, "I don't know, I'm just doing it." They can't describe the steps and sequences that they use before, during, or after problem solving. They can't transform into words the visual images held in their mind. They seldom plan for, reflect on, and evaluate the quality of their own thinking skills and strategies.

By asking students to describe what goes on in their head while they are thinking, we determine if students are becoming more aware of their thinking. When asked, they should be able to:

- Describe what they know and what they need to know;
- Describe what data are lacking and their plans for producing those data;
- Describe their plan of action before they begin to solve a problem;
- List the steps and tell where they are in the sequence of a problem strategy;
- Trace the pathways and blind alleys they took on the road to a problem solution.

They should also learn to apply cognitive vocabulary correctly as they describe their thinking skills and strategies, using such phrases as:

- "I have a hypothesis. . . ."
- "My theory is . . ."
- "When I compare these points of view. . . "
- "By way of summary . . ."
- "What I need to know is . . ."
- "The assumptions on which I am working are . . ."

7. Striving for Accuracy and Precision

A man who has committed a mistake and doesn't correct it is committing another mistake.

—Confucius

Intelligent people want to communicate accurately in both written and oral form. Often, however, we use language that is vague and imprecise, describing objects or events with words like *weird*, *nice*, or *OK*, calling specific objects *stuff*, *junk*, and *things*, and punctuating sentences with meaningless interjections like *ya know*, *er*, and *uh*.

We use vague or general nouns and pronouns ("*They* told me to." "*Everybody* has one." "*Teachers* don't understand me."), nonspecific verbs ("Let's *do* it."), and unqualified comparatives ("This soda is *better*; I like it *more*.").

Unless prompted, students rarely review their papers before turning them in. They seem to feel little inclination to reflect upon the accuracy of their work, to take pride in their accomplishments. Their desire to get the assignment over with surpasses their pleasure in craftsmanship.

We can observe students growing in their desire for accuracy:

- They take time to check over their tests and papers.
- They review the rules by which they are to abide.
- They review the models and visions they are to follow.
- They review the criteria they are to employ, and they confirm that their finished product matches the criteria exactly.

As students' language becomes more precise, we hear them using more descriptive words to distinguish attributes. They use correct names and when universal labels are unavailable, they use relevant analogies. They spontaneously provide criteria for their own value judgments and describe why they think one product is better than another. They speak in complete sentences, voluntarily provide supporting evidence for their ideas, and elaborate, clarify and operationally define their terminology. Their oral and written expression become more concise, descriptive, and coherent.

8. A Sense of Humor

I bought my grandson some war toys; you know, rocket launchers, laser guns, star-wars stuff. Gee, they were realistic: expensive, complicated and they didn't work.

—Anonymous

Laughter transcends all human beings. Its positive effects on physiological functions include a drop in the pulse rate, the secretion of endorphins, and increased oxygen in the blood. It has been found to liberate creativity and provoke such higher-level thinking skills as anticipation, finding novel relationships, and visual imagery.

The acquisition of a sense of humor follows a developmental sequence similar to that described by Piaget (1972) and Kohlberg (1981). We may observe some students whose sense of humor has not yet been fully developed. They laugh at all the wrong things—human frailty, ethnic humor, sacrilegious riddles, and ribald profanities.

People who behave intelligently have the ability to perceive situations from an original and often humorous vantage point. They tend to initiate humor more often, to place greater value on having a sense of humor, to appreciate and understand others' humor, and to be verbally playful when interacting with others. They thrive on finding incongruity and have a whimsical frame of mind that is characteristic of creative problem solvers (Cornett 1986).

9. Questioning and Problem Posing

The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skills.

—Albert Einstein

Someone asked the Nobel Laureate I. I. Rabi why he became a physicist, rather than a doctor or a lawyer or a tailor, like his father. Rabi explained that his mother made him a scientist without ever intending it. Every other Jewish mother in Brooklyn would ask her child, "So? What did you learn in school today?" But not his mother. She always asked, "Izzi, what good questions did you ask today?" (Barell 1988).

One of the characteristics that distinguishes humans from other forms of life is our inclination and our ability to *find* problems to solve. Yet students often depend on others to solve problems, to find answers, and to ask questions for them. They sometimes are reluctant to ask questions for fear of displaying ignorance.

Over time, we want to observe a shift from the teacher's asking questions and posing problems toward the students' asking questions and finding problems for themselves. Furthermore, the types of questions students ask should change and become more specific and profound. For example, students should ask for data to support others' conclusions and assumptions—using such questions as "What evidence do you have?" or "How do you know that's true?" And they should pose more hypothetical problems characterized by "if" questions: "What do you think would happen if . . .?" or "If that is true, then what might happen if . . .?"

We want students to be alert to, and recognize, discrepancies and phenomena in their environment and to inquire about their causes: "Why do cats purr?" "How high can birds fly?" "Why does the hair on my head grow fast, while the hair on my arms and legs grows slowly?" "What would happen if we put the saltwater fish in a freshwater aquarium?" "Besides war, what are some possible solutions to international conflicts?"

10. Drawing on Past Knowledge and Applying It to New Situations

If the processes don't transfer, they cannot even be called THINKING. They can be called LEARNING, MEMORY, or HABIT, but *not thinking. The purpose of a course on thinking is to enhance students' abilities to face new challenges and to attack novel problems confidently, rationally, and productively.*

—Marilyn J. Adams (1989)

The ultimate goal of teaching is for students to apply school-learned knowledge to real-life situations and to content areas beyond those in which it was learned. Yet we find that even though students can, for example, pass the mastery tests in mathematics, they often have difficulty deciding whether to buy six items for $2.39 or seven for $2.86 at the supermarket.

Too often students begin a task as if they were approaching it for the very first time. Teachers are often dismayed when they invite students to recall how they solved a similar problem and students don't remember, even though they've recently solved the same type of problem. They act as though they've never heard of it before. It's as if each experience is encapsulated into a separate episode that has no relationship to anything that came before or that comes afterward.

Intelligent human beings learn from experience. They abstract meaning from their experiences and apply it in new situations. When students say, "This reminds me of . . ." or "This is just like the time when I . . .," they show that they are developing this ability. They explain what they are doing by using analogies and references to previous experiences. They call on their store of knowledge and experience as sources of data to support, theories to explain, or processes to solve each new challenge.

When parents and other teachers report how they have observed students thinking at home or in other classes, we know students are transferring. For example: parents report their child's increased interest in school, better use of time and finances, and improved organization of books and other belongings at home. (One parent reported that during a slumber party, his daughter invited her friends to "brainstorm" which activities and games they preferred. This happened after she learned brainstorming techniques in school.)

We might hear, for example, the social studies teacher describe how a student used a problem-solving strategy that was originally learned in the science class. We might hear the woodshop teacher tell how a student volunteered a plan to measure accurately before cutting a piece of wood: "Measure twice and cut once," an axiom learned in algebra class.

11. Risk Taking

We can never discover new continents until we have the courage to lose sight of all coasts.

—André Gide

Intelligent people see to have an almost uncontrollable urge to go beyond established limits. Dick Fosbury was such a person. In the early 1960s, this young, lanky Oregon athlete wouldn't high-jump like everyone else. Fosbury insisted on going over the bar backwards and head first. His unorthodox technique, which came to be known as the "Fosbury Flop," not only won him an Olympic gold medal, it also became the standard practice for future athletes, who broke records with jumps that experts believed were unattainable.

David Perkins (1985) states that creative people are uneasy with the status quo; they "live on the edge of their competence." They seem compelled to place themselves in situations where they don't know what is going to happen. They accept confusion, uncertainty, and the higher risks of failure as part of the process and learn to view failure as normal, even interesting and challenging.

Students often display a reluctance to venture forth with ideas or statements that might be considered bizarre or far-out. They feel more comfortable knowing that they are "correct" and often demand to know whether their answers are "right," rather enjoy the feeling of sustained uncertainty. They hesitate to respond to open-ended questions, fearing that they will not give the "correct" answers. Students often report feeling more secure when they can apply already known rules or algorithms, rather than when they have to compose their own.

Students demonstrate their risk-taking ability as they gain security in brainstorming, offering novel relationships, sharing original thoughts, tackling new problems, and requesting *not* to be given an answer because they want to figure it out for themselves.

12. Using All the Senses

Observe perpetually.

—Henry James

Language, culture, and physical learning are all derived from our senses. To know a wine it must be drunk; to know a role it must be acted; to know a game it must be played; to

Peter's Letter

In the packet I read about "intellects," it says that people who behave intelligently are great problem solvers who are not necessarily mathematicians or scientists. Some are people like mechanics. The skills it takes to be a good mechanic are all listed in this packet. And when I say that, I disgust myself in thinking that all mechanics are morons. I'm talking about how hypocritical it is to say that mechanics are stupid when I am one myself. Everyone is a mechanic in a way, but me in particular because I've had industrial arts and automotive classes since 9th grade. My passion is fixing my car, making it go faster and better. So how could I think badly about mechanics? Well, it's that little thing know as peer pressure. My parents, friends, and a majority of people look down on people who fix cars. So, I look down on myself; I hide my hobby like it was a crime. People don't realize the massive amount of problem-solving power it takes to fix someone else's mess.

All of these characteristics of intelligent behavior are used by "industrial artists." But don't get me wrong, there are definitely bad mechanics. That's why I fix my car myself. I believe the same skills I use in my Critical Thinking/Discussion class are the ones I use to diagnose an engineering problem:

- Persevering when the solution is not readily apparent (it took me months to fix a vibration the car made that no other mechanic could fix),
- Checking for accuracy,
- Problem posing,
- Working with past knowledge,
- Ingenuity and creativity (ask Mr. Ferrari about this one).

These I believe are the most used skills. We are all "mechanics" in a way. It's just that some of us get our hands greasy.

—Peter King, Graduate,
Smoky Hills High School,
Aurora, Colorado

know a dance it must be moved; to know a goal it must be envisioned. Those whose sensory pathways are open and alert absorb more information from the environment than those whose pathways are oblivious to sensory stimuli.

We can observe students using their senses when they touch objects in their environment, when they request that a story or rhyme be read again and again, or when they act out roles. Often, what they say tells us that their senses are engaged: "Let me see, let me see . . ." "I want to feel it . . ." Let me try it . . ." "Let me hold it . . ."

As children mature, we can observe that they conceive and express many ways of solving problems by the use of the senses: Making observations, gathering data, experimenting, manipulating, scrutinizing, identifying variables, interviewing, breaking problems down into components, visualizing, role playing, illustrating, or model building. Their expressions use a range and variety of sensory words: "I *feel* like . . ." "It *touches* me," "I *hear* your ideas," "It leaves a bad *taste* in my mouth," "Get the *picture*?"

13. Ingenuity, Originality, Insightfulness: Creativity

It is by logic that we prove, but by intuition that we discover.
—Leo Rosten

Intelligent human beings know how to be creative when the situation demands it. They often try to create different solutions to problems, examining alternative possibilities from many angles (lateral thinking). They tend to project themselves into different roles, starting with a vision and working backward to their "solution."

We often hear students (and adults), however, saying things like "I can't draw," "I was never very good at art," or "I can't sing a note." Many people believe that creativity lies in a person's genes and chromosomes, but we are coming to realize that all of us have the capacity to generate novel, original, clever or ingenious products, solutions, and techniques—if that capacity is consciously developed.

Intelligent people are intrinsically rather than extrinsically motivated. Fame and glory don't seem to drive most creative people. Rather, it is the rewards of the work—the fascination of mixing paint or combining sounds or manipulating numbers. They work on the task because of its aesthetic challenge rather than its material rewards.

Creative people are open to criticism. They hold up their products for others to judge and seek feedback in an ever increasing effort to refine their technique (Perkins 1985). They constantly strive for greater fluency, elaboration, novelty, parsimony, simplicity, craftsmanship, perfection, beauty, harmony, or balance.

14. Wonderment, Inquisitiveness, Curiosity, and the Enjoyment of Problem Solving—A Sense of Efficacy as a Thinker

All thinking begins with wonderment.
—Socrates

People performing at their peak seem to enter another world. Time becomes distorted and a sense of euphoria prevails. They report a sense of feeling alive and fully alert. Athletes talk of a "runner's high" or "entering the zone." Creative people often experience simil. periods of euphoria in their work, and it may be that their unconscious internal motivation is the desire to recapture this euphoria.

Many people don't let themselves feel wonder and curiosity in the face of problems, and thus, they don't enjoy the challenge of solving problems. They may say, "These types of thinking games turn me off," "I was never good at these brainteasers," or "Go ask your father, he's the brain in this family." In high school or college, these people never enrolled in math or other "hard" academic subjects if they didn't have to. They perceive thinking only as hard work and recoil from situations that demand "too much" of it.

We want students to move toward not only an "I CAN" attitude, but also toward an "I ENJOY" feeling. We want them to seek problems to solve for themselves and to give to others to solve; to make up problems to solve on their own and to request them from others. Furthermore, we want students to solve problems with increasing independence—without parents' or teachers' help or intervention. We want them to voluntarily continue to learn throughout a lifetime, for if they don't, then the school has failed them.

Children (and adults) must actively sense the world around them, not just let it pass by. The wonders of nature promote endless thought—the changing of the seasons, the life cycle of a butterfly, the physics behind a bird in flight, the passing of day into night.

As students advance to higher grade levels, they should derive even more pleasure from thinking. Their curiosity will become stronger as the problems they encounter become more complex. Their environment will attract their inquiry as their senses capture the rhythm, patterns, shapes, colors, and harmonies of the universe. They will display cognizant and compassionate behavior toward other life forms as they are able to understand the need for protecting their environment, respecting the roles and values of other human beings, and perceiving the delicate worth, uniqueness, and relationships of everything and everyone they encounter. Passion, wonderment, a sense of awe: These are the prerequisites for intelligent life.

REFERENCES

Adams, M. J. (1989). "Thinking Skills Curricula: Their Promise and Progress." *Educational Psychologist* 24,1: 25–77. Hillsdale, N.J.: Erlbaum.

Barell, J. (April 1988). *Cogitare: A Newsletter of the ASCD Network on Teaching Thinking* 3, 1: entire issue.

Cornett, C. (1986). *Learning Through Laughter: Humor in the Classroom*. Bloomington, Iowa.: Phi Delta Kappa Educational Foundation.

DeBono, E. (1970). *Lateral Thinking: Creativity Step by Step*. New York: Harper and Row.

Ennis, R. (1985). "Goals for a Critical Thinking Curriculum" *Developing Minds: A Resource Book for Teaching Thinking*, edited by A. L. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Feuerstein, R., Y. Rand, M. Hoffman, and R. Miller (1980). "Instrumental Enrichment" *An Intervention Program for Cognitive Modifiability*. Baltimore, Md.: University Park Press.

Glatthorn, A., and J. Baron (1985). "The Good Thinker." *Developing Minds: A Resource Book for Teaching Thinking*, edited by A. L. Costa, Alexandria, Va.: Association for Supervision and Curriculum Development.

Kohlberg, L. (1981). *The Meaning and Measurement of Moral Development*. Worcester, Mass.: Clark University Press.

Perkins, D. (1985). "What Creative Thinking Is." *Developing Minds: A Resource Book for Teaching Thinking*, edited by A. L. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Piaget, J. (1972). *The Psychology of Intelligence*. Totowa, N.J.: Littlefield Adams.

Sternberg, R. (1984). *Beyond IQ: A Triarchic Theory of Human Intelligence*. New York: Cambridge University Press.

PART IV

A Curriculum for Thinking

The more a man thinks, the better adapted he becomes to thinking, and education is nothing if it is not the methodical creation of the habit of thinking.

—Ernest Dimnet

There is no doubt that it would be helpful to include in this book a scope and sequence chart identifying which cognitive functions should be taught at which grade levels and in what order. Indeed, many school districts have made such valiant attempts at curriculum development. These endeavors have proved to be highly instructive for the participants, extremely helpful in the placement of learning activities and materials, basic to lesson planning, and crucial to the assessment of student progress. Such local curriculum development is strongly encouraged.

Numerous researchers and teachers believe that thinking skills can and should be the focus of special exercises, texts, and programs. In *Cognitive Process Instruction*, Lochhead and Clement (1972) speak of the need "to isolate specific cognitive skills and to design instructional material appropriate for each skill." Edward de Bono claims that "generalizable thinking skills" can and should be taught in addition to "local skills" required in particular subject areas. Howard Citron believes that we must "systematically develop students' thinking and reasoning abilities in a 'purer' sense and directly build transfer of these abilities to academic learning and real behavior." The idea that certain generic cognitive functions underlie all school learning is basic to the thinking skills programs described in Part VIII of this resource book.

There is little agreement among psychologists, however, on what constitutes thinking. There are several compelling taxonomies of thinking skills to be used in building a curriculum. The ones developed by Feuerstein, Bloom, Guilford, Upton, Kohlberg, and Erickson are the most persuasive. The research on the effectiveness of these approaches is advanced cautiously, and the placement of grade or age level and the sequence in which each thinking skill should be learned is disputed vigorously.

In fear of suggesting a "national curriculum for thinking skills," no such scope and sequence chart is included here. In keeping with the philosophy of this resource book—that teaching for thinking should itself be an inquiry—guidelines for local decision making are presented instead. These guidelines include building a curriculum that is consistent with children's biological and psychological development, analyzing materials and matching learning activities to students' cognitive maturation, and constructing lessons with appropriate cognitive objectives.

REFERENCE

Lochhead, J., and J. Clement, eds. (1979). *Cognitive Process Instruction.* Philadelphia, Pa.: Franklin Institute Press.

21
The Biological Basis for Thinking

Lawrence F. Lowery

We may be the universe's way of looking at itself. Aside from ourselves, we know of no other organism that can contemplate the outer edges of the universe or the inner workings of the atom. No other creature can imagine the future or reconstruct the past beyond the limits of its own life. How have humans become uniquely able to attain such a level of thinking? What knowledge about out thinking is important for educators to contemplate as they look to the future of schooling in light of the present and past.

Most people act as though thinking and the brain are synonymous. A fine thinker is often referred to as "brainy." "Brains over brawn" clearly equates the brain to clever thinking. A "brainless" person lacks intelligence. But thinking and the brain are not synonymous. They are quite distinct.

The brain is a physical organ, which at birth is about one third its eventual mass. Its estimated number of 100 billion cells will double within two years following birth, and many cells in the following 15 years will develop 600,000 connections between themselves and other cells (Maranto 1984). In the past ten years we have learned much about the physiology of the brain—its electroconductivity, chemistry, and anatomy.

Thinking, however, is the ghost in the machinery. It is something beyond the physiological attributes. Imagine looking at a chess board at midgame. The physical placements of the pieces can de described, but where are the strategies of offense and defense? Similarly, imagine touring the chambers of a court and locating where the jury, judge, defendant, and prosecutor reside. Can you point to the "justice" that is carried out there? Strategies of chess and courtroom justice are processes within physical configurations (Restak 1979). And so, too, is thinking with the brain. Neurobiologists may identify one or more factors actively engaged among cells during a thought process, but with the more than 100 billion interactions that are possible within our heads, it is the *process* of thinking that is of prime importance, not the particular mechanism.

By piecing together research information obtained from anthropologists, biologists, neurobiologists, psychologists, and psychobiologists, we know that thinking depends on our physical attributes. We are not born with our thinking capabilities completely in place; they develop sequentially over time. There is a biological foundation for all human thinking.

Biological Structures and Thinking

With a head that swivels and tilts and eyes that perceive color and depth, the human structure is built to move about and explore unknown territory. The upright stance frees the forelimbs, and the hands, with their opposable thumbs, can manipulate the environment. These biological structures provide the means by which our thinking is imposed on the world to test or alter it. In so doing, we learn about the environment by noting what happens. There is no separating the intricate relationship of bipedalism, hand manipulation, sensory input, and brain development. Their interdependency is important to us all our lives. Just as young children observe objects in their environment by looking, touching, tasting, smelling, and throwing them, adults place a space probe on the surface of Mars and turn on the TV eye to see what it can see. A mechanical hand touches the surface and fondles the soil. Antennae listen. Sensors "smell" the atmosphere. With each of these actions—the youngster's firsthand, sensory experiences and the adult's inventive extension of the senses—humans gather knowledge about the world.

Educators have long praised the hands-on approach to teaching. But in spite of the praise, a visit to most classrooms reveals a different environment in which learning is taking place. Books replace experience very early and are almost the exclusive way by which students are taught from grade 4 through 12. When not doing assignments in books, children spend time listening to teachers or responding to their questions. Classrooms are primarily environments in which symbols are manipulated and substituted for experience.

Books are important. We can learn from them. But books can only do this if our experiential foundation is well prepared. To learn geometry, we must have experience in handling geometric forms and comparing them for similarities and differences. To learn about electricity, we must explore relationships among batteries, wires, and bulbs.

At one time the particular biological adaptations that enabled humans to generate, hear, and recognize sounds were important for survival. It took a long time for humans to invent ways to convey information using marks as symbols. Humans were not biologically designed for the purpose of reading or writing. Reading and writing are fortunate extensions of biological attributes that were designed for other purposes. The only way we can learn anything is through our biological structures.

Biological Stages and Thinking

Compared to other living organisms that we know about, humans enter this world quite empty-headed. Many species of birds, fish, and other animals are born with brains preprogrammed with information that enables them to survive, gather food, and reproduce their own kind. Some can travel to locations they never experienced directly. Others behave in ways that are independent of learning. But the human baby is quite helpless. It must construct a view of the world for itself.

From a biological perspective, the lack of having a view is superb. It has survival value. Humans can reproduce their kind in virtually any environment, and the offspring will learn that environment through observations and interactions with it. We have been endowed with a powerful genetic gift—a set of thinking capabilities that are programmed to appear at intervals and spaced well enough apart to let the current capability establish itself.

One might view these capabilities as maps, one overlaid on another to depict more complexity of surfaces, streets, cities, terrains, and continents. But they are maps without content; the names, terms, and qualities are not yet in place. The individual's interactions with the environment gradually fill in the content—first one map, then another, and another.

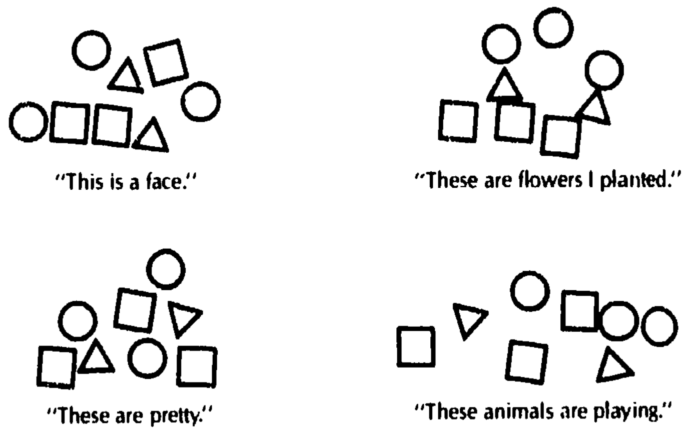
The nature of thinking capabilities and the sequence in which they appear have been well established on two research fronts. The *biological* basis underlying their appearance is established by periodic increases in brain size (Epstein 1974), brain weight (Epstein 1974), cellular growth within the brain (Winick and Ross 1969), electrical functioning within the brain (Monnier 1960), and head circumference (Eichorn and Bayley 1962). The *psychological* basis is established through (1) evidence of the individual's capacity to deal with independent ideas and to relate them in increasing combinations in two- or three-year spurts from about age 3 through 17 (Pascual-Leone 1970; Case 1974), and (2) the individual's tendency to exhibit the same kinds of behaviors as other individuals within two- to three-year ranges, and as they grow older, to replace each view by a more sophisticated view, which, in turn, is replaced (Piaget 1969). Although researchers have provided various descriptions of the unfolding of the thinking phenomenon (Bruner and Kenney 1966; Erikson 1950; Gagne 1970; Vygotsky 1974), the sequence is described here in terms of classroom usefulness.

Stage 1: Building a Repertoire

A baby begins life with the first thinking capability ready to go. Although quite passive until motor development is in place, the baby receives information through all his senses. He organizes the information into mental structures of what is seen, heard, smelled, tasted, and felt. As muscle coordination becomes functional, his thinking leads him to reach out to touch objects and later to move into unexplored territories. When he can grasp an object, he pulls it to himself, fondling, tasting, and maybe throwing it. Each action and interaction provides more information about the world. His mind organizes the information, and he contemplates other actions to impose on the world. In his first few months, he acts only on objects that he sees. When an object is placed out of sight, he seems not to think about it. At one year of age, he actively seeks objects that he knows exist behind barriers, such as in drawers, behind cabinet doors, or in boxes.

The most important aspect of this first stage of thinking is the establishment of *object permanence*—that is, objects that have been experienced are known to exist even though they are out of sight. Such an important development for thinking and so fundamental to all that we do! We would not know where to go home at night if we did not have object permanence. We would not know where we stopped reading a book if we could not trust that the print on the pages would remain the same when we are not looking at them.

FIGURE 1
Examples of Thinking: Stage 1



Knowing that the world can be trusted to keep things in place and as they are is important to all later learnings.

The way thoughts are structured during the opening stage is best revealed through a child's behaviors. When given objects to play with, the child will explore them one at a time, attracted by their perceptual feature. When the child has finished exploring it, the object will be discarded. The thinking capability at this stage is highly sensory, and actions are imposed on objects one at a time: perceiving aspects of color, size, and shape; touching it and sensing textures and firmness; pushing, pulling, or throwing it and noting how it behaves from such actions; tasting it and noting its flavor, firmness, and texture. These experiences provide the fundamental repertoire for future stages. Biologically, we have been given about three years in which to establish the repertoire.

Stage 2: Comparing the Known to the Unknown

The second thinking process begins to unfold at about age three. Now, when the child thinks about objects and acts upon them, she produces pairings as groups, piles, or chains on the basis of size, shape, color, and so on, from her previous experiences (repertoire). In so doing, she establishes additional mental constructs about the world and how the objects and events in it are related. All her thinking is characterized by the ability to group two objects together on the basis of a common attribute or to link two events on the basis of a relationship. This will continue to be the dominant way in which she thinks and solves problems until about age six (Kofksy 1966; Allen 1967; Lowery 1981a).

The power of thinking at this stage is amazing. The child will construct fundamental concepts about the physical world and its properties (similarity and difference comparisons based on sizes, shapes, colors, and so on); about ordinal and cardinal numbers (one-to-one correspondences of varying degrees); about all measures (comparisons of a known measure, such as a meter stick, to an unknown measure, such as the dimensions of a table); and about the use of symbols to stand for meaning (word recognitions). The child will learn more words during this stage than she will over the rest of her life. She can also learn to read music and, with proper motor coordination, play musical instruments, dance complex patterns, or carry out gymnastic or other athletic routines.

Educators have seldom provided instruction that allows the potential of this stage to develop. When we do challenge children to use this stage of thinking ability, the challenge usually takes the form of a rote-memory/recall routine. And we continue to teach toward this type of routine throughout all the school years. It is matching, sorting, pairing, and seriating real objects, illustrations, and symbols. To realize what is possible for the child, educators should consider the potential of the computer. The computer, which can only make simple comparisons on a one-to-one basis, does not use a stage of "thinking" beyond this one. But we appreciate the computer's capability and are in awe of what it can do. Why not also appreciate the child's capability at this stage (which will soon surpass the computer's current capability) and provide experiences that will develop it?

Stage 3: Putting Things Together

The next thinking process begins at about age six and is established for most children by age eight (Lovell, Mitchell, and Everett 1962; Smedslund 1964; Bruner and Kenney 1966). The process enables the child to group all objects in a set on the basis of one common attribute. For the first time, the resulting construct is comprehensive and has a rationale or logic to it. Without formal instruction, the child will put all the blue objects together from any array of objects, and then continue to sort the yellows, reds, and other colors into groups. If asked whether or not the objects can be arranged in another way, the child will rearrange them on the basis of some other attribute. If earlier experiences have provided a rich repertoire, the child will have many possibilities available to impose on any set of objects using this new thinking capability (Lowery 1969).

In formal schooling, the concepts of "all" and "some" can be easily taught at this stage. Upon these concepts, the child can build an understanding of all the fundamental operations of mathematics. Simple rules can be understood and generated by the child if given the opportunity. In our everyday existence, we seldom need to use thinking any higher than this stage.

FIGURE 2
Examples of Thinking: Stage 2

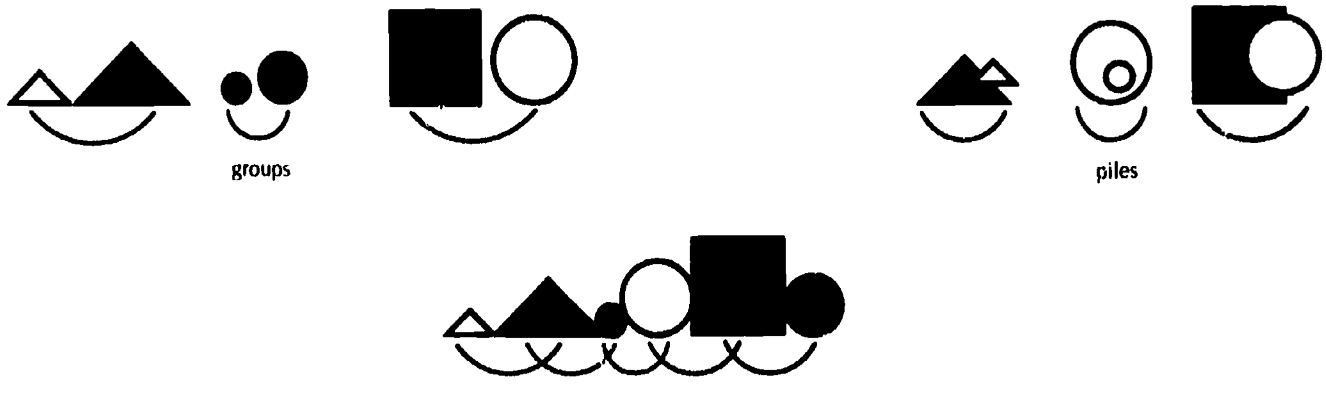
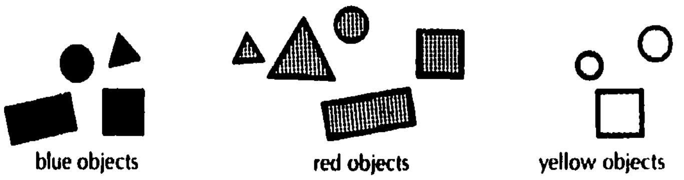
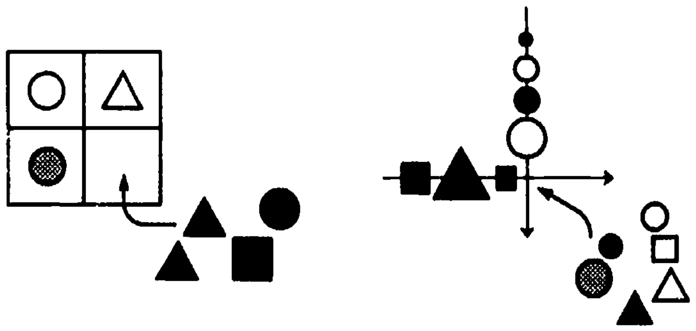


FIGURE 3
Examples of Thinking: Stage 3



All grouped on the basis of color.

FIGURE 4
Examples of Thinking: Stage 4



Stage 4: Simultaneous Ideas

When children exhibit thinking that indicates they can mentally combine more than one idea at a time, they have entered Stage 4. For most children this takes place at about age eight and continues to develop until age ten (Inhelder and Piaget 1964; Vernon 1965).

Students begin to enjoy puns and can easily understand homonyms. Their creative writing moves from "It is an old house; it is a brown house; it is an empty house" (descriptions of a house, one property at a time) to "It is an old, brown, empty house" (multiple descriptors for the same noun). Their scientific reasoning moves from trial-and-error thinking, or following an experimental "recipe," to contemplating the effects of comparing two situations simultaneously under different conditions. In mathematics, place and value can now be understood.

If the earlier levels have been properly established, the youngster can now exhibit sophisticated products in all fields. Complex problems involving more than one idea at a time can be tackled. The essence of quality writing becomes apparent both through analysis of an author's writings and the youngster's own work.

Stage 5: Superordinate/Subordinate Relationships

Thinking about the relationships among groups of objects and a superordinate conception of them marks the stage of development that appears at about age ten. Such thinking realizes that if one collection of objects is included in another, then all the objects in the smaller grouping are but a part (some) of the larger. Conversely, some (a part) of the larger class is all of the smaller.

One use of this stage of thinking is evident as deductive reasoning that logically makes inferences between the more general and the less general: *All women are mortal. All queens are women. Thus all queens are mortal.*

The conclusion of a deductive argument is simply an explicit statement of something that is implicit in the premises. Its validity or consistency can be certified by logical considerations alone, usually through a transitivity of implications.

Some callytoots are herbitods. All herbitods have four legs. Therefore, which of the following must be true?

1. All callytoots have four legs.
2. All herbitods are callytoots.
3. Some callytoots have four legs.
4. It cannot be determined whether any of the above are true.

Teachers can substitute real concepts for make-believe ones (try "mammals" for "callytoots" and "dogs" for "herbitods") without interfering with the logic of the thinking represented by this stage.

Prior to this stage, children use superordinate words synonymously with subordinate words. For example, they use the word "bird" (which does not exist in any real way) for a particular bird, such as a canary, a robin, or an eagle. At this stage, children can conceptualize the abstractness of "bird" and similar superordinate terms such as "justice," "freedom," "specific gravity," or "phyla," but only if the proper experiences have been made available for the conceptualization to take place.

The logic required to understand relationships is the major thrust of thinking at this stage. For it to develop and be useful to the student, curriculum materials must provide opportunities to do such thinking. For educators, this is the time to provide a curriculum that moves students from the real objects and experiences to the abstractions that can be derived from them or the abstractions that represent them (such as metaphors). This cannot be done by memorizing definitions. It can be done only by encouraging students to think about the relationships among objects or ideas.

FIGURE 5
Examples of Thinking: Stage 5

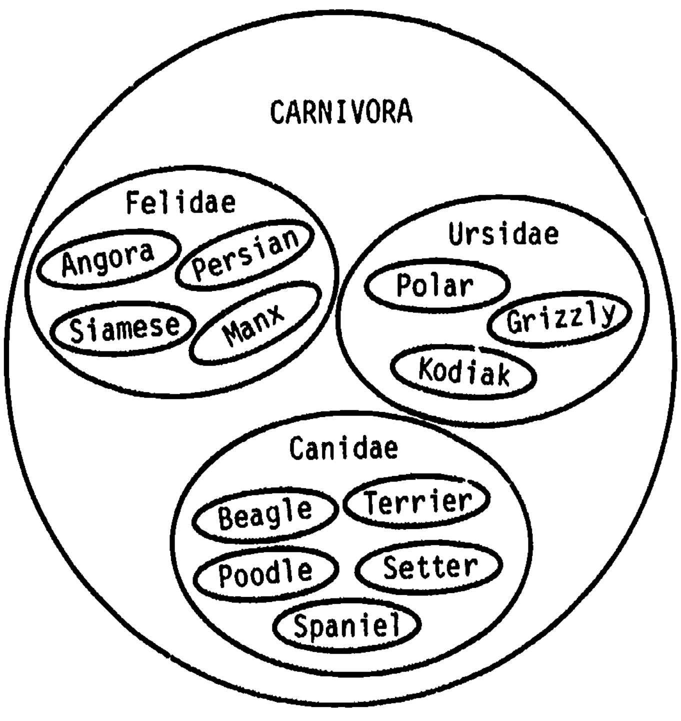


FIGURE 6
Examples of Thinking: Stage 6

$$
\begin{aligned}
24 + 32 &= (3 \times 8) + (4 \times 8) \\
&= (3 + 4) \times 8 \\
&= 7 \times 8 \\
&= 56
\end{aligned}
$$

Stage 6: Combinatorial Reasoning

As the next stage unfolds, at about age 13 (Lawson and Renner 1975; Lowery 1981b), the student becomes more flexible in her thinking. She can organize and then reorganize a collection of objects or ideas in different ways, while realizing that each way is possible at the same time and that the choice for an organization depends on one's purpose. For example, if a student is given a set of books with the identifying characteristics of size (number of pages), shape, color, and content, she realizes that the books can be organized on the basis of: size; shape; color; content; size and shape; size and color; size and content; shape and color; shape and content; color and content; size, shape, and color; size, shape, and content; shape, color, and content; size, shape, color, and content. Given the goal of locating information, she selects only the content as the organizing attribute because the other attributes are not useful to achieving the goal. Given a different goal, such as the determination of the ratio of books with fewer than 100 pages to those with more than 100 pages, she reclassifies the books for a different attribute to achieve that goal.

Similarly, solving problems that involve the identification and systematic testing of each variable requires this stage of ability to separate variables by exclusion. For example, factors that influence the rate of swing of a pendulum are determined by isolating possible factors and testing them one at a time, while all others are held constant.

Schools must not continue to teach at the upper grade levels the way they teach at the earlier grade levels, making only the content more abstract. Students need experiences appropriate to the thinking they are learning. If such experiences are not provided at this stage, many students, as adults, will be unable to identify and isolate the possible

ERIC

combinations of relationships involved in complex problems they will face in their personal and professional lives.

Stage 7: Flexible Thinking

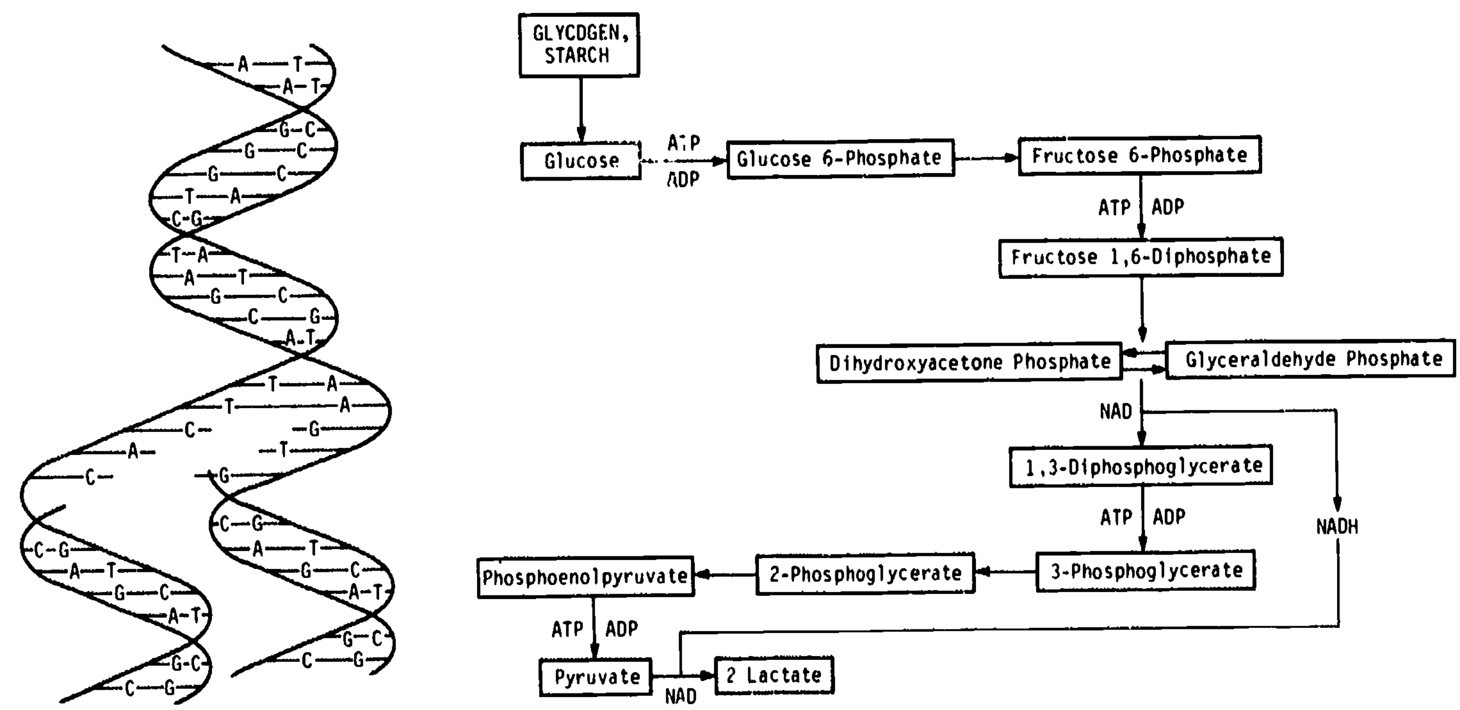
When flexible thinking appears, about 16 (Karplus and Karplus 1972; Lowery 1981a; Lowery 1981b), the student becomes able to develop a framework based on a logical rationale about the relationships among the objects or ideas in the taxonomy, while at the same time realizing that the arrangement is one of many possible ones that eventually may be changed based on fresh insights.

This stage of thinking can deal very flexibility with complex situations. Each field of endeavor produces new knowledge and further ideas. Resolutions to problems and knowledge generation often take many forms. The field of science is noteworthy for its examples. Darwin organized ideas concerning how all living orgasms are related and formulated a comprehensive theory. Einstein did the same for the physical world. Mendeleev demonstrated this stage of thinking when he logically ordered the more than 50 different elements known in his day. His first *Periodic Chart of the Elements* clearly indicated the existence of elements not yet identified. Mendeleev predicted, in advance of seeing the elements, their weight and other important properties. This biological sequence of human thinking capabilities takes us wondrously from the early establishment of object permanence to the conceptualization of permanence and consistency among objects and events we have never, and may never, experience because of distance in time and space!

Educational Implications

The notion of stages is more than the sequential progression of thinking development. It includes the patterning of responses throughout the sequence and the time periods necessary for consolidating each capability. Development of the seven biologically based stages described here is invariant (Inhelder and Piaget 1964; Kofsky 1966; Allen 1967; Hooper and Sipple 1974; Kroes 1974; Cowan 1978) and involves a sequence common to all cultures (Bruner, Goodnow, and Austin 1956; Price-Williams 1962; Lovell, Mitchell, and Everett 1962; Schmidt and Nzimande 1970; Wei, Lavatelli, and Jones 1971; Lowery and Allen 1978; Cowan 1978); a hierarchical integration of lower to higher levels; and a gradual consolidation in formation that unifies behaviors, concepts, and skills. The result is a broad structural network of interrelated capabilities appearing, not all at once, but within a fairly narrowly defined period followed by a plateau of several years. For thinking to develop properly, a very long childhood is necessary—one in which the youngster is free from having to carry out survival activities until all the stages

FIGURE 7
Examples of Thinking: Stage 7



DNA

Embden-Meyerhof Pathway

FIGURE 8
Examples of Thinking

are in place. This is why humans have a longer, biologically determined childhood than any other animal on earth. Pierce (1977) said it this way:

> Although at any stage of development, nature is preparing us for the next stage, the beauty of the system is that we are conscious of none of this. Ideally, we must fully accept and exist within our developmental stage and respond fully to its content and possibilities. This means that every stage is complete and perfect within itself. The three-year-old is not an incomplete five-year-old; the child is not an incomplete adult. Never are we simply on our way; always we have arrived. Everything is preparatory to something else that is in formation.

The importance of this biological basis for the development of thinking is too often overlooked by educators. The periodic rapid increases in brain growth (perhaps the establishment of cellular networking) coupled by the appearance of new, content-free thinking capabilities (which overlay earlier capabilities containing content) are followed by plateaus (time periods that allow new capabilities to become integrated, used, and made functional). Unfortunately, the organization of curriculum and teaching in American schools and textbooks reflects an assumed, constant continuum of the thinking capacities of learners.

Most teachers are familiar with and trained in the vertical sequencing of content: skills and concepts constantly increase in complexity as students move through the grades; curriculum expectations for a student's performance are constructed upon the indices of school grade, chronological age, or achievement scores rather than upon individual cognitive and affective development indices.

In the competitive, social context of school, educators try to accelerate the stages of development through school intervention (Furth 1977). They act as if the distance from childhood to intellectual adulthood is measured only in terms of quantity—students acquire more experience, greater information, and broader knowledge as they grow older. This is an incomplete view of intellectual growth. The most significant differences between youngsters and adults rest in the nature and quality of their understanding. As youngsters develop, they pass through ways of thinking, each representing a different organization of experience, information, and knowledge, and each leading to a very different view of the world.

In our current educational system, many students progressively lose control over their own rate and sense of success (Collins 1974; Covington and Berry 1976). The reasons for this are highly complex, but two aspects related to the biology of thinking seem to be constructive:

1. The potential for success diminishes in relation to the degree of mismatch between content and thinking capability during a plateau period.

2. As personal evaluation becomes official evaluation in formal schooling, the mistakes and errors that are a natural part of learning become misinterpreted as failures. Students become motivated to work for extrinsic, symbolic rewards, such as gold stars and grades or to please adults, rather than for the sake of exploration and learning.

When cognitively mismatched content is accompanied by external expectations and rewards, the standards for successful performance are extended beyond the reach of many students. Over time, students are likely to lose confidence and develop a sense of failure. The result may contribute to developmental dysfunction—a slowing down or solidifying of stages plus asynchrony (very good performance in some things and very poor in others).

It is important for curriculum and instruction to reflect the biological basis for thinking. A *horizontal curriculum* is one in which students are challenged to use a particular stage of thinking with different materials at various levels of abstraction without the progressive requirement of having to be at a more and more advanced developmental stage. The model allows students at an identified stage of development to explore many experiences within and near that stage. Teachers do not compare a student's progress with that of other students, but rather select worthwhile experiences appropriate to his or her stage, organize them for meaningful interpretation, and orchestrate them to provoke the student's thinking. Numerous researchers have helped to validate this model in the sciences (Askham 1972; Loggins 1972; Lowery and Allen 1978) and in mathematics (Ginsburg 1977; Langbort 1982; Rupley 1981).

The essence of the approach is derived from the biological basis for thinking—the thinking capability is independent of the objects involved in a given task. Students experience small, sequential steps of equilibration through an inexhaustible set of possible experiences. For example, a teacher might design sorting tasks to challenge a student who is at or beyond Thinking Stage 2 (comparing the known to the unknown) by asking the student to find from an array of marbles two that are alike on the basis of first one color and then another. The activity can be done with other objects using colors or physical properties. In each variation, the thinking capability required remains the same—pairing two objects on the basis of a single property. Studies show that when instructed in this way, students' thinking capabilities become more proficient and transfer more easily to new tasks.

The horizontal curriculum approach can also be used to extend students toward abstractions without requiring a higher stage of thinking. For example, if a student who is at or beyond Thinking Stage 3 (putting things together) can group all objects within a set so that they logically belong together, the action is considered to be firsthand or concrete. The action involves manipulations of real objects and not abstractions of reality. The student who can do the logical, concrete action has the potential to impose the same thinking on pictorial representations of reality without having to be at a more advanced stage. Pictorial representations are considered to be one step removed from reality. Again, without having to be at a more advanced stage, the same student has the potential to successfully carry out the same thinking on symbols and abstractions that are several steps away from reality.

Experiences designed to make use of thinking capabilities may provide significant cognitive and affective benefits by allowing students to perform progressively challenging tasks that are within a realm of potential success, while the accelerated and often mismatched vertical schemes may be inviting failure and eroding self-worth. The horizontal curriculum model allows teachers to be *teachers* having purpose for and power over materials rather than *managers* who keep track of places and pages in order not to interrupt the sequence dictated by the materials.

Our biological heritage provides us with a sequence of thinking capabilities and a set of physical tools that contribute to the establishment of each thinking capability. Originally designed to enhance our chances for survival, the interplay between thinking and actions has brought about understandings about the world that transcend the immediacy of survival. We have the leisure to fantasize and contemplate. We create through art, music, and construction; we imagine and communicate through books. We explore frontiers that are beyond the tangible and experiential. Educators must understand the heritage in order to appropriately select and sequence worthwhile experiences for students and to enhance their ability to think well. An understanding of the biological basis for thinking can lead to the conceptualization of a school curriculum far more responsive to the realities of how humans learn and to the intellectual differences among students at all grade levels, from early childhood through adolescence.

References

Allen, L. R. (1967). "An Examination of the Classificatory Ability of Children Who Have Been Exposed to One of the 'New' Elementary Science Programs." Doctoral diss., University of California, Berkeley.

Askham, L. R. (1972). "Classification of Plants by Children in an Outdoor Environment." Doctoral diss., University of California, Berkeley.

Bruner, J. S., J. J. Goodnow, and G. A. Austin (1956). *A Study of Thinking*. New York: John Wiley and Sons.

Bruner, J.S., and M.J. Kenny (1966). *Studies in Cognitive Growth*. New York: John Wiley and Sons.

Case, R. (1974). "Structures and Strictures, Some Functional Limitations on the Course of Cognitive Growth." *Cognitive Psychology* 6, 4: 544–573.

Collins, M. E. (1974). "Dependence and Independence in Young School-Age Children." Doctoral diss., University of California, Berkeley.

Covington, M., and R. Berry (1976). *Self-Worth and School Learning*. New York: Holt, Rinehart, and Winston.

Cowan, P. A. (1978). *Piaget with Feeling*. New York: Holt, Rinehart, and Winston.

Eichorn, D., and N. Bayley (1962). "Growth in Head Circumference from Birth Through Young Adulthood." *Child Development* 33: 257–271.

Epstein, H. T. (1974). "Phrenoblysis: Special Brain and Growth Periods I—Human Brain and Skull Development." *Developmental Psychobiology* 7, 3: 207–216.

Erikson, E. H. (1950). *Childhood and Society*. New York: Norton.

Furth, H. (1977). "Piagetian Theory and Its Implications for the Helping Professions." Paper presented at the Annual Piagetian Conference, University of Southern California.

Gagne, R. M. (1970). *The Conditions of Learning*. New York: Holt, Rinehart, and Winston.

Ginsburg, H. (1977). "The Psychology of Arithmetic Thinking." *Journal of Children's Mathematical Behavior* 14: 1–89.

Hooper, F., and T. Sipple (1974). "A Cross-Sectional Investigation of Children's Classificatory Abilities." *Technical Report*. Madison, Wisc.: Research and Development Center for Cognitive Learning, University of Wisconsin.

Inhelder, B., and J. Piaget (1964). *The Early Growth of Logic in the Child*. Translated by A. Lunzer and D. Papert. New York: W. W. Norton.

Karplus, R., and E. Karplus (November 1972). "Intellectual Development Beyond Elementary School III—Ratio: A Longitudinal Study." *School Science and Mathematics* 72, 8: 735–742

Kofsky, E. (1966). "A Scalogram Study of Classificatory Development." *Child Development* 37: 190–204.

Kroes, W. (September 1974). "Concept Shift and the Development of the Concept of Class in Children." *Journal of Genetic Psychology* 125, 1: 119–126.

Langbort, C. R. (1982). "An Investigation of the Ability of Fourth Grade Children to Solve Problems Using Hand-Held Calculators." Doctoral diss., University of California, Berkeley.

Lawson, A. E., and J. W. Renner (September 1975). "Piagetian Theory and Biology Teaching." *American Biology Teacher* 37, 6: 336–343.

Loggins, P. (1972). "Visual Multiple Class Membership Sorting Abilities among Second Grade Children—Tasks of Increasing Difficulty across Categories of Sex and Socio-Economic Status." Doctoral diss., University of California, Berkeley.

Lovell, K., B. Mitchell, and I. R. Everett (1962). "An Experimental Study of the Growth of Some Logical Structures." *British Journal of Psychology* 53: 175–188.

Lowery, L. F. (1981a) *Learning About Learning: Classification Abilities*. Berkeley: University of California Department of Education.

Lowery, L. F. (1981b). *Learning About Learning: Propositional Abilities*. Berkeley: University of California Department of Education.

Lowery, L. F. (1969). "Visual Resemblance Sorting Abilities Among First Grade Pupils." *Journal of Research in Science Teaching* 6, 3: 248–256.

Lowery, L. F., and L. R. Allen (July 1978). "Visual Resemblance Sorting Abilities of U.S. and Malaysian First Grade Children." *Journal of Research in Science Teaching* 15, 4: 287–292.

Maranto, G. (May 1984). "Neuroscience: The Mind within the Brain." *Discover* 5, 5: 34–43.

Monnier, M. (1960). "Definition of Stages of Development." In *Discussions on Child Development*, edited by J. Tanner and B. Inhelder. New York: International Universities Press. pp. 175–188.

Pascual-Leone, J. (1970). "A Mathematical Model for the Transition Rule in Piaget's Developmental Stages." *Acta Psychologica* 63: 301–345.

Piaget, J. (1969). *Psychology of Intelligence*. Totowa, N.J.: Littlefield, Adams, and Company.

Pierce, J. C. (1977). *The Magical Child*. New York: E. P. Dutton.

Price-Williams, D. R. (1962). "Abstract and Concrete Modes of Classification in a Primitive Society." *British Journal of Educational Psychology* 32: 50–62.

Restak, R. M. (1979). *The Brain. The Last Frontier*. New York: Warner Books.

Rupley, W. (1981). "The Effects of Numerical Characteristics on the Difficulty of Proportional Reasoning Tasks." Doctoral diss., University of California, Berkeley.

Schmidt, W. H. O., and A. Nzimande (1970). "Cultural Difference in Color/Form Preferences and in Classificatory Behavior." *Human Development* 13: 140–148.

Smedslund, J. (1964). "Concrete Reasoning: A Study of Intellectual Development." *Monographs of the Society for Research in Child Development* 29.

Vernon, P. E. (1965). "Environmental Handicaps and Intellectual Development." *British Journal of Educational Psychology* 35: 9–20.

Vygotsky, L. (1974). "The Problem of Age-Periodization of Child Development." *Human Development* 17: 24–40.

Wei, T., T. Lavatelli, and C. Jones (September 1971). "Piaget's Concept of Classification: A Comparative Study of Socially Disadvantaged and Middle-Class Young Children." *Child Development* 42, 3: 919–977.

Winick, M., and P. Ross (1969). "Head Circumference and Cellular Growth of the Brain in Normal and Marasmic Children." *Journal of Pediatrics* 74: 774–778.

22

Cognitive Levels Matching and Curriculum Analysis

Esther Fusco

There are one-story intellects, two-story intellects, and three-story intellects with skylights. All fact collectors who have no aim beyond their facts are one-story men. Two-story men compare, reason, generalize, using the labor of fact collectors as their own. Three-story men idealize, imagine, predict—their best illumination comes from above the skylight.

—Oliver Wendell Holmes

In the early 1980s, the Shoreham—Wading River School District developed an inservice program designed to promote students' cognitive development. Initially, five staff members attended a course at Brandeis University designed by P. K. Arlin and H. T. Epstein. The construct, Cognitive Levels Matching (CLM), refers in its broadest sense to teachers' ability to employ both formal and informal assessments to determine students' cognitive levels. Based on these assessments, teachers adapt curricular tasks and guide students' acquisition of knowledge and problem-solving abilities in ways consistent with their cognitive abilities. To do so, teachers need to:

1. Understand cognitive developmental principles.
2. Understand the methods of assessing students' cognitive abilities.
3. Develop the ability to analyze and modify the cognitive demands of school-based experiences.

Thus, acquisition of a developmental perspective and creation of a "match" are central tenets of the program. The term "match" recognizes and stresses the importance of fitting learners' abilities with certain curricular tasks.

"The environmental circumstances force accommodative modifications in schemata only when there is an appropriate match between the circumstances that a child encounters and the schemata that he has already assimilated into his repertoire" (Hunt 1961).

Hunt's approach stresses the matching process in teaching by encouraging the analysis of already assimilated schemata of an individual and the newly presented task or circumstance. Hunt considered this process difficult since such assessment can only be conducted through observing behavior, listening as individuals express themselves on particular matters, and awareness of individuals' past experiences. This is further complicated by the need to analyze individuals' potential intellectual ability.

The first CLM course presented at Brandeis was consistent with Hunt's viewpoint and also embodied Piaget's stages of intellectual development. The project has been expanded since then and now incorporates the work of other cognitive developmentalists (Arlin 1977; Elkind 1976; Sigel 1978). The original tenets have been expanded and successfully employed in other districts in New York, Washington, Indiana, and Maine.

Such a matching approach requires that teachers become responsible educational leaders and model reflective thinking by designing environments consistent with the principles of cognitive development. To create this environment, they must assess the cognitive demands of the curricular task and the cognitive abilities of the students, and then systematically (and often spontaneously) attempt to match the two. From this approach, another tenet emerges: the teacher is responsible for infusing thinking into the classroom. Thus, the teacher serves as the instructional leader, decision maker, and mediator of the learning, continually structuring the classroom environment in a developmentally appropriate fashion.

The dynamic matching process advocated here requires "thinking on your feet." Acquiring this thinking/teaching ability involves the teacher's ability to make a simultaneous assessment of the student and the curricular task. Therefore, the teacher understands the cognitive demands of the concept and then shifts, refocuses, extends, and shapes the process to enable students to construct their own knowledge. There is an assumption here that knowledge does not reside outside the children, nor can it be poured into them. Rather, learning is viewed as a constructed process that unfolds within students as they interact with the content and reflect on it.

Over the years, the notion of cognitively matched instruction has been restructured as we have learned more about the relationship of developmental perspective to the teaching/learning process. An initial course presents theoretical background on classroom application. Advanced courses are designed to reinforce and expand upon the first course's goals. One major component that teachers must focus on is cognitive assessment of the curriculum.

To assess the cognitive demands of curriculum, teachers must first decide what concept or task they want to present and recognize the steps involved in the presentations. Once this is accomplished, teachers consider the cognitive schemata (Inhelder and Piaget 1958) that the curriculum demands of the students. Teachers who have completed the introductory course may initially refer to the Concrete and Formal Stage Concepts table (Figure 1) for assistance in determining the schemata necessary for understanding the thinking concept or task required, but eventually they will be able to do this automatically.

Examples of Cognitive Assessment

Several illustrations may help clarify the cognitive assessment process. The first deals with understanding alphabetization, which requires students to be able to:

1. Recognize letters.
2. Comprehend the word "initial."
3. Recall the order of the alphabet.
4. Understand the words "before," "after," "beginning," "middle," and "end."
5. Understand what to do with words that have the same initial letters.

The cognitive prerequisites for alphabetizing are:

1. Simple classification (e.g., these are all "g" words).

FIGURE 1

Concepts Associated with the Concrete and Formal Stages

CONCEPT DEFINITION	ASSESSMENT	EXAMPLE	OWN EXAMPLE
Simple classification: the ability to spontaneously group objects by one attribute and be able to shift to another attribute and regroup the same objects.	Attribute blocks—make groups that are the same, go together, or are alike in some way.	1. Finding the "short e" and "long e" words in a list. 2. Classifying animals as meat eating or non-meat eating. 3. Discussing how two pictures of patterns are alike and how they are different.	
Two-way classification: the ability to simultaneously coordinate two attributes of objects and group objects by that coordination.	Matrices: apple/flower; circle/square Venn diagrams; "l-shaped" classification task.	1. Comprehending similes. 2. Applying a grammatical rule that has two conditions.	
Three-way classification: the ability to simultaneously coordinate three attributes of objects and group objects that share three attributes.	Matrices: shape/color/direction.	1. Identifying countries that have the same three natural resources. 2. Grouping words.	
Class inclusion: the ability to understand and coordinate, in a hierarchical sense, part-whole relationships.	Flowers (plastic vs. colors); blocks (wooden vs. colors); cards (animals vs. types).	1. Fractions. 2. Recognizing the main idea of a paragraph. 3. States and capitals. 4. Missing addends.	

Developed by P. K. Arlin, University of British Columbia, and the staff of Shoreham-Wading River in the Cognitive Levels Matching project.

FIGURE 1
Concepts Associated with the Concrete and Formal Stages
(Continued)

CONCEPT DEFINITION	ASSESSMENT	EXAMPLE	OWN EXAMPLE
Simple Seriation: the ability to order a set of objects along some relevant dimension such as size.	Sticks of graduated sizes. Stacking cups. People pieces.	1. Getting in line according to size. 2. Putting events in a story in order.	
Double Seriation: the ability to order one set of objects according to some relevant dimension and to order a second set of objects along a relevant dimension in relation to that set of objects.	Cups ordered by size and in relation to sticks, which are also ordered by size or some other dimension.	1. One-to-one correspondence. 2. Copying words from the board to paper. 3. Alphabetical order.	
Number Conservation: recognizing that the property of number does not change in relation to a set of objects regardless of how those objects are arranged as long as no operation (+, −) is performed on them. (The operation of reversibility supports this understanding.)	Two rows of 8-10 blocks, which are set up in a 1-1 correspondence and then one row is pushed together. . .	1. Basic addition and subtraction facts. 2. Different representations of the same number.	
Quantity Conservation: recognizing that the property of quantity does not change . . . (as above)	Two balls of clay; the size of a ball is changed after child establishes that both balls have the same amount of clay.	1. Pouring coke into different sized glasses. 2. Distributing materials.	
Length Conservation: recognizing that the property of objects called length does not change . . . (as above). (The operation of compensation also supports this concept.)	Two pipe cleaners of equal length. Displacement of one of the pipe cleaners or the curling up of one.	1. Concept of units of measure. 2. Distances of cities and countries from each other. 3. Number lines and time lines.	
Weight conservation: the ability to recognize that weight does not change when the shape and form of an object is altered unless the object is operated on by addition or subtraction. Requires the operation of compensation.	Two balls of clay, a pan balance. Establish equivalence and then alter the shape of one ball so that it "feels" lighter.	1. Scientific concepts of density, mass, and gravity. 2. The solar system. 3. Stress on bridges, and so on.	
Volume conservation: the recognition that volume does not change even if the form of an object is changed, unless it is operated on. Requires multiplicative compensations—namely, even though the form of the object is changed, what the volume gains or loses in one dimension is compensated for by what it gains or loses in the other two.	Two cylinders of equal size, one of brass, the other of aluminum; and two breakers of water with equal water levels. The islands problem with two sets of blocks. Clay balls with the two beakers of water.	1. Interior and exterior volume. 2. Displacement of volume. 3. Mathematical understanding of volume. 4. Analysis of closed systems. A change in one part of the system affects all other parts.	
Formal scheme—Multiplicative compensations: see definition above.	Same as above.	Same as above. 5. Centrifugal force.	
Formal scheme—Probability: the ability to develop a relationship between confirming and possible cases, with both beginning to be calculated as a function of the combinations, permutations, or arrangements compatible with the given elements.	Five red, five blue, and five yellow beads in an open box.	1. Figuring the odds in a game of chance. 2. The likelihood that a particular political event will occur given several preconditons.	

Continued

FIGURE 1

Concepts Associated with the Concrete and Formal Stages
(Continued)

CONCEPT DEFINITION	ASSESSMENT	EXAMPLE	OWN EXAMPLE
Formal scheme—Correlations: the ability to conclude that there is or is not a causal relationship, whether negative or positive, and to explain the minority cases by inference of chance variables. The task for the subject is to find out whether there is a relationship between the facts described by two or more variables when the empirical distribution is irregular.	Cards with people who have brown or black hair and blue or brown eyes. Different sets of cards with objects that vary in two or more dimensions.	1. Is there a relationship between economic condition and social protest? 2. Is there a relationship between hours of sunshine and plant growth? 3. Is there a relationship between movie genre and socio-historic and cultural events?	
Formal scheme—Combinations: the ability to systematically generate all possible combinations of the givens when a problem's solution demands that all possibilities be accounted for.	Electronic analog with five buttons and a light source. Chemical combinations tasks. Tokens tasks.	1. Qualitative analysis problems—chemistry. 2. Variation of ingredients for a specific recipe. 3. Meaningful combinations of beginnings, middles, and ends in writing tasks.	
Formal logic: the ability to reason using propositions based on a formal system.	Most tasks that assess formal schemes employ various logical propositions.	1. Syllogistic reasoning. 2. "If/then." 3. Making inferences. 4. Separating facts. 5. Literary criticism.	
Formal scheme—Proportional reasoning: the ability to discover the equality of two ratios that form a proportion.	Balance beam problem. Projection of shadows. "Mr. Big/Mr. Small."	1. Understanding analogies. 2. Ratio and proportions. 3. Making drawings to scale.	
Formal scheme—The coordination of two or more systems of reference: the ability to coordinate two systems, each involving a direct and an inverse operation, but with one of the systems in a relation of compensation or symmetry with respect to the other. This represents a type of relativity of thought.	Snail/path problem. Cyclists problem.	1. Understanding and comparing political or economic systems. 2. Developing a political ideology. 3. Generating multiple solutions to problems depending on multiple contexts. 4. Interpreting alternate historical accounts or interpretations.	
Formal scheme—Mechanical equilibrium: the ability to simultaneously make the distinction and the intimate coordination of two complementary forms of reversibility—inversion and reciprocity.	Piston problem.	1. Developing an understanding of work and energy.	
Forms of conservations beyond direct verification: the ability to deduce and verify certain conservations from their implied consequences. Developing a chain of inferences through which conservation can be verified by observing only effects.	Conservation of momentum problem with six suspended lead spheres.	1. Developing an understanding of momentum.	

2. Simple and double seriation ("g" words in order: ga, ge, gi).

3. Class inclusion when alphabetizing to second and third letters (these "g" words are in the correct group and order: game, gate, gave; great, green, greet).

4. Hierarchical classification (these are ordered properly: fee, fit, got, grace, help).

In constructing the learning experience, teachers consider the task analysis and cognitive prerequisites. Students' understanding of alphabetization can be assessed when such information is available, since the teacher can observe their performance and determine whether their demonstrated knowledge is appropriate to the task.

Examples of cognitive assessment are numerous in literature. Seventh graders read *Sounder* and engage in an active class discussion. The teacher asks what Armstrong (1972) meant when he wrote, "Cabin quiet was long and sad." In asking this question, the teacher recognizes that the students must comprehend the imaginary relationship and comparison the writer has created. The ability to understand this analogy or metaphor involves transposing the qualities of people, time, and cabins. Determining this comparison requires the students to first organize and classify the information and then reason proportionally. Thus, the cognitive demands require the use of the schemata classification and proportional reasoning.

Social studies provides still another curriculum example for determining cognitive levels. Suppose an 8th grade history teacher discusses the concept of tariffs. The teacher's goal is to enable students to comprehend what tariffs are and how they serve as another source of revenue for the government.

The cognitive schemata for comprehending tariffs and related concepts include:

1. Classification (qualities and attributes of terms such as import, export, free trade, duty, foreign trade, and revenue).

2. Coordination of two or more reference systems (comprehending the symmetrical relationships that exist in international trade, reciprocal trade agreements, and diverse monetary systems).

3. Conservation beyond direct verification (understanding the results of a tariff).

4. Proportional reasoning (understanding the relationship of taxes to quantity, rates, and needs of country).

5. Correlational reasoning (developing an awareness of kinds of tariffs, their purpose, and how they are levied; their effects on industrial development, job protection, and prices).

As a final example, science courses also offer opportunities for cognitive assessment. Photosynthesis is an abstract concept that requires some understanding of the physics of light, chemical structure and reactions, diffusion, and the biochemical basis of organismic activities. The comprehension of this concept requires formal logical reasoning because it presupposes that students are able to use the following processes:

1. Classification, to comprehend the attributes of terms such as chloroplasts, molecules, energy related to work, wavelengths, photosynthesis, glucose, chlorophyll, and electromagnetic radiation.

2. Correlational reasoning, to comprehend the causal relationships between white light and the band of colored light, and CO_2 and blue/yellow bromthymol.

3. Combinatorial reasoning, to recognize what is required in plants for photosynthesis to take place, the types of light essential for plant growth, and activities that are necessary for plants to produce sugar or starch.

4. Proportional reasoning, to understand the number of chloroplasts in each cell and the quantities and substances necessary for photosynthesis.

5. Conservation beyond direct verification, to deduce and verify the consequences of chlorophyll's reaction to white light.

Applications of Cognitive Abilities

Once assessment is complete, the teacher constructs activities that reflect an understanding of students' various cognitive abilities. Suppose the teacher has had a group of students read *Twenty-One Balloons*, by William Rene du Bois (1947). The teacher has assessed the students' cognitive levels and thus might use the following activities to deal with the group's cognitive range as students read the book. The cognitive schemata listed next to the activity indicates the schema the teacher anticipates emphasizing and each activity specifically related to the book's content.

1. How many different ways, both old and new, can you think of that people use to get from one place to another? (Classification)

2. Create a club you would like to join. Describe the rules and regulations for granting membership. Choose two people as honorary members, and tell us who they are and why you selected them. (Classification, correlational reasoning)

3. Imagine that an emergency has just happened and you only have ten minutes to get out of your house safely. What would you do first? Second? What would you take with you? Why? (Spatial-temporal relationships, seriation, correlational reasoning)

4. You are Thomas the Travel Agent. Andrea the Adventurer comes into your office with a request. She wants you to

design the most unusual itinerary you can for her trip. Be as creative as you like; just remember that your plans should begin with the date of departure and include all the necessary information for it to be a successful trip for this famous customer. You may want to call a travel agent for helpful information. Have fun with this. (Correlational reasoning, frames of reference, classification, spatial-temporal relationships, and formal logic)

Conclusion

This chapter has focused on the cognitive analysis of curriculum, which is merely one dimension of the process. Other components of the process of cognitively matching instruction are the informal and formal assessment of students' cognitive abilities and the systematic matching of students' conceptual level with the demands of the curriculum. Each component is vital and integral in constructing classrooms that are dedicated to facilitating students' cognitive development.

REFERENCES

Arlin, P. K. (1977). "Piagetian Operations in Problem Finding." *Developmental Psychology* 13: 297–298.

Armstrong, William H. (1969). *Sounder*. New York: Harper and Row.

de Bois, William Rene. (1947). *Twenty-One Balloons*. New York: Viking.

Elkind, D. (1976). *Child Development and Education*. New York: Oxford University Press.

Hunt, J. M. (1964). *Intelligence and Experience*. New York: Ronald Press.

Inhelder, B., and J. Piaget. (1958). *The Growth of Logical Thinking from Childhood to Adolescence*. New York: Basic Books.

Sigel, I. (1978). "A Comparison of Two Teaching Strategies: Didactic and Inquiry." In *Proceedings of the Seventh Interdisciplinary Conference of Piagetian Theory and the Helping Professions*. Vol. 2, pp. 10–18. Edited by G. I. Lubin, M. K. Poulsen, J. E. Margary, and M. Soto-McAlister. Los Angeles: University of Southern California.

23

Staff Development for Critical Thinking: Lesson Plan Remodelling as the Strategy

Richard W. Paul

Let our teaching be full of ideas; hitherto, it has been stuffed only with facts.

—Anatole France

The basic idea behind lesson plan remodelling for critical thinking is simple. When remodelling lessons, the teacher critiques a lesson plan using certain strategies and principles and formulates a new lesson plan based on that critical process.

First, the strategies and principles used in the remodelling process need to be well thought out. Teachers then should understand the strategies and principles and use them in critiquing and remodelling the lesson. Furthermore, the remodel should clearly follow from the critique.

What is Lesson Plan Remodelling?

Lesson plan remodelling can become a powerful tool in critical thinking staff development. It is action oriented and puts emphasis on close examination and critical assessment of what is being introduced into the classroom on a day-to-day basis. It makes the infusion of critical thinking more manageable by paring it down to the critique of particular lesson plans and to the progressive infusion of particular critical thinking principles. Lesson plan remodelling also is developmental in that, over time, teachers can remodel more and more lesson plans, and what has been remodelled can be re-remodelled. It can provide a means of cooperative learning for teachers.

Results of this process can be collected and shared so teachers can learn from and be encouraged by what other teachers do. Dissemination of plausible remodels also provides recognition for motivated teachers. Furthermore, lesson plan remodelling forges a unity between staff development, curriculum development, and student development. Lesson plan remodelling helps avoid recipe solutions to critical thinking instruction, and integrates cognitive and affective goals into the curriculum.

Of course, lesson plan remodelling is no panacea. It will not work for those who are deeply complacent or cynical, nor for those who do not put a high value on students learning to think for themselves. It will not work for those who have a low command of critical thinking skills coupled with low self-esteem. It will not work for those who are burned out or who have given up on change. And, finally, it will not work for those who want a quick and easy solution based on recipes and formulas.

This chapter is adapted from Richard W. Paul, "Staff Development for Critical Thinking: Lesson Plan Remodelling as the Strategy." *Journal of Staff Development* 8, 3 (Fall 1987): 40–46. Copyright © 1990 by Richard W. Paul.

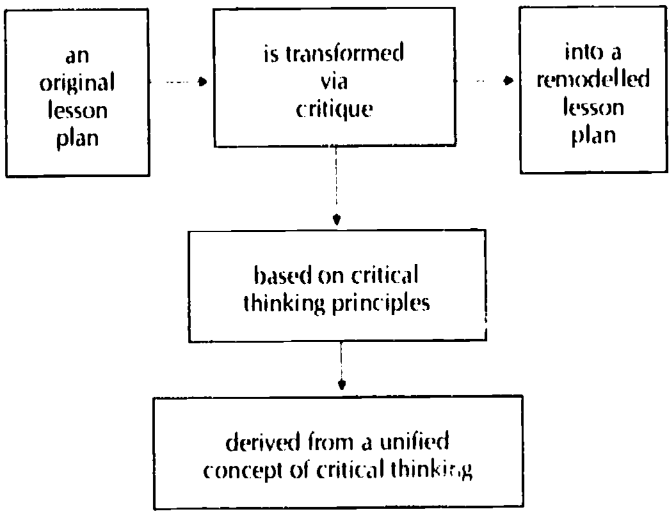
Instead, lesson plan remodelling is a long-term solution that transforms teaching incrementally as the teachers develop and mature in their critical thinking insights and skills.

If teachers can develop the art of critiquing lesson plans they use and learn how to use that critique as the basis for remodelling the lesson plans, they will progressively (a) refine and develop their own critical thinking skills and insights, (b) reshape the actual or living curriculum, and (c) develop their teaching skills.

The lesson plan critique is based on integrating one or more critical thinking strategies, which are derived from critical thinking principles, thus leading to a unified concept of critical thinking in the remodelled lesson (see Figure 1).

FIGURE 1

Critical Thinking Lesson Plan Remodeling



Using Exemplary Models

Staff developers who have a reasonable number of exemplary lesson plan remodels, with accompanying explanatory principles, can develop a series of staff development sessions that enable teachers to begin to develop new teaching skills as a result of their experience in lesson remodelling.

Teachers can increase their own skills in this process if they are provided with (a) clearly contrasting "*before* lesson plans" and "*after* lesson plans," (b) lucid and specific critiques, (c) a set of principles that are clearly explained and illustrated, and (d) a coherent unifying concept. To put it another way, teachers learn how to remodel lesson plans that incorporate critical thinking only through practice. The more one does it, the better one gets (with the proviso that exemplary paradigms are available to provide the teacher with ideas for how to proceed).

While a lesson remodelling strategy for critical thinking inservice does not have to be tied to any particular handbook of examples, it is easy to see the advantages of having some type of handbook with sample "before" and "after" lessons. A handbook of examples is useful because many teachers do not have a clear concept of critical thinking; they often hold the view that critical thinking is negative, judgmental thinking, or think of it merely as a set of atomistic skills with little sense of how those skills can be integrated or orchestrated.

Since teachers generally do not have a clear sense of the relationship between the component micro-skills and macro-abilities of critical thinking and the affective dimensions of thought, it is unlikely that they will be able to see this relationship through abstract theorizing they conduct themselves. The value of having exemplary lesson plan remodelling samples then becomes obvious.

Staff developers should not simply present teachers with prepackaged, finished lesson plans (ones designed as a result of the critical thinking of someone else) because a major opportunity for teachers to develop their own thinking skills, insights, and motivations will then have been lost. Teachers must learn to translate the critical thinking concept into "principles," link the "principles" to application, and produce exemplary "before" and "after" lesson plans of their own. Providing teachers with the scaffolding for carrying out the process for themselves opens the door for open-ended development of critical thinking skills and insights. It begins a process which gives the teacher more and more expertise and more and more success in critiquing and remodelling the day-to-day practice of teaching. Most important, it progressively sharpens their own critical thinking abilities.

One Approach to Lesson Plan Remodelling

The Center for Critical Thinking and Moral Critique at Sonoma State University in Rohnert Park, California, has developed four handbooks for critical thinking, which illustrate the remodelling process (see the last four entries under Recommended Readings at the end of this chapter). The handbooks explain critical thinking by translating general theory into specific teaching strategies. The multiple strategies allow "novice" critical thinkers to begin with elementary strategies, while more "advanced" critical thinkers can use more complex strategies. This is especially

ERIC Full Text Provided by ERIC

important since most teachers have had no formal training in critical thinking.

This approach respects the teachers' autonomy and level of development. Teachers choose which strategies to use in a particular situation and control the rate and style of integration. It is a flexible approach that maximizes the decision making and thinking of the teacher. The teacher can apply the strategies to any kind of material (e.g., text lessons, lessons or units the teacher has created, discussion outside of formal lessons, movies, etc.).

The use of multiple strategies in the handbooks addresses the need to integrate the cognitive and affective domains of thought, thus going beyond an emphasis on skills alone. It is based on the notion that, to understand critical thinking, we must understand the problems a person faces in integrating critical thinking into everyday life. The handbooks are based on the view that critical thinkers think for themselves rationally, logically, and fair-mindedly. Such people learn to detect irrational processes of thought and to think beyond them.

From this perspective we can distinguish three kinds of thinkers: (a) *uncritical thinkers*, who do not develop elementary critical thinking skills in any significant fashion; (b) *weak-sense critical thinkers*, who develop intellectual skills but who apply them in a narrow-minded or self-serving fashion; and (c) *strong-sense critical thinkers*, who develop not only a battery of skills but also the disposition and commitment to use them in a fair-minded and open-minded way.

In emphasizing teaching for strong-sense critical thinking, the handbooks reflect our commitment to teaching in such a way that children learn to become responsible for their own thinking as soon and as completely as possible. This requires that students learn how to take command of their thinking, which in turn requires that they learn how to notice and think about their own thinking as well as the thinking of others. Consequently, we should enable children to talk about their thinking in order to be mindful and directive in it. We should help students gain tools by which they can probe deeply into and take command of their own mental processes. Finally, we should help students gain this mentally-skilled self-control in an effort to become more honest with themselves and more fair to others, and not simply for the purpose of "doing better" in school.

We should help students develop mental skills and processes in an ethically responsible manner. This is not a "good-boy/bad-boy" approach to thinking since everyone must think his or her own way to the ethical insights that underlie becoming a fair-minded thinker. We need to be careful not to judge the "content" of the student's thinking (Paul 1990). Rather, we should facilitate a process whereby the student's own insights can be developed. A Socratic questioning approach, for instance, would foster this.

The global objectives of critical thinking-based instruction are intimately linked to specific instrumental objectives. It is precisely because we want students to learn how to think for themselves in an ethically responsible way that we use the strategies we do: (a) helping students gain insight into their tendency to think in narrowly self-serving ways (egocentricity) and into their tendency to think as others think (sociocentricity); (b) stimulating students to be empathic toward the points of view of others and to suspend or withhold judgment when they do not have the evidence to justify making a judgment; (c) stimulating students to avoid oversimplification, to develop their own perspective, to transfer their ideas to new contexts, to clarify issues and ideas, to pursue root questions, to evaluate sources, solutions, actions, and policies; (d) encouraging students to make interdisciplinary connections, to notice when they are making assumptions, how they are using or ought to be using evidence; (e) stimulating students to consider the implications and consequences of their ideas, the possible contradictions or inconsistencies in their thinking, the qualifications or lack of qualifications in their generalizations; and (f) approaching students with these techniques in encouraging, supportive, nonjudgmental ways.

A taxonomy of critical thinking strategies listed in Figure 2 is divided into three categories; one for the affective and two for the cognitive. In teaching for strong-sense critical thinking, the affective dimension of thinking is as important as the cognitive. Teachers should enable students to continually use their emerging critical thinking skills and abilities in keeping with the critical spirit, and the critical spirit can be nurtured only when students actually practice critical thinking in some (cognitive) way. One cannot develop one's fair-mindedness, for example, without actually thinking fair-mindedly. One cannot develop one's intellectual independence without actually thinking independently. This is true of all the essential critical thinking traits, values, or dispositions. They are developmentally embedded in thinking itself.

The cognitive strategies are divided into two groups to emphasize the importance of distinguishing critical thinking *micro-skills* (the most elementary critical thinking skills) from critical thinking *macro-abilities* or *processes* (the actual orchestration of skills in an extended activity of thought). For example, the ability to clarify a basic issue typically requires an extended sequence of thought. In that sequence, one may use a variety of micro-skills: one might distinguish ideas, make inferences, explore assumptions, suspend a judgment, use qualifiers, and explore implications. Macro-practice is almost always more important than micro-drill because in the

FIGURE 2

Taxonomy of Critical Thinking Strategies

A. Affective Strategies	
S-1	Fostering independent thinking
S-2	Developing insight into ego/sociocentricity
S-3	Fostering reciprocity
S-4	Exploring thoughts underlying feelings
S-5	Suspending judgment
B. Cognitive Strategies—Macro-Abilities	
S-6	Avoiding oversimplification
S-7	Applying/transferring ideas to new contexts
S-8	Developing one's perspective
S-9	Clarifying issues and claims
S-10	Clarifying ideas
S-11	Developing criteria for evaluation
S-12	Evaluating source credibility
S-13	Raising and pursuing root questions
S-14	Evaluating arguments
S-15	Generating or assessing solutions
S-16	Evaluating actions and policies
S-17	Clarifying or critiquing text
S-18	Making interdisciplinary connections
S-19	Conducting socratic discussion
S-20	Fostering dialogical thinking
S-21	Fostering dialectical thinking
C. Cognitive Strategies—Micro-Skills	
S-22	Distinguishing facts from ideas
S-23	Integrating critical vocabulary
S-24	Distinguishing ideas
S-25	Examining assumptions
S-26	Distinguishing relevant from irrelevant facts
S-27	Making plausible inferences
S-28	Supplying evidence for a conclusion
S-29	Recognizing contradictions
S-30	Exploring implications and consequences
S-31	Refining generalizations

Source: Paul, Binker, and Charbonneau 1987.

real world we typically have to orchestrate our thinking. Teachers need to be continually vigilant against the misguided tendency to fragmentize, atomize, mechanize, and proceduralize thinking.

The strategies listed in Figure 2, therefore, should be seen as tools for helping students develop particular micro-skills and for helping students develop macro-abilities that are needed to orchestrate micro-skills in extended ways. In some cases, the strategies can help students to gain insight into the traits, values, and dispositions essential for strong-sense critical thinking.

The "clarifying issues" strategy is displayed in Figure 3 to illustrate how principles and applications are presented in the handbook (Paul, Binker, and Charbonneau 1987). The strategy of "clarifying issues" can be read from three points of view: (a) as defining *a behavior* (What sorts of things do students need to be able to do in order to do this?), (b) as clarifying the *general concept* (How does this description further pin down what we mean by critical thinking?), and (c) as illustrating *value commitments of critical thinking* (What values are inherent in the behaviors fostered through this principle?)

The remodelling of a sample lesson plan is displayed in Figure 4 to illustrate the procedures in a complete remodel (Paul, Binker, and Charbonneau 1987).

The critique is written from the perspective of one who wants to bring critical thinking principles into practice. The original lesson plan provides a place to look for opportunities for infusion. The critique's purpose is therefore *constructive*, not destructive. It is to put oneself in the position of seeing clearly what can and ought to be infused into the original if we are to make it over into a lesson plan that fosters critical thinking. This is the spirit that should be maintained in lesson plan remodelling. Constructiveness is intrinsic to the spirit of critical thinking itself.

Teachers should learn the art of lesson plan critique so that they can remodel the plans they use and bring critical thinking into the classroom. In doing this for themselves, teachers learn to think more critically and become better teachers.

Some Staff Development Design Possibilities

Let us consider how we can incorporate these critical thinking issues into inservice design. There are five basic goals we need to aim for:

1. *To help teachers clarify the global concept.* What is it to think critically? How is the fair-minded critical thinker unlike the self-serving critical thinker and the uncritical thinker?

2. *To help teachers understand component teaching strategies that parallel the component critical thinking values, processes, and skills.* What are the basic values that (strong-sense) critical thinking presupposes? What are the micro-skills of critical thinking? What are the macro-processes? Why distinguish macro-processes from micro-skills?

3. *To help teachers see a variety of ways in which the various component strategies can be used in classroom settings.* What do critical thinkers do? Why? What do they avoid doing? Why? When can this aspect of critical thought be fostered? What questions or activities foster it?

4. *To help teachers get experience in lesson plan critique.* What are the strengths and weaknesses of this lesson? What critical principles, concepts, or strategies apply to it?

5. *To help teachers get experience in lesson plan remodelling.* How can I take full advantage of the strengths of this lesson? How can this material best be used to foster critical insights? Which questions or activities should I drop, use, alter, or expand upon? What should I add to it?

These goals are interrelated and the achievement of any, or all, of them is a matter of degree. I recommend against trying to achieve an absolutistic understanding of any one of these before proceeding to others. Furthermore, I would emphasize that understanding in each case should be viewed practically or pragmatically. One does not learn about what critical thinking is by memorizing a definition of a set of distinctions. The teacher's mind must be actively engaged at each point in the process—concept, principles, application, critique, and remodel. At all of these levels, "hands-on" activities should immediately follow any introduction of explanatory or illustrative material.

For example, if teachers are shown a handbook formulation of one of the "principles," they should then have an opportunity to brainstorm applications of the principles, or have an opportunity to try out their own formulations of the principle. When they are shown the critique of one lesson plan, they should be given an opportunity to critique another. If they are shown a complete remodel (including the original lesson plan, critique, and remodel), they should be given an opportunity to do a full critique of their own, whether individually or in groups. This back and forth movement between example and practice should characterize the staff development process overall.

These practice sessions should not be rushed and the products of that practice should be collected and shared in some form with the group as a whole. Teachers need to see that they are fruitfully engaged in this process; dissemination of the products of the process demonstrates this fruitfulness. Of course, staff development participants should understand that "initial practice" is not the same as "final product," and what is remodelled today by critical thought can be reremodelled tomorrow and improved progressively thereafter as experience, skills, and insights grow.

In any case, I caution against spending too much time on the general formulations of what critical thinking is before moving to the level of particular principles and strategies. The reason for this is simple: people tend to have trouble assimilating general concepts unless they are made accessible by concrete examples. Furthermore, we want teachers to develop an *operational* view of critical thinking and to understand it as particular intellectual behaviors derived from basic insights, commitments, and principles.

Critical thinking is not a set of high-sounding platitudes but a very real and practical way to think and to act on those thoughts.

Staff developers should help teachers make realistic translations from the general to the specific as soon as possible. Teachers need to see how acceptance of the general concept of critical thinking translates into clear and implementable critical thinking teaching and learning strategies.

FIGURE 3

The Clarifying Issues Strategy

Principle: In order to think critically about issues we must first be able to state the issue clearly. The more completely, clearly, and accurately the issue is formulated, the easier and more helpful the discussion of its settlement. Given a clear statement of the issues, and prior to evaluating conclusions or solutions, it is important to recognize what is required to settle the issue. The critical thinker recognizes problematic concepts, objects and standards of evaluation, the purpose of evaluation, and relevant facts.

Application: Teachers should encourage students to slow down and reflect on issues before discussing conclusions. When discussing an issue the teacher can ask students first, Is the issue clear? What do you need to know to settle this issue? What would someone who disagreed with you say about this issue? Students should be encouraged to continually reformulate the issue in light of new information. They should be encouraged to see how the first statement of the issue or problem is rarely best (i.e., most accurate, clear, complete) and that they are in the best position to settle questions only after they have developed as clear a formulation as possible.

When discussing an issue, teachers can have students ask themselves such questions as: Do I understand the issue? Do I know how to settle it? Have I stated it fairly? (Does my formulation assume one answer is correct? Would everyone involved accept this as a fair and accurate statement of the issue?) Are the ideas clear? Do I have to analyze any ideas? Do I know when the terms apply and don't apply? Am I evaluating anything? What? Why? What criteria should I use in the evaluation? What facts are relevant? How can I get the evidence I need?

Source: Paul, Binker, and Charbonneau 1987.

FIGURE 4

Remodelling of a Sample Lesson Plan

A. **Grade:** 2nd Grade, language arts

B. **Title of Lesson:** Two Ways to Win

C. **Objectives:**
1. Use analytic terms such as: assume, infer, imply
2. Make inference from story clues
3. Discuss and evaluate an assumption about making friends
4. Clarify "good sport" by contrasting it with its opposite, "bad sport"

D. **Original Lesson Plan:**

1. *Abstract*

Students read a story about a brother and sister named Cleo and Toby. They learn that Cleo and Toby are new in town and worried about making new friends. Cleo and Toby ice skate at the park every day after school, believing that winning an upcoming race can help them make new friends (and that they won't make any friends if they don't win). Neither of them win; Cleo, because she falls, and Toby, because he forfeits his chance to win by stopping to help a boy who has fallen. Cleo and Toby meet some children who come over after the race to compliment Toby on his good sportsmanship and Cleo on her skating.

Most questions about the story probe the factual components. Some require students to infer. One question has students discuss what "good sport" means. Another asks if Cleo's belief about meeting people is correct.

2. *Critique*

There are a number of good questions in the original lesson which require students to make inference, e.g, "Have Toby and Cleo lived on the block all their lives?" The text also asks students if they know who won the race. Since they do not, this question encourages students to suspend judgment. Although "good sportsmanship" is a good idea for students to discuss, the text fails to have students practice techniques for clarifying ideas. Instead, they ask students to list the characteristics of a good sport (a central idea in the story) with no discussions of what it means to be a bad sport. The use of opposite cases to clarify ideas helps students develop fuller and more accurate ideas. With such practice a student can begin to recognize borderline cases as well—cases to which neither concept perfectly applies, e.g., where someone was a good sport in some respects, bad in others.

E. **Strategies Used to Remodel**
1. Clarifying ideas [S-10]
2. Supplying evidence for a conclusion [S-28]
3. Integrating critical vocabulary [S-23]
4. Making assumptions explicit [S-14]
5. Evaluating assumptions [S-25]

F. **Remodelled Lesson Plan**

Where the original lesson asks, "What does 'a good sport' mean?, we suggest an extension, [S-10]. The teacher should make two lists on the board of the students' responses to the question "How do good sports and bad sports behave?" Students could go back to the story and apply the ideas on the list to the characters in the story, giving reasons to support any claims they make regarding the characters' sportsmanship [S-28]. In some cases there might not be enough information to determine whether a particular character is a good or bad sport. Or they might find a character who is borderline, having some characteristics of both good and bad sports. Again, students should cite evidence from the story to support their claims. The students could also change details of the story to make further points about the nature of good and bad sportsmanship. (If the girl had pushed Cleo down in order to win the race, that would have been very bad sportsmanship.) To further probe the idea of good sportsmanship, ask questions like the following: How did Toby impress the other children? Why did they think he did a good thing? If you had seen the race, what would you have thought of Toby? Why do we value the kind of behavior we call 'good sportsmanship'? Why don't we like bad sportsmanship? Why are people ever bad sports?

There are a number of places in the lesson where the teacher could introduce, or give students further practice using, critical thinking vocabulary [S-23]. Here are a few examples of how to do so: "What can you infer from the story title and picture? What arts of the story imply that Toby and Cleo will have some competition in the race? What do Toby and Cleo assume about meeting new people and making new friends? [S-14] Is this a good or bad assumption? [S-25] Why? Why do you think they made this assumption? Have you ever made similar assumptions? Why? What can you infer that Cleo felt at the end of the story? How can you tell?

Source: Paul, Binker, and Charbonneau 1987.

Conclusion

Lesson plan remodelling as a strategy for staff and curriculum development is not a simple one-shot approach; it requires patience and commitment. But remodelling genuinely develops the critical thinking of teachers and puts them in a position to understand and structure the inner workings of the curriculum, thus building confidence, self-respect, and professionalism. With such an approach, enthusiasm for critical thinking strategies will grow over time.

It is an approach worth serious consideration as the fundamental thrust of a staff development program.

If teachers become proficient at critiquing and remodelling lesson plans, they can redirect the focus of their critique and "remodel" any other aspect of school life and activities. In this way, teachers can become increasingly less dependent on direction or supervision from above and increasingly more activated by self-direction. Responsible, constructive critical thinking, developed through lesson plan remodelling, is a vehicle for this transformation.

References

Paul, R. (1990). *Critical Thinking: What Every Person Needs to Survive in a Rapidly Changing World.* Rohnert Park, Calif.: Center for Critical Thinking and Moral Critique, Sonoma State University.

Paul, R. W., A. J. A. Binker, and M. Charbonneau. (1987). *Critical Thinking Handbook: K–3. A Guide for Remodelling Lesson Plans in Language Arts, Social Studies, and Science.* Rohnert Park, Calif.: Center for Critical Thinking and Moral Critique, Sonoma State University.

Recommended Readings

Paul, R. (1990). *Critical Thinking: What Every Person Needs to Survive in a Rapidly Changing World.* Rohnert Pa. :, Calif.: Center for Critical Thinking and Moral Critique, Sonoma State University.

Paul, R. W., A. J. A. Binker, and D. Weil. (1990). *Critical Thinking Handbook: K–3. A Guide for Remodelling Lesson Plans in Language Arts, Social Studies, and Science.* Rohnert Park, Calif.: Foundation for Critical Thinking, Sonoma State University.

Paul, R. W., A. J. A. Binker, K. Jensen, and H. Kreklau. (1990). *Critical Thinking Handbook: 4th–6th Grades. A Guide for Remodelling Lesson Plans in Language Arts, Social Studies, and Science.* Rohnert Park, Calif.: Foundation for Critical Thinking, Sonoma State University.

Paul, R. W., A. J. A. Binker, D. Marin, C. Vetrano, and H. Kreklau. (1989). *Critical Thinking Handbook: 6th–9th Grades. A Guide for Remodelling Lesson Plans in Language Arts, Social Studies, and Science.* Rohnert Park, Calif.: Center for Critical Thinking and Moral Critique, Sonoma State University.

Paul, R. W., A. J. A. Binker, D. Marin, and K. Adamson (1989). *Critical Thinking Handbook: High School. A Guide for Redesigning Instruction.* Rohnert Park, Calif.: Center for Critical Thinking and Moral Critique, Sonoma State University.

24

How Our Brain Is Organized Along Three Planes to Process Complexity, Context, and Continuity

Robert Sylwester

The tens of billions of individual neurons in our brain have an awesomely complex but elegantly simple structure and function—and the large integrated networks that combine the actions of many neurons are likewise simultaneously complex and simple. More genetic material is used to organize our brain than any other organ.

Over the years, brain researchers have proposed many theories about our brain's overall architecture, but a general reductionist pattern has emerged that began with the concept of a single holistic brain, moved to an intense cultural interest in the two cerebral hemispheres, and continued on through MacLean's (1978) discovery of our triune brain—a three-layer brain, composed of (1) a finger-size brain stem that regulates such survival functions as circulation and respiration, (2) a limbic system of interconnected pea- to walnut-size structures that surrounds the top of the brain stem and regulates our emotional and nurturing life, and (3) a neocortex about the size of a thick dinner napkin that is deeply folded around the limbic system. The neocortex occupies 85 percent of the mass of our brain and processes conscious rational thought.

More recently, Gardner (1983) has suggested that our conscious brain functions through seven different forms of intelligence that are processed in different brain areas. Gazzaniga (1985) continued the reductionist pattern by suggesting that our brain is divided into hundreds or even thousands of interconnected semi-autonomous networks of neurons (modules). Each module specializes in a single limited cognitive function (such as an aspect of face recognition), and groups of modules consolidate their activities to process more complex cognitive functions. The existing evidence seems to support this modular theory of brain organization, but the search continues for the way in which the few functions that dominate cognition are organized within the general architecture of our brain.

The discussion that follows assumes a modular brain and describes an emerging simple functional model of our brain that focuses on its integration of three educationally significant cognitive concepts: complexity, context, and continuity. But realize that it's a simple model for a complex structure, and simplifying our brain's organization doesn't eliminate its complexity, it merely masks it. Still, it's an intriguing model that can lead educators to useful contemplation and conversation about the development of thinking skills.

One Vertical and Two Horizontal Planes

Our brain must continually interpret the wide range of environmental change that occurs both inside and outside our body, and it must be able to solve the problems that emerge from both environments. Our brain is organized functionally along three general planes that collaborate in such tasks. Each plane focuses on processing the normal

ERIC

behavioral range of one important aspect of understanding and responding to environmental problems. We can thus think of our brain as being developmentally organized:

(1) vertically, from the bottom to the top of our brain—to process the various levels of complexity at which we objectively and subjectively confront and solve problems;

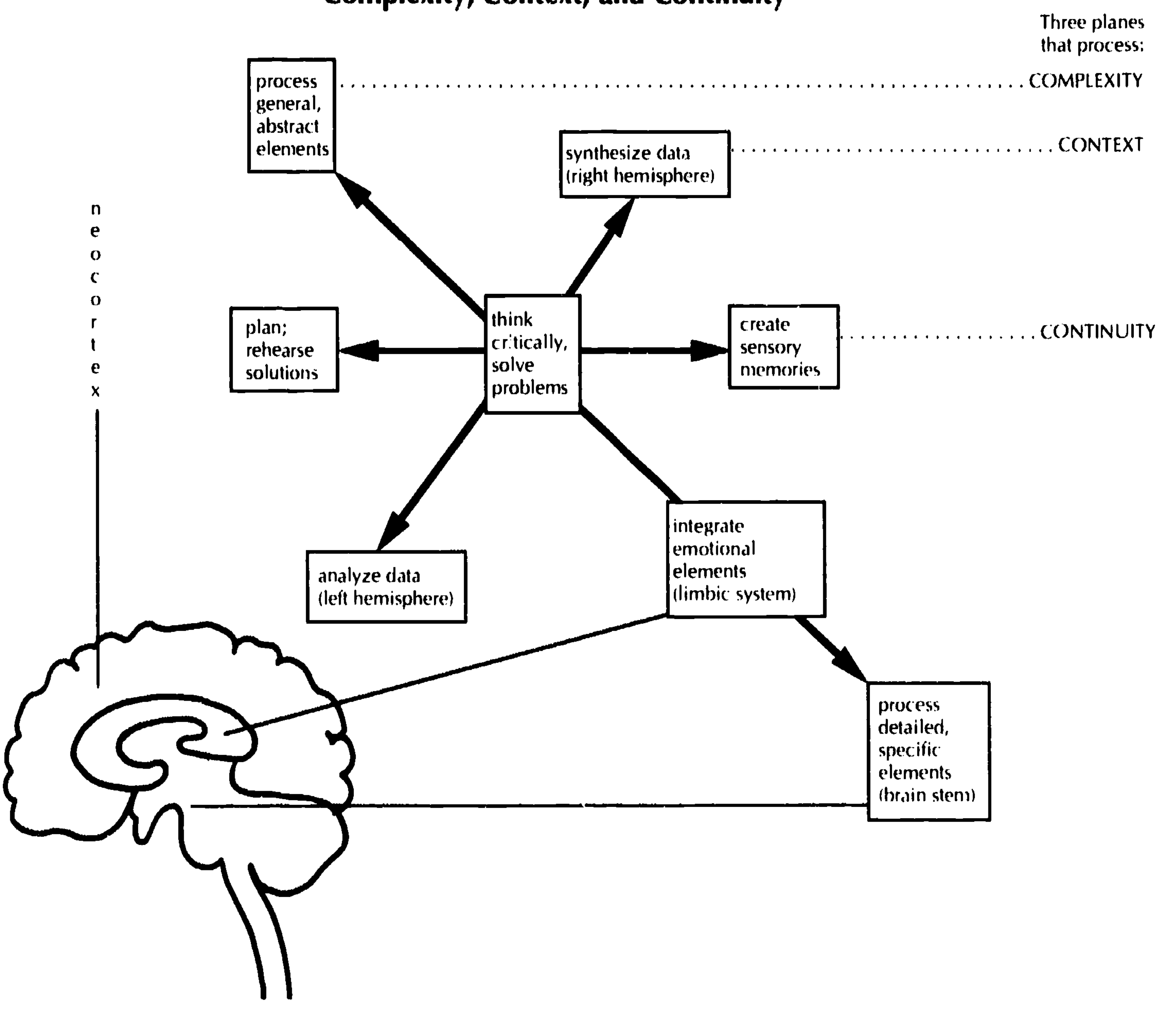
(2) horizontally, from the right to the left side of the napkin-size neocortex—to process the varying amount of context (background and foreground information) that we incorporate into different stages of problem solving and communication; and

(3) horizontally, from the back to the front of the neocortex—to process the continuity of past, present, and future experiences that we generallv incorporate into problem-solving activities.

Figure 1 shows a model of this conception of the human brain.

FIGURE 1

A Schematic Model of the Human Brain Across Three Intersecting Planes: Complexity, Context, and Continuity



Bottom-to-Top Vertical Organization: Complexity

The brain stem mechanisms at the base of our brain have very specific, detailed, and objective sensory and motor assignments—to bring in information from specific sensory receptors, to activate specific muscle fibers, to regulate survival mechanisms. The limbic system mechanisms that are further up in our brain have less distinct and more subjective assignments. They interact with many other neural networks to insert the dimension of emotion into the processes we use to solve problems. The frontal lobe mechanisms, which lie toward the top end of our brain's vertical plane, process complex problem-solving and planning decisions that are more objective, general, and abstract. Many areas of our large frontal lobes where this occurs have no direct sensory or motor connections with the outside world.

Think of a school district hierarchy as being functionally similar to our brain's vertical plane in the levels of complexity of its staff assignments. The bottom positions in the hierarchy have very detailed, specific, and objective job descriptions—a school bus driver follows a very specific route and schedule, and the district doesn't appreciate creative deviations. Once the students arrive at school though, they work with teachers who have a broader and more subjective nurturing assignment. Teachers generally get more emotionally involved with their students than bus drivers, and we expect them to be much more flexible and creative in carrying out their assignment. A building administrator's assignment is still farther up the hierarchy, and continuous interaction with a small set of specific students gives way to concern for the overall operation of the school and its total student body and staff.

The district's central office staff is yet another step removed from teaching students—and even from the problems of specific teachers. The tasks become more complex and objective. System planning becomes more central to their assignment than the execution of the plan within a specific school. Finally, it's difficult to clearly define the superintendent's assignment, beyond the very general and abstract charge to administer the system in a creative, flexible, humane, and fiscally responsible manner.

A cynic might suggest that too many central office positions are also unconnected to the outside world (much like some areas of our frontal lobes) but it's not as simple as that. Successful planning within our brain and within a school system requires enough psychological distance from a complex issue to develop a broader and more objective view that is unobstructed by too many details and personal bias.

We see the importance of this distance in observing the behavior of ineffective school administrators who don't delegate responsibility effectively, and tend to respond specifically and subjectively to general problems. Their limited vision of the school and its mission leads to a mistrust of those who provide the information they need to understand a problem, and of those who should execute the specific tasks involved in its resolution. Superintendents should spend their energy on solving student transportation issues, not on driving a school bus.

Our brain is designed to divide cognitive tasks in an analogous hierarchical fashion. It objectively processes very detailed or specific and general or abstract tasks at the two ends of the vertical plane, but it depends heavily on many intermediate levels that insert emotion into the process. A healthy brain can integrate the functions of all of its mechanisms. It gathers useful data, takes the time to plan an effective and emotionally satisfying response, and trusts its ability to carry out its plan. It isn't obsessed with input and output details, nor does it continually make general plans about what it will do without exhibiting the skills and courage to carry out its plans.

A brain that doesn't trust itself, or that can't properly delegate its various cognitive tasks among its mechanisms, will suffer from fear, anxiety, stress, depression, obsession, compulsion, and addiction—and, sadly, school districts can also exhibit analogous institutional pathologies.

A sound hierarchical organization doesn't assume that one assignment is implicitly more important than another. Indeed, the mechanism that runs our heart is located at the lower end of our brain's vertical plane. Although we don't want it to be creative (and do the heartbeats in waltz time), we certainly do depend on our heart's continued detailed attention to its specific task of pumping our blood in a regular rhythm. So it should be also with the levels of prestige that our profession ascribes to the range of school assignments—from driving a school bus to administering the entire school system, from learning calculating to learning calculus.

Right-to-Left Horizontal Organization: Context

Since our brain can't process all the information that the surrounding environment contains at any given moment, it must continually separate the more significant foreground information from the less significant background (or contextual) information—and generally focus on what's currently foreground while monitoring the background. This ability is crucial in problem solving and social relationships. For example, we must quickly find the direction signs and ignore almost everything else in an unfamiliar airport as we dash to a connecting flight. Conversely, we may simply enjoy the pure background breadth of a magnificent sunset, without focusing on any specific foreground elements. In between such extremes are many experiences with a more complex separation task, such as separating the body language from the words a person uses during a party conversation, and determining which carries the more important foreground message and which is mostly background noise.

Our brain is fortunately designed to simplify this task at various levels of cognitive processing—principally by reducing sensory input to relatively narrow ranges (e.g., ten octaves of sound) and by favoring certain sensory properties (e.g., high-pitched over low-pitched sounds).

In addition, our brain is designed to process high-contrast sensory information with more intensity than low-contrast information. For example, our visual system attends more to high-contrast spots, lines, or edges than to low-contrast solid areas. Your brain is currently aware of the low-contrast white areas that make up most of this page (background), but it focuses its attention on the black lines that make up these words (foreground), since they contrast strongly with the adjoining white paper.

Long before brain researchers discovered that lines and edges contain more potentially useful biochemical information than solid areas, we had exploited this almost mechanical property of our brain by creating written languages that use vertical, horizontal, diagonal, or curved lines to represent the words that represent our ideas and emotions.

And it certainly simplifies recognition and memory formation to focus principally on a few elements, such as the high-contrast lines, edges, contours, and colors of a person's face, rather than on all the low-contrast skin information that exists between such lines.

Movement is an important form of contrast, and the continuous firing patterns of our visual system allow both focused and peripheral attention processes to track movement across our visual field. This ability is crucial to survival in animals that are both predator and prey to other animals, and so it dominates their vision. For example, a frog's visual system responds to moving spots and ignores everything else. A starving frog will ignore a stationary insect. In effect, the frog responds to its environment as follows: if the spot is small and moving, eat it; if it's large and moving, jump. How simple life could be!

Contrast is also basic to attention in our other sensory systems—sounds that interrupt silence, shifting tones that create a melody, warm smells that greet our entry into a bakery, and wintry blasts that chill our exit. Experienced teachers who want to quiet a noisy classroom don't ask their students to be quiet, since their speech provides little auditory contrast. Rather, they generally flip the light switch off and on, since that provides a novel visual contrast that will spark student attention. Emotional intensity and novelty tend to stimulate our attention because they introduce a major contrast to the current situation.

The foreground/background differentiation that is built into our sensory processing system is also evident in the functional organization of our brain's two hemispheres. Researchers who study our brain's hemispheres suggest that although our neocortex integrates a wide variety of rational functions, most human right hemispheres specialize in those tasks that relate to synthesis and space, and most left hemispheres specialize in those tasks that relate to analysis and time. Further, our right hemisphere seems more oriented to the parallel (or simultaneous) processing of information, and our left hemisphere to the serial processing of information.

Think of the functional roles our two hemispheres play in terms of our brain's need to simultaneously see an entire forest and one of its individual trees. If you close your eyes and then quickly open them, you'll instantly see everything in your visual field, but most of what you see will be the basic lines and edges that make up shapes. You'll get a general background or cartoon view of the scene rather than a detailed view.

Now focus your attention on one object, examine it intensely, and then imagine what kind of a brain it would take to instantly process that much information from every single object in your visual field every time you open your eyes (let alone the vast amount of information your brain would also get from its other equally powerful sense organs). It would be a very large, high-powered, and inefficient brain confronted with a continuous overload of information.

Thus, our brain must have mechanisms that see the forest—that synthesize the context by gathering a little bit of high-contrast information from each of many units in our sensory fields in order to get a general sense of what's out there, and how all these units are related. Our right hemisphere has been called our metaphoric mind because metaphors, parables, maps, graphs, cartoons, and so on provide only the outlines of a broad concept that can be experienced and interpreted in many ways.

Conversely, the left hemisphere of most people focuses on the analysis of individual elements of this broad sensory field—by carefully examining the lower-contrast details of an individual tree while the right hemisphere monitors the entire forest. This analysis must be done sequentially, over time, since our brain can't simultaneously examine several individual trees in different areas of our visual field. Thus, our left hemisphere is better equipped to process any information that must be processed sequentially.

Most human left hemispheres play a major role in processing language because the information in language is carried in the sequence of elements (sounds, letters, words) and the length of the chain, and not in the elements themselves (e.g., *do*, *dog*, *god*, *good*). Further, a word packs a considerable amount of information into a few relatively similar sounds or symbols, and so our comprehension of it requires the close attention to subtle shifts in sounds and line orientations that would be characteristic of left hemisphere processing.

Gazzaniga (1985, 1988) suggests that our brain contains an important interpreter function that is also located principally within our left hemisphere (probably because of its close relationship to analytic and language functions). Our brain's interpreter creates reasonable explanations for events that are otherwise difficult to explain (e.g., why the behavior of two siblings differs so much). Thus, this interpreter function is central to our belief system and self-concept. It leads to religious resolve, political activism, fears and anxieties, arguments, diets, and a whole lot more.

Our brain continually switches its perception of what is foreground and what is background as it confronts problems —between the words and body language of a party conversation; among the driving mechanisms inside a car, the traffic on the highway, and the conversation with passengers.

A community's collective brain likewise agonizes between community and personal needs in an issue, as it searches to decide which is foreground and which is background. For example, a state may place general social needs into the foreground, and decide to limit state funding for transplant operations in order to spread its limited public health funds as broadly as possible. But this objectively reasonable decision could have dire subjective consequences for a person who needs a transplant for continued life, who is dependent on public health funds, and who subjectively places a reverse priority on state and individual needs.

Some 200 million axons connect our two hemispheres through the corpus callosum, and billions of bits of information pass back and forth every second. Given the number, complexity, and context of the problems our brain confronts, it's not surprising that our two hemispheres are continually conversing.

Schools should focus much of their curricular energy on helping students learn how to differentiate between the foreground and background elements of real problems. Edge detectors are built into our visual system, but a vast cognitive distance separates our almost automatic ability to recognize a line on a sheet of paper and our learned ability to draw the line that differentiates community and individual needs. Our profession exists because of that vast distance—and a student's right to learn how to traverse it.

Back-to-Front Horizontal Organization: Continuity

Foreground and background have a somewhat spatial conceptual orientation, but our brain must also confront the temporal dimensions of problems.

Events occur in the present, but they often result from prior related events and they lead to future events. Our brain's principal concern is to identify and respond to potentially beneficial or harmful environmental changes, and much of this problem-solving activity is centered in our neocortex. We must be able to draw on our past experiences and predict what might occur in the future in order to avoid becoming a prisoner of the absolute present—viewing each current problem as a novel event.

Our neocortex is thus organized to integrate the past, present, and future into the solution of current problems—dedicating major areas to the various processes that constitute memory (past), critical thinking and problem solving (present), and planning and rehearsal (future).

Our brain's ability to rapidly integrate these temporal functions suggests that the highly interconnected mechanisms are spread across the neocortex, but both the location and maturation of functions appear to follow a general back/past, middle/present, and front/future focus. One could also use Piagetian stages of cognitive development to roughly divide the maturation of the neocortex, with the earlier-developing sensory/motor and concrete operations stages centered in the back half, and the later-developing formal operations stage centered in the front half.

The Past: Memory. Our neocortex is divided into right and left hemispheres on the two sides of a line running straight back from our nose across the top of our head. Each hemisphere is divided into four lobes. The three that process sensory memories occupy the area roughly behind a line drawn across the top of our head from ear to ear. The temporal lobes (located above and behind our ears) process hearing and speech. The occipital lobes (located at the back of our head) process vision. The parietal lobes (located at the top of our head) process touch and motor control. Important connections combine sensory information and memories, so that when we hear the word *banana*, we can see and feel a banana in our mind.

The spatial and locational elements of memory are located principally in the right hemisphere and the temporal and language elements in the left hemisphere. Memory functions at several levels. Episodic memories are very personal—intimately tied to a specific episode or context (the memory of my first attempt to run my computer). Semantic memories are more abstract—symbolic and context free (knowing how to use computer function keys and software). My semantic understanding of keyboards allows me to work easily on a variety of typewriters and computers. Procedural memories are automatic skill sequences (knowing how to touch-type). They do not rely on conscious verbal recall (except to initiate, monitor, or stop the extended movement sequence), and so they are fast and efficient.

Initial learning, such as learning how to type, is often episodic, since it contains both foreground and background elements of the experience. Continued experience with such an activity in a variety of contexts strengthens the foreground (or skill) elements of the memory and weakens the memory of the initial context—and the memory becomes semantic, more broadly useful. Extensive use of the memorized skill tends to combine related elements. This eliminates our need to consciously activate individual elements—and the memory becomes procedural. Thus, when I was learning to type I knew where all the keys were and I was slow. Today, I don't consciously know where any of the keys are, and I'm a fast and efficient typist. My fingers have become an automatic extension of my brain's language mechanisms.

The Present: Critical Thinking and Problem Solving. Our brain has more frontal lobe capacity than we normally need to survive, because the problem-solving mechanisms located there must be sufficient for crisis conditions (just as furnaces must be able to function effectively on the coldest day of the year).

Since our survival doesn't require our problem-solving mechanisms to operate at capacity most of the time, we've invented social and cultural problems to keep them continually stimulated and alert. The arts, games, and social organizations provide pleasant metaphoric settings that help to develop and maintain our brain's problem-solving mechanisms. They are not trivial activities—in life or in the curriculum. Jean Piaget's suggestion that play is the serious business of childhood attests to the important developmental and maintenance roles that such activities play in mastering problem solving.

Our brain's problem-solving mechanisms are especially effective at rapidly processing ambiguities, metaphors, abstractions, patterns, and changes as they create and confront concepts. They can categorize 100 leaves as maple leaves even though no 2 of the leaves are identical, and they can recognize a classmate at a 25th reunion, despite all the changes that have occurred. This permits us to succeed in a world in which most of the problems we confront require a quick general response rather than detailed accuracy. Thus, we quickly classify objects into general categories and estimate general solutions to our problems. We then adapt our preliminary decisions to any new information we might gather, using reference materials and machines to achieve any further levels of precision if that's necessary.

We call it intuition, common sense—and we depend on it for much of what we call problem solving. It can lead to mistakes and to the overgeneralizations of stereotyping and prejudicial behavior, but also to music, art, drama, invention, and a host of other human experiences that open us to the broad exploration of our complex world.

The Future: Planning and Rehearsal. Brain mechanisms in the prefrontal cortex, located right behind our high forehead, permit us to plan and rehearse future actions—to take risks initially within our mind, rather than in the real world. It's responsible for budgets, reservations, and lesson plans—and it's the last part of the neocortex to mature.

Our brain's ability to predict events is crucial to scientific thought, but it also leads to the worrying we do about the future. But if we can worry about our future, we can also worry about the future of others and our environment—and so our prefrontal cortex (with its strong limbic system connections) also processes feelings of empathy, compassion, altruism, and parenting.

A Perfect Brain?

And so that's how our brain is organized across three planes to respond to a wide range of challenges from its inner and outer environments. We seem most comfortable when we're in the cognitive center of the three intersecting planes—where things are neither too simple nor too complex, and emotion reigns supreme; where trees meld easily into the forest, and we're satisfied with the focus of our attention; where the present is comfortably continuous with the past and future. The farther out we go on any plane, the less sure we are of ourselves, and the more we depend on experts and technological assistance to solve our problems.

We don't have a perfect brain, but it's certainly excellent—fearfully and wonderfully made, as an early contemplator of the human condition poetically put it.

How pleasant to be in a profession that is trusted with a child's brain, and the challenging responsibility to be encouraging and helpful as that brain transforms itself into an adult's mind. We currently don't have very many solid answers to the multitude of questions that exist about how best to assist in that transformation—but our developing scientific understanding of our brain should increase the kind of educational research that will lead to schools that significantly enhance the transformation.

References

Gardner, H. (1983). *Frames of Mind: The Theory of Multiple Intelligences.* New York: Basic Books.

Gazzaniga, M. (1988). *Mind Matters: How the Mind and Brain Interact to Create Our Conscious Lives.* Boston: Houghton Mifflin.

Gazzaniga, M. (1985). *The Social Brain: Discovering the Networks of the Mind.* New York: Basic Books.

MacLean, Paul. (1978). "A Mind of Three Minds: Educating the Triune Brain." In *Education and the Brain,* 77th Yearbook of the National Society for the Study of Education, edited by J. Chall and A. Mirsky. Chicago: The University of Chicago Press.

25

Toward a Model of Human Intellectual Functioning

Arthur L. Costa

Learning and memory are influenced by the sets, intentions, and plans generated in the neocortex of the brain, as well as by the information received from the immediate environment and from internal states, drives, and muscular responses. The reality we perceive, feel, see, and hear is influenced by the constructive processes of the brain, as well as by the cues that impinge upon it.

—Merlin C. Wittrock (1978)

The information processing model described in this chapter serves as a basis for the definitions of thinking, instructional strategies, and teaching behaviors discussed in later chapters. Such a model serves as a guide to curriculum and instructional development, *not* as a neurobiological definition of thinking. Such a definition is still open to interpretation. In fact, brain researchers are attempting to discover whether thinking is a natural bodily function similar to the heart pumping blood or whether it is the result of intense effort, strict discipline, and careful programming of instructional outcomes.

While there are numerous models of human intellectual functioning, it is best to adopt a familiar one as a guide. For example, if you're familiar with Bloom's Taxonomy (Bloom 1956) or Guilford's Structure of Intellect (Guilford 1967), you can use them as a guide in materials selection, staff development, and defining thinking. Adopting a description of human intellectual functioning can help you recognize and develop teaching methodologies, curriculum sequences, learning activities, and assessment procedures that go beyond superficial learning.

An examination of several models of thinking yields more similarities than differences. Many authors distinguish three to four basic thought clusters (Smith and Tyler 1945): (1) *input* of data through the senses and from memory; (2) *processing* those data into meaningful relationships; (3) *output* or application of those relationships in new or novel situations; and (4) metacognition. Figure 1 presents a comparison of several authors' constructs.

Thus, every event a person experiences causes the brain to call up meaningful, related information from storage—whether the event is commonplace or a carefully developed classroom learning experience. The more meaningful, relevant, and complex the experience is, the more actively the brain attempts to integrate and assimilate it into its existing storehouse of programs and structures. According to this model of intellectual functioning, the most complex thinking occurs when external stimuli challenge the brain to (1) draw upon the greatest amount of data or structures already in storage; (2) expand an already existing structure; and (3) develop new structures.

A problem may be defined as any stimulus or challenge, the response to which is not readily apparent. If there is a ready match between what is perceived by the senses and what is an existing structure or program already in storage, no problem exists. Piaget calls this *assimilation*. If, however, the new information cannot be explained or resolved with knowledge in short- or long-term memory, the information

ERIC

FIGURE 1

Comparison of Thinking Models

DATA INPUT PHASE	PROCESSING PHASE	OUTPUT PHASE	SOURCE
Internal and external input	Central Processing	Output	Atkinson & Shiffrin 1968, pp. 90–122
Participation and awareness	Internalization	Dissemination	Bell & Steinaker 1979
Knowledge	Comprehension Analysis Synthesis	Application Evaluation	Bloom & others 1956
Descriptive	Interpretive	Evaluative	Eisner, 1979 pp. 203–213; Great Books Foundation
Input	Elaboration	Output	Feuerstein 1980, pp. 71–103
Fluency	Manipulation	Persistence	Foshay 1979, pp. 93–113
Cognition and memory	Evaluation	Convergent and divergent production	Guilford 1967
Fact	Concept	Value	Harmin 1973
Receiving	Responding Valuing Organizing	Characterizing	Krathwohl & others 1964
Alertness	Information processing	Action	Restak 1979, p. 44
Learning	Integrating	Applying	Sexton & Poling 1973, p. 7
Intuitive	Awareness	Function	Strasser & others 1972, pp. 46–47
Intake storage	Mediation	Action	Suchman 1966, pp. 177–187
Concept formation	Interpretation Inference	Application	Taba 1964, pp. 30–38
Detailed information, recall of previous knowledge	Comparison	Rule generation Auto-criticism	Whimbey 1976, pp. 116–138
Pre-exposure	Exposure	Re-creation	Barazakov 1984
Memory	Critical thinking and problem solving	Planning and rehearsal	Sylwester 1991

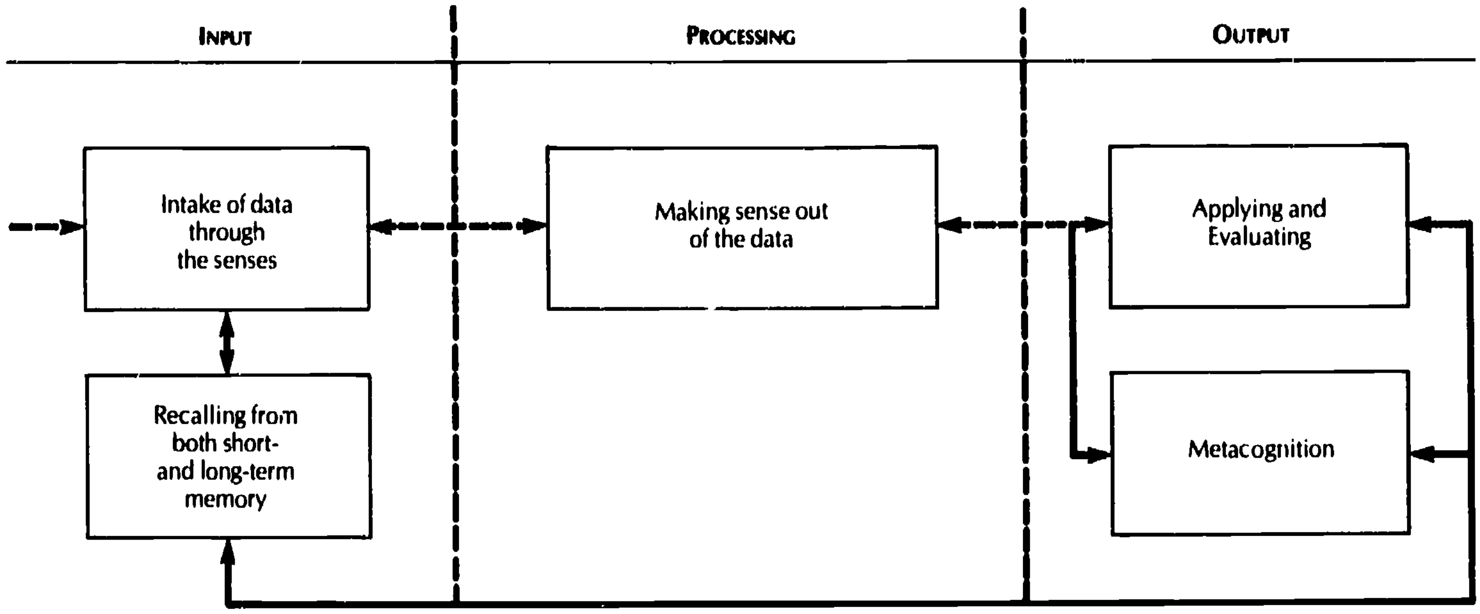
must be processed, action taken to gather more information to resolve the discrepancy, and the ultimate resolution evaluated for its "fit" with reality. Piaget refers to this as *accommodation.* Our brains seem to dislike disequilibrium and constantly strive to satisfy and resolve discrepancies perceived in the environment.

Inputting information alone seems to be brain-dysfunctional. Information that the brain has not processed remains in memory for very short periods of time. Merely experiencing or memorizing without acting on that information commits it to short-term memory. Finding a pattern through comparisons, classifications, and causal, sequential, or hierarchical relationships apparently forms or expands a structure in the brain so that the information is available for application in situations other than that in which it was learned. For example, try to remember which direction Lincoln, Kennedy, Roosevelt, and Jefferson are facing on their respective coins. Only when comparisons are made, relationships drawn, and connections built will this information stay in long-term memory.

Figure 2 provides a simplistic visual presentation of this complex model of intellectual functioning. It deletes such

FIGURE 2

A Model of Intellectual Functioning



From Toward a Model of Human Intellectual Functioning.

important factors as affect, motivation, and perceptual abilities.

Our brains never stop. We process information during sleep and even under anesthesia. The brain actively engages in these processes regardless of the external input that is presented. The brain does *not* remain inactive when it is not fully engaged in learning specific information. When learning tasks are presented that are insufficiently organized, unmotivating, or are not meaningful enough to engage these thought processes, the brain seeks stimulation in other ways: random thoughts, feelings, physical sensations, daydreaming, fantasy, problem solving, creative inspiration, and spontaneous memories. Instead of focusing on a lecture on igneous, sedimentary, and metamorphic rocks, for example, the brain may focus on the teacher's blue dress and start daydreaming about what to wear to the dance next Saturday. Thus, the brain continues to find patterns and relationships but not necessarily in the direction that the teacher intends.

Teachers and parents are crucial mediators of these intellectual behaviors. They can present or call attention to discrepancies and pose problems intended to invite more than a memory (assimilation) type response. Teachers can purposely arrange the classroom and learning experiences to cause the exercise of these intellectual functions.

REFERENCES

Atkinson, R. C., and R. M. Siffrin. (1968). "Human Memory: A Proposed System and Its Control Process." In *The Psychology of Learning and Motivation, Vol. 2,* edited by K. W. Spence and J. T. Spence. New York: Academic Press.

Bell, M., and N. Steinaker. (1979). *The Experimental Taxonomy: A New Approach to Teaching and Learning.* New York: Academic Press.

Bloom, B. S., M. D. Englehart, E. J. Furst, W. H. Hill, and D. R. Krathwohl. (1956). *Taxonomy of Educational Objectives: Handbook I: Cognitive Domain.* New York: David McKay.

Eisner, E. (1979). *The Educational Imagination.* New York: Macmillan.

Feuerstein, R. (1980). *Instrumental Enrichment.* Baltimore, Md.: University Park Press.

Foshay, A. W. "Toward a Human Curriculum." In *Education in Flux: Implications for Curriculum Development,* edited by J. J. Jelenek. Tempe, Ariz.: University of Arizona Press.

Guilford, J. P. (1967). *The Nature of Human Intelligence.* New York: McGraw-Hill.

Harmin, M., H. Kirschenbaum, and S. Simon. (1973). *Clarifying Values Through Subject Matter.* Minneapolis, Minn.: Winston Press, Inc.

Krathwohl, D., B. S. Bloom, and B. B. Masia. (1964). *Taxonomy of Educational Objectives: Handbook II: Affective Domain.* New York: David McKay.

Restak, R. (1979). *The Brain: The Last Frontier.* New York: Warner Books.

Sexton, T. G., and D. R. Poling. (1973). *Can Intelligence Be Taught?* Bloomington, Ind.: Phi Delta Kappa Educational Foundation. Fastbook Series #29.

Smith, E. R., and R. W. Tyler (1942) *Appraising and Recording Student Progress.* New York: Harper.

Strasser, B. B., R. W. Babock, R. Cowan, G. T. Dalis, S. E. Gothold, and J. R. Rudolph. (1972). *Teaching Toward Inquiry.* Washington, D.C.: National Education Association.

Suchman, J. R. (1966). "A Model for the Analysis of Inquiry." In *Analyses of Concept Learning*. New York: Academic Press.

Sylwester, R. (1990). "How Our Brain Is Organized Along Three Planes to Process Complexity, Context, and Continuity." In *Developing Minds: A Resource Book for Teaching Thinking*, 2nd ed., edited by A. Costa. Alexandria: Association for Supervision and Curriculum Development.

Taba, H., S. Levine, and F. Elzey. (1964). *Thinking in Elementary School Children*. San Francisco, Calif.: San Francisco State College, Cooperative Research Project No. 1574.

Whimbey, A., and L. S. Whimbey. (1976). *Intelligence Can Be Taught*. New York: Bantam.

Wittrock, M. C. (1978). In *Cognitive Processes of the Brain, 1978 Yearbook of the National Society for the Study of Education, Part II*, NSSE.

26

A "Grow as You Go" Thinking Skills Model

Antoinette Worsham

Sometimes you know the story. Sometimes you make it up as you go along and have no idea how it will come out. Everything changes as it moves. That is what makes the movement which makes the story.

—Ernest Hemingway

Many of us have memories of school as a place where we sat, listened to the teacher, took notes, studied those notes, did our homework, took tests on the content presented, and then pressed on to the next chapter or unit, repeating the cycle. Seldom did we get to interact with the teacher unless we were among the brighter students who were called upon because our hands shot up first; and even less often, if ever, did we exchange ideas with other students.

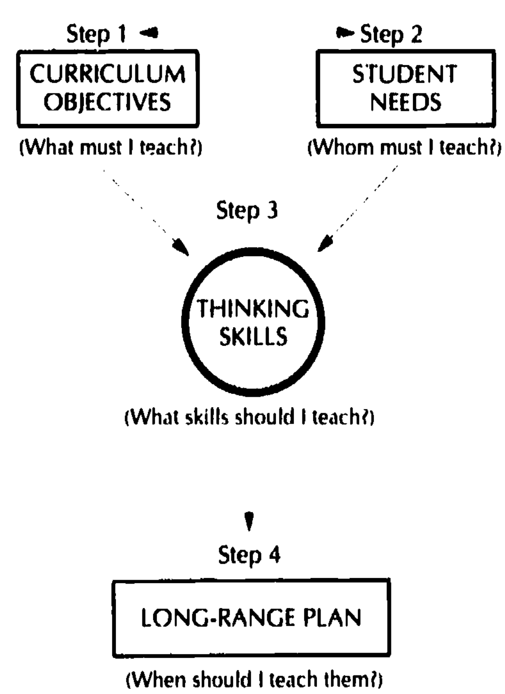
What is unfortunate about this "traditional" approach is that it allows little real student involvement beyond the factual recall level. Thinking is not only not encouraged, but frequently not allowed, because it slows down the lesson and puts the teacher behind schedule in covering the curriculum.

Teachers at Patapsco Middle School, Howard County, Maryland, have replaced the traditional approach with the student-centered Inclusion Process (Worsham and Stockton 1986), an explicit instruction model for teaching thinking. In this three-year pilot program, students are made responsible for their own learning, teachers facilitate rather than pontificate, and cooperative learning strategies replace individual competition.

This chapter originally appeared in *Educational Leadership* (April 1988) 45, 7: 56–57.

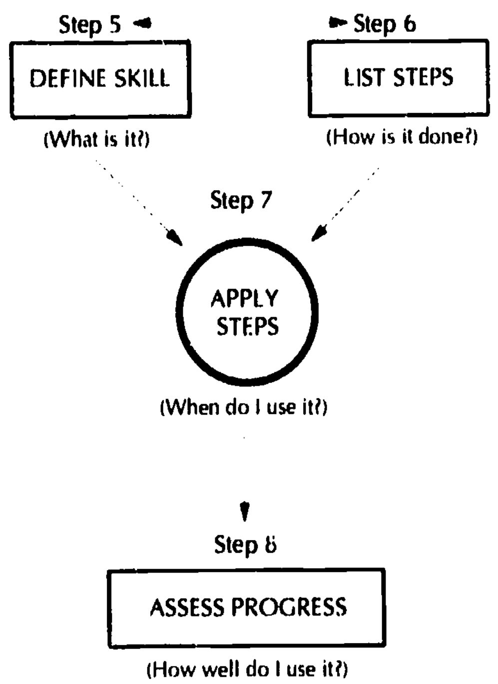
The model provides an eight-step framework that enables schools and school systems to incorporate selected thinking skills into their instructional programs. The framework is divided into two phases: planning (Figure 1) and implementation (Figure 2).

FIGURE 1
Phase One—PLANNING STEPS



ERIC

FIGURE 2
Phase 2—IMPLEMENTATION STEPS



The Patapsco story began in December 1984, when the Maryland State Department of Education awarded the school the first of its three grants to begin using the Inclusion Process to incorporate thinking skills into language arts, math, science, and social studies. That year the teacher training began at 6th grade level; during the following two years, it continued for 7th and 8th grade teachers. Now most of the other faculty members have been trained.

A series of focus lessons introduces students to the 12 thinking skills. During these lessons students generate definitions and, primarily through inductive reasoning, develop an understanding of how to apply these skills step by step in the content areas.

Students designate a section of their notebooks for "Thinking Skills," where they keep their definitions and steps. They quickly recognize that the thinking skills learned in one class are useful in learning the content in other classes as well.

Teachers structure classroom environments that enable students to ask the right questions, moving from simple comprehension of ideas to the more complex processes required to solve problems. Rather than giving information, the teachers have learned the value of this rule: "Don't tell what you can ask. Don't ask what the student should be asking."

Students find tasks less overwhelming when approached in pairs and small groups. They learn how to generate and arrange their ideas by using visual organizers and how to think before responding by using wait time and think–pair–share strategies (McTighe and Lyman 1988). They improve their thinking through conscious reflection (metacognition) and practice and discover that writing in logs helps them to make connections between and among their school subjects and their everyday experiences. One 8th grade student summed it up, "Thinking's hard work, and I usually feel great when I'm finished. But I guess I'm never really finished thinking, and that's good too."

The model has been implemented in six other Maryland counties and nine other states. It can be applied in many configurations (K–12) as a framework, allowing each school or school system to tailor the improvement of thinking to its own needs, and perhaps to start new kinds of memories of school. Since it is a process model, not a commercial program, the Inclusion Process is a true "grow as you go" approach.

REFERENCES

Worsham, A., and A. Stockton. (1986). *A Model for Teaching Thinking: The Inclusion Process.* Bloomington, Ind.: Phi Delta Kappa.

McTighe J., and F. T. Lyman, Jr. (1988). "Cueing Thinking in the Classroom: The Promise of Theory-Embedded Tools." *Educational Leadership* 45, 7: 18–25.

PART V

Thinking Pervades the Curriculum

The human mind takes pleasure in ALL understanding. . . While there are undeniable differences in the facility with which students take to different subjects, perhaps we write off too soon the young artist's capacity for enjoying physics and the young scientist's capacity for enjoying Latin. If we ever plumb the depths of the human learning process, I suspect we will find that at the bottom it is one experience; that a pleasure in philosophy or literature is closely related to a pleasure in chemistry or economics. We will perceive that Einstein's intellectual journey ending in $E = mc^2$ is related to Charles Darwin's curiosity about the variety of sparrows on a single South American island, and that both are related to Shakespeare's analysis of the paradoxical nature of lust in Sonnet 129. In each case we are dealing with the human striving to understand—and what each mind found out is perhaps less important than why each mind wanted to understand.

—Ole Sand, *On Staying Awake: Talks with Teachers* (Washington, D.C.: NEA, 1970).

Thinking is essential to learning—any kind of learning. To learn requires an engagement of and transformation of the mind. As students travel from teacher to teacher, thinking will be reinforced if patterns of thought are revisited in several content areas, if skills are transferred across subject lines, and if relationships are made between comparable problem-solving experiences encountered throughout the school day. To be successful, however, teachers will need more time to plan thematically, to meet together across departmental and grade-level boundaries, and to work in teams to monitor and assess the results of their transdisciplinary efforts. Finding ways to nurture, reinforce, and transfer intellectual skills throughout a thoughtful curriculum is as much a matter of teachers' planning abilities as one of finding similarities and overlaps among content areas.

I see the school staff as an orchestra. Each staff member is a talented professional: The 3rd grade teacher may be likened to an outstanding violinist, the high school history teacher to a master cellist, the middle school industrial arts teacher to a marvelous flutist, and so on. Each is an expert player.

In an orchestra, the musicians all play in the same key, and to the same tempo. They rehearse together and have a common vision of the entire score, each knowing well the part he or she plays in producing that overall vision. This does not mean that they all play the same notes at the same time; music is a blend of melody, harmony, rhythm, and dynamics that requires musicians to support one another in a coordinated, concerted group effort. In the same way, teachers can support one another in creating a curriculum. Although they do not teach the same thinking processes at the same time or approach teaching in exactly the same way, their cumulative efforts produce a beautiful, harmonious "music" in the mind and learning of each student.

The "conductors" of this work are the administrators. They have a broad purview of the curriculum, know how each part contributes to the overall effect to be achieved, can coach each member, and can work with a team to imprint a unique style on the interpretation of the score.

In this section, several commonly taught subjects and skills are examined to determine the thinking processes on which they are based and to show that process and content are interdependent and inseparable: to teach one without the other is meaningless indeed.

27

What's All the Fuss About Mathematical Problem Solving?

Alan H. Schoenfeld

In the 1939 movie version of *Alice in Wonderland*, W. C. Fields plays the role of Humpty Dumpty. Talking to him, Alice rapidly finds herself turned verbally upside-down. When she complains about the shifting sands of his word use, Fields says as only Fields can: "Words mean what I want 'em to mean, little girl—not a little bit more, not a little bit less."

Thus it is with *problem solving*. According to the National Council of Teachers of Mathematics (1980), problem solving is the "theme of the 1980s"—but ask seven educators to define problem solving for you, and you're likely to get at least nine different opinions. To prove the point, consider the following problems. Play with them for a few minutes before you read on. We'll use these problems to discuss some aspects of the problem solving movement, and to demonstrate how crucial problem solving is in mathematics and other disciplines.

1. An army bus holds 36 soldiers. If 1128 soldiers are being bussed to their training site, how many busses are needed?

2. Imagine you are talking to a student in your class on the telephone and want the student to draw some figures. [They might be part of a homework assignment, for example]. The other student cannot see the figures. Write a set of directions so that the other student can draw the figures exactly as shown in Figure 1.

3. Suppose a test for cancer is 98% accurate: 98% of the people who have the disease test positive, and 98% of the people who do not have the disease test negative. In addition, suppose that .5% of the population (1 person in every 200) has the disease. Someone you know has just tested positive. How likely is it that this person has the disease? Justify your answer as well as you can.

Before discussing the problems themselves, let's review trends in mathematics education, culminating in the 1980s. From early in this century through the 1950s, mathematics curricula were relatively stable—and boring. For the most part students memorized mathematical facts and procedures, and engaged little in understanding concepts or applying skills. Thus the Gestalt psychologist Wertheimer, in a classic complaint about the system, could decry "blind mechanical activity" and report conversations with children who said, "I can add, subtract, multiply, and divide with the best of them; the problem is, I never know which one to do."

All that changed on October 4, 1957. The Russians launched Sputnik, and the Americans launched the *new math* in response. The 1960s became a decade of abstraction, and teachers and parents alike felt quite ill at ease with the new approach in mathematics instruction. At the end of the sixties, the general perception was the new math had failed. Kids weren't learning the abstractions, and basic skills had been lost in the unsuccessful rush to teach things like number theory (in the guise of "clock arithmetic") to kids.

This chapter originally appeared in Alan H. Schoenfeld, "What's All the Fuss About Problem Solving?" *The Educator* 3, 3 (Fall 1989): 4–7. Graduate School of Education, University of California, Berkeley. Copyright © 1989 by Alan H. Schoenfeld.

The resulting backlash became the *back to basics* movement. The next decade of drill and practice on the basics substantiated the worst fears of the progressives. After it, not only were students incapable of doing problem solving (no surprise, since that hadn't been addressed in the curriculum), but the students who went through the drill and practice were actually worse at the basics than those who'd had the new math!

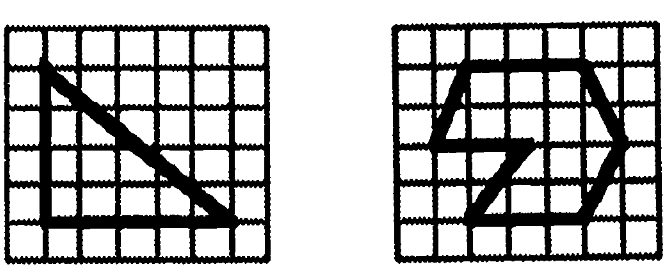
The pendulum then swung in the opposite direction. The National Council of Teachers of Mathematics declared problem solving to be the theme of the 1980s, and the bandwagon started rolling. Unfortunately, much of what has passed for problem solving during the 1980s—trick solutions to trick problems, or silly word problems—has been pretty superficial. Perhaps it has been slightly more valuable than drill and practice on number facts, but not much.

If it weren't for the current perception of a national crisis in mathematics education (see *Everybody Counts*), we might be at the beginning of the "back to back to basics" movement. The crisis has postponed the return swing of the pendulum, and extended our chance to make some sense of problem solving. Let's try to do so now, by returning to the problems illustrated earlier.

Problem 1 comes from the Third National Assessment of Educational Progress (Carpenter et al. 1983), a comprehensive nationwide survey of American students' mathematical performance. The data show that 70% of the students who took the exam did the computation correctly, finding that 36 goes into 1128 a total of 31 times, with 12 leftover. So, how many busses are needed? Here's what the students said:

- 29% said the number of busses needed is 31 remainder 12.
- 18% said the number of busses needed is 31.
- 23% correctly said the number of busses needed is 32.
- 30% did the computation incorrectly.

FIGURE 1



It's important to note that 70% of the students did the right computation. They'd learned their school arithmetic lessons much in the same way that Wertheimer described: blindly and by rote. When students report that busses have "remainders," it's clear they're not looking at the problems as real. They're seen as phony school math problems—cover stories for drill and practice—which students don't expect to make sense. They simply do the computation and write the answer down.

Imagine a situation where students were taking busses to a school outing. Would any student, if asked to call a bus company, request "31 remainder 12" busses? Of course not. And where did students learn such *non-sense*? Alas, in their math classes, through drill-and-practice in word problems. Although the aim of mathematics instruction is to help students to think, it's clear that as of 1983, we still have a long way to go.

Problem 2 comes from the 1987–88 California Assessment Program's statewide assessment of 12th graders' mathematical skills (California State Department of Education 1989). Surely you'd expect students to be able to explain how to draw simple geometric figures. Consider the figure on the left, for example. Here's a sample answer that, although wordy, works just fine:

> You're going to draw a right triangle on a sheet of graph paper. So, get a piece of graph paper. The right angle opens to the right. The triangle has a height of 4 units and a base of 5 units. So, start by drawing a horizontal line segment 5 units long. OK? Now, put your pen at the left-hand corner of the line segment you just drew, and draw a line segment that goes straight up—vertically—four units. That makes a 90-degree angle opening to the right, OK? Now join the endpoints of the two line segments, going from the top of the vertical line to the right end of the horizontal line. That will make a triangle whose hypotenuse slopes down to the right. If that looks right, we're done.

Here's a more concise version:

> You're going to draw a right triangle on a sheet of graph paper. So, get a piece of graph paper. The right angle opens to the right. The triangle has a height of 4 units and a base of 5 units. So, mark off a set of axes and plot three points A, B, and C at (0,0), (0,4), and (5,0) respectively. Draw the triangle ABC.

Note that this problem calls for more than merely understanding the terminology of the plane; it calls for being able to *communicate mathematically*, to express oneself using the language of mathematics. That's an important and seemingly simple skill. However, appearances can be deceiving: Less than 15% of the twelfth graders working on Problem 2 provided answers that adequately communicated the given information. Why, you ask? In part, because mathematics curricula haven't focused on communication skills. Students who haven't been asked to use mathematical terminology in writing and speaking don't develop these skills. And, in our increasingly mathematical and technological society, they're increasingly behind the technological eight ball.

Problem 3, borrowed from Paulos (1988), is a different type. Given the conditions of the problem (1 in 200 have the disease), a person who tests positive in a random sample of the population on a test that is 98% accurate only has about a 20% chance of actually having the disease!

The explanation is that there are a lot of false positives. Suppose, for example, that we take a random sample of 10,000 people from the population. Of these, 50 will have the disease and 9950 won't (assuming that 1 in 200 have it). Of the 50 who have the disease, 49 (that is, 98%) will test positive and 1 (2%) will test negative. But don't forget about the rest. Of the 9950 who don't have the disease, 9751 (98%) will test negative, but the remaining 199 (2%) will test positive. Consequently, 248 people (49 + 199) will test positive—and only 49 of them (roughly 20%) will actually have the disease. However, the vast majority of those who test positive don't have it.

Odds are you haven't seen this kind of calculation, but it's vitally important. It's an elementary application of statistical reasoning, quite accessible to high school students. And understanding this kind of reasoning is critical. After all, think about the implications of forced AIDS or drug testing—if the assumptions are the same as in this case, a test that is 98% accurate can yield 80% false positives!

If you examine these three examples, you'll see they have a common core. Simply put, they're all about the use of mathematics to make sense of things.

In the first problem, the proper use of mathematics is to symbolize the problem (represent the situation in the problem statement with mathematical symbols), do the mathematics (in this case a long division), and interpret the result in terms of the original situation. In a nutshell, that's what the use of mathematical symbolism is all about.

In the second problem, we see the need for mathematical communication. Math, like writing, has multiple virtues. It has aesthetic values, but also practical and communicative ones; and if you can't communicate with it, you're in trouble.

The third problem illustrates how mathematical thinking can help us make sense of complicated dilemmas in our lives. In this respect it departs significantly from the talk of "relevance," so prevalent during the sixties, when glib attempts were made to make math look "applied." The third problem demonstrates how thinking mathematically can be a way to perceive the world and make sense of it—a means of symbolic empowerment that helps us to perceive patterns and regularities, organize them mentally and symbolically, and come to grips with them.

That's what real mathematics is all about. (Readers with a taste for more might want to look at my book, *Mathematical Problem Solving* [1985], or Polya's *Mathematical Discovery* [1981]). Indeed, sense-making should be what schooling is all about. From art to literature to physics, what we should be learning are multiple ways of seeing the world, and the different disciplinary tools and perspectives that help us make sense of it.

Fortunately, things seem to be moving in that direction. At the national level a number of new reports stress the development of mathematical power, including *Everybody Counts*, The National Council of Teachers of Mathematics' *Standards* (1989), and *Reshaping School Mathematics* (National Research Council 1990).

California is a leader in this regard. The 1985 California Mathematics Framework (California State Department of Education) laid the philosophical foundations for this kind of approach. And the current Framework's group is fleshing out the details of curricula designed to help students think mathematically, in a sequel to be issued in 1992.

Given these developments, the prospects look brighter than at any other time in this century for meaningful problem solving instruction occurring in our schools. If we do our job right, schools will become places where students really learn to think.

References

California State Department of Education. (1985). *Mathematics Framework for California Public Schools Kindergarten Through Grade Twelve*. Sacramento, Calif.: State Department.

California State Department of Education. (1989). *A Question of Thinking*. Sacramento, Calif.: State Department.

Carpenter, T. P., M. M. Lindquist, W. Matthews, and E. A. Silver. (1983). "Results of the Third NAEP Mathematics Assessment: Secondary School." *Mathematics Teacher* 76, 9: 652–659.

National Council of Teachers of Mathematics. (1980). *Problem Solving in School Mathematics* (NCTM Yearbook). Reston, Va.: NCTM.

National Council of Teachers of Mathematics. (1989). *Curriculum and Evaluation Standards for School Mathematics*. Reston, Va.: NCTM.

National Research Council. (1989). *Everybody Counts: A Report to the Nation on the Future of Mathematics Education*. Washington, D.C.: National Academy Press.

National Research Council. (1990). *Reshaping School Mathematics*. Washington, D.C.: National Academy Press.

Paulos, J. A. (1988). *Innumeracy: Mathematical Illiteracy and Its Consequences*. New York: Hill and Wang.

Polya, G. (1981). *Mathematical Discovery*. New York: Wiley.

Schoenfeld, A. H. (1985). *Mathematical Problem Solving*. New York: Academic Press.

Wertheimer, M. (1949/59). *Productive Thinking*. New York: Harper and Row.

28

The Thinking/Writing Connection

Carol Booth Olson

If writing were words, writing would be easy. Writing is the stuff that happens in spite of words. There's no other way for writing to happen than with words, but at the same time it's got to happen in spite of them. The thing that gets you in writing is that story the words themselves don't tell but make you know.

—William Saroyan

In *High School*, a report on the state of secondary education in America, Carnegie Foundation President Ernest Boyer (1983) advocates teaching writing across the curriculum because "clear writing leads to clear thinking; clear thinking is the basis of clear writing." Perhaps more than "any other form of communication," he adds, "writing holds us responsible for our words and ultimately makes us more thoughtful human beings." In essence, Boyer's statement recognizes the thinking/writing connection—that depth and clarity of thinking enhance the quality of writing, while writing serves as a learning tool for heightening and refining thinking.

This renewed emphasis on writing as a reflection of thinking comes at a time when the reasoning skills of American school children appear to be on the decline. For example, *Reading, Thinking and Writing* (NAEP 1981), a report of a national reading and literature assessment of over 100,000 9-, 13-, and 17-year-olds cites as its "major and overriding" finding that although students at each age level had little difficulty making judgments about what they read, most lacked the problem-solving and critical thinking skills to explain and defend their judgments in writing. According to this report, the results of this assessment do not point to any cognitive inability on the part of students to respond analytically. Rather, because of the current emphasis in testing and instruction on multiple choice, true/false, and short-answer responses, students are simply unused to undertaking critical thinking tasks. Ongoing assessments of student achievement conducted by the National Assessment of Educational Progress continue to corroborate these findings. As Langer and Applebee (1987, p. 4) conclude in a recent research study, "Simply put, in the whole range of academic course work, American children do not write frequently enough and the reading and writing tasks they are given do not require them to think deeply enough."

What is important to note is that thinking and writing are interdependent processes—ways of making meaning out of experience. Both take practice. And that practice must be sustained. When contrasting the current emphasis on teaching to the proficiency test with the expectations of higher education, we have to wonder when, where, and how students will get the wide-ranging practice in thinking and writing that will enable them to tap the full range of their cognitive potential.

Taba (1967, p. 12) acknowledges the crucial role the teacher can play in providing students with the kind of practice that will facilitate cognitive growth when she concludes that "how people think may depend largely on the kinds of 'thinking experience' they have had." Writing is a complex and challenging thinking experience. In fact, researchers have observed that "writing is among the most complex of all human mental activities" (Flower and Hayes 1982, pp. 39–40). In order to produce a composition, writers must tap their memory to establish what they know, review the information they have generated and translate it into inner speech or print, organize main ideas, re-see the whole to find a focus, construct a structural framework for communicating an intended message, transform this network of thought into a written paper, and evaluate the product.

This description of the writing process mirrors the stages of the thinking process as portrayed in Bloom's Taxonomy of the Cognitive Domain—knowledge, comprehension, application, analysis, synthesis, evaluation. All of Bloom's levels of thinking recapitulate the writing process and vice versa (Figure 1).

Thinking and writing are recursive processes in which one often has to go backward to go forward. It is admittedly somewhat inappropriate, then, to describe that act of composing in a strictly linear fashion. However, whether evaluation should precede synthesis, whether one has to analyze in order to apply, or whether stages in the writing process can simultaneously tap two or more thinking levels does not alter the important point that composing involves all of the skills in the taxonomy.

Writing demands complex, cognitive activity whatever the order of levels of thinking because, while composing, writers must simultaneously entertain two main questions. The first is a content-oriented concern: What do I have to say? The second, a procedural concern that deals with transforming thought into print, focuses more on form and less on substance: How will I get my ideas into writing? Whether a student describes in rich sensory detail what it's like to eat an orange (a primarily comprehension-level task) or interprets and comments on the significance of the "Turtle Chapter" in The Grapes of Wrath (a predominantly analysis-level task), balancing the twin demands of the writing process taps all the levels of thinking.

Flower and Hayes (1980, p. 33) have likened the writer in the act of composing to a busy switchboard operator, juggling constraints and working on cognitive overload. Because students must grapple with such constraints as the limited knowledge they have to construct and express meaning, the imprecision of the language they possess to communicate what they know, the challenge of assessing their audiences and purposes for writing, and the demands of the contexts in which writing occurs (Frederiksen and Dominic 1981, pp. 39–40), it is not enough to simply assign writing tasks and anticipate spontaneous improvement in thinking. Practice in writing alone will not necessarily lead to enhanced thinking and writing skills. To facilitate the growth of problem-solving ability, teachers must carefully structure lessons that gradually increase the intellectual complexity and provide guided practice that makes the what in a paper more accessible to students and also allows them to focus more on the how of composing.

Virginia Bergquist, a teacher and consultant with the University of California, Irvine, Thinking/Writing Project, carefully crafted the lesson seen boxed here (along with annotations).[1] The lesson is organized according to the stage process model of composition—prewriting, precomposing, writing, sharing, revising, editing, and evaluating—and moves students through all of the levels of thinking, from knowledge through evaluation.

Writing Domain: Analytical/Expository

Thinking Level: Evaluation Grade Level: Elementary (4-6)

PERSUASIVE LETTERS

Lesson:
Predicting possible reactions and meeting them with logical arguments, students will write a letter designed to persuade a specific audience to do something.

Objectives:
Thinking Skills—Students will function at the EVALUATION level by PREDICTING AND PERSUADING

Writing Skills—Students will be expected to write a persuasive letter that contains a well-supported argument directed toward a particular audience.

Although the lesson described here was designed for students in grades 4–6, it has been used successfully with a wide range of students, including adults, to guide the evaluation skills of predicting and persuading.

Prewriting

1. As a class, ask students to brainstorm *who* they have tried to persuade in the past, *what* they have tried to persuade them to do, *how* they tried to persuade them, and *what* the *results* were on the following chart:

What	Who	How	Results
Take me to the movies.	Big brother	Begged	Was mad but took me anyway,
Let me take skating lessons.	Mom	Panted and whined	Said, "No."
Stay all night.	Friend	Asked politely	Stayed
Buy me a bike.	Parents	Cried	Didn't buy it

2. Ask students to describe and explain orally their situations (*what, who*) to the class. Discuss the *how* and *results* columns.

3. Ask the class if anyone has ever tried writing a persuasive letter. If nobody has, suggest it and explain that letter writing can be a very effective tool for persuasion.

Prewriting activities generate ideas for writing. In any of its wide range of forms-class discussion, brainstorming, visualizing, free writing, and so on—prewriting aims to stimulate the free flow of thought. In this lesson, Bergquist asks students to share experiences in which they tried to persuade someone to do something, to allow something, or to give something. This activity stimulates students interest, elicits a wealth of examples, and sets the stage for introducing the prompt; that is, the writing assignment.

The Prompt

Choose one thing that you would like to persuade someone to do. Write a letter to persuade your chosen audience. Your letter should show that you have:

- Clearly stated what you want and why.
- Used a tone suited to your audience.
- Predicted two possible objections your audience might have.
- Shown logically that those objections have been considered and resolved.
- Followed the standard letter form of greeting, body, and closing.

Notice that the lesson now moves from past to present as students are asked to think of something they would like to persuade someone of now. Perry noted that one sign of cognitive growth is the ability to move from the stage of Basic Duality, where the world is perceived in absolutes, to the stage of Multiplicity, in which the individual recognizes there is more than one approach to or perspective on a problem (Perry 1970). In our sample lesson, the teacher encourages this transition in young children by asking them to anticipate the objections of their audience, presumably a parent, other trusted adult, teacher, or friend.

Precomposing

Focusing

4. Students may work in pairs, in groups, or individually. Ask students to choose one thing they would like to persuade someone to do (who, what) and enter the information in the first two columns of this chart:

Who	What	Possible Objections	Possible Arguments
Mom	Let me take three friends to Farrell's for my birthday.	1. 2. 3.	1. 2. 3.

Predicting objections of audience and experimenting with tone:

Oral Persuasion

5. Introduce the concept of tone by presenting students with this situation: Suppose you were certain that you had put your favorite record album in a special spot in your bedroom, and it's not there. After searching your room thoroughly and feeling frustrated, you must set out to question the following people about whether they've moved, misplaced, or taken your record:

- The housekeeper
- Your mom
- Your younger brother or sister
- A neighborhood friend who is always "borrowing" things without asking.

a. What words and tone of voice would you use to inquire about the whereabouts of your record with each specific audience?
b. How would your language and tone differ depending on your relationship with each person?

6. Explain to students that tone is used in writing as well as speaking. The tones one might verbally use can also be conveyed in writing, depending on nuances of chosen words.

7. Ask two students to role play the situation they chose during the Focusing Stage (see Step 4) in front of the class. Ask the students to identify which person is the *audience* and which person is the *persuader*. Before the role play begins, brainstorm characteristics of the *audience* that might influence their reactions. (For example, if a student wanted to persuade his mom to let him buy a boogie board, it would help the partner who is playing the role of his mom to anticipate her objections if she knew that Mom had earlier refused to let her son buy a skateboard because she was afraid he might fall and hurt himself.) *Persuaders* can experiment with different tones in attempting to persuade the chosen *audience*. Discuss which tones the *persuader* used that were most effective, and why.

8. Students should enter the possible reactions of audiences and possible arguments of the persuader on the chart:

Who	What	Possible Objections	Possible Arguments
Mom	Let me take three friends to Farrell's for my birthday.	1. It's too expensive. 2. 3.	1. I'll help pay with my allowance. 2. 3.

Transition from Oral Persuasion to Written Persuasion:

9. Help students make the transition from oral role play to written expression by conducting the following activity:

a. On a lined sheet of paper, the persuader should request the audience to do something. Example: "Mom, will you let me take three friends to Farrell's for my birthday?"
b. The audience should read the question silently, write a response according to his or her first possible reaction, and return it to the persuader. Example: "No, Farrell's is too expensive."
c. The paper is passed back and forth in this manner until the audience is convinced or the persuader gives up.
d. The persuader should then read over the dialogue and enter on another chart new possible reactions and possible arguments.
e. Have the students switch roles and do the exercise again so that both students' charts are complete.

Who	What	Possible Objections	Possible Arguments
Mom	Let me take three friends to Farrell's for my birthday.	1. It's too expensive. 2. I don't know where Farrell's is.	1. I'll help pay with my allowance. 2. There's a Farrell's only two blocks from school.

(Continued)

10. Review the prompt and proper letter format with the class. Discuss possible opening statements they could use in their letters. (It is helpful to list them on the chalkboard.) Sample letter format:

(date)

Greeting: *Dear Mary,*

Body: *It is really important to me that . . . .*

Closing paragraph: *So, you see, this is why . . . .*

Closing: *Sincerely,*

(Signature)

11. Read a model to the class emphasizing the structure followed. Students may use their own structure but should include:

- What is wanted
- Reasons for wanting it
- Two possible objections
- Reasons to overcome the objections
- Closing summary

The following is a sample of the model.

(date)

Dear Mom,

This year I would like to have my birthday party at Farrell's with three of my best friends. I've always wanted to go there because they sing "Happy Birthday" and play the big drum if you tell them it's your birthday.

I know you probably will think that it will be too expensive, but it really won't be because I will pay for my friends' ice cream with my allowance. You won't need to give me any extra money because my ice cream will be free just because it's my birthday. That's why everyone likes to go to Farrell's on their birthday.

You might not know where there is a Farrell's and be worried about driving with kids in the car. Guess what? There is a Farrell's just two blocks from school. We could walk and meet you there.

I hope you will think about my idea and say "Yes." The only thing I really want for my birthday is to have a party at Farrell's. Please let me know what you decide.

Love,

Molly

Helping students generate ideas for writing is often not enough to enable them to organize and articulate their thoughts. **Precomposing** activities help students focus on the specific requirements of the prompt as well as formulate a writing plan. Since Bergquist's lesson calls for sophisticated critical thinking on the part of young students, it includes a very extensive precomposing stage to prepare them for writing. Students work in pairs and role play, first orally and then in writing, to generate a list of the possible objections they may encounter and to formulate reasons to overcome those anticipated objections.

Writing

12. Students write their letters referring to their lists of possible reactions of audience and possible arguments of persuader.

Writing is the stage in which thought is transformed into print. But more than that, it is an act of discovery. Often it is only when we write about what we think (and vice versa) that we grasp what it is that we truly want to communicate. Precomposing activities should facilitate and not inhibit the growth of thought that occurs in writing. The goal of the first draft should be fluency rather than refinement of ideas or expression.

In order for students to perceive writing as genuine communication and not just a chore to accommodate the teacher, opportunities must be provided for sharing writing—for giving and receiving feedback on work in progress. **Sharing** enables students to discover how their words affect other readers. **Responding** assists them in internalizing the criteria for good writing.

Sharing

13. Students share letters and help each other decide whether or not the letter will persuade the intended audience. Partners should underline the objections of the audience in red and arguments to overcome objections in green. Partners should also discuss whether or not the tone is appropriate for the audience. *Optional:* Partners may indicate a preliminary primary trait score (see Evaluation section).

Revising

14. Based on the feedback received, students should revise letters to make them more persuasive. They should consider the following questions:

- Is what I want clearly stated?
- Have I stated the reasons why I want it?
- Do the words I chose create the right tone for my audience?
- Did I include two possible objections?
- Are my arguments against those objections persuasive?
- Is my closing paragraph effective?

Editing

15. Students may edit their own letters or exchange them with a friend. The secondary trait scoring guide should be used as a reference (see Evaluation section).

Evaluation

16. *Primary Trait Scoring Guide:*

3 This letter clearly states what is wanted and why, anticipates objections and meets them with logical arguments. It probably would persuade your audience because the arguments are presented in a tone suited to them.

2 This letter presents persuasive arguments but does not anticipate the possible reactions of your audience. It might persuade them, but then again it might not.

1 This letter would probably not persuade your audience since it is not presented in a tone suited to your audience and does not anticipate possible reactions or meet them with specific arguments.

17. *Secondary Trait Scoring Guide*

2 This letter follows proper letter format, is neat and easy to read, and has no errors in spelling, mechanics, or usage. A letter like this is a pleasure to receive. Your audience will be impressed with your writing skills.

1 This letter follows most of proper letter format but is not as neat and easy to read. It has a few errors in spelling, mechanics, or usage. If your primary trait score is high, your audience still *might* be persuaded.

0 This letter is not neat or easy to read. It has many errors in spelling, mechanics, or usage. Even if your primary trait score is high, your audience probably would not do what you want them to since they might not be able to read it.

For many writers, **editing** occurs automatically as they compose. For those writers, editing is simply proofreading for minor errors in grammar, punctuation, spelling, and so forth. For students who have not acquired (or young writers who are still acquiring) the conventions of written English, it requires more conscious attention to correctness.

Although any revision is an act of self-evaluation, the **evaluation** stage of the composing process involves assessment of the final written product. Whether this rating comes in the form of the letter grade, holistic score, or analytic comment, the criteria on which the paper is to be judged should be clearly delineated and communicated early in the writing process. Primary and secondary trait scoring guides allow the teacher to rank clarity and logic over details of format and correctness.

As mentioned previously, students need to see writing as a mode of genuine communication rather than as something artificially imposed. Positive perceptions of writing as a useful, personal tool are fostered by a postwriting activity like publishing the writing in some form or, in this case, delivering the final product to the person for whom it is intended.

Finally, working from the premise that there is a developmental sequence in the growth of thought—that this sequence progresses from concrete to abstract levels, and that "the mental structures developed at a preceding stage are," as Taba (1967, p. 12) says, "prerequisite to success in a subsequent one and are incorporated into it"—the teacher can use the Persuasive Letters lesson as a stepping stone to two other writing assignments that will provide additional practice in higher-level thinking and writing skills.

Extension Activities

Application

Deliver the final letter to the audience it was intended for. Ask your audience to write back and tell you if your arguments were persuasive.

SUBSEQUENT EXTENSION ACTIVITIES

Analysis

Prompt: After reading Mark Twain's *Tom Sawyer*, explain how Tom persuaded his friends to whitewash the fence for him. How would you characterize the tone he used with his friends? Why do you think his approach to persuasion was effective?

Evaluation

Prompt: Choose a real audience at home or at school and try to convince them of something by writing a letter or composing a speech. You might try convincing:

- The teacher to give the class an extra recess.
- The principal to allow the class to raise money for a special field trip.
- The custodian to take you as a morning helper.
- Other classes to write letters and send art to homebound children or a children's hospital.
- Another school to exchange letters and art with your class.
- A community club to sponsor an activity at your school.
- Students at your school to write letters about endangered species legislation to members of Congress.
- Students at your school to write letters stating a position on the nuclear arms race to members of Congress.

Regardless of whether one uses the stage process model of composition described in the Persuasive Letters lesson or another technique for facilitating written expression, the important point is that writing can and should be used as a learning tool across the curriculum for expanding and refining thinking. The most successful teachers of writing will think critically about critical thinking before designing curriculums. Writing develops thinking, after all, not so much from having students perfect any single written product or reaching the top of a critical thinking hierarchy as much as from providing enough guided practice to cause students to internalize a workable problem-solving process.

NOTE

[1]This lesson appears in *Thinking/Writing: Fostering Critical Thinking Through Writing*, edited by Carol Booth Olson (Fund for the Improvement of Postsecondary Education, 1985). It was written by Virginia Bergquist, a teacher at Meadowpark Elementary in Irvine Unified School District and teacher/consultant from the University of California, Irvine, Thinking/Writing Project.

REFERENCES

Boyer, E. L. (1983). High School: A Report on Secondary Education *in America*. New York: Harper and Row.

Flower, L. and J. R. Hayes. (1980). "The Dynamics of Composing." In *Cognitive Processes in Writing*, edited by L. W. Gregg and E. R. Steinberg. Hillsdale, N.J.: Lawrence Erlbaum.

Flower, L. and J. R. Hayes. (1982). "Plans that Guide the Composing Process." In *Writing: The Nature, Development and Teaching of Writing Communication*, vol. 2, edited by C. H. Frederiksen and J. F. Dominic. Hillsdale, N.J.: Lawrence Erlbaum.

Frederiksen, C. H. and J. F. Dominic, eds. (1981). "Introduction: Perspectives on the Activity of Writing." In *Writing: The Nature, Development, and Teaching of Written Communication.* Hillsdale, N.J.: Lawrence Erlbaum.

Langer, J. A., and A. N. Applebee. (1987). *How Writing Shapes Thinking*. NCTE Research Report No. 212. Urbana, Ill.: National Council of Teachers of English.

National Assessment of Educational Progress (NAEP). (1981). *Reading, Thinking, and Writing*. Report No. 11-L-01. Washington, D.C.: NAEP.

Perry, W. (1970). *Forms of Intellectual and Ethical Development in the College Years*. New York: Holt, Rinehart and Winston.

Taba, H. (1967). *Thinking in Elementary School Children*. Cooperative Research Project No. 1574. Washington, D.C.: U.S. Department of Health, Education, and Welfare.

29

Reading and Thinking

Beau Fly Jones

Knowledge is the most powerful problem-solving tool there is. If I want to solve problems in mathematics I've got to have mathematical concepts. But there's a difference between teaching knowledge as a tool that facilitates problem solving and teaching it simply as a thing to be memorized.

—John Bransford

The definition of reading that arises from schema theory argues that meaning is not contained in the text (Rumelhart 1980; Spiro 1980). It is not enough for the reader merely to decode words in order to determine their meaning. Rather, reading involves an interaction of the reader, the information suggested in the text, and the characteristics of the context. The goal of reading, in this view, is to construct meaning from text.

This definition of reading raises two key questions: (1) What are the key characteristics of the reader, the text, and the context that affect comprehension? and (2) How do students process text-based instruction?

This chapter is a summary of a paper presented at the annual meeting of the American Educational Research Association, Chicago, April 1985. For further elaboration, see Jones 1985 and Jones, Friedman, Tinzmann, and Cox 1984.

The original research was conducted for the U.S. Army Research Institute, Contract No. MDA-903-82-069. The opinions and findings contained herein are those of the author and should not be construed as those of the Department of the Army or the North Central Regional Educational Laboratory.

Characteristics of the Reader, the Text, and the Context

First, the reader's prior knowledge is critical and includes knowledge of content as well as learning strategies. Clearly, the greater the reader's knowledge of content and repertoire of reading and learning strategies, the greater the comprehension. Second, the reader's ability to control his or her own learning contributes significantly to the ability to comprehend. This ability, called metacognition (Armbruster and Brown 1984), includes the ability to plan, monitor comprehension, and evaluate what is learned. There is strong evidence that direct instruction in the use of metacognitive strategies can markedly improve comprehension (Paris, Cross, and Lipson in press). There also appear to be individual differences in the ability to access prior knowledge and mediate one's own comprehension (Spiro 1980).

Extensive research, conducted largely at The Center for the Study of Reading at the University of Illinois at Urbana, has shown that existing commercial materials often hinder comprehension because they lack appropriate connectives, pronoun references, and highlighting and signaling devices that help students understand the text (Anderson and Armbruster 1984; Davison 1984; Osborn, Jones, and Stein 1985). Other comprehension problems arise from poor text design (Duchastel 1982, Hartley 1982).

Anderson and Armbruster have distinguished "considerate" from "inconsiderate" texts. The latter hinder or prevent comprehension because they are poorly written and are therefore inconsiderate to the reader. Considerate texts include various features that are intended to help readers learn. Four characteristics of considerate texts are structure—text structures that are well-organized and clearly signaled through the text; cohesiveness—the flow of ideas that is guided by text markers, connectives, and pronouns that help identify the text structure and the flow or arrangement of

163

ideas; unity—the absence of irrelevant information and remarks; and age appropriateness.

Research on text design emphasizes additional features to help the reader learn:

• Before reading—Reviews, previews, advance organizers, graphics, titles, subtitles, and paragraph headings emphasize the macro-structure or overall organizational pattern.

• During reading—Underlining, boldfacing, italics, boxes, and marginal notes identify and emphasize important information from segments of the text.

• After reading—Summaries and graphic organizers help students select important information and integrate information from diverse segments of text.

In schema-theory literature, context is traditionally defined in terms of the nature of the task and purpose for reading. Undoubtedly, these are powerful variables that influence reading rate, reading and study strategies, planning, and so on. Other context variables discussed at length in research literature are the amount of knowledge about the text and the task. Specifically, information given about the task and setting of the story or message, the author's purpose, ancillary text features, and the reader's cultural background all influence his or her interpretation of the text.

More powerful than these variables, however, is the role of the teacher. According to the Commission on Reading (1985), the effects of the teacher are far more significant than the effects of instructional materials, curriculum alignment, and other variables. Specifically, the teacher is important as a manager of instruction, with the ability to make effective decisions about content, pacing, grouping, and use of time (Berliner 1984). Equally important, the teacher is a mediator of learning, providing instruction that is explicit, sustained, and interactive, guiding the students to construct meaning from text.

The Process: Comprehending and Responding to Text

The reader engages in different activities before, during, and after reading (Collins, Brown, and Larkin 1980; Tierney 1983). And in responding to essay questions about the text, the student progresses through various phases of planning, drafting, editing, and revising (Graves 1978).

Before reading, a reader may use any of a variety of strategies to link new information to prior knowledge and to predict the gist of what the text will contain. These strategies include mentally reviewing previously acquired information; skimming the title, headings, subheadings, questions, and graphics; making hypotheses or predictions about the text's content or structure; self-questioning; prelearning new vocabulary; and so on. All of these strategies activate existing schemata or knowledge structures. Further, the reader determines the purpose of reading (for pleasure or for information) to plan the appropriate rate of reading and strategy (note taking, for example).

During reading, the reader begins to refine earlier predictions and hypotheses, noting what is important and unimportant, what is clear and unclear, and possibly what analogies are relevant to the content. Depending on the purpose, the reader may use any of several strategies to encode and recall what is read: generative underlining (Rickards and August 1975), inferring the main idea (Pearson and Leyes in press; Wittrock 1984), elaborating the text (Weinstein and Mayer in press), forming analogies (Alexander and White 1984; Sternberg 1977), answering questions associated with the text (Brown and Palincsar 1982), and so on. The reader may also engage in a number of innovative note-taking activities, such as matrix outlining (Jones, Amiran, and Katims 1985) and fix-up strategies when the text is unclear (Anderson 1980).

In this stage, readers also evaluate word meanings. Is a given word important? Can it be defined in the immediate context? In the distant context? Is it important enough to disrupt reading and look up in a dictionary? For words whose meaning is given, the reader may use various strategies to link the new word to prior knowledge, such as identifying a synonym or visualizing.

After-reading activities, like those during reading, depend on the purpose for reading. If the information is not to be processed in depth, memorized, or assessed for comprehension and retention, there may be few after-reading activities. If it is to be learned, however, the reader may engage in a number of activities to study what was read or monitor his own comprehension. Here the reader might outline or summarize the text, look back to check for mislearning, or reread what was unclear (Winograd 1984).

Responses to essay questions are often part of the reading/thinking process. The teacher assigns essay questions to assess what the student has learned and to facilitate comprehension and writing skills. Throughout the country, the emphasis in writing instruction is largely process oriented (Applebee 1981). While I fully support this emphasis in the context of language arts courses, other considerations pertain to the context of content courses. It is important to distinguish learning to write from writing to learn, which is obviously analogous to the distinction between learning to read and eading to learnreading to learn (Herber 1978). In learning to write, the focus of instruction should be process oriented. However, it is important to be product oriented when writing to learn if the student is expected to complete essay questions containing specific information and text

FIGURE 1

The Interaction of the Teacher, the Reader, and the Text

Stage I. Before Reading—Readiness Processing

Teacher Behaviors

1. Explains objectives (such as reading to learn) and identifies text to be read
2. May preteach or mention critical vocabulary
3. Asks students to skim title, subtitles, graphics, and questions, and to respond by making predictions/hypotheses
4. May generate questions to focus the students' attention
5. May provide or elicit extended review of previously acquired information
6. May provide advance organizers (such as outlines, graphics, previews, summaries)
7. Stimulates readers to generate the questions they want the selection to answer
8. May suggest or explain specific reading/learning strategy

Reader Behaviors

1. Mentally reviews prior knowledge of author, topic, and skills; considers reading rate
2. Becomes aware of new vocabulary and word meanings
3. Makes predictions/hypotheses about
   a. content and text structure
   b. type of responses indicated by the questions (such as compare/contrast, details)
4. Relates frame questions to titles, subtitles, graphics, and so on
5. May take notes
6. Begins to construct ideas about the text content and its relation to prior knowledge
7. Asks own questions
8. Recalls prior knowledge of reading/learning strategy

Learner Outcomes

1. Establishes purpose(s) of reading
2. Estimates rate of reading
3. Activates existing knowledge structures
4. Forms some rudimentary ideas about meaning

Stage II. During Reading—On-Line Processing

Text Characteristics

Context Text

1. Considerate/inconsiderate text
   a. structure
   b. cohesiveness
   c. unity
   d. age appropriateness
2. Vocabulary
3. Text condition
   a. explicit/literal
   b. implicit/inferential
   c. inadequate
4. Graphics
5. Questions

Instructional Text

1. Horizontal and vertical sequencing
2. Examples/models/explanations
3. Different modes of presentation
4. Guided and independent practice
5. Reviews/tests
6. Correctives/enrichment

Reader Behaviors

1. Decodes words; may visualize meaning
2. Pays special attention to new vocabulary words
3. Seeks to define unfamiliar words in context or with a dictionary
4. Begins to confirm or reject predictions and hypotheses
5. Searches for links to prior knowledge
   a. synonyms for new vocabulary
   b. analogies
6. Elaborates text by self-questioning and explanation, visualizing, taking a particular perspective, and so on
7. Searches for information to answer questions
8. May underline or take notes in prose or graphic form
9. Monitors comprehension; notes gaps and contradictions
10. Seeks to distinguish important from unimportant information

Learner Outcomes

1. Engages in reading and thinking
2. Generates surface-level understanding
3. Becomes aware of gaps in knowledge, possible errors
4. Refines hypotheses regarding content and responses to questions

Stage III. After Reading—In-Depth Processing

Teacher Behaviors

1. Discusses word meanings
2. Evaluates predictions/hypotheses made before reading
3. Monitors comprehension
   a. fills in gaps; corrects notes
   b. clarifies confusions
4. Guides students to construct
   a. graphic outlines
   b. graphic organizers
   c. explanations
5. Discusses author's purpose/different perspectives
6. Explains applications of comprehension strategy
7. Focuses on higher-order questioning strategies

Reader Behaviors

1. Links new word meanings to prior knowledge
2. Confirms/rejects earlier predictions/hypotheses
3. Evaluates comprehension; identifies important information; may engage in review or other fix-up strategies
4. Organizes notes, diagrams, and so on
   a. categorizes
   b. labels
   c. restructures
5. Analyzes author's purpose/perspective
6. Thinks about appropriate strategy
7. Engages in inferring, application, analysis, reasoning; tries to defend answers

Learner Outcomes

1. Constructs in-depth, organized meaning
2. Increases knowledge of concepts and facts
3. Gains knowledge of author's purpose, text structure, and content (idea) structure
4. Increases awareness of comprehension strategy taught and the process of comprehension monitoring

Stage IV. After Reading—Response Processing

Teacher Behaviors

1. Guides students to summarize passage and answer questions using notes, graphics, and so on
2. Discusses essay purpose and text structure (such as compare/contrast)
3. Guides students to organize notes for response to essay question(s)
4. Establishes criteria for prewriting, drafting, revisions, and editing; provides model response
5. Monitors writing process for class
6. Holds conferences with students
7. Reads/publishes selected essays

Reader Behaviors

1. Summarizes content orally or in writing; generates overviews
2. Plans text structure for essay; reviews appropriate text markers
3. Converts notes into outline for longer questions requiring a paragraph or essay; generates analogies, examples, and so on
4. Discusses notes, criteria; engages in self-questioning regarding audience, focus, point of view
5. Engages in prewriting, drafting, revising, and editing
6. Discusses ideas with teacher and other students
7. Reads other students' essays

Learner Outcomes

1. Increased in-depth processing
2. Increased comprehension of content
3. Increased retention
4. Increased knowledge of text structures and frames
5. Increased awareness of writing process and applications
6. Increased control over writing process

Copyright 1984 by Beau Fly Jones

structures in literature and other content courses.

Observations of instruction in some of the most outstanding public and private schools in the country clearly show that good teachers provide what I term *response instruction* (Jones 1985). Such teachers have very specific content and text structure objectives in mind when they give essay assignments (e.g., compare/contrast two characters or situations in a novel). Moreover, teachers communicate these ideas to students in various ways: through course objectives, handouts, verbal explanations, modeling, comments on exam questions, and so on. I have seen such teachers provide explicit essay-writing instructions before testing. These efforts are to be commended, because writing objectives are often a hidden agenda in content courses as well as in language arts courses.

A Model of Instruction

If comprehension is a process that involves different activities at different stages of reading—before, during, and after reading, and in responding to questions—then instruction should assist the reader at each of these stages (Anderson 1980). Specifically, instruction, provided in materials or by the teacher, should help the reader construct meaning from text and should teach the reader to become an independent learner at each stage of the learning process. In many instances, instruction should teach readers a repertoire of reading and encoding strategies to use before and during reading, as well as in-depth study or learning strategies and writing skills they can use after reading. Additionally, instruction should provide students opportunities to learn which strategy is most appropriate for a given task or text condition, and it should give the criteria by which they will be judged and can judge themselves.

Figure 1 is a model of the interaction of the reader, the text, and the teacher at each stage of student cognitive processing. It provides an in-depth look at this interaction and identifies specific behaviors related to the role of the teacher as mediator.

Conclusions

The model of student cognitive processing I have presented incorporates research in reading, thinking, teaching, and instructional materials. It has led to three conclusions:

First, the teacher is critical in helping students process information from texts—whether the texts are for literature, content subjects, math, or problem solving; whether they are in print or electronic media; and whether they are verbal or graphic. Given the importance of text-based instruction in all course areas and at all grade levels, it would be useful for researchers and practitioners alike to use the interaction model to document precisely what teachers do and say that helps students construct meaning from the various texts they read (Duffy 1985).

Second, reading to learn—the act of constructing meaning from text—is fundamentally higher-order thinking at every stage of comprehending and responding to text. Therefore, it is as critical to define thinking skills with reference to research on reading and instructional materials as it is to define reading comprehension with reference to research on depth of processing and higher-order thinking. I hope the proposed model will facilitate this integration of ideas and data among researchers and practitioners.

Third, it is simply impossible to understand fully the teaching process of the model of instruction in any course without first understanding the characteristics of the textual materials and the interaction of the teacher, the reader, and the text. Given the preponderance of text-based instruction, this conclusion has implications for instructional design and research on teaching in all subject areas, including those in higher-order thinking.

References

Alexander, P. A., and C. S. White. (1984). "Effects of a Componential Approach to Analogy Training on Fourth Graders' Performance of Analogy and Comprehension Tasks: An Exploratory Investigation." College Station, Texas: Texas A & M University.

Anderson, T. H. (1980). "Study Strategies and Adjunct Aids." In *Theoretical Issues in Reading Comprehension*, edited by R. J. Spiro, B. C. Bruce, and W. F. Brewer. Hillsdale, N. J.: Lawrence Erlbaum.

Anderson, T. H., and B. B. Armbruster (1984). "Content Area Textbooks." In *Learning to Read in American Schools: Basal Readers and Content Texts*, edited by R. C. Anderson, J. Osborn, and R. J. Tierney. Hillsdale, N.J.: Lawrence Erlbaum.

Applebee, A. N. (1981). *Writing in the Secondary Schools: English and the Content Areas*. NCTE Research Report No. 21. Urbana, Ill.: National Council of Teachers of English.

Armbruster, B. B., and A. L. Brown (1984). "Learning from Reading: The Role of Metacognition." In *Learning to Read in American Schools: Basal Readers and Content Texts*, edited by R. C. Anderson, J. Osborn, and R. J. Tierney. Hillsdale, N.J.: Lawrence Erlbaum.

Berliner, D. C. (1984). "The Half-Full Glass: A Review of Research in Teaching." In *Using What We Know About Teaching*, edited by P. L. Hosford. Alexandria, Va.: Association for Supervision and Curriculum Development.

Brown, A. L. and A. S. Palincsar. (1982). *Inducing Strategic Learning from Texts by Means of Informed Self-Control Training*. (Technical Report No. 262). Urbana, Ill.: University of Illinois, Center for the Study of Reading.

Collins, A., J. S. Brown, and K. M. Larkin (1980). "Inference in Text Understanding." In *Theoretical Issues in Reading Comprehen-*

sion, edited by R. J. Spiro, B. C. Bruce, and W. F. Brewer. Hillsdale, N.J.: Lawrence Erlbaum.

Commission on Reading. (1985). *Becoming a Nation of Readers.* Springfield, Ill.: Phillips Bros.

Davison A. (1984). "Readability—Appraising Text Difficulty." In *Learning to Read in American Schools: Basal Readers and Content Texts*, edited by R. C. Anderson, J. Osborn, and R. J. Tierney. Hillsdale, N.J.: Lawrence Erlbaum.

Duchastel, P. C. (1982). "Textual Display Techniques." In *Principles for Structuring, Designing, and Displaying Text.* Englewood Cliffs, N.J.: Educational Technology Publications.

Hartley, J. (1982). "Designing Instructional Text." In *The Technology of Tests.* Englewood Cliffs, N.J.: Educational Technology Publications.

Herber, H. L. (1978). *Reading in the Content Areas.* (Text for Teachers). Englewood Cliffs, N.J.: Prentice-Hall.

Jones, B. F. (April 1985). "Student Cognitive Processing of Text-Based Instruction: An Interaction of the Reader, the Text, and the Context." Paper presented at the annual meeting of the American Educational Research Association, Chicago.

Jones, B. F., M. R. Amiran, and M. Katims. (1985). "Teaching Cognitive Strategies and Text Structures." In *Thinking and Learning Skills: Relating Instruction to Research. Vol. 1*, edited by J. Segal, S. F. Chipman, and R. Glaser. Hillsdale, N.J.: Lawrence Erlbaum.

Jones, B. F., L. B. Friedman, M. Tinzman, and B. E. Cox. (1984). *Content-Driven Comprehension Instruction: A Model for Army Training Literature.* Technical Report. Alexandria, Va.: Army Research Institute.

Osborn, J., B. F. Jones, and M. Stein (April 1985). "The Case for Improving Textbooks." *Educational Leadership* 42, 7: 9–16.

Paris, S. G., D. R. Cross, and M. Y. Lipson. (December 1984)." Informed Strategies for Learning: A Program to Improve Children's Reading Awareness and Comprehension." *Journal of Educational Psychology* 76, 6: 1239–1252.

Pearson, P. D., and M. Leyes. (1985). "Application of an Explicit Skills Model in Developing Comprehension Instruction." In *Reading, Thinking, and Concept Development: Strategies for the Classroom*, edited by E. J. Cooper and T. L. Harris. New York: The College Board.

Rickards, J. P., and G. J. August. (1975). "Generative Underlining Strategies in Prose Recall." *Journal of Educational Psychology* 67: 860–865.

Rumelhart, D. E. (1980). "Schemata: The Building Blocks of Cognition." In *Theoretical Issues in Reading Comprehension*, edited by R. J. Spiro, B. C. Bruce, and W. F. Brewer. Hillsdale, N.J.: Lawrence Erlbaum.

Spiro, R.J. (1980). "Constructive Processes in Prose Comprehension and Recall." In *Theoretical Issues in Reading Comprehension*, edited by R. J. Spiro, B. C. Bruce, and W. F. Brewer. Hillsdale, N.J.: Lawrence Erlbaum.

Sternberg, R. J. (1977). *Intelligence, Information Processing, and Analogical Reasoning: The Componential Analysis of Human Abilities.* Hillsdale, N.J.: Lawrence Erlbaum.

Tierney, R. J. (1983). *Learning from Text.* (Reading Education Report No. 57). Urbana, Ill.: University of Illinois, Center for the Study of Reading.

Weinstein, C. E., and R. E. Meyer. (In press). "The Teaching of Learning Strategies." In *Handbook of Research on Teaching*, 3rd ed., edited by M. C. Wittrock. New York: Macmillan.

Winograd, P. N. (1984). "Strategic Difficulties in Summarizing Texts." *Reading Research Quarterly* 19: 404–425.

Wittrock, M. C. (1984). *Generative Reading Comprehension.* Ginn Occasional Reports. Boston, Mass.: Ginn and Company.

30

Making Science Learning More Science-Like

Bruce Wellman

Science begins with a sense of wonder and is honed by curiosity.

—Charles Roth (1986)

Science as a way of knowing involves systematic ways of asking questions, making careful observations of the world around us, and forging connections between present knowledge and new discoveries as they unfold. "Science is both a method and a set of ideas; both a process and a product" (Harlen 1985).

Yet for many students, science is "what you do fifth period," or as a 4th grader once explained to me, "Science is the book we read on Thursdays when we're not doing social studies."

How do we make school science more science-like? How do we create teaching and learning processes that are fueled by wonder and curiosity? We can start by examining the content of science courses and text materials. Edition by edition, year by year, science texts have grown in size and in the number of topics they cover. The typical high school science text averages between 7 and 10 new concepts, terms, or symbols per page, and students are presented with as many as 2,400 to 3,000 terms and symbols per science course (Rowe 1983). When courses are structured as collections of "science factoids," it's no wonder that the primary science learning activity is brute memorization. And it's not surprising that many students don't like science and don't believe that studying science can be valuable to them. Studies indicate that students' attitudes become more negative with each science course they take (Yager and Penick 1989).

In real-world science, content exists within a context and within several interactive processes. Content is defined by its relation to these processes, and each is embedded in the other (Crowell 1989). Here, content is not just symbols to be memorized and regurgitated on command; it is something to think with and to think about.

A school science program should strive to develop and maintain this kind of environment for thinking. There are six aspects to such an environment; they are shown in Figure 1.

A Concept Framework

The concept framework is an important organizing principle for spelling out the "big ideas" in a course. Big ideas are the "Velcro" that holds thinking and learning together. As students experience science directly and teachers help them construct meaning, more hooks are added to the Velcro and more learning "sticks." Big ideas appear in more than one science topic or unit; they often cut across life science, physical science, and earth science, as well as the technological applications of science principles. Figure 2 shows examples of such key concepts. The teacher's task is to help students see this big picture and develop organizing schema of their own with which they can filter future learning for better understanding.

Content Information

Content information is tied to the concept framework, since the latter helps teachers to organize their thinking about a course's content and to focus on topics and ideas that illuminate the framework's big ideas in ways that students can grab onto. Thoughtfully used, the framework provides a relief valve for the often difficult decisions about what to include in a curriculum that must engage students in meaningful ways, for developing depth in the curriculum usually means concentrating on fewer topics and units.

FIGURE 1

Six Aspects of a Complete Science Program

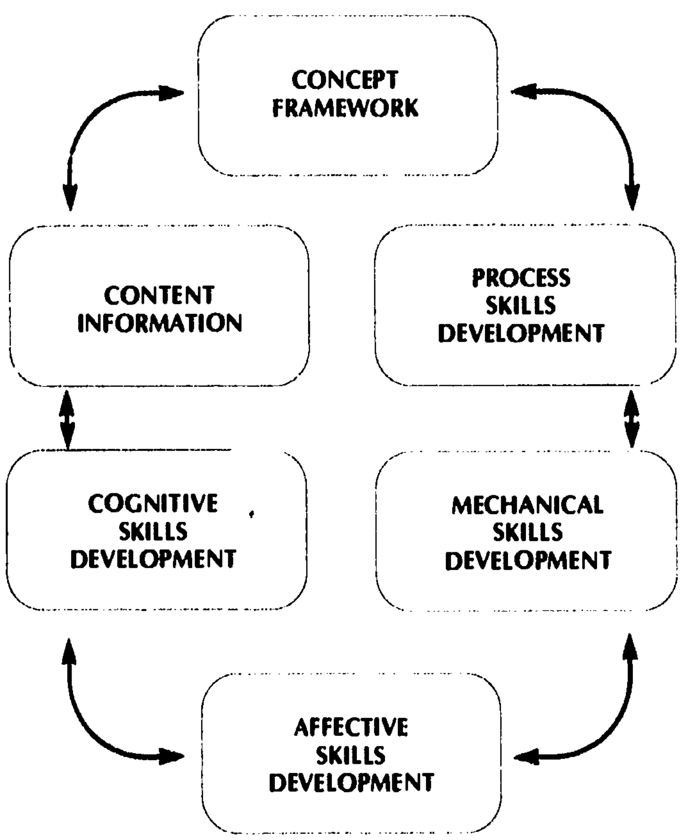


FIGURE 2

Examples of Key Concepts

1. Cause and Effect
2. Change
3. Cycle
4. Diversity and Continuity
5. Interaction
6. Model
7. Organism
8. Population
9. Pattern and Symmetry
10. Property
11. Structure/Function
12. System
13. Variable

Process Skills

The process skills of observing, communicating, comparing, and organizing are the basic "doing" skills of science. They are the foundation on which personal science knowledge and thinking are built (Lowery 1985). Figure 3 shows various activities that fall under each of these skill areas. These activities are part of "learning to see"—in all of its sensory manifestations—and this is students' most important task. Students must learn to trust their senses as primary data-gathering devices and to appreciate that the mechanical and electronic tools of science are sensory extensions that have no perceptions of their own. Students also must learn to question the inferences they draw from sensory data and to reflect on why they think about phenomena and events in the way that they do (Costa 1984).

Cognitive Skills

Deep-thinking and problem-solving skills form the core of science and effective science instruction. Science revolves around questions, not answers. Learning to ask good questions is the essence of science and learning about science. Asking questions leads to gathering and using evidence to support arguments. A good science education helps students build a belief system based on evidence and not on inference or hearsay (Rowe 1978). Figure 4 lists the stages involved in problem solving in science. Other critical cognitive skills are learning to judge the reliability of observations and learning to clarify findings and inferences before drawing conclusions.

Affective Skills

Attitudes and values shape all of our perceptions and activities. Thoughtful science education can help students develop core values and beliefs that will guide them in science and in other endeavors:

- *Curiosity and a desire for knowledge.* Developing a disposition for knowing and understanding the world around us is an important goal in learning science.
- *Patience and self-discipline.* Learning takes time. Science requires learners to stay focused, both perceptually and cognitively, as they observe and process their observations.
- *Craftsmanship.* Care and precision with materials, organisms, and equipment is as much an attitude as it is a cognitive process skill.
- *Having confidence in and relying on data.* Students need to develop a respect for evidence. This implies rigorous testing of ideas and monitoring one's own thinking processes.
- *Comfort with ambiguity.* In science, results are always tentative. Observable facts and data are not always compelling. Ambiguity gives rise to new problems and questions.

FIGURE 3

Basic Science Processes

1. **Observing**
   - Seeing
   - Feeling
   - Hearing
   - Smelling
   - Tasting
   - Using several senses

2. **Communicating**
   - Describing, speaking, sounding
   - Formulating operational definitions
   - Recording, making tables, writing
   - Researching the literature, reading, referencing
   - Picturing, drawing, illustrating
   - Graphing

3. **Comparing**
   - Making general comparisons or comparisons from different perspectives
   - Estimating
   - Making numerical comparisons
   - Measuring lengths, angles
   - Measuring temperatures
   - Weighing
   - Measuring areas, volumes, pressures
   - Making time comparisons, measuring rates

4. **Organizing**
   - Seriating, sequencing, ordering
   - Sorting, matching, grouping
   - Classifying

Adapted from Lowery 1985.

• *Willingness to modify explanations.* Additional data or reinterpretations of existing data can suggest alternative explanations for phenomena and events. A willingness to rethink conclusions is often one of science's, and science learning's, most difficult personal decisions.

• *Cooperation.* Science is based on cooperation and the shared discussion of ideas, theories, and techniques within research groups and between research groups.

• *Respect for living things.* All living things deserve humane care, both in the lab and in the field. Our attitudes toward the care and handling of live organisms say much about who we are as human beings.

• *Respect for, and trust in, thinking processes.* Exploring and learning in science are active processes, not episodes or events. Science is defined by patterns of reasoning that lead to theory building and theory testing. Trust in the process is essential.

• *Honesty.* Data should be presented and recorded as observed, not bent to fit the observer's preconceptions (Bybee, Buchwald, Crissman, Heil, Kuerbis, Matsumoto, and McInerey 1989; Nay and Crocker 1970).

Mechanical Skills

Mechanical skills are the essential "hands-on" skills of science and are usually assumed to be part of the basic processes. Categorizing them separately is a way of emphasizing their importance in the thinking-learning process. Using tools skillfully is important because there is a kinesthetic way of knowing that grows out of manipulating instruments, equipment, and mechanical devices. For instance, knowing how to measure accurately with a ruler or a balance helps students learn to refine their observations and record more detailed evidence; stripping wires and making physical

FIGURE 4

Stages of Problem Solving in Science

1. **Planning and Designing**
   - Defining a problem
   - Formulating questions
   - Predicting experimental results
   - Formulating hypotheses
   - Identifying variables
   - Designing observation procedures
   - Designing measurement procedures
   - Designing experiments

2. **Performing**
   - Making qualitative observations
   - Making quantitative observations
   - Manipulating apparatus and tools
   - Controlling variables
   - Recording observations
   - Calculating numerically
   - Following experimental design
   - Recording results

3. **Analyzing and Interpreting**
   - Organizing and charting results
   - Graphing data
   - Determining qualitative relationships
   - Determining quantitative relationships
   - Determining the accuracy of data
   - Defining limitations and assumptions
   - Proposing generalizations and models
   - Explaining relationships
   - Formulating new questions
   - Defining new problems based on the results of the investigation

4. **Applying**
   - Making predictions based on experimental results
   - Formulating hypotheses based on experimental results
   - Applying experimental techniques to new problems or variables

Adapted from Lunetta and Tamir 1979.

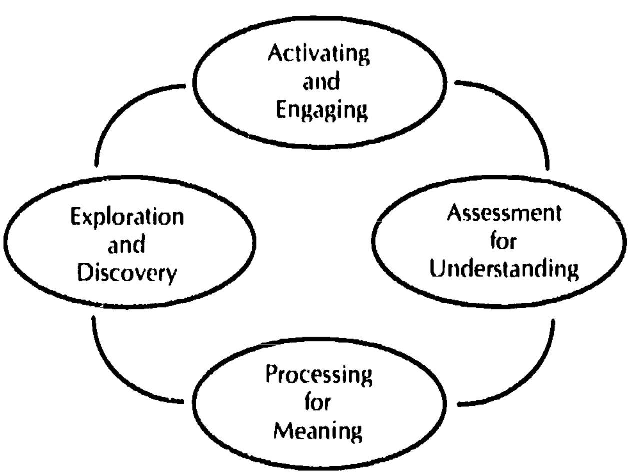
ERIC

connections helps students understand electric current and the movement of current in circuits. It is important for all learners to develop these and other mechanical skills. Students who get their hands on science also get their minds on science, while observers risk becoming passive thinkers who don't know quite how to delve deeply into phenomena, concepts, and theories.

The Science Learning Cycle

The science learning process is an endless journey for which there is no map. It is a journey guided only by the questions "Where are we now?" and "Where should we go next?" The teacher's organizing task is to initiate and facilitate learning activities that help students create their own maps to the territory being explored. These maps are highly personal and are continually revised. The four stages of the Science Learning Cycle, shown in Figure 5, guide the map-making process.

FIGURE 5
The Science Learning Cycle



Activating and Engaging

This is the stage of finding out what students already know about the territory that will be explored. The prior knowledge and understandings that they bring to the journey help to determine the journey's starting point and often indicate vital side trips that might be taken. Effective activating techniques get learners cognitively and affectively ready for new learning (Saphier and Gower 1987).

The stage of activating prior knowledge and engaging students' interest is also the stage of finding out students' preconceptions and naive theories about the topic at hand. Preconceptions are "amazingly tenacious and resistant to extinction" (Ausubel 1968). By rooting out these misconceptions early on, the teacher can identify areas to target during activities, discussions, and debriefing sessions, and thus shape learning experiences to dislodge them.

Exploration and Discovery

Students explore and discover when they enter the territory of ideas and actions that are at the heart of science learning. This is the stage of "messing about" with materials and ideas (Hawkins 1970), and it also becomes the stage of focused observation, data gathering from firsthand experience and reference material, processing information, and making conclusions. Most science learning time is spent at this stage of the journey.

Processing for Meaning

Activity is not enough. During a journey we need to stop and examine our surroundings and establish some reference points so that we know where we are, and so that we can describe our journey to others. Processing for meaning occurs at all stages of the trip. It is especially important to summarize learning that occurs during lab activity periods. The teacher's role here is to probe student thinking and help students clarify their findings and results.

Processing for meaning is also a discrete stage that occurs at significant mileposts, such as the transition between the major concepts in a unit, where students, singly or in groups, present their thinking and theories about the topic under investigation. Conflicting ideas, explanations, and theories often emerge during such sessions. From this model of scientific pluralism comes an understanding of the "revolutionary nature of science; that progress in scientific knowledge comes about through major changes in scientists' theories" (Driver 1983). Conflicting theories become fodder for thought and discussion. It is here that teachers explore why students think as they do, and help students to articulate the reasoning behind their conclusions.

Assessment for Understanding

What should students know and be able to do as a result of their science experiences, and how do they display their knowledge and skills? These are the questions that define science assessment. All too often we fall back on assessing only what is easiest to assess: factual knowledge. Knowledge of science content is important, but only so far as it informs thinking and action. At this stage of the cycle, the teacher's task is to be a good observer of the science learning process and to develop ways of recording students' actions and interactions with materials, ideas, and other learners. What we assess, how we assess, and what we do with our assessments of student thinking and learning should become models for our values about teaching and should themselves be student learning activities.

* * *

Science is the process of making meaning. It is a deeply personal process, with possibilities for wonder, curiosity, and discovery. Tired science demonstrations, canned laboratory exercises, and reading aloud from stilted textbooks will not create a community of questing learners. If we want to engage students in the pursuit of science as a valid intellectual goal, then we must focus our teaching and learning energies on meaning-making activities that bring students' hearts and minds into the science learning cycle.

References

Ausubel, D. P. (1968). *Educational Psychology: A Cognitive View.* New York: Holt, Rinehart and Winston.

Bybee, R. W., C. E. Buchwald, S. Crissman, D. R. Heil, P. J. Kuerbis, C. Matsumoto, and J. D. McInerey. (1989). *Science and Technology Education for the Elementary Years: Frameworks for Curriculum and Instruction.* Andover, Mass., and Colorado Springs, Colo.: The National Center for Improving Science Education.

Costa, A. L. (November 1984). "Mediating the Metacognitive." *Educational Leadership* 42, 3: 57–62.

Crowell, S. (September 1989). "A New Way of Thinking: The Challenge of the Future." *Educational Leadership* 47, 1: 60–63.

Driver, R. (1983). *The Pupil as Scientist?* Milton Keynes, England: Open University Press.

Harlen, W., ed. (1985). *Primary Science . . . Taking the Plunge.* London: Heinemann.

Hawkins, D. (1970). "Messing About in Science." In *The ess Reader.* Newton, Mass.: Education Development Center.

Lowery, L. F. (1985). *The Everyday Science Sourcebook.* Palo Alto, Calif.: Dale Seymour.

Lunetta, V. N., and P. Tamir. (May 1979). "Matching Lab Activites with Teaching Goals." *The Science Teacher* 46, 5: 22–24.

Nay, M. A., and R. K. Crocker. (January–March 1970). "Science Teaching and the Affective Attributes of Scientists." *Science Education*: 61–62.

Roth, C. (1986). "Of Crocodiles and Abalone." Keynote Address at the Museum Institute for Teaching Science Summer Institute, Museum of Science, Boston.

Rowe, M. B. (Spring 1983). "Science Education: Framework for Decision Makers." *Daedalus* 112, 2: 123–142.

Rowe, M. B. (1978). *Teaching Science As Continuous Inquiry: A Basic.* New York: McGraw-Hill.

Saphier, J., and R. Gower. (1987). *The Skillful Teacher.* Carlisle, Mass.: Research for Better Teaching.

Yager, R. E., and J. E. Penick. (January 1989). "An Exemplary Program Payoff: What Student Perceptions Reveal About Science Programs." *The Science Teacher*: 54–56.

31

Infusing Critical Thinking Into United States History Courses

Kevin O'Reilly

More than to give information, a teacher needs to help guide a student's mind to think, and even beyond that, to help him shape his character. Giving information is easy. Forming a thinking mind is hard. And shaping a strong character is hardest of all, partly because it must be shaped mostly from within. Giving information is only the beginning of a teacher's responsibility; the end is to stimulate, excite, motivate, lift, challenge, inspire.

—Bruce R. Clark

Some people believe the content of history is more important than critical thinking skills, while others give preference to the skills. The dichotomy is false, however. Real history involves both at the same time—one and inseparable. Certainly historical investigation involves both accumulation of evidence and careful thinking about that evidence (evaluating sources, making inferences, etc.). Reading historical works also involves both the digestion of information and a comparison of it to interpretations in other works, identification of point of view, and so forth.

It follows that critical thinking should be infused into the subject matter of history. Indeed it would not be too much of an exaggeration to say that we teachers and textbook editors are the ones to blame for creating the artificial distinction between content and skills in the first place. In many teachers' tests and most textbooks, skills questions are in separate sections, usually at the end. Reintegrating content and skills just brings history back to its natural state.

How to integrate critical thinking skills into the content of history involves overcoming a number of problems and raises a number of issues. This article will describe my experiences in infusing critical thinking into my 11th grade United States history course. The article presents the concept of critical thinking, the skills involved and the methodologies for teaching the skills, the application of skills to interpretations, and issues related to teaching critical thinking.

What Is Critical Thinking?

There is some disagreement among teachers about what critical thinking is and is not. What I mean by critical thinking is: Having good reasons for what you believe (Ennis 1979). It involves careful, precise, persistent, and objective analysis of any knowledge claim or belief in order to judge its validity and/or worth (Beyer 1985).

Thus, critical thinking cannot be equated with any kind of thinking. It is not quite the same as decision making, although it is a part of decision making. It is not quite the same as brainstorming, which prohibits any judgments of suggested ideas. Critical thinking involves certain skills of analyzing and evaluating (as in Bloom's taxonomy) but also certain attitudes, such as a willingness to ask questions and to consider other points of view (Fraser and West 1961).

There are a host of skills involved in critical thinking in history, such as:

- Identifying and evaluating sources of information
- Assessing cause-and-effect reasoning
- Analyzing comparisons or analogies
- Evaluating generalizations
- Identifying frames of reference and unstated assumptions
- Analyzing language
- Bringing in information relevant to the topic.

Skills and Methodologies

The first three of the above skills will be demonstrated in this article. The sequence of methodologies used to teach these skills is:

1. The students are confronted with a problem from history that involves the use of the skill to be taught.
2. A concrete demonstration or familiar example is used to introduce the skill.
3. The students think about their thinking (metacognition). They establish criteria for the skill.
4. The students repeat the skill with coaching.
5. The students apply the skill to new history problems, new interpretations, textbooks, and classroom questions.
6. The students demonstrate the skill in their writing.

The skills below follow this sequence.

Evaluating Evidence or Sources of Information

In one U.S. history class, students are confronted with the problem of what happened to the Lost Colony of Roanoke (Step 1—introductory problem). This problem raises the need to understand how to evaluate evidence.

The next class begins with a role play of robbery (Step 2—concrete demonstration). The class questions the role players about who the thief was. After the questioning I tell the students we are now going to focus on the skill of evaluating evidence. (Step 3—metacognition). Specifically what criteria can we use to decide the strength of the evidence? Why did they believe only some of the testimony? The students have always been able to suggest two or three criteria for evaluating evidence. An example of criteria that we made into a poster is shown in Figure 1.

FIGURE 1

Evaluating Evidence:

P — Primary or Secondary?
R — Reason to lie or protect himself?
O — Is there other evidence saying the same thing as this evidence?

The purpose of the poster is to make critical thinking part of the climate of the classroom. Space is left at the bottom of the poster so that new criteria can be added as new problems are analyzed.

In the third class, students fill in worksheets like the one shown in Figure 2. Students fill in the worksheet individually and then discuss their answers in groups. Thus, the students coach each other on the skill. (Step 4—repetition and coaching)

FIGURE 2

Strengths and Weaknesses of Evidence

Give the strengths and weaknesses for each piece of evidence below:

1. Rita, Larry, and Nella say Cliff definitely stole the bike because they all saw him take it

   Strengths Weaknesses

2. A newspaper article in 1865 reported that, according to a mill owner, the working conditions in the Lowell mills in the 1840s were very good.

   Strengths Weaknesses

Some students have had difficulty with questions in the above worksheet. They may not know what makes something a primary source or when someone has a reason to lie. They get a worksheet like the one shown in Figure 3, which breaks the skill down even further.

Notice that in each worksheet familiar examples are paired with historical examples.

After several repetitions of these worksheets, students try evaluating the evidence presented in problems such as "Was John Smith really rescued by Pocahontas?" They would also be asked to include one or two pieces of evidence in the essays they write and to show why their evidence is strong. (Step 6—demonstrate in writing).

FIGURE 3

Primary Sources/Reasons to Lie

A. A primary source is evidence given by a person who was present at or part of the event being reported on or it is an object that was part of the event. Put a "P" next to each item that is a primary source. Ask yourself if the person doing the reporting was part of the event or saw the event reported on. If so, it is a primary source.

   ____ 1. Terry said he saw Derek buy the sneakers.

   ____ 2. In his book *The American Dream* (1977), Lew Smith said Marquette was a great explorer.

B. A person has a reason to lie when he makes himself or his group look good or when he helps his own interests. He has no reason to lie when he makes himself look bad or his enemy look good. Put an "R" next to each item in which the person has a reason to lie.

   ____ 1. Bill said he didn't steal the radio.

   ____ 2. The Pilgrims said they would not have survived without the help of friendly Indians, such as Squanto.

Assessing Cause-and-Effect Reasoning

The Roanoke problem could also be used to introduce cause-and-effect reasoning. If it is not introduced there however, it can be introduced when we study the causes of the Salem Witch Trials.[1] The skill itself is introduced by using familiar occurrences and asking what caused them, for example, why someone is sick, why an engine won't start, or why a baseball team didn't do well this year. The answers are the causation arguments. The first answer given is written on the chalkboard. For example, "The engine won't start because the choke is not working." This argument is then questioned: How strong is it? (It is reasonable, but there might be other causes.) A second example is written on the board, "Whenever I study for math tests I don't do well, so I'm going to stop studying." Here, there is no reasonable connection between the proposed cause—studying—and the effect—low scores. In addition, there are other causes that are more plausible.

The examination of these two examples leads to a discussion of the evaluation of causal arguments in general. Two important questions have emerged: Is there a reasonable connection between the proposed cause and the effect? and, Are there other possible causes that could have led to this effect?

Some students need more guidance, however. They may have difficulty in deciding which is the effect or in following all the steps in analyzing the argument. The visual model in Figure 4 has proven helpful for some students.

The students repeat the skill on more historical problems and on worksheets such as the one in Figure 5. They can use the cause-and-effect diagram for help or they can answer the questions without it.

Again, students would apply the skill to historical interpretations and would be called upon to demonstrate the skill in their writing.

Analyzing Comparisons

Some Americans in the 1780s believed that strong central government would be bad for the United States because the strong central government of England had been one of the main problems the American colonies had to endure. James Madison, on the other hand, argued that confederation (weak central governments) hadn't worked in ancient Greece. Both arguments are suitable for raising the need to understand how to analyze comparison reasoning.

The historical problem is followed by telling the students that Pete had a faster time than they did in an automobile race, so Pete was a better driver. What would they ask? (Was he driving the same kind of car?) Students seem to know the evaluative question to ask for comparison: How are the two cases different?

After discussing the criteria for analyzing comparisons students practice the skill on worksheets like those for evidence and cause and effect. They are then confronted with the interpretation shown in Figure 6 and asked to apply the skill, along with the other skills they have learned.

Applying Critical Thinking Skills to Interpretation

Textbooks do not provide students with several interpretations of events. As a result, most students don't realize that historians disagree. They think that knowledge is complete, unchanging, and exists to be memorized, whereas most teachers believe that knowledge is incomplete, changing, and must be sought after and assessed.

Giving students several interpretations of events helps them overcome their erroneous views of the nature of knowledge. The problem is that real historical interpretations were not written for high school students. The vocabulary and concepts are too difficult.

The interpretation in Figure 6 was written to overcome this problem. It is based on a real interpretation by Barton Bernstein. The footnotes are his. It is only a short excerpt from the actual seven-page interpretation.[2]

Students analyze this interpretation, first individually and then in small groups. They should be able to suggest two or more of the following:

1. The weakness of the evidence in footnote 1 in which a Soviet quotes a secondary source and the way that the

FIGURE 4

Cause and Effect

Cause	Reasonable Connection?	Effect	Put the effect (often an action or event) down first, then the cause. Ask if the cause could reasonably lead the effect. Cover up the cause and ask yourself if there could be any other possible causes for this effect.
Other Possible Causes			

words "orderly" and "wide participation" in the evidence got changed to "free" in the argument;

FIGURE 5

Immigration

Evaluate each of the following for its cause-and-effect reasoning:

1. Jean's car stalls frequently. The mechanic decides that the problem couldn't be the starter or the valves because the car only stalls when it is raining or wet out. He checks the wires and notices that they are cracked in two places. He concludes that the problem is in the wires.
   How good is the mechanic's thinking?
2. Jewish immigrants have the highest social mobility of any immigrant group. They are also the most interested in education. It is obvious that they move up the social ladder so easily because of their commitment to education.
   How good is this reasoning?

2. The evidence in footnote 2 is from a secondary source;

3. The analogy in the third paragraph between Soviet domination of Eastern Europe and American domination of Latin America—is the domination of the same type?

4. The cause-and-effect reasoning in the fourth paragraph (that because the Soviets tightened up on Eastern Europe in 1947 after the Truman Doctrine, it must have been because of the Truman Doctrine) does not provide any evidence to establish the connection between U.S. policy and Soviet control of Eastern Europe. Also, there are other possible causes for tightening up.

It is important to remember that by this point in the course, students have examined interpretations on many topics such as the Constitution, slavery, the causes of the Civil War, reconstruction, immigration, the *Lusitania*, the Sacco and Vanzetti case, the causes of the Great Depression, and the atomic bomb. So they should be fairly skilled at evaluating arguments.

Issues

A number of issues could be raised in regard to the critical thinking approach to American history, three of which will be discussed here: evaluation, content coverage versus depth, and the time necessary to write lessons.

The best way to evaluate critical thinking skills is through essays and short answer questions. Objective testing, such as multiple choice, has been used for particular skills, but is frequently problematic. Only certain parts of certain skills lend themselves to such testing. One result of this difficulty of evaluating most thinking skills through objective tests is the widespread use of the misleading, almost useless, "Fact vs. Opinion" questions. Essays and short answers require students to put information together in their own way and to make their own judgments.

The issue on content coverage has come up at many of the workshops I've conducted. One teacher asked, "This sounds good, but when do we do content," missing the whole idea of combining the two, as suggested at the beginning of the article. The pressure to cover content is twofold. The first culprit is the one-year survey course. A change in scope and sequence in schools away from covering U.S. history in survey courses in 5th, 8th, and 11th grade would go a long way in alleviating this structural problem. The second culprit is a little surprising. One might think that state curriculum guidelines, state testing, or school curriculums force teachers into the coverage mode. Research by Fred Newmann at the Center on Effective Secondary Schools in Madison, Wisconsin indicates, however, that the main pressure for coverage comes from the individual classroom teacher. Remove all the other structures and most teachers will continue to cover material while students take notes. We teachers are interested in history and we feel compelled to cover as much of it as possible. In my own case, I feel bad at the end of a school year when I haven't taught a particular topic.

There is no question about it, going into more depth on particular topics to teach critical thinking skills will cut down the amount of information you can cover. We need a change of perspective, however, from what we teach to what students learn. Obviously, if we teach critical thinking skills, students will learn more of those skills. But they will also remember more content. Jerome Bruner and a host of cognitive psychologists have argued for many years that information learned in the process of problem solving and puzzlement will be remembered much longer than those passively jotted into notebooks (Engle 1987).

Chester Finn and Diane Ravitch have completely missed the point in their book *What Do Our 17-Year-Olds Know?* We've been drilling students with information for the past 70 years. It isn't that we haven't taught the students when the Civil War is, it's that they don't remember it. Facts taught at the memory level are easily forgotten. If you've ever had the experience of teaching students you taught in a previous course you know how little they retain.

My argument is that by teaching through a critical thinking, problem approach students will learn more skills and remember more of the content as well.

How long it takes to write lessons such as those outlined in this article is an important issue. It takes many hours to write such lessons, anywhere from 2 hours to over 100 hours.

FIGURE 6

An Interpretation of History

Historian A

The United States, not the Soviet Union, bears primary responsibility for causing the Cold War. At the Yalta Conference, Josef Stalin, the Soviet leader, made clear that he wanted the Soviet Union to have a sphere of influence in Eastern Europe to protect against any future invasions by Germany. If millions of people had just been killed in the United States because of an invasion, we would have tried to protect our borders, too.

Within their sphere in Eastern Europe, the Soviets allowed considerable freedom in 1945 and 1946. Free elections were held in several countries. Bulgaria's elections under Soviet occupation were declared to be the freest in the country's history.[1] Communist candidates were elected in many areas because of their popularity, especially with the peasants.[2]

The problems started when Harry Truman took over as President in April, 1945. He self-righteously attacked the Soviets for their domination of Eastern Europe, but he said nothing about the American sphere of influence in Latin America. Backed by the atomic bomb, he tried to intimidate Stalin. The United States even began to build Germany again—the very thing the Russians feared most!

The Soviets began to tighten their grip on Eastern Europe in response to the American threats, although they still allowed considerable freedom in some countries. Then, in 1947, President Truman declared Cold War on the Soviet Union. In the Truman Doctrine, he said the Soviets relied on terror and oppression and were threatening the world. The Soviets now clamped down tight on Eastern Europe to protect themselves against the United States threat. American threats had brought on the Cold War.

NOTES

[1] "He (Soviet Foreign Minister Molotove) read a press report taken from the *New York Times* concerning the orderly fashion in which the elections in Bulgaria had taken place. He said no one could deny the fact that there was wider participation in these elections than in any other in the history of Bulgaria." U.S. Department of State. *Foreign Relations Papers of the United States*, 1945, Volume II, p. 731.

[2] "To most people in war-devastated Eastern Europe, rapid economic reconstruction was the most vital issue, even more so than politics. And to a majority of them, state planning (that is, Communism) appeared necessary and logical." Zbigniew Brzezinski, *The Soviet Bloc*, (1960), p. 7.

Teachers don't have time to create such elaborate lessons. I have three suggestions. Ideally, social studies teachers should be given no more than 4 courses and 80 students. Part of their job description would be curriculum development—they would be held accountable for reading journals and books and for writing creative lessons. In the present structure of schools, teachers implement curriculum but have little time to create it. Asking them to design curriculum only adds to an already overloaded schedule.

A less fundamental change is to pay teachers a reasonable rate for summer curriculum development work. That would allow teachers to create a bank of critical thinking prol.' .ns that could be added to in subsequent years.

The third suggestion is to write less complex lessons. It is possible to set up critical thinking problems from textbooks. A change in questioning techniques can also put a skills framework on classroom discussions. These changes do not require a great deal of time to implement. However, they are not as effective, in my view, as are more complex, sophisticated lessons that take more time to create.

Conclusion

Research indicates that 90 percent of instruction in social studies is from textbooks (Marquant 1988). Step one in teaching critical thinking skills is to reduce dependence on textbooks. Step two is to examine our testing. What are we testing for?

Infusing critical thinking into United States history involves a good deal of creative thinking and a great deal of time and hard work. The feedback I get from students makes it well worth the effort.

NOTES

1. These and the other historical problems and interpretations described in this article are from O'Reilly, K. (1983–1987). *Critical Thinking in American History*. Four volumes. Pacific Grove, Calif.: Midwest Publications. The Salem Witch Trials problem is from Book 1, "Exploration to Constitution," pp. 45–63.

2. O'Reilly. Book 4, "Spanish-American War to Vietnam," pp. 80–86.

REFERENCES

Beyer, B. (April 1985). "Critical Thinking: What Is It?" *Social Education*, 49: 270–276.

Engle, S. (November 1987). "Commentary on California and New York Curricula." Paper given at the National Council for Social Studies annual conference in Dallas, Texas.

Ennis, R. (1979). "A Conception of Rational Thinking." In *Philosophy of Education*, edited by Jerold Coombs. Bloomington, Ill: Philosophy of Education Society.

Fraser D. M., and E. West (1961). *Social Studies in Secondary Schools*. New York: Ronald Press.

Marquant, R. (February 1988). "U.S. History: Revising the Way the Textbooks Tell It." *The Christian Science Monitor*.

32

The Role of the Arts in Cognition and Curriculum

Elliot W. Eisner

My thesis is straightforward but not widely accepted. It is that the arts are cognitive activities, guided by human intelligence, that make unique forms of meaning possible. I shall argue further that the meanings secured through the arts require what might best be described as forms of artistic literacy, without which artistic meaning is impeded and the ability to use more conventional forms of expression is hampered.

To talk about the cognitive character of the arts or about the kind of meaning that they convey is not particularly common. The models of mind that have typified U.S. educational psychology (particularly that aspect of psychology concerned with learning and knowing) have made tidy separations between thinking and feeling, feeling and acting, and acting and thinking![1] The view of thinking that has been most common is rooted in the Platonic belief that mind and body are distinct, and, of the two, body is base while mind is lofty (see *The Republic* 1951).[2] Feeling is located in *soma*, idea in *psyche*. The literature distinguishes between cognition and affect, and we tend to regard as cognitive those activities of mind that mediate ideas through words and numbers. We consider words more abstract than images, icons less flexible than propositions. We regard words as high in that hierarchy of cognitive achievement we use to describe cognitive growth. Jean Piaget, for example, regarded formal operations, those mental operations that deal with logical relationships, as the apotheosis of cognitive achievement (Inhelder and Piaget 1958). For some cognitive psychologists, thinking is a kind of inner speech that allows one to reason (see Schaff 1973).[3] Since reason is a condition of rationality, and since reasoning is believed to require the logical treatment of words, operations of the mind that do not employ logic are placed on the margins of rationality.

In this view, the arts, if not considered irrational, are thought of as *a-rational*. As for meaning, it is most commonly regarded as an attribute of propositions, the property of assertions for which scientific warrant can be secured. The arts are considered emotive forms that might provide satisfaction—but not understanding.

The consequences of the view of mind have, in my opinion, been disastrous for education. First, this view has created a dubious status hierarchy among subjects taught in schools. Mathematics is the queen of the hill; other subjects, especially those in which students "work with their hands," are assigned lower intellectual status. Simply recall the standard whipping boy at school activities, basket weaving. Basket weaving epitomizes low status and mindlessness. Let me state quickly that I reject mindless forms of basket weaving in school. But let me add just as quickly that I also reject mindless forms of algebra and that I find nothing inherently more intellectually complex in algebra than in basket weaving; it depends upon the nature of the algebra and the nature of baskets we choose to weave.

Besides making some subjects the targets of verbal abuse, the status hierarchy among subjects that emanates from such an indefensible conception of mind has practical day-to-day consequences in schools. Consider how time is allocated in school programs. Time is surely one of the most precious of school resources. As researchers of time on task have told us (Rosenshine 1976), the relationship between the amount of time allocated and learning is a significant one. Partly because of our view of intellect, however, some subjects—the fine arts, for example—receive very little attention in school programs. On the average, elementary school teachers devote about 4 percent of school time each week to instruction in the fine arts.[4] And this time is not prime time, such as the so-called cognitive subjects command. For the fine arts, Friday afternoons are very popular.

Space does not permit a lengthy recital of sins that have been committed by school in the name of cognitive development. Yet it is important to remember that the conception of giftedness used in many states excludes ability in the fine arts, that tax dollars support programs whose criteria discriminate against students whose gifts are in the fine arts, and that many colleges and universities do not consider high school grades in the fine arts when making admissions decisions.[5] We legitimate such practices by distinguishing between intelligence and talent, assigning the former to verbal and mathematical forms of reasoning and the latter to performance in activities we deem more concrete: playing a musical instrument, dancing, painting.

I could elaborate at length on each of these points. But I mention them simply to highlight the model of mind that has been so widely accepted and to provide a context for my remarks concerning the role of the arts in cognition and curriculum.

If you were to consult the *Dictionary of Psychology* (1934) regarding the meaning of *cognition*, you would find that cognition is "the process through which the organism becomes aware of the environment." Thus, cognition is a process that makes awareness possible. It is, in this sense, a matter of becoming conscious, of noticing, of recognizing, of perceiving. It is a matter of distinguishing one thing from another: a figure from its ground, the various subtleties and nuances that, when perceived, become a part of one's consciousness.

In this process, the functions of the senses are crucial. They bring to awareness the qualitative world we inhabit. To become aware of the world, two conditions must be satisfied. First, the qualities must be available for experiencing by a sentient human being. Second, the individual must be able to "read" their presence. When both of these conditions are met, the human being is capable of forming concepts of the world. These concepts take shape in the information that the senses have provided.

The process of forming concepts is one of construing *general* features from qualitative particulars. The perception of the qualitative world is always fragmented: We never see a particular immediately, in an instant. Time is always involved.[6] General configurations are formed—that is, differentiated from wholes to parts. Through time this process yields structured patterns that constitute a set. The patterns formed in this way are concepts. They are root forms of experience that we are able to recall and to manipulate imaginatively.

The importance of the senses in concept formation is that: (1) no concepts can be formed without sensory information,[7] (2) the degree to which the particular senses are differentiated has a large effect on the kind and subtlety of the concepts that are formed, and (3) without concepts formed as images (whether these images are visual, auditory, or in some other sensory form), image surrogates—words, for example—are meaningless.[8]

It is easy to see how such concrete concepts as dog or chair, red or blue, depend upon sensory information. But what about such abstract concepts as justice, category, nation, infinity? I would argue that these words are nothing more than meaningless noises or marks on paper unless their referents can be imagined. Unless we have a conception of justice, the word is empty. Unless we can imagine infinity, the term is nothing more than a few decibels of sound moving through space. I do not mean to imply that we conjure up an image every time we hear a word. Our automatic response mechanisms make this unnecessary. But when I say "the man was a feckless mountebank," the statement will have meaning only if you have referents for "feckless" and "mountebank." If you do not, then you turn to a friend or a dictionary for other words whose images allow you to create an analogy. It is through such analogies or through illustrative examples that so-called abstract concepts take on meaning. Concepts, in this view, are not linguistic at base; instead, they are sensory. The forms concepts take are as diverse as our sensory capacities and the abilities we have developed to use them.

The process of concept formation is of particular importance in the development of scientific theory. In the social sciences, for example, theoreticians form concepts by construing social situations in ways that others have not noticed. Terms such as class, social structure, adaptation, role, status, and reinforcement are meaningful because they bracket aspects of the social world for us to experience (see Weitz 1956).[9] They call to our attention qualities of the world that otherwise would have gone unseen. But the reality is in the flesh and blood of experience, not simply in the words. Put another way, there is an icon—a stylized image of reality—underlying any term that is meaningful. The makers of such icons are people we regard as perceptive or insightful. Indeed, the Latin root of "intuition" is *intueri*, meaning to look upon, to see. In the beginning there was the image, not the word.

One important characteristic of concepts is that they can be not only recalled but, imaginatively manipulated. We can combine qualities we have encountered to form entities that never were, but that might become: hence unicorns, helixes, ideals of perfection toward which we strive, and new tunes to whistle. We can construct models of the world from which we can derive verbal or numerical propositions or from which we can create visual or auditory images. The point is that, while the sensory system provides us with information about the world in sensory form, our imaginative capacities—when coupled with an inclination toward play—allow us to examine and explore the possibilities of this information (see Sutton-Smith 1979).[10] Although our imaginative lives might be played out in solitary fantasy or daydreaming, imagination often provides the springboard for expression. How is experience expressed? What vehicles are used? What skills are employed? And what do the arts have to do with it? It is to that side of the cognitive coin that I now turn.

Thus far I have emphasized the cognitive function of the sensory systems, and I have pointed out that concepts formed from sensory information can be recalled and manipulated through imagination. But thus far, this manipulation of concepts has been private, something occurring within the personal experience of individuals. The other side of the coin deals with the problem of externalization. In some way, an individual must acquire and employ a form that can represent to self and to others what has been conceptualized. This task requires what I call a *form of representation*. (This concept is elaborated in greater detail in my forthcoming book *Cognition and Curriculum, A Basis for Deciding What to Teach*).[11] The problem of representing conceptions is a problem of finding or inventing equivalents for those conceptions. In this task, the form or forms to be employed must themselves appeal to one or more of the senses. A visual concept, for example, might be externalized in a form that is visual, or the form might instead be auditory, verbal, or both. Thus, for example, we could represent an imaginary stream of rolling and flowing blue amoebic shapes either visually or through sound. The stream might be described through words, or it might be represented through movement—perhaps dance. Regardless of the form we select, it must be one that the sensory systems can pick up. Put another way, the form must be empirical.

The kind of information that we are able to convey about what we have conceptualized is both constrained and made possible by the forms of representation that we have access to and are able to use. Some of the things an individual knows are better represented by some forms than others. What one can convey about a river that slowly winds its way to the sea will be significantly influenced by the form of representation one chooses to use. The same holds true for portrayals of classrooms, teaching, love affairs, and memorable cities one has visited.

Consider suspense. Almost all of us are able to invent a way of conveying suspense through music. From old cowboy movies and mystery dramas on radio and television, we already have a repertoire of models to draw upon. But think about how suspense would be represented through painting or sculpture. Here the problem becomes much more difficult. Why? Because suspense is a temporal experience, and painting and sculpture are largely spatial. It is more difficult to use the latter to represent the former than to use music, which itself is temporal.

Some forms of representation can illuminate some aspects of the world that others cannot. What a person can learn about the world through visual form is not likely to be provided through auditory form. What an individual knows takes shape in the empirical world only through a vehicle or vehicles that make knowing public. The vehicles we use for this purpose are the forms of representation.

Although I have described the externalization of concepts as one-directional—that is, as moving from inside out—the process is actually reciprocal. For example, what a person knows how to do affects what he or she conceptualizes. If you walk around the world with black and white film in your camera, you look for contrasts of light and dark, for texture, for patterns of shadow against buildings and walls. As Ernst Gombrich put it, "Artists don't paint what they can see, they see what they can paint." The ability to use a form of representation skillfully guides our perception. The process flows, as it were, from representation to conception as well as from conception to representation.

Dialectical relationships between conception and representation occur in other ways as well. For example, the externalization of a conception through a form of representation allows the editing process to occur. By stabilizing what is evanescent, the conception can be modified, abbreviated, sharpened, revised, or discarded altogether. Further, in the process of representation new concepts are formed. Indeed, the act of discovery through expression is so important that R. G. Collingwood (1958) describes its presence as the difference between art and craft. The craftsman knows how to do a job well, but produces nothing essentially new. The artist not only has the skills of the craftsman, but discovers new possibilities as work progresses. The *work* of art is to make expressive form become a source of surprise, a discovery, a form that embodies a conception not held at the outset.

The selection of a form of representation does not adequately resolve the question of how that form, once selected, becomes "equivalent" to the conception. I suggest that we secure equivalence by treating forms of representation in one of three ways. The first of these modes of treatment is *mimetic*, the second is *expressive*, and the third is *conventional*.

Mimetic modes of treatment are efforts to imitate the surface features of perceived or conceptualized forms, within the constraints of some material. Early examples of mimesis are the running animals found on the walls of the

ERIC

Lascaux Caves. According to Gombrich (1969), the history of art is replete with efforts to create illusions that imitate the visual features of the environment as it was or as it was imagined. But mimesis as a way of treating a form of representation is not limited to what is visual. Mimesis occurs in auditory forms of representation, such as music and voice, and in movement through dance. Mimesis is possible in any of the forms used to provide information that the senses can pick up.

As I have already said, the creation of an equivalent for a conception is always both constrained and made possible by the medium a person employs. Different media appeal to different sensory systems. Thus, when a person transforms visual conceptions into sound or movement, he or she must find what Rudolf Arnheim (1954) calls the "structural equivalent" of the conception within the medium he or she elects to use. Such transformation requires the invention of analogies.

In language, analogic functions are performed by metaphor. When we move from the auditory to the visual, however, we must create a structural equivalent between the auditory and the visual. For example, the sounds "ooo loo loo" and "eee pee pee" are represented best by two very different kinds of graphic lines—one waving, the other pointed or jagged. Humans have the capacity to perceive and grasp these structural equivalences even when they take shape in different forms of representation—one visual, the other auditory. Thus, mimesis, the business of imitating the surface features of a conceptualization within the limits of some medium, is one way to secure equivalence between a conception and its forms of representation.

The second way to do this is by treating the forms expressively. By expressively, I mean that what is conveyed is what the object, event, or conception expresses - not what it looks like. Thus, "sorrow" can be represented mimetically, but it can also be represented expressively. In the arts, this expressive mode of treatment is of particular interest: the tense nervousness of Velasquez's Pope Innocent X, the celebration of color in a Sam Francis, the asceticism of a late Barnett Newman, the ethereal quality of Helen Frankenthaler's work, the symbolic undertones of an Edward Hopper, the crisp architecture of Bach's fugues, the romantic expansiveness of Beethoven's Seventh Symphony, the lighthearted whimsy of the poetry of e.e. cummings. What these artists have created are expressive images. In general, mimesis is a minor element in their works, used only to complement the dominant intent. Pablo Picasso succinctly stated the importance of the expressive mode of treatment in art when he said: "A painter takes the sun and makes it into a yellow spot, an artist takes a yellow spot and makes it into the sun."

By contrast, the conventional mode of treatment uses an arbitrary sign, on whose meaning society has agreed, to convey that meaning. Thus words and numbers are meaningful, not because they look like their referents, but because we have agreed that they shall stand for them. The use of convention is, of course, not limited to words and numbers. Swastikas, crosses, six-pointed stars, the iconography of cultures past and present are all examples of visual conventions. Conventions in music take such forms as anthems, wedding marches, and graduation processionals.

In much of art the three modes of treatment are combined. Erwin Panofsky (1955) made his major contribution to the history of art—to the study of iconography—by describing these relationships. The works of Jasper Johns, Marc Chagall, Joseph Cornell, Jack Levine, Robert Rauschenberg, and Andy Warhol demonstrate the ingenious ways in which visual artists have exploited all three modes of treatment in their effort to convey meaning.

I hope that I have made my point clear: Any form of representation one chooses to use—visual, auditory, or discursive—must also be treated in some way. Some forms tend to call forth one particular mode of treatment. The treatment of mathematics, for example, is essentially conventional, even though we may recognize its aesthetic qualities. The visual arts, by contrast, tend to emphasize the mimetic and the expressive. Language tends to be treated conventionally and expressively (save for occasional instances of onomatopoeia, which are obviously mimetic). The forms we choose provide potential options. The options we choose give us opportunities to convey what we know and what we are likely to experience.

Just as any form of representation we elect to use must be treated in a particular way, the elements within that form must also be related to each other. This relationship constitutes a syntax, an arrangement of parts used to construct a whole. Some forms of representation, such as mathematics and propositional discourse, are governed rather rigorously by publicly codified rules, through which the operations applied to such forms are to be performed. To be able to add, one must be able to apply correctly a set of prescribed operations to a set of numerical elements. To be able to punctuate, one must follow certain publicly articulated rules so that the marks placed within a sentence or paragraph are correct. Similarly, in spelling, rules govern the arrangements of elements (letters) that constitute words. There are only two ways to spell most words in English: correctly or incorrectly. Forms of representation that are treated through convention tend to emphasize the rule-governed end of the syntactical continuum. When forms are treated in this way, the scoring of performance can be handled by machines, because the need for judgment is small.

Forms of representation that are treated expressively have no comparable rules. There are, of course, rules of a sort to guide one in making a painting of a particular style or designing a building of a particular architectural period. But the quality of performance in such forms is not determined by measuring the extent to which the rules are followed (as is done for spelling and arithmetic). Instead, quality is judged by other criteria—in some cases, criteria that don't even exist prior to the creation of the work. Syntactical forms that are open rather than closed, that allow for the idiosyncratic creation of relationships without being regarded as incorrect, are figurative in character. Thus, it is possible to array forms of representation not only with respect to their modes of treatment, but in relation to the ends of the syntactical continuum toward which they lean. In general, the arts lean toward the figurative. That is why, given the same task, 30 students in music, poetry, or visual art will create 30 different solutions, all of which can be "right," while 30 students in arithmetic will—if the teacher has taught effectively—come up with identical solutions. That is also why the arts are regarded as subjective: One cannot apply a conventionally defined set of rules to determine whether the meanings that are conveyed are accurate. Idiosyncratic arrangements are encouraged when figurative syntaxes are employed.

The importance of this distinction between rule-governed and figurative syntactical emphases becomes apparent when we consider the kinds of cognitive processes that each type of syntax elicits. Learning of rules fosters acquiescence: One learns to *obey* a rule or to *follow* it. Figurative syntaxes, by contrast, encourage invention, personal choice, exploratory activity, and judgment. The use of forms whose syntax is figurative is an uncertain enterprise since there are no formally codified rules to guide judgments. The student, like the artist, is thrown on his or her own resources. How does one know when the painting is finished, the poem completed, the story ended? There is no predefined standard by which to check a solution. There is no correct answer given in the back of the book, no procedure for determining proof. The necessary cognitive operations are what were known, in earlier psychological jargon, as "higher mental processes." At the least, tasks that emphasize the figurative give people opportunities to form new structures, to make speculative decisions, and to act upon them. Such tasks also enable people to learn to judge—not by applying clear-cut standards, but by appealing to a form of rationality that focuses on the rightness of a form to a function.

It would be well at this point to recall the theme of this article, the role of the arts in cognition and curriculum. I began by describing a commonly held view: Cognition requires that ideas be linguistically mediated, whereas the arts are expressive and affective activities depending more upon talent than intelligence or cognition. I next analyzed the role of the senses in concept formation, arguing that all concepts are basically sensory in character and that concept formation requires the ability to perceive qualitative nuances in the qualitative world and to abstract their structural features for purposes of recall or imaginative manipulation. From there I moved to a discussion of the task of representation. An individual who wishes to externalize a concept must find some way of constructing an equivalent for it in the empirical world. To do this, people invent new forms of representation or borrow from those already available in the culture. Because these forms can be treated in different ways and because they appeal to different sensory systems, the kind of meanings each yields is unique. What we can convey in one form of representation has no literal equivalent in another. I have labeled the modes of treating these forms as mimetic, expressive, and conventional. Because the elements within forms of representation can be ordered according to different rules, I have identified a syntactical continuum, highly rule-governed at one end and figurative at the other. The rule-governed end of the continuum prescribes the rules of operations that must, by convention, be followed in ordering these elements. The figurative end allows maximum degrees of latitude for idiosyncratic arrangement. The former is more of a code; the latter, more of a metaphor.

But what is the significance of such analysis for education? What bearing does it have on what we do in school? What might it mean for what we teach? There are four implications, I believe, for the conduct of education and for education theory.

First, the view that I have advanced makes it impossible to regard as cognitive any mental activity that is not itself rooted in sensory forms of life. This expands our conceptions of intelligence and literacy. Any conception of intelligence that omits the ordering of qualities through direct experience is neglecting a central feature of intellectual functioning. But no intelligence test that is published today includes such tasks. The models of mind that underlie current tests assign only marginal intellectual status to what is an intellectual activity. One no more plays the violin with one's fingers than one counts with his toes. In each case, mind must operate, and the kind and number of opportunities a person is given to learn will significantly affect the degree to which his or her ability develops. The concepts of talent and lack of talent have been used too long to cover up weak or nonexistent programs in the arts. To be sure, individual aptitudes in the arts vary, but such differences also exist in other content areas. So-called lack of talent is too often nothing more than an excuse for absent opportunity. It also serves as a self-fulfilling prophecy.

Second, the view that I have advanced recognizes that the realm of meaning has many mansions. Science, for example, despite its enormous usefulness, can never have a monopoly on meaning because the form of representation it employs is only one among the several that are available. It is not possible to represent or to know everything in one form. The way Willy Loman conveys his inability to cope with a sinking career can only be represented through the expressive treatment of form that Arthur Miller employed in *Death of a Salesman*. The quality of space in the paintings of Giorgio de Chirico or Hans Hofmann depends on the artists' arrangements of visual images; it cannot be rendered through number. When Dylan Thomas (1953) wrote, "Do not go gentle into that good night,/Old age should burn and rave at close of day;/Rage, rage against the dying of the light," he conveyed a message about being in the anteroom of death that cannot be translated fully, even in propositional prose.

What this means for education is that—insofar as we in schools, colleges, and universities are interested in providing the conditions that enable students to secure deep and diverse forms of meaning in their lives—we cannot in good conscience omit the fine arts. Insofar as we seek to develop the skills for securing such meanings, we must develop multiple forms of literacy. Such meanings do not accrue to the unprepared mind. The task of the schools is to provide the conditions that foster the development of such literacy. At present, for the vast majority of students, the schools fail in this task.

Third, educational equity is one consequence for students of the change in education policy that my arguments suggest. As I have already pointed out, the benefits derived from excellence in differing forms of representation are not equal. Students who perform at outstanding levels in the fine arts do not have these grades taken into account when they apply for admission to colleges and universities. The beneficiaries of the funds allocated to education for the gifted often do not include students whose gifts are in the fine arts.[12] The amount of school time devoted to cultivating abilities in the arts is extremely limited; hence, students with abilities and interests in the arts are denied the opportunities that students in science, mathematics, or English receive.

Such policies and practices amount to a form of educational inequity. This inequity would cease if the arguments I have presented were used as grounds for decisions about the allocation of school time, about the criteria used to identify gifted students, and about the aptitudes suitable for college and university study. It is an anomaly of the first order that a university should confer credit in the fine arts for courses taken on its own campus and deny credits to students who have taken such courses in high schools. At present, that's the way it is.

Finally, the view I have presented implies that the cultivation of literacy in, for example visual and auditory forms of representation can significantly improve a student's ability to use propositional forms of representation. The ability to create or understand sociology, psychology, or economics depends on the ability to perceive qualitative nuances in the social world, the ability to conceptualize patterns from which to share what has been experienced, and the ability to write about them in a form that is compelling. Without such perceptivity, the content of writing will be shallow. Without the ability to manipulate conceptions of the world imaginatively, the work is likely to be uninspired. Without an ear for the melody, cadence, and tempo of language, the tale is likely to be unconvincing. Education in the arts cultivates sensitive perception, develops insight, fosters imagination, and places a premium on well-crafted form.

These skills and dispositions are of central importance in both writing and reading. Without them, children are unlikely to write—not because they cannot spell, but because they have nothing to say. The writer starts with vision and ends with words. The reader begins with these words, but ends with vision. The reader uses the writer's words in order to see.

The interaction of the senses enriches meaning. The arts are not mere diversions from the important business of education; they are essential resources.

Notes

1. These distinctions are reified most clearly in the customary separation between the cognitive and the affective domains, which are typically discussed as if they were independent entities or processes.

2. See especially *The Republic* (1951). Translated by F. M. Cornford. New York: Oxford University Press.

3. See for example, Schaff, A. (1973). *Language and Cognition*. New York: McGraw-Hill.

4. If an elementary teacher provides one hour of instruction in art and one hour of instruction in music each week, the percentage of instructional time devoted to both is about 7 percent. Many teachers provide less time than this.

5. The University of California, like many other state universities, provides no credit for grades received in the fine arts when computing grade-point averages for students seeking admission.

6. The acquisition of visual information over time is a function of micromovements of the eye and brain called sac des.

7. Insofar as something is conceivable, it must, by definition, be a part of human experience. Experience without sensory content is an impossibility.

8. The view argues that the reception and organization of sensory material require the use of intelligence. Intelligence is not

something that one applies after experiencing the empirical world. Rather, it is a central factor in the process of experience.

9. See Weitz, M. (September 1956). "The Role of Theory in Aesthetics." *Journal of Aesthetics and Art Criticism.*

10. In a sense, play is the ability to suspend rules in order to explore new arrangements. See Sutton-Smith, B., ed. (1979). *Play and Learning.* New York: Halsted Press.

11. This concept is elaborated in greater detail in Eisner, E.W. (1985). *Cognition and Curriculum, A Basis for Deciding What to Teach.* New York: Longman, Inc.

12. Until a few years ago, the Mentally Gifted Minor Program (MGM) in California - now Gifted and Talented Education (GTE) - did not include students who were gifted in the fine arts.

REFERENCES

Arnheim, R. (1954). *Art and Visual Perception.* Berkeley: University of California Press.

Collingwood, R. G. (1958). *Principles of Art.* Oxford University Press.

The Dictionary of Psychology. (1934). Cambridge: Riverside Press.

Gombrich, E. H. (1969). "Visual Discovery Through Art." In *Psychology and the Visual Arts,* edited by J. Hogg. Middlesex, England: Penguin Books.

Inhelder, B., and J. Piaget. (1958). *The Growth of Cognitive Thinking from Childhood to Adolescence.* Translated by A. Parsons and S. Milgram. New York: Basic Books.

Panofsky, E. (1955). *Meaning in the Visual Arts: Papers in and on Art History.* Garden City, N.Y.: Doubleday.

Rosenshine, B. (1976). "Classroom Instruction." In *Psychology of Teaching, 75th Yearbook of the National Society for the Study of Education, Part I,* edited by N. L. Gage. Chicago: University of Chicago Press.

Thomas, D. (1953). "Do Not Go Gentle Into That Good Night," *The Collected Poems of Dylan Thomas.* New York: New Directions.

33

Aesthetics: Where Thinking Originates

Arthur L. Costa

All information gets to the brain through our sensory channels—our tactile, gustatory, olfactory, visual, kinesthetic, and auditory senses. Persons whose sensory pathways are open and alert absorb more information from the environment than those whose pathways are withered and immune to sensory stimuli. Cognitive education should include the development of sensory acumen; therefore, *aesthetics* is an essential element of thinking skills programs. Aesthetics, as used here, means sensitivity to the artistic features of the environment and to the qualities of experience that evoke feelings like joy, exhilaration, and awe.

Although the aesthetic dimensions permeate the spirit of inquiry and are inherent to creativity and prerequisite to discovery, they have received little attention as part of cognitive instruction. Adding an aesthetic dimension to thinking implies that learners become not only cognitively involved, but also cognitively enraptured with the phenomena, principles, and discrepancies they encounter. Aesthetics is the sensitive beginning of rational thought, which leads to enlightened thinking about the complexities of our environment. It may be that from within the aesthetic realm the skills of observing, investigating, and questioning germinate. These are bases for further scientific inquiry. Aesthetics may also be the key to sustaining motivation, interest, and enthusiasm, since children must become aware of their environment before they can explain it, use it wisely, and adjust to it. With the addition of aesthetics, cognition shifts from a passive comprehension to a tenacious quest.

Children need many opportunities to commune with the world around them—to reflect on the changing formations of a cloud, to be charmed by the opening of a bud, to sense the logical simplicity of mathematical order. They need to be moved by the beauty of a sunset, intrigued by the geometry of a spider web, and exhilarated by the iridescence of a hummingbird's wings. The intricacies of a mathematical formula, the orderly patterns of chemical change, the apparent serenity of a distant constellation—all are aesthetic wonders that children need to experience.

Students who respond to the aesthetic aspects of their world behave in a way that reflects and supports their awareness. They derive more pleasure from thinking, and their curiosity becomes stronger as the problems they encounter become more complex. Their environment attracts their inquiry as their senses capture the rhythms, patterns, shapes, colors, and harmonies of the universe. They display cognizant and compassionate behavior because they perceive the delicate worth, uniqueness, and relatedness of everything and everyone they encounter. As children explore, investigate, and observe, their natural curiosity leads them to ask, "What?" "How?" and "What if?"

Children need help in developing this feeling for, awareness of, and intuitiveness about the forces affecting the universe—the vastness of space, the magnitude of time, the dynamics of change. Can this attitude be taught in specific lesson plans and instructional models? Are steps for its development written in method books? Can we construct instructional theory for cognitive education that includes aesthetic awareness as a basis for learning?

Perhaps we need to identify teachers who model thinking with an aesthetic sense, for it may be that these are the teachers who make children aware of the outside world and inspire them to become ardent observers and insatiable questioners. They may help students develop a compassionate attitude toward the environment and impart the sense of curiosity that is a prerequisite for higher-level thought—a curiosity that students will carry with them as they wonder throughout life.

34

Infusing the Teaching of Critical Thinking into Content Instruction

Robert J. Swartz

The movement to bring the explicit teaching of thinking into the classroom has stimulated the creation of a variety of special programs and courses. There are indications, however, that when a separate program is used as *the sole vehicle* for instruction in thinking, however effective it may be otherwise, the transfer of what is learned into other academic work and into everyday thinking is far less automatic than we would like (Perkins and Salomon 1988; Salomon and Perkins 1989). What can be done in content area instruction to remedy this? In this chapter I describe two basic approaches that address this problem, and elaborate the strategies used in the more integrative of the two—*infusing* the teaching of thinking into standard content area instruction.

Why Teach Critical Thinking in the Content Areas?

Much of the effort to teach thinking has focused on "higher-order thinking." What is involved in such thinking is neither esoteric nor technically difficult. In fact, it typically involves thinking processes that we all use regularly. Comparing and contrasting, predicting, finding causes, locating reliable sources of information, and deciding about things to do, for example, are forms of thinking that we employ almost every day of our lives. They are representative of a broad array of other activities no less familiar to us that are the focal points for our critical and creative thinking.

Performing these activities, however, does not necessarily involve either critical or creative thinking; *how* we perform them determines whether critical and creative thought are involved. If, for example, we develop and consider new and interesting options in the course of making a decision, we are exercising creativity. If we make well-considered and well-founded judgments about the reasonableness of these options, we are exercising careful critical thought. Of course, we do not always do this. But what is involved in the operations of our thought when it is critical and creative is not unfamiliar to us.

The idea that it is important to spend time with *all* students to help them reorganize their thinking in this way and the idea that there are clear instructional strategies to do so that yield demonstrable results are two fundamental tenets of the thinking skills movement of the 1980s. Why, though, do this in the context of subject area instruction?

The fundamental reason is that what we teach students in the content areas is not a set of inert pieces of information: it is the primary material that informed and literate people use to engage in much of their thinking. We want information about nutrition taught in science class to influence their dietary habits. We want an understanding of the political history of our country in American history to affect their choice of political candidates. Reliable and relevant information is the raw material for the natural thinking tasks that guide us through our lives. Infusion as a strategy for teaching thinking is based on the natural fusion of what we normally teach students with the forms of thinking that we use every day as we live our lives.

Two Approaches to Integrating Instruction in Thinking into the Content Areas

Lesson designers and teachers who emphasize the direct and explicit teaching of thinking and who want to enhance thinking in the content areas have, in general, used two related approaches. The first is "bridging" the use of skillful thinking into content lessons from lessons that teach these skills directly apart from the regular curriculum. Usually this is done by organizing instruction so that students are prompted to use the "bridged" skills to think about what they are learning in the lesson. For example, after students are taught sequencing skills directly through common sequencing activities, they are taught about England's royalty. They are then asked to use the sequencing skills they've been taught to organize what they learn about the lineage of the English monarchs, instead of simply learning the names of the monarchs and the dates of their reign (Presseisen 1987).

Several stand-alone programs, including *Instrumental Enrichment* (Feuerstein 1979), *Project Impact* (Winocur 1983), and *Building Thinking Skills* (Black and Black 1987) advocate this approach. Although the kinds of skills these programs attempt to teach vary (e.g., *Building Thinking Skills* concentrates on a basic cluster of important analytic skills such as comparing and contrasting and categorizing, while *Project Impact* includes instruction in other skills such as predicting and generalizing), they all share a "bridging" approach to the successful teaching of thinking. *Instrumental Enrichment* and *Project Impact* rely on teachers to effect such bridging. *Building Thinking Skills* now has a companion work, *Organizing Thinking* (Black and Black 1990), which provides a host of restructured lessons that incorporate the skills that are taught in *Building Thinking Skills* into content from standard language arts, social studies, science, and mathematics curriculums. This work makes extensive use of such sophisticated techniques as the use of graphic organizers to accomplish this.

The restructured lessons that result when bridging is attempted should not be confused with lessons that teach thinking directly, even though in the best of these, various specialized methods of instruction (e.g., an inquiry approach) are used to bring out the desired thinking. Rather, by themselves, such lessons usually constitute no more than *opportunities* for thinking and lack the scaffolding and structure necessary to accomplish the teaching of the specific thinking skills they incorporate. They are no substitute for the direct instruction lessons that they supplement.

The second approach collapses these two strands into one. It involves teaching important thinking skills explicitly within content instruction itself. This is what I call *infusion* (Swartz 1987). Lessons representing this approach have a dual purpose: instruction in skillful thinking *and* a deeper mastery of the content that had been the sole objective of instruction. The best of such lessons aim at a mutual reinforcement of learning through the careful choice of both skills and content.

Infused lessons usually involve a complex restructuring of content lessons. Teachers use a rich variety of techniques, including explicit commentary on the thinking processes being taught and various metacognitive strategies, judiciously blended to reinforce students' learning of the thinking skill and their active engagement with the content. Imagine that the sequencing activity used in the monarchs of England lesson was the sole vehicle for teaching about the monarchs *and* for teaching better sequencing skills. In this case, we would expect direct instruction about strategies for sequencing to be blended with instruction about the monarchs in ways that the lesson designer hopes would lead to students' learning the strategies for sequencing *and* understanding the relationships between the monarchs.

Figure 1 shows the relationships and some of the basic characteristics of these two approaches to teaching thinking in the content areas. Which of these two approaches is better for the classroom teacher to use? Proponents of bridging sometimes argue that to infuse direct instruction into content teaching often distracts students and makes it harder to teach the thinking skills that are the objects of instruction. I know of no research to support this. Nor do I know of research to support the opposite claim—that teaching thinking skills separately creates such a gulf between the lessons in which these skills are learned and the subject matter in which we want students to use them that it is hard for students to apply these skills in learning content. For all we know, both approaches are equally viable, and choices between them may be justified on the grounds of economy, teaching style, and even the needs of individual students.

Examples of Infused Lessons

Teachers can, of course, infuse a wide variety of thinking skills into their teaching. Without devaluing the teaching of either creative thinking skills or basic analytical and/or information processing skills, I have chosen to describe lesson examples that infuse only basic *critical thinking* skills—those needed to make wise critical judgments. My rationale for this selection is one of advocacy. I believe that these skills are crucial in our ability to make decisions and solve problems. Yet one rarely finds these skills emphasized.

Here is a list of core critical thinking skills from which the teachers whose lessons are described in this chapter have chosen their thinking skill emphases:

Critical Thinking Skills (skills for assessing the reasonableness of ideas)

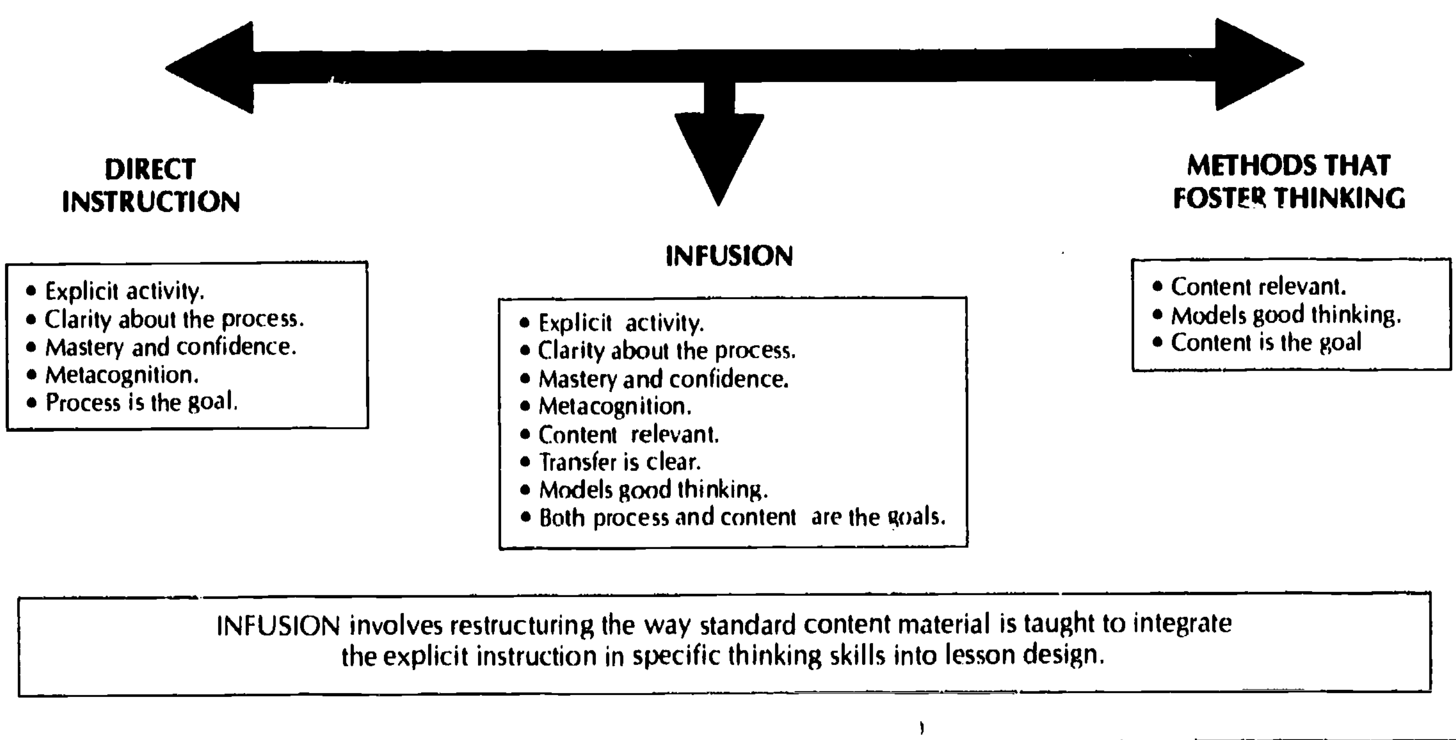
1. Support of Basic Information
   - determining the accuracy of observations
   - determining the reliability of secondary sources
2. Inference
   - use of evidence
     - — well-founded causal explanation
     - — well-founded prediction
     - — well-founded generalization
     - — well-founded reasoning by analogy
   - deduction
     - — valid conditional arguments (If . . ., then . . .)
     - — valid categorical arguments (All/Some . . .)

In an earlier work, David Perkins and I describe a paradigmatic critical-thinking-in-the-content-areas lesson developed by Kevin O'Reilly, a high school American history teacher from the Hamilton-Wenham School system in Massachusetts (Swartz and Perkins 1989). To teach about the reliability of sources of information in history, O'Reilly first stages a scuffle in the corridors outside his classroom and then asks student witnesses to tell what happened. He compares the accounts his students give to the variety of accounts that were given about the Battle of Lexington in 1775, the battle that started the fighting in the Revolutionary War. As students attempt to determine which of the eyewitnesses gave the most accurate account of the battle and reflect on why one historical account is better or worse than another, they are armed with critical skills that they draw on again and again in O'Reilly's classroom. These skills relate to the reliability and accuracy of eyewitnesses, of observation, and of other sources of information in general—skills that are important in our life outside the classroom. In the immediate context of their study of the Revolutionary War, O'Reilly's students use these skills to make informed critical judgments about the accuracy of various textbook accounts of the Lexington incident that students who are simply directed to read these texts to "get the facts" cannot make.

Besides developing very important critical thinking skills, O'Reilly's students learn a tremendous amount about the context for the battle and the biases that people might have had in describing what happened during the battle (it occurred right after the Boston Massacre trials, and some colonists wanted to use it as a rallying cry to the uncommitted against the British). They also gain a critical perspective on the role of such reports in the construction of a history and on the way that histories themselves can be written from different points of view.

Infusion is not restricted to American history or to high school. Cathy Skowron, a 1st grade teacher in the Province-

FIGURE 1
Infusing the Teaching of Thinking



town Elementary School, uses the same technique. She follows the tale of Chicken Little (which she has just read to her students) with a discussion, prompted by her questioning, of whether the other animals should have trusted Chicken Little, and how they could have determined whether she was a reliable source of information. After all, it might have paid for them to consider this question. Believing her without raising these questions is one of the primary reasons they were led into the foxes' den.

Many primary grade teachers use such stories only to help students build listening skills or vocabulary. Skowron appreciates this, but wants to do more. Helping them to develop some initial skill at determine the reliability of sources of information is the additional goal she now has in teaching this story. This, in fact, makes it easy for her to extend her content objectives. Integrating questions that help students consider the reliability of Chicken Little as a source of information helps them to understand the story at a different level. They now begin to grasp the "moral" of the Chicken Little story: that uncritical thinking can be dangerous. This allows Skowron to begin to teach them what a moral to a story is.

Skowron's lesson differs from O'Reilly's 9th grade American history lesson in the sophistication of content, the level of vocabulary, and in the expectations that she has about the background knowledge of her students. Nonetheless, like O'Reilly, she tries to help students consider factors that are often overlooked in making a judgment about the reliability of sources of information. Students not only learn to raise questions of reliability in appropriate contexts, but think more thoroughly about how to answer these questions.

The same critical thinking skill can be taught, reinforced, and elaborated in many other contexts, subjects, and grade levels. For example, one teacher helps her students with library research by giving them a variety of books on the same topic and then by helping them draft questions they need to answer in order to decide which source is likely to give them the most accurate information about a topic. In so doing, they focus on relevant factors like the date of the books, the expertise of the authors, whether the account is firsthand or secondhand, whether the book is fictional, and so on. She reports that students' interest in the topic they are researching is piqued, and better research projects result.

Other critical thinking skills can also be the focus of infused lessons. Skowron also prompts her students to think about whether Chicken Little herself had good evidence that the sky was falling. Did she jump to a conclusion? Could something else, other than the sky, have hit her on the head? What could it have been, and how could we find out whether that was what caused the bump on her head? In general, how can we find out what *causes* something to happen?

Causal explanation and causal reasoning involve a cluster of skills different from those involved in thinking about the reliability of sources of information. They are fundamental skills of *inference*—supporting a hypothesis that is considered reasonable with evidence. The most common pattern of thinking used for careful causal reasoning involves four focal points: (1) brainstorming possible causes to produce several causal hypotheses, (2) reflecting on what evidence we can get to decide which hypothesis is the most likely, (3) gathering relevant evidence, and (4) choosing the best explanation, based on the evidence gathered. Skowron also tries to teach students this pattern of thinking in her handling of the Chicken Little story. In this lesson, even 1st grade students can begin to appreciate the impulsiveness of the characters' behavior. "Chicken Little thinking," for example, is the term teachers subsequently use to remind students of jumping to a conclusion.

Similarly structured lessons to teach skillful causal explanation have been taught in 5th grade science on the extinction of the dinosaurs (Swartz and Perkins 1989, ch. 4). These lessons likewise involve students in identifying possible causes and thinking through what evidence would be needed to pick out one of these as the most reasonable explanation. Such lessons are ideal contexts to introduce students to the idea of a scientific theory and what sort of evidence we need to support it. Various theories about what caused the extinction of the dinosaurs form the context for this—ideas that never cease to excite the imagination of elementary school students.

This pattern of thinking can even be taught in 9th grade English classes in ways that enhance students' deep comprehension of texts that they are reading. For example, instead of asking students to read *Huckleberry Finn* merely for the surface plot, teachers can ask them to answer questions that call for careful reflective thinking—for example, "What motivates Huck Finn's father to abduct him?" In this case, leading students through the causal reasoning process can help them learn more careful thinking about causes and can help them grasp the crucial relationship between Huck and his father—a key component in understanding this text. In addition, they will become more conscious of the need to use skillful causal reasoning when they make judgments about human motivation in general. Once again, judicious blending of thinking-skill objectives and content objectives creates a dynamic lesson that enhances the achievement of each.

Infusing critical thinking skills into standard subject area instruction can also spur students to explore rich concepts that are often introduced only in cursory ways. Causal explanation, for example, also plays a role in determining responsibility. Cathy Peabody, a 12th grade English teacher in Groton, Massachusetts, asks her students the same set of causal questions about *Romeo and Juliet*. Recognizing that it is a play in which chance, emotion, misunderstanding, and deliberate intent create a tragic causal web, Peabody helps her students brainstorm possible causal chains leading to the tragedy and then select the most likely explanation based on evidence in the text. They develop a more skillful approach to causal reasoning through this activity. But she takes the lesson further. She asks, "Who among the people involved in this causal chain (if anyone) was *responsible* for the death of Romeo and Juliet? Juliet's father? Friar Lawrence? Just Romeo and Juliet themselves? Anyone else? Why? On what basis do we hold people responsible for things that happen?" These are perplexing questions that require good, careful, and critical thinking. It is through these questions that Peabody brings her students to the deeper issues of causality and responsibility that Shakespeare intends us to grapple with when reading the play. Thinking carefully about the deaths of Romeo and Juliet provides a basis for learning better causal reasoning skills *and* a framework within which students can probe the concept of responsibility more systematically and with more depth than if they simply read the play for structure and plot.

In addition, Peabody helps her students see analogies between the issues in the play and issues in their own experience, just as O'Reilly does. They consider situations in which they have been involved and questions of responsibility or blame have arisen. Peabody prompts them to test their ideas about responsibility by applying them in these cases too.

These examples show what can be done to infuse the teaching of two key critical thinking skills into the curriculum by finding natural contexts in which they can be used. Imagine the richness of a curriculum and the depth of learning possible when a school decides to infuse all of the major critical thinking skills in similar ways. Indeed, a number of schools in the United States have adopted this as a major goal (Dundas and Rowe 1986; Desilets 1988). They form living laboratories to test many of the implications of this approach to teaching thinking vis-a-vis student learning, curricular coverage, and teacher involvement in curricular decision making.

Instructional Strategies

Explicitly Structure Students' Thinking

Teachers are often told to stop asking only "what" questions and to ask more "why" questions—questions that prompt more than simple recall. This is one of the main uses practitioners have made of the insights of Benjamin Bloom.

The infusion lessons I have described *sound like* examples of this sort. Nonetheless, there are important subtleties in the lessons of O'Reilly and the other teachers that go beyond the mere asking of "higher-order questions."

There is no doubt that a lot of thinking beyond simple recall occurs in classrooms where many "why" and "how" questions are asked. But is this enough to *teach* critical thinking? If I ask, "Why did Huck Finn's father abduct him?" I give students an *opportunity* to think. But if they are in the habit of guessing or making hasty judgments about what causes things to happen, all I have done is give them another opportunity to do the same. This is part of what is now called teaching *for* thinking. Its claim to provide instruction that will improve student thinking is relatively weak. To be sure, some students might pull themselves up by their bootstraps, but it is unlikely that many will. Questioning of this sort doesn't teach students who are generally unaware of how they think to modify any bad habits they have in thinking about questions like this one.

What O'Reilly, Skowron, and Peabody do, on the other hand, involves the use of some very specific strategies designed to make the lessons they teach more effective in achieving their thinking goals as well as their content goals. For example, in teaching students causal reasoning these teachers *explicitly direct their students to attend to evidence* by asking them to make lists of evidence that could count for and against possible causes of an event like the abduction of Huck Finn or the death of Romeo and Juliet. The students are then asked to search the text thoroughly for such evidence in order to help them make a carefully considered judgment about the causes of these events. Thus, they focus on points they often overlook when making judgments about causes: they have to make sure that their explanation for what motivated Huck's father or brought about the death of Romeo and Juliet is well supported by evidence and that competing explanations are ruled out. Asking students to defend their judgments of causal explanation with reasons (as Skowron and Peabody do) can cap off such direct instruction.

The teachers I have described make quite explicit to students the focal points of good thinking and *directly* coach them to modify their usual thinking habits. This is the essence of what Brandt (1984) calls "teaching OF thinking" and it is one of the central innovations of the thinking skills movement of the 1980s (Costa 1985c). In the early 1980s, the primary use of this technique was in instructional efforts that were separate from the standard curriculum. Integrating such direct thinking skills instruction *into* the standard curriculum is the innovation of infusion efforts of the sort I have described in this chapter.

Help Students Reflect on Their Thinking

Using focusing questions that make explicit use of critical thinking terminology has a specific function in the lessons of teachers like O'Reilly, Skowron, and Peabody. It helps to cue students and focus their attention on certain ingredients in their thinking (like considering evidence) that they often miss. This shades into the use of another important technique that these teachers incorporate into their lessons: prompting students to reflect on their thinking so that they can monitor and direct it better themselves, developing their *metacognition* (Costa 1985a; Beyer 1987; Swartz 1989b).

Considerable research shows that in certain circumstances, metacognition is extremely effective for enhancing learning (Bransford, Sherwood, Vye, and Riser 1986). When we think about our thinking, we can become aware of how we are doing it and deliberately modify it. We can do this by setting goals, forming a plan to meet those goals, and then acting according to the plan. Of course, this is not an unfamiliar technique for taking better control of actions; the great insight about metacognition as a tool for good thinking is that thinking itself is subject to our deliberate control, just as our overt behavior is. By taking charge of our own thinking *we* can reorganize it to counter shortfalls we may detect in the way we ordinarily think.

With this in mind, teachers can use various strategies to help students get used to monitoring, planning, evaluating, and directing their thinking. O'Reilly often asks his students to list the factors they considered in reflecting on the reliability of eyewitness accounts of the Battle of Lexington after they have gone through the process of judging their reliability. This helps students monitor their thinking. O'Reilly then asks students to share these and to develop a comprehensive list of factors that *should* be considered in assessing the reliability of an eyewitness report. They craft this list into a set of guidelines that they can use whenever they need to assess the reliability of eyewitness reports. Using these guidelines, students can see that they may not have considered all the relevant factors (evaluating their thinking) and they can decide to broaden the way they think about reliability in the future (planning their thinking).

In this lesson, many students found that they initially judged reliability by considering only whether the person was at the battle or heard it secondhand, and how close he was to the battle. When they heard other students remark that they also considered the possible bias or vested interest the eyewitness may have had in having people believe *his* account, they realize that they should have considered this factor as well. In one case, many students judged a particular eyewitness report to be quite credible, but didn't consider that it was given many years after the battle (51 years to be exact). When they heard other students mention this, they realized that it is important to take account of how long after the event the eyewitness reported what happened. They also became quite sensitive to the fact that no one of these factors is definitive; rather, they give reasons to doubt or endorse credibility and must be weighed together. Teachers report that this technique helps students become much more conscious of how they are thinking and leads them to try to modify their thinking.

There are, of course, a myriad of other strategies that have been introduced into instruction to promote metacognition. These range from very directive strategies like giving students an explicit plan or a graphic organizer to guide their thinking in the lesson (Beyer 1987; Black and Black 1990) to techniques like "Think–Pair–Share" (McTighe 1987), in which students "think out loud" so that other students can help them directly while they are doing their thinking (Swartz and Perkins 1989, ch. 7; Swartz 1989b). But whatever techniques are used, keeping in mind the goals of metacognitive instruction is crucial for making these techniques effective in infused lessons.

Give Students More Practice for Transfer

Helping students plan their thinking through various metacognitive activities in the classroom seems hollow unless they have a chance to actually follow the plan a number of times so that they get used to thinking this way. This is the motivation behind practices employed by O'Reilly, Skowron, and Peabody to explicitly teach for transfer when they introduce infused lessons. Research supports explicit transfer as an important ingredient in teaching thinking and it should build on metacognitive strategies of the sort described above (Perkins and Salomon 1988).

A number of months after the lesson on the Battle of Lexington, Kevin O'Reilly has students read several eyewitness accounts of conditions under slavery before the war (from slaveholders, abolitionists, Northern newspaper articles, and so on). On the wall is a chart outlining guidelines that students have developed in their previous work for thinking about the reliability of eyewitnesses. While some students recognize this as an occasion for applying these guidelines, others don't. O'Reilly simply reminds them of their previous work and its applicability to this case as a prompt to follow the plan for thinking that they devised themselves. In classrooms where this is practiced, teachers report that it takes only one or two such reminders before most students apply their plan much more automatically.

Most teachers, of course, hope that the habit of guiding thinking according to a plan sticks with students outside the classroom as well. Some teachers reinforce this habit more directly as extensions of their subject area instruction. Helping students apply the specific critical thinking skills being taught in infused lessons to examples from their own lives, as O'Reilly and Peabody do, is an obvious way to do this. Other techniques for teaching directly for transfer are described in a variety of published works on teaching thinking (see Swartz and Perkins 1989, ch. 7; Swartz 1989b; Beyer 1987; Perkins and Salomon 1988).

Develop Dispositions of Critical Thinking

O'Reilly, Skowron, and Peabody are also sensitive to the need to promote the development of a variety of attitudes and dispositions of thinking. Their concern is to break students from a rigid "I've got to get the right answers so that I can pass the test" attitude. They seek to help students become more open-minded, to respect others' points of view, to be willing to change their mind in the light of new information, to consider unpopular or unusual ideas, and, above all, to seek reasons for ideas before they accept them.

Teaching for these attitudes in no way conflicts with the use of the cognitively oriented techniques just described. In fact, it is an overlay in the thinking classroom that complements the features of infused lessons that I have described. O'Reilly, Skowron, and Peabody all make changes in the classroom environment and structure, in their interactions with students, and in their own style of expression in the classroom to help foster these attitudes.

Skowron, for example, asks her students various prompting questions for which a variety of different answers are accepted (e.g., when she brainstorms possible causes of the bump on Chicken Little's head). She also uses longer periods of wait time for student responses. O'Reilly and Peabody break students into small cooperative learning groups that have specific thinking tasks and then ask that the results be shared with the whole class. O'Reilly, for example, sometimes breaks his class into six groups and has each work on an eyewitness report of the Battle of Lexington, listing its strengths and weaknesses and then sharing the results so that the whole class can try to arrive at a collective judgment about which reports are credible and why. Peabody, likewise, has her students work in collaborative groups, each exploring one of the possible causal chains leading to the death of Romeo and Juliet and then sharing the results of their work. These techniques foster respect for other points of view and an attitude of collaboration in working on a thinking task.

These teachers also think through issues with the students, admit they don't know the answers to certain questions, and try to find out along with the students. Such modeling, many teachers believe, is invaluable in shaping students' attitudes in the classroom.

A multitude of practices (of which some, like collaborative learning, have been well researched independent of teaching thinking) can play an important role in helping build good thinking attitudes in infused lessons. Costa 1985b, Beyer 1987, and Costa and Lowrey 1989 are valuable resources in elaborating such techniques.

A Summary of the Basic Instructional Strategies

There are no pat formulas for constructing the more elaborate types of infused lessons found in the work of O'Reilly, Skowron, and Peabody. They use a variety of practices to serve their goals as teachers of thinking. What stands out, however, is that these practices include four basic components that should be attended to in designing such lessons:

- They explicitly help students better organize the way they engage in specific thinking processes.
- They involve significant opportunities for students to reflect on the thinking they are doing.
- They follow up specific lessons with opportunities for students to get more practice doing the same sort of thinking in new situations.
- They are conducted in an open classroom environment where good thinking attitudes are modeled and where students are given opportunities to manifest those attitudes (as in collaborative learning).

The lessons I have commented upon and analyzed are examples of what can be done to teach important generic skills of critical thinking across the curriculum in the content areas. Such lessons are a *must* if we are to help our students realize their full potential. And why should we stop short of that!

REFERENCES

Beyer, B. (1987). *Practical Strategies for the Teaching of Thinking*. Newton, Mass.: Allyn and Bacon.

Black, S., and H. Black. (1990). *Organizing Thinking*. Pacific Grove, Calif.: Midwest Publications.

Black, S., and H. Black. (1987). *Building Thinking Skills*. Pacific Grove, Calif.: Midwest Publications.

Brandt, R. (1984). "Teaching of Thinking, for Thinking, About Thinking." *Educational Leadership* 42, 1: 3.

Bransford, J., R. Sherwood, N. Vye, and J. Riser. (November 1986). "Teaching Thinking and Problem Solving: Research Foundations." *American Psychologist* 41, 10: 1078–1089.

Costa, A. (1985a). "Mediating the Metacognitive." In *Developing Minds*, edited by A. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Costa, A. (1985b). "Teacher Behavior That Enables Student Thinking." In *Developing Minds*, edited by A. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Costa, A. (1985c). "Teaching For, Of and About Thinking." In *Developing Minds*, edited by A. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Costa, A., and L. Lowery. (1989). *Techniques for Teaching Thinking*. Pacific Grove, Calif.: Midwest Publications.

Desilets, B. (November 1988). "An Experience in Empowerment: The Bedford Model." *Cogitare: A newsletter of the ASCD Network on Teaching Thinking*.

Dundas, K., and J. Rowe. (1986). *The Provincetown Elementary School: A Place For Thinking*. Provincetown, Mass.: Provincetown Elementary School.

Feuerstein, R. (1979). *Instrumental Enrichment*. Washington, D.C.: Curriculum Development Associates, Inc.

McTighe, J. (1987). "Teaching For, Of, and About Thinking." In *Thinking Skills Instruction: Concepts and Techniques*, edited by K. Heiman and J. Slomnienko. Washington, D.C.: National Education Association.

Perkins, D. N., and G. Salomon. (January/February 1989). "Are Cognitive Skills Context-Bound?" *Educational Researcher* 18, 1: 16–25.

Perkins, D. N., and G. Salomon. (September 1988). "Teaching for Transfer." *Educational Leadership*

Presseisen, B. (1987). *Thinking Skills Throughout the Curriculum*. Bloomington, Ind.: Pi Lambda Theta, Inc.

Salomon, G., and D. N. Perkins. (1989). "Rocky Roads to Transfer: Rethinking Mechanisms of a Neglected Phenomenon." *Educational Psychologist* 24, 2: 113–142.

Swartz, R. (1989a) "Critical Thinking." *Addison-Wesley Science Professional Information Bulletin*. Menlo Park, Calif.: Addison-Wesley.

Swartz, R. (1989b). "Making Good Thinking Stick: The Role of Metacognition, Extended Practice, and Teacher Modeling in the Teaching of Thinking." In *Thinking Across Cultures: The Third International Conference*, edited by D. Topping, D. Crowell, and V. Kobayashi. Hillsdale, N.J.: Erlbaum.

Swartz, R. (1987). "Teaching for Thinking: A Developmental Model for the Infusion of Thinking Skills into Mainstream Instruction." In *Teaching Thinking Skills: Theory and Practice*, edited by J. Baron and R. Sternberg. New York: W. H. Freeman.

Swartz, R., and D. N. Perkins. (1989). *Teaching Thinking: Issues and Approaches*. Pacific Grove, Calif.: Midwest Publications.

Winocur, S. (1983). *Project Impact*. Costa Mesa, Calif.: Orange County School District.

WORKS CONTAINING PUBLISHED EXAMPLES OF INFUSED LESSONS

Barman, C., et al. (1989). *Addison-Wesley Science*. Menlo Park, Calif.: Addison-Wesley.

O'Reilly, K. (1983). *Critical Thinking in American History*. Pacific Grove, Calif.: Midwest Publications.

Paul, R., A. Binker, and M. Charbonneau. (1987). *Critical Thinking Handbook: K–3. A Guide for Remodelling Lesson Plans in Language Arts, Social Studies, and Science*. Rhonert Park, Calif.: Sonoma State University.

Paul, R., A. Binker, and H. Kreklau. (1987). *Critical Thinking Handbook: 4th—6th Grades. A Guide for Remodelling Lesson Plans in Language Arts, Social Studies, and Science*. Rhonert Park, Calif.: Sonoma State University.

Schraer, R., and J. Stolze. (1988). "Critical and Creative Thinking." In *Biology: The Study of Life, Teacher's Resource Book*. Newton, Mass.: Allyn and Bacon.

Sterns, P., D. Schwartz, and B. Beyer. (1989). *World History: Traditions and New Directions*. Menlo Park, Calif.: Addison-Wesley.

35

Why Embed Thinking Skills Instruction in Subject Matter Instruction?

Richard S. Prawat

There are several arguments for embedding thinking skills instruction in subject matter instruction. On the practical side, two steps become one: Instead of teaching *general* thinking skills and then showing students how they can be applied to *particular* subjects, teachers can simply teach the skills in the context of their application. Similar thinking skills, however, take on different character in different subject matter domains, thus complicating matters. In social studies, for example, judging the credibility of information relevant to particular social decisions may lie at the core of critical thinking; in math, examining the premises that underlie mathematical claims may better capture the essence of this type of thinking. Advocates of the embedding approach believe that the better transfer of skills across subjects compensates for the added complexity of the teaching process.

The conceptual arguments for embedding thinking skills in subject matter content are more controversial. Much of the back-and-forth on this issue has dealt with critical thinking, which involves a kind of "show me" attitude—a propensity to be skeptical about knowledge claims. Advocates of the embedding approach argue that before one can adequately question a particular activity or belief, one quite naturally needs to understand what is involved. Disciplinary knowledge plays a key role here. For example, in science we are more inclined to show healthy skepticism about a new finding if we know something about the scientific process—how those within the scientific community go about establishing truth claims, for instance, and how the process can go wrong on occasion. The same point might be made about other fields as well. Advocates of the embedding approach argue that we cannot divorce critical thinking about an activity from knowledge of the processes that define the activity. The same holds true for beliefs. Before we can pick apart an argument, we have to understand the basis for the argument. It thus makes sense to teach thinking skills in the context of what it is that we want people to think about.

As the selections in this section of the book indicate, the embedding approach encompasses a good deal more than critical thinking. In fact, critical thinking is but one of three categories of thinking skills, and each plays a distinctive role in the processing of information.

Executive Control Skills

Executive control skills help to mobilize and direct mental energy. They are complex and, like critical thinking, take on different coloration in different subject matter domains; nevertheless, there is a sameness about these processes across various domains. Problem analysis, planning, and decision making appear to be key aspects of the executive control function regardless of the subject matter context. These processes, in turn, involve a diverse but important set of skills, such as defining situations, setting goals, formulating plans, comparing alternative courses of action, judging difficulty, apportioning time, and monitoring results. Without these skills, our activity would be aimless or entirely at the mercy of external factors.

In reading, we use executive control skills when we articulate our reasons for reading (e.g., for general knowledge or to gain more specific information) and when we engage in important prereading activities like skimming the text to get a feel for its overall structure (cf. Jones 1990). Skimming is akin to problem analysis, and may lead to developing a plan for allocating time in order to maximize learning.

In mathematics, planning may take a somewhat different form: It may involve outlining a solution to a problem at a very general level, adding detail as the solution proceeds (cf. Schoenfeld 1990). In social studies, considerable emphasis is placed on comparing alternative courses of action, taking into account both personal and social factors. What these processes have in common is that they foster a reflective, deliberative approach to problem solving or decision making. Instead of jumping in, willy-nilly, students who regulate their behavior in this way pull back to carefully consider what must be done, and to devise alternative ways to approach a particular situation. This is a valuable set of skills; research shows that experts in a number of domains devote more time to problem analysis and planning than to any other aspect of the problem-solving and decision-making process.

Learning Skills

Good students often invent learning skills of various sorts, some more effectively than others. One of the most powerful learning skills is relating new information to what we already know. There are several things that we can do to ensure that potentially relevant prior knowledge is activated and used as a framework to make sense out of new information. Self-questioning is very effective in this regard—asking "What do I know about this topic that may help me understand this new information?" Good learners seem to have developed a knack for doing this, but it is a thinking skill that can be taught in the context of subject matter instruction. Other examples include the use of various memory strategies or mnemonics, such as visualization, underlining particular sections of text, constructing concept maps that depict important relationships between ideas, developing metaphors or analogies, using charts to compare and contrast items on various dimensions, outlining important points, making use of models or other concrete representations of procedural or conceptual knowledge, and so forth.

How a particular learning skill is implemented differs from one subject matter domain to another, and some skills are more useful in certain fields than others. For instance, much of the work on mnemonics has focused on vocabulary acquisition in foreign languages, and forming analogies is a particularly fruitful strategy in science. On the other hand, making comparisons is a useful learning strategy in many different subject matter domains, although the processes of comparing books in English, systems of the body in science, and types of triangles in mathematics are only roughly equivalent (Ackerman and Perkins 1989). For this reason, it may be helpful to embed learning skills in subject matter instruction.

Critical Thinking Skills

Critical thinking functions more like a critic than a guide. As Ennis (1962) explains, critical thinking leads to the "correct assessment of statements." The skills involved in critical thinking are thus primarily reactive in nature. They are used to judge the adequacy or acceptability of the intellectual "products" that result from implementing the executive control skills and the learning skills. Critical thinking involves the ability to respond evaluatively to either one's own or someone else's interpretations of reality. Like the other skills, critical thinking manifests itself differently in different subject matter contexts. Members of each field have their own characteristic ways of reasoning. Mathematicians are quite fond of deductive reasoning while scientists prefer a type of inductive reasoning. Social scientists, on the other hand, rely heavily on informal reasoning to evaluate the truth or falsity of various claims. These different approaches may be best taught in the context of a particular subject matter domain.

A Cautionary Note

The problem with the embedding approach is not that thinking skills will be lost during instruction, but that they may acquire an exaggerated importance vis-a-vis subject matter goals. When this happens, thinking skills become just another thing to learn in an already crowded curriculum. As an example, Palincsar, Stevens, and Gavalek (1989) found that roughly half the teachers who used their technique in teaching reading were *un*successful, even though the students had mastered the requisite executive control skills. Upon closer examination, Palincsar and her colleagues discovered that the unsuccessful teachers had misconceived the task, regarding mastery of the reading skills as an end in and of itself rather than as a means to an end—that of developing student understanding. The successful teachers, on the other hand, were better able to provide students with a sense of what the enterprise was all about.

And this is the key. Whether teachers use embedded instruction or a separate course approach, they need to keep in mind that the purpose of all skill instruction is to help students learn.

REFERENCES

Ackerman, D., and D. N. Perkins. (1989). "Integrating Thinking and Learning Skills Across the Curriculum." In *Interdisciplinary Curriculum: Design and Implementation*, edited by H. H. Jacobs. Alexandria, Va.: Association for Supervision and Curriculum Development.

Ennis, H. R. (February 1962). "A Concept of Critical Thinking." *Harvard Educational Review* 32, 1: 83–111.

Jones, B. F. (1990). "Reading and Thinking." In *Developing Minds*, 2nd edition, edited by A. L. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Palincsar, A. S., D. D. Stevens, and J. R. Gavelek. (1989). Collaborating in the Interest of Collaborative Learning. *International Journal of Educational Research* 13, 1: 41–52.

Schoenfeld, A. H. (1990). "What's All the Fuss About Mathematical Problem Solving?" In *Developing Minds*, 2nd edition, edited by A. L. Costa. Alexandria, Va.: Association for Supervision and Curriculum Developmet.

36

Critical Thinking as a Lived Activity

Patricia Copa, Francine Hultgren, and Joan Wilkosz

Teaching for thinking is a popular theme in contemporary American education. Its desirability and its purpose are generally assumed and not questioned. But why is being able to think critically something we value for students? And what is it that young people should be able to do better because of it?

In home economics classes, programs designed specifically to improve the well-being of individuals and families, the answers to these questions are not mere academic exercises but are, instead, the very core of teaching and learning: in home economics, thinking *must* translate into action. We value critical thinking specifically because it helps people take action to solve practical problems.

Learning to think and act in better ways involves more than acquiring new ideas, techniques, or skills. It often demands giving up the familiar, comfortable ways of approaching ideas, ascribing meanings, and translating thoughts into action. Wallerstein (1987) is correct in calling attention to the "transformative" quality demanded of such an effort:

> Critical thinking starts from perceiving the root causes of one's place in society—the socioeconomic, political, cultural and historical context of our personal lives. But critical thinking continues beyond perception—towards the actions and decisions people make to shape and gain control over their lives. True knowledge evolves from the interaction of reflection and action (or praxis) and occurs when human beings participate in a transforming act (p. 34).

These central ideas have become part of the home economics curriculums and staff development programs developed in several states over the past ten years. And their infusion into the curriculum has changed the way that teachers do their jobs.

A Practical Problem Framework for the Home Economics Curriculum

In 1979, a document called *Home Economics—A Definition* (Brown and Paolucci 1979) redefined and clarified the mission of home economics. The work outlines a proactive role for families in guiding and supporting their members and in promoting a better society. According to this document, the mission of home economics is to:

> enable families, both as individual units and generally as a social institution, to build and maintain systems of action which lead (1) to maturing in individual self-formation and (2) to enlightened cooperative participation in the critique and formulation of social goals and means for accomplishing them (p. 23).

The document emphasizes that a family is defined by its members' essential characteristics, not by a particular composition or form. Accordingly, the family is defined as "a unit of intimate transacting, and interdependent persons who share some values and goals, resources, responsibility for decisions, and have commitment to one another over time" (Bivens, Fitch, Newkirk, Paolucci, Riggs, St. Marie, and Vaughn 1975, p. 36). The family is thought of both on the individual level—e.g., Joyce and her daughter, the Joneses, Pete and his grandfather, Pat and Sid—and as one of a number of social institutions (including, for example, schools, government, the press, churches) that contribute to the ongoing operation of society. These interrelated notions of family are the focus of home economics programs in general and school programs in particular.

Furthermore, the home economics curriculum is directed toward the *practical perennial problems* of the family. In addition to being perennial or recurring in families from one generation to the next, these problems display a "practical" quality that makes them different from abstract mental puzzles and how-to problems. The practical problems of families are first and foremost human problems and, as such, are permeated by humanly constructed meanings, traditions, values, power structures, and relationships, as well as unique histories. In this respect, they are of the nature Reid (1979) describes as "unclear, moral problems":

1. *They are questions that demand answering and commitment to action:* It is not enough merely to *think* about them.

2. *The grounds on which decisions should be made are uncertain:* There are no prescribed rules for dealing with them, and much of the information needed is unclear and continually changing.

3. *In addressing practical problems, some existing state of affairs must be taken into account:* There is no opportunity to "block out" or control past or present "variables."

4. *Each problem is in some way unique:* It has a specific setting with particular actors, a political climate, and a broader cultural context.

5. *Practical problems compel negotiation between competing goals and values:* Some potential goals will have to be compromised as others take precedence.

6. *The outcome of the chosen approach to action can never be fully predicted.* Nor will the fact that the outcomes of alternatives not selected be known.

7. *The action chosen for addressing the problem has implications and consequences that go beyond resolving that problem alone:* What is done in a particular situation is believed to lead or not to lead to some more desirable general state of affairs.

Unfortunately, problems do not come with labels that say "this is a practical problem" or "this is a technical concern." Instead, viewing the world of families in terms of practical problems requires a special orientation, one that is not always popular in this age of scientific answers and technological solutions. Science and technology are insufficient to address adequately many of the problems families have. It is often necessary to examine critically the conditions out of which the problems arise, rather than to seek an expedient remedy for them. For example, the rising numbers of persons who declare bankruptcy and families who cannot purchase adequate food, clothing, and health care could be attributed to their lack of specific knowledge, inadequate decision-making skills, or a combination of both. From this perspective, a possible solution is better distribution of information or better teaching of thinking skills, with the emphasis on helping individuals or individual families.

On the other hand, these problems may be pursued by examining the larger social and political conditions in which the dilemmas are found. When, for example, reports say that 40 percent of the poor in the United States are children and another 10 percent are elderly (i.e., 50 percent of the poor are the young and the old), we can see that the problems of individuals are really a larger societal concern; the examination of the problem of poverty may not focus on the individual, but on some quality of society that has allowed poverty to grow. From this perspective, providing information and improving problem-solving skills by themselves may not be effective ways to address certain dilemmas.

The perennial problems of families relate to such general concerns as meeting food and other material needs, nurturing children, caring for the elderly, developing a system of communicating, and forming value orientations, to name a few. If we address such problems more specifically in relation to societal conditions, we can frame the problems in the form of questions like "What should be done about X in Y area of concern?" Some examples might be:

- What should be done about the confusion caused by conflicting information about food and nutrition?
- What should be done about being critically aware of the social forces affecting the family?
- What should be done about developing parenting practices that foster healthy self-concepts in children?
- What should be done about providing living environments that are safe and healthy (physically, psychologically, and socially)?

Because both students and teachers pose these problems, the curriculum becomes a genuine part of students' lives, rather than a lesson structured and predetermined by the teacher. The problems are named by recognizing a gap between what *is* and what *ought* to be.

The instructional approach for addressing these perennial problems is rooted in a Freirian philosophy of teaching and learning that draws upon personal experience to create social connectedness and mutual responsibility in developing alternatives to the status quo. Freire's problem-posing approach encourages probing and critical inquiry, rather than supplying predetermined answers (Shor 1987; Shor and Freire 1987). This problem-posing process of *listening* (investigating issues or themes in daily life), *dialoguing* (naming the issues for critical thinking), and *acting* (planning and carrying out alternatives for desired change as a result of reflection) is the basis of curriculum models for home economics developed in several states (e.g., Minnesota, Maryland, Wisconsin, Oregon)

The Minnesota Problem-Posing Model

The goal of the Minnesota model is to help students become self-directed—to take an active role in their own development, rather than rely on reactive or coping behaviors. Students are encouraged to be critically aware of the social and economic conditions that affect their lives and discourage their movement toward independence and full development. Such an awareness will help students be better able to initiate critical, creative, and morally responsible decision-making about actions that improve their own lives and the lives of their families. This type of education, then, will assist students in making informed decisions that contribute to their freedom now and in the future (Wilkosz 1983).

Two interrelated conceptual frameworks provide the overall structure for the curriculum model:

1. *Discrepancies between basic goals and existing conditions.* We assume that problems exist when goals are not accomplished, that is, when the existing human condition is contrary to what is valued as an end. For example, if we value having a sense of rootedness, we see a problem when adolescents feel lonely or alienated.

2. *Human action systems.* Human action systems are the ways in which family members act on their environment in order to survive and in order to understand and improve their social and economic condition. Three types of action are involved:

- Technical/instrumental action, which involves knowledge of how to work to secure the basic necessities of life;
- Interpretive/communicative action, which involves shared or inferred meanings, values, beliefs, and attitudes; and
- Emancipatory/proactive action, which involves the ability and willingness to have control over one's life.

Instruction focuses on three major themes:

- Critical Realities Theme: A given situation is analyzed by examining the effects of existing social and economic conditions on the achievement of broad human goals
- Problems Theme: Practical problems are identified and clarified by examining factors that affect meaning and understanding, such as knowledge, values, and prevailing ideologies and beliefs.
- Valued Ends Theme: Reasoned deliberation is directed toward what ought to be done, and plans are made for the accomplishment of these valued ends.

From Re-Conceptualization to Practice

The Minnesota Department of Education introduced its model by offering workshops throughout the state to help teachers become aware of the long-range curriculum plan and to stimulate thinking about secondary home economics curriculum development. A framework for engaging teachers in dialogue about existing beliefs and practices in the field was examined and critiqued. Classroom teachers were invited to join a "teacher leader" group to participate in the future development, critique, and implementation of the model. The reactions from teachers and their willingness to stay involved varied depending on their conceptual understanding of the curriculum and their ability to accept and adapt to change. The ten-year change process involved the following elements:

1. *Awareness and exposure.* Teachers received an overview of the Minnesota Department of Education, Secondary Vocational Education Division's curricular long-range development and implementation plan, which included as its central focus the Problem-Posing Curriculum Model.

2. *Theory and concepts.* Teachers examined a philosophical and theoretical basis for the plan.

3. *Explanation, demonstration, and modeling.* Materials and procedures were presented.

4. *Practice.* Teachers were provided with opportunities to study, question, and react independently and in small groups.

5. *Input, react, and critique.* Teachers were encouraged to ask questions to clarify their understanding of the curriculum plan before critiquing it.

6. *Feedback.* The project staff received feedback based on participants' critiques.

7. *Transfer.* Participants prepared curriculums for classroom implementation. The project staff developed curriculum models to provide direction for this process.

8. *Implementation.* The curriculum was field-tested in secondary home economics classrooms.

9. *Assessment.* The curriculum was evaluated, using criteria for determining student progress toward the accomplishment of specified learner outcomes.

10. *Revision from feedback.* The curriculum was revised based on the evaluation results. Revision focused on enhancing instruction, student understanding, and progress.

What Teachers Do

As a result of these curriculum efforts, home economics teachers throughout the state redesigned their own curriculum and instructional approaches. The current classroom emphasis is on encouraging discussion that focuses on practical reasoning, sound judgment, and action. Both critical thinking and ethical reasoning are stressed. Students are given opportunities to engage in technical/instructional action, interpretive/communicative action, and emancipatory/proactive action. As they gain experience in using these problem-focused and reasoning skills, students become more active participants and appear to enjoy their involvement. They also develop greater respect and empathy for the views of others.

A curriculum and an instructional climate that emphasize reasoned dialogue focused on addressing problems, using judgment, and considering seriously the best courses of action help students learn to: (a) identify and clarify their goals, (b) defend their goals, (c) identify and weigh means or alternatives for achieving their goals, (d) make sound decisions, (e) take action, (f) weigh the action. If such an instructional process were part of the school's core curriculum, students would soon learn to use critical thinking and reasoning in all of their problem-focusing and decision-making activities.

Curriculum as Both People and Paper: Wisconsin's Pilot School Project

In Wisconsin, there have been several efforts to help teachers develop a deeper understanding of the ideas found in the "Family-Focus Approach" to home economics. The Wisconsin Department of Public Instruction (1986) developed a conceptual guide that presents a rationale for a middle and high school home economics program organized around the practical problem approach.

When state directives prescribed the development of curriculum guides for all public school courses, a home economics "Pilot School" project was formed. Five "Guide Leaders" were identified and assumed primary responsibility for writing the curriculum guides. Even more important, these guide leaders learned ways to use the new approach and helped approximately 60 other teachers use it too. These 60 teachers were designated as Pilot School Teachers and charged with the responsibility of (1) learning what they needed to know to begin to teach from a family-focused approach, (2) converting their own programs over to the model within five years, and (3) serving as resources for other teachers. Multi-day workshops were held throughout the two-year period during which Guide Leaders and Pilot Teachers worked on their tasks.

Participation in the Transformation: Experiencing the Change Process

All participants had to master concepts and internalize the curriculum approach while using the process it proprosed to study, think about, and develop a written curriculum guide. The group assigned to the Families, Work, and Careers course, for example, began by examining the meaning of work in various socio-political contexts throughout history. In addition, the members studied aphorisms about work for the beliefs and values they projected. They then focused on critically examining work norms that were reflected in everyday messages, such as those found in periodicals, novels, TV shows, and advertisements. The group became a place where individuals could express views without reprisal; questioning for clarity gave all participants a fuller awareness of the ideas being studied.

As ideas were clarified (communicative action), the group moved beyond past or present ideas of work and discussed what might be or should be present when justice, fairness, and equity were the dominant guiding principles (emancipatory action). The group's thinking about valued ends for work grew and changed as the group learned and thought more about the interactions between people and work. The group began to view certain values as disempowering and likely to promote the interests and well-being of only select groups of people in society. When better-defined valued ends were weighed against increasingly clear conceptions of context, discrepancies between what existed and what was held as desirable became more apparent. Through the process, the relevant family concerns or problems became better understood and actions that could be taken to address the problems began to be examined. When Reid's (1979) qualities of practical problems were used to examine issues of involving families and work, participants asked questions like those below.

QUESTIONS ABOUT CONTEXTUAL CONDITIONS:

- What meanings for work and reasons for working are held by individuals, families, and society?
- How have ideas about work and its conduct evolved over time? What reasons have there been for change?

QUESTIONS ABOUT REASONED GOALS BASED ON RIGHTNESS AND JUSTNESS:

- What goals for working promote a free and just society?
- What should be a person's or a family's responsibility to society's work?
- What is society's obligation to a person's or family's work?

QUESTIONS ABOUT ALTERNATIVE MEANS OR STRATEGIES IN RELATION TO CONTEXTUAL FACTORS AND GOALS:

- How can goals of individual fulfillment and a free and just society be realized best through a society's, a family's, and an individual's work?
- How can the benefits and costs of society's work be distributed fairly to the family and its members?

QUESTIONS ABOUT PROJECTED CONSEQUENCES BASED ON CAUSE/EFFECT PREDICTIONS:

- What are the reciprocal effects of the work of individuals, families, and society?

• What are the intrinsic and extrinsic benefits and costs of work to the individual, the family, and society?

QUESTIONS REGARDING REASONED JUDGMENTS:

• How should individuals best prepare for their own work roles in society and in the family?

• What should be done about balancing the demands of work done in different roles and different settings?

After participating in the program, teachers found that their teaching behavior changed, as comments from an informal questionnaire and from conversations with teachers show:

I feel the Pilot School Program has made me more questioning of practices and conditions. I have become aware of valued ends in daily life and have used that awareness in classroom discussions.

I see greater purpose in what I teach . . . I have tried to focus courses on concepts. I am uncomfortable with teaching facts that do not lead to bigger ideas.

More group involvement, more emphasis on communication skills, meanings for things/reasons.

My content/classroom is more student run. I get ideas from students and they have more responsibility in the classroom learning.

Some of the changes in the ways that teachers think about practices were most dramatically illustrated in the metaphors they used to describe their experience as teachers—and how they reported changes in these metaphors. During one session, a teacher read aloud a metaphorical description of teaching she had written a few years earlier. It described students as plants that need soil, sunlight, air, water, and so forth to grow—certainly an image that invokes familiar and pleasant feelings of recognition. She went on to say that she had thought of herself as being like the water, pouring herself on the plants, rushing through their systems, and provoking them to send forth their tender green leaves and fragrant flowers. Now, however, she said she pictures herself more as the sun, providing warmth and light, and beckoning her "plants" to come forth, to swell and grow. Certainly this is a different picture of teaching, and is one that coincides with teachers' reports of encouraging student initiative and leadership.

Ethical Thinking and Moral Purpose

As discussion of the practical problem orientation illustrates, practical problems pose moral questions (what should be done under competing values and points of view). A response to these problems requires ethical thinking, the aim of which is to become clearer about the moral decisions to be made and, in the process, choose freely and responsibly the most defensible action to take. Valuing takes place in a context—each person's own lived experience as it is shaped by living in that particular social reality. Therefore, critical thinking and moral purpose have a personal and a social context that are brought into existence as a person acts within the world. In order to act with moral purpose and practice ethical thinking, then, it is not sufficient to engage in critical abstract thinking as an academic exercise only; persons are challenged to live that way of thinking in their daily lives as they struggle to build and support a democratic society.

Since home economics involves families make morally defensible judgments regarding the practical problems of the family, the curriculum orientation described here is the basis of an approach to a secondary home economics curriculum that relates sound thinking to better ways of acting. Arizona, Maryland, Nebraska, Ohio, and Pennsylvania have been involved in similar efforts. The idea that "critical thinking involves calling into question the assumptions underlying our customary, habitual ways of thinking and acting and then being ready to act differently on the basis of this critical questioning" (Brookfield 1987, p. 1) is clearly evident here in these projects. The transformative possibilities of such knowing and re-knowing are the valued ends of critical thinking as it is lived within an ethical orientation.

REFERENCES

Bivens, G., M. Fitch, G. Newkirk, B. Paolucci, E. Riggs, S. St. Marie., and G. Vaughn (1975). "Home Economics—New Directions." *Journal of Home Economics*. 67, 3: 26–27

Brookfield, S. D. (1987). *Developing Critical Thinkers*. San Francisco: Jossey-Bass.

Brown, M., and B. Paolucci. (1979). *Home Economics: A Definition*. Washington, D.C.: American Home Economics Association.

Reid, W. D. (1979). "Practical Reasoning and Curriculum Theory: In Search of a New Paradigm." *Curriculum Inquiry*, 9, 3: 187–207.

Shor, I. (1987). *Freire for the Classroom: A Sourcebook for Liberatory Teaching*. Portsmouth, N.H.: Boynton/Cook.

Shor, I., and P. Freire. (1987). *Pedagogy for Liberation: Dialogues on Transforming Education*. South Hadley, Mass., Bergin and Garvey.

Wallerstein, N. (1987). "Problem-posing Education: Freire's Method for Transformation." In *Freire for the Classroom: A Sourcebook for Liberatory Teaching*. Edited by I. Shor. Portsmouth, N.H.: Boynton/Cook.

Wilkosz, J., ed. (1983) *Minnesota Home Economics SEEO and Strengthening Project*. St. Paul: Minnesota State Department of Education.

Wisconsin Department of Public Instruction. (1986). A Guide to Curriculum Planning in Home Economics. Madison: Wisconsin Department of Public Instruction.

Part VI

Teaching for Thinking

Teachers are the ones who touch students and interact with them. They are the ones who implement educational policy and curriculum content, scope and sequence. And —most important—they are the ones who establish the educational climate and who structure learning experiences. In short, they have almost complete power over the process that takes place in the classroom. And it is my contention that process is more important than content in education.

—J. J. Foley

Much research has been conducted on the relationships between teacher behaviors and student learning. Generally, researchers have found that most student learning and achievement can be attributed to certain teaching characteristics. Teachers' verbal interactions, classroom management, clarity, classroom organization, questioning strategies, response behaviors, direction giving, and reward systems, all have significant and direct effects on student learning.

Along these lines, John Thomas (1980) and many others have shown that "how you teach is what you get." When teachers decide for students what, how, and when they should learn, and when the reward system is external, students excel on standardized achievement tests but perform poorly on tasks of reasoning, creativity, and internal locus of control. On the other hand, when teachers give students the responsibility for deciding what to learn, how to learn it, and how to evaluate their own growth in that learning, and when the reward system is internal to the task, students excel in problem solving, creativity, and internal locus of control but perform less well on low-level achievement tests.

We grew up in a society that valued knowing right answers and performing well on standardized tests. As the emphasis has shifted toward thinking skills such as reasoning, creativity, and problem solving, achieving our educational goals requires some new teacher behaviors and strategies.

For some teachers and students, the behaviors associated with the teaching of thinking may feel unnatural. For example, we may have been taught by behavioral psychologists to praise students when they perform a desired behavior because behaviors are repeated when they are reinforced. This works well for convergent types of performance where all students should be doing the same thing. ("Look at how John is adjusting the microscope. Notice how John is not putting the lens down through the glass slide. Very good, John." The signal is for everybody to do it the same way.) When, educational goals are divergent, however, such reinforcement is confusing to students. Therefore, when our goal is to have students create, innovate, and originate, praising them in this manner may be counterproductive.

This section describes a variety of ways to use instructional behaviors to support the teaching of thinking. The suggestions are directly related to the goal of teaching students metacognition, transfer, reasoning, and creativity.

In mastering any new technique, whether it be our backhand in tennis or our follow-through in bowling, we may feel uncomfortable for a time. But with conscious effort and practice we can achieve the automaticity of expertise, integrating skills into graceful performance.

Reference

Thomas, J. (Summer 1980). "Agency and Achievement: Self-Management and Self-Regard." *Review of Educational Research* 50, 2: 213–240.

37

Teacher Behaviors That Enable Student Thinking

Arthur L. Costa

What the teacher says and does in the classroom greatly affects student learning. Over the past 20 years many researchers have demonstrated that certain teacher behaviors influence students' achievement, self-concept, social relationships, and thinking abilities. Teacher behaviors that invite, maintain, and enhance students' thinking in the classroom fall into four major categories:

1. *Questioning* to help students collect and recollect information, process that information into meaningful relationships, and apply those relationships in different or novel situations.

2. *Structuring* the classroom by arranging for individual, small-group, and total-group interaction; by managing the resources of time, energy, space, and materials to facilitate thinking; and by legitimizing thinking as a valid objective for students.

3. *Responding* to help students maintain, extend, and become aware of their thinking.

4. *Modeling* desirable intellectual behaviors in the day-to-day problems and strategies of the classroom and school.

Dillon (1984) distinguishes two types of classroom interaction: *recitation* and *discussion*. Recitation is characterized by recurring sequences of teacher questions and student answers, where students recite what they already know or are learning through the teacher's questioning. The interaction is teacher-centered because the teacher controls the classroom by asking questions and reinforcing responses.

Discussion, on the other hand, involves group interaction in which students discuss what they don't know, usually by considering a subject from more than one point of view. The teacher is the discussion leader, whose role is to promote discussion by creating an atmosphere of freedom, clarity, and equality. John Goodlad (1984) found that only 4 to 8 percent of classroom time is spent in discussion and that less than 1 percent of teacher talk is intended to elicit students' responses.

This latter definition of classroom interaction—discussion—must be kept in focus as we consider which teacher behaviors are facilitative. Analyses of major problems and instructional strategies intended to enhance thinking, creativity, cooperation, and positive self-worth stress the need for this dialectic discussion strategy (Costa 1984; Paul 1985).

Teacher Questions and Statements That Cause Thinking

Early in their school experience, children learn to listen and respond to the language of the teacher. Their behavior is usually based on cues that are embedded in teachers' questions or statements (Davis and Tinsley 1967). One of these cues is the *level of thinking* apparent in teachers' questions or statements (Measel and Mood 1972). For example, Cole and Williams (1973) found correlations between the syntax of teachers' questions and the syntax of students' responses. And Gallagher and Ashner (1963) report that teachers who frequently use questions that require divergent thinking cause students to use more divergent thinking than do teachers who use more cognitive memory questions. Moreover, students score higher on tests of critical thinking and on standardized achievement tests when teachers use higher-level cognitive questions (Newton 1978; Redfield and Rousseau 1981).

A Teacher's Testimonial

After the inservice on teacher behaviors and their consequences on students' thinking, I decided to test some of the theories in the sophomore biology class I teach. I was particularly interested in examining my questioning behaviors and students' responses to them. I was also curious about the effects of silence and nonjudgmental acceptance. When I began the grand experiment, I immediately discovered how difficult it is to structure questions and watch for reactions at the same time.

Given this limitation, I consciously practiced my questioning and response behaviors during a two-week period and began to notice a number of things evolving in the class.

First, the time I spent on lecturing to students declined. There was a shift to a more Socratic format as students became accustomed to processing and applying information. They appeared to become actively involved in what was going on, rather than passively taking notes and listening.

Second, some students who did not participate in class began to join in the discussions. These students seemed to come to an understanding of the material after they had the opportunity to talk about it. The number of "relevant" student questions increased, and students generally began to accept the position that it is not necessary for an answer to be right to be acceptable. More than one answer may solve the same problem.

Third, as I began "accepting" solutions to problems as plausible, more students risked answers. The level of anxiety decreased as students realized their answers wouldn't be classified as either right or wrong. I think that in the process, students were getting much needed practice in using their higher-order cognitive skills.

Finally, I've noticed an increase in test scores on inquiry/application questions. I'm not sure that this increase is due to students becoming more familiar with the test format or to gaining experience in solving these types of questions in class. I hope that it is the latter. Maybe it's a combination of both.

Although this "experiment" in no way reflects the scientific model, it has increased my sensitivity to the need for me to monitor my own behaviors in the classroom. What I do and the manner in which I do it has direct bearing on student behavior and learning.

Ron Edwards, Teacher
Jesuit High School
Sacramento, California.

Keeping in mind that teachers can cause students to think by carefully designing the syntax of questions and other statements, let us now turn to the Model of Intellectual Functioning shown in Figure 1 (and further described in Part III, Chapter 25). This model shows the basic steps we take in processing information: (1) getting information through the senses or from memory, (2) comparing that information with what we already know, (3) drawing meaningful relationships, (4) applying and transferring those relationships to hypothetical or novel situations, and (5) evaluating what we have done. In the classroom, the teacher's task is to manipulate the syntactical structure of questions and other statements to invite students to take these steps. What follows are some examples of questions or statements that teachers might pose at each step of the process.

Gathering and Recalling Information (Input)

To cause students to *input* information, teachers can design questions and statements that draw from students the concepts, facts, feelings, or experiences that they have stored in long- or short-term memory. They can also design questions that prompt students to use their senses to gather information and process it at the next higher level of thinking.

Cognitive objectives that teachers should emphasize at the input level of thinking include: *completing, counting, matching, naming, defining, observing, reciting, selecting, describing, listing, identifying, and recalling.* Some examples of questions or statements designed to elicit these cognitive objectives are:

Question/Statement	*Desired Cognitive Behavior*
Name the states that bound California.	Naming
How does this picture make you feel?	Describing
What word does this picture go with?	Matching
What were the names of the children in the story?	Naming
How many coins are in the stack?	Counting
Which words on this list are rhyming words?	Selecting
Mexican houses were made of mud bricks called ______.	Completing
List the first four numbers in a set of positive integers.	Listing
How did you feel about the grade you received in algebra?	Recalling

Making Sense of Gathered Information (Processing)

To help students process the information that they gathered through their senses and retrieved from long- and short-term memory, teachers should carefully word their questions and statements in a way that will prompt students to draw relationships of cause and effect. Processing includes cognitive objectives like synthesizing, analyzing, categorizing, explaining, classifying, comparing, contrasting, stating causality, inferring, experimenting, organizing, distinguishing, sequencing, summarizing, grouping, and making analogies. Some examples of questions or statements designed to elicit these cognitive objectives are:

Question/Statement	*Desired Cognitive Behavior*
Why did Columbus believe he could get to the East by sailing west?	Explaining

What do you think caused the liquid to turn blue?	Stating causality
What other machines can you think of that work on the same principle as this one?	Making analogies
How can you arrange the blocks to give a crowded feeling?	Organizing
How are pine needles different from redwood needles?	Contrasting
How does the formula for finding the volume of a cone compare with the formula for finding the volume of a pyramid?	Comparing
Arrange the following elements of a set in ascending order: 13/4, 3/2, 5/6, 32/5.	Sequencing
From our experiments with food coloring in different water temperatures, what can you infer about the movement of molecules?	Inferring

Applying and Evaluating Actions in Novel Situations (Output)

Questions and statements that lead to *output* require students to use the concepts or principles they have developed in novel or hypothetical situations. Application invites students to think creatively and hypothetically, to use imagination, to expose or apply value systems, and to make judgments. Some of the behavioral objectives here are: *applying a principle, imagining, planning, evaluating, judging, predicting, extrapolating, creating, forecasting, inventing, hypothesizing, speculating, generalizing, model building, and designing.*

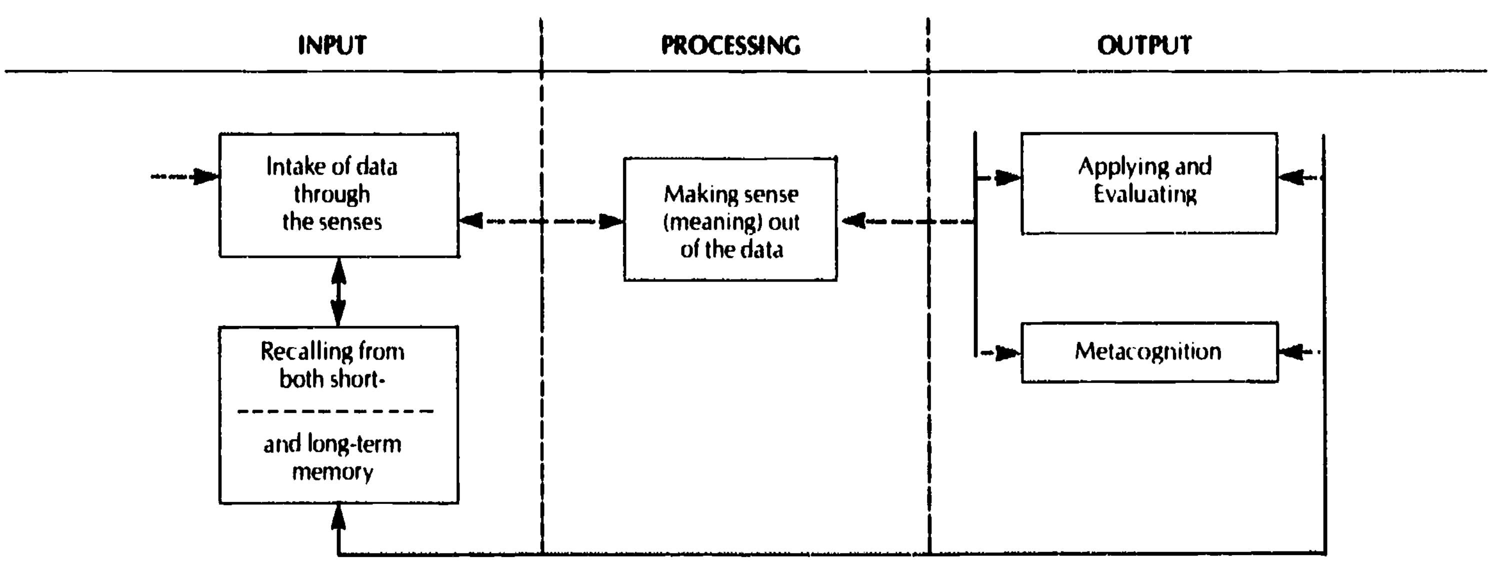
Examples of questions designed to elicit these cognitive objectives are:

Question	*Desired Cognitive Behavior*
If our population continues to grow as it has been, what will life be like in the 21st century?	Speculating
What can you say about all countries' economies that are dependent on only one crop?	Generalizing
What would be the fairest solution to this problem?	Evaluating
From what we have learned, which painting is the best example of modern art?	Judging
What do you think might happen if we placed the saltwater fish in the freshwater aquarium?	Hypothesizing

Teachers have awesome power. Through the careful and selective use of questions or statements, they prompt students to perform cognitive behaviors. Over time, with this kind of help, students should be able to:

- Develop the relationship between the verbal syntax and the mental processes;
- Experience, and thus exercise, these mental functions;
- Become aware of these cognitive processes;

FIGURE 1
A Model of Intellectual Functioning



But . . . Do I Have The Time To Do It Right?

Dave Schumaker

Teachers should ask themselves, "Have my students really been learning what I have been teaching them, and can they put that knowledge to work in creative and critical thinking situations?" When I asked myself that question, the answer was, "No, my students have short-term memories; what they seem to learn one week is gone the next. I have to teach complex concepts such as photosynthesis and genetics over and over again, and the students still don't seem to understand them." It does not matter how much material you cover; if the students don't understand it and can't use it when you are finished teaching, it is useless to them.

If you want to change your students' attitudes toward learning, you should have them listen to each other and give them time to think before speaking. You should design your lessons around the basic questioning format that requires students to gather facts and process them using higher cognitive skills. I am convinced that good questioning skills improve student learning, and I have been trying to pass this notion on to other teachers.

The question that comes up at almost every workshop I conduct is, "But . . . it sounds like it takes too much time. I have to get through the book or my curriculum, and how will I be able to do that if I spend so much time questioning?" Since I have changed my method of questioning students, I have found that my students have changed their attitudes toward learning. This change, very subtle at first, is now quite startling. They pay attention; they listen to each other and give answers that show they are thinking about what they are going to say. I find that the quality of their questions has also improved; they seem to have a better understanding of the concepts and are showing improvement on tests and written work. Since I have become used to this new style, the amount of material I cover seems to be about the same now as it was in the past, although I must admit that when I was learning to use good questioning techniques the process did take longer.

The other question that I commonly hear is, "Do I have to change my teaching strategies?" Of course not! All teaching strategies require teachers to ask questions and students to answer them. The only thing you will change is your style of questioning, and that alone will allow your students to take a quantum jump in their ability to learn the material presented and truly understand how to apply it to problem-solving situations.

Let's face it—education has been under fire for some time, and we need to do all we can to improve our product. Our product is educated students, and through the implementation of sound questioning practices we can improve the quality of student education without the addition of a single dollar to our budgets or an extra minute to our teaching day.

- Apply these cognitive processes beyond the classroom;
- Understand and appreciate teachers' invitations to think;
- Increase their own inclination and desire to ask a range of questions.

Structuring the Classroom for Thinking

Structuring may be described as the way teachers control such classroom environmental resources as time, space, human energy, and materials. Every teacher in every classroom structures those resources, either consciously or unconsciously, directly or indirectly. Even the "unstructured" classroom imposes a structure to which students react and within which students interact.

Research on school and teaching effectiveness has repeatedly demonstrated that higher student achievement occurs in a well-structured classroom where students know the objective of the lesson, time is used efficiently, the teacher is clear about the directions, the classroom environment conveys a congenial sense of order, and student energies are engaged in a meaningful learning task.

Structuring the classroom for thinking should be conscious, deliberate, clear, and based on the desired objectives for the students. Knowing what learning tasks are to be accomplished and what type of interaction is desired, the teacher gives directions, states ground rules, describes objectives, places limits, and creates a classroom organizational pattern intended to best elicit the desired cognitive performance from students.

There are three central aspects of teacher structuring:

1. The clarity of verbal and written instructions
2. The structuring of time and energy
3. The different ways of organizing and arranging interaction patterns.

Instructional Clarity

Teacher: Why do you think Robert Frost repeated the last line of this verse?
Student: (No response)
Teacher: (After a long pause) Well, what feelings did *you* have as you read the poem?
Student: Why don't you just tell us the answer? (Wasserman 1978)

Students expend great amounts of energy trying to figure out teachers' intentions. Because some students come from homes, previous teachers, or other schools where thinking skills were not valued, they often are dismayed and resistant to the teacher's invitations to think. Such resistance and reluctance to respond should be taken as an indication that a program to develop intellectual skills is sorely needed.

Teachers must convey to students that the goal of instruction is thinking, that the responsibility for thinking is theirs, that it is often desirable to have more than one solution to a problem, that it is commendable when they take time to plan, that an answer can be changed with additional information.

Research in classroom management seems to indicate that the clarity and purposefulness of the teacher's directions for a new learning task affect student behavior. For example, if the messages and directions presented by the teacher are confused, garbled, and unclear, then students will have a more difficult learning task. Similarly, providing too many details at one time and repeating information that students already know increases class restlessness and the possibility for nonattentiveness (Kounin 1970).

Rosenshine and Furst (1971) placed teacher clarity at the top of their list of effective instructional behaviors. Teacher clarity is consistently and positively associated with student achievement. Students increase their understanding of directions when the teacher:

- Frequently repeats concepts from one sentence to the next or says the same thing in more than one way;
- Reviews prior work;
- Prepares students for upcoming tasks by describing the work to be done and how to do it;
- Allows time for students to think about, respond to, and synthesize what they are learning;
- Uses visual and verbal examples;
- Reviews difficult concepts on the chalkboard; and
- Models the type of performance required in the task.

It seems imperative, therefore, that teachers convey to students their objectives, instructional strategies, and assessment procedures so that students will realize that thinking is a legitimate goal of education.

Structuring Time and Energy

Many researchers have demonstrated that achievement (in basic skills at certain grade levels as measured by standardized tests) correlates highly with the amount of time students are successfully engaged in learning (Borg 1980; Stallings and Kaskowitz 1974; McDonald 1976), and this same proposition holds true for teaching thinking.

But how much time is enough? This can only be answered in terms of the needs of a particular population of students. A survey of the most popular curriculums and programs for teaching thinking suggests that at least two to three hours per week with carefully designed materials and well-planned and -executed lessons is needed to permanently affect students' cognitive abilities. Furthermore, it seems this intensity needs to be maintained for at least two years for mastery of these mental functions.

A school that typically tracks students in 1-year or 1-semester segments and 55-minute periods may have difficulty providing such intense instructional continuity. But an emphasis on thinking cannot be viewed by the student as an isolated event occurring from 2:00 to 2:53 each Thursday or when an itinerant teacher arrives to teach "thinking skills." Students must repeatedly receive cognitive skills instruction and encounter situations that require them to think throughout the school day, across academic content areas, and over extended periods of time. Only then can students transfer, generalize, and apply cognitive skills (Sternberg and Wagner 1982, pp. 50, 53). For some schools, this may require a reconsideration of curriculum goals, school organization, allocation of time, and assessment procedures.

Structuring time alone, however, is inadequate. Schools must also consider the quality of the task during that time: the degree that students' *energies* are engaged. According to Piaget's constructivist theory, all knowledge arises—or is constructed—from interactions between learners and their environment (Furth 1981). That is, the extent to which teachers mediate the interaction of pupils with instructional materials and with the content of the lesson determines how well skills are likely to be learned. Much research has also shown that *active* learning has a positive effect on students' development of decision-making and problem-solving skills (Thomas 1980), and on students' attitudes toward the school, the teachers, the content to be learned, and learning itself (Kahn and Weiss 1973).

This research strongly suggests that teachers should organize their classrooms in ways that encourage students to become active thinkers, not passive observers. This might include Socratic discussions led by teachers, individual manipulations, and cooperative small-group or total-group investigations.

Structuring Classroom Organizational Patterns for Thinking

Of all the various patterns of classroom organization that a teacher might use, some seem to get better results than others for certain students at certain grade levels and for certain goals of instruction. For example, Gage (1976) reports that students learn more in a question-and-answer discussion strategy. Greater gains were found for 5th grade reading when teachers spent time discussing, explaining, asking higher-level questions, and stimulating cognitive processes. Group work with individual monitoring by the teacher seemed best for reading while less group work proved best for math.

McDonald (1976), in the research on Phase II of the Beginning Teacher Evaluation Study, found that individual work seemed very ineffective if not carefully monitored by the teacher. Students were off-task more, and a greater number of errors went uncorrected if the teacher did not constantly monitor individual students' learning.

The lecture method has long been found wanting in terms of student learning. Early studies have shown that there are vast individual differences in the amount of learning assimilated by students through lecture (Jones 1923). And Ebbinhous (1913) found that the curve of retention dropped from about 60 percent of immediate recall after the lecture to about 20 percent after eight weeks.

Different students need different classroom organizational patterns. Some students learn best individually; some learn best in groups. There are students who can only learn when an adult is present to constantly encourage and reinforce them; others can't learn when another person is nearby. Some students need noise, others need quiet. Some need bright light, some need subdued light. Some need formal settings, others need informal situations. Some need to move, others need to be stationary (Dunn and Dunn 1978). Less able students seem to do better in highly structured situations where direct help is generous, while more able students seem to prefer less structured situations (Sternberg and Wagner 1982, p. 51).

What kind of classroom structure, then, produces the greatest achievement of cognitive skills and strategies? Thomas (1980) states:

> Where the locus of control over learning-related behaviors is entirely vested in the teacher, where maximum structure is provided for carrying out learning activities, and where the motivation to perform is provided for through external rewards, praise, and/or fear of reprisal, there is little latitude or opportunity for students to develop a sense of agency and subsequently, to become proficient in using learning strategies. . . . What may be required is an instructional procedure replete with tasks for which strategies have some payoff and perhaps a deliberate attempt to teach and/or allow for the discovery of varieties of cognitive strategies appropriate to these tasks (Thomas 1980, p. 236).

The Johnsons (Johnson, Johnson, Holubec, and Roy 1984) found that students working cooperatively in groups used more higher-level reasoning strategies and greater critical thinking competencies than students working in competitive and individualistic learning situations.

What most authorities in curriculum and instruction promote, and what the authors above support with research, is that when higher-level thinking, creativity, and problem solving are the objectives, students must be in a classroom climate where they are in the decision-making role—where they construct strategies to solve problems, where they determine the correctness of an answer based on data they produced and validated, where they play a key part in setting their own goals and devising ways to assess the accomplishment of thosea goals.

The reward system in such a classroom should be intrinsic rather than extrinsic; it must spring from an internal motivation to learn—an intellectual curiosity about phenomena, a proud striving for craftsmanship and accuracy, a sense of being a productive and interdependent member of a community of scholars, and a desire to emulate respected others (Lepper and Greene 1978; Bruner, Goodnow, and Austin 1956).

Teachers who value internal rather than external rewards, who engage students in structuring their own learning, who realize human variability in learning, and who can teach toward multiple goals use a repertoire of classroom organizational patterns. Classrooms organized for thinking are characterized by:

- Individual students working alone, engaged in a task requiring one or more cognitive skills, such as comparing, classifying, sorting, and evaluating. During individual work, teachers monitor students' progress and mediate their experiences.
- Groups working cooperatively, in pairs or small groups, on such collaborative problem solving as planning strategies for group projects, contributing data and ideas to the progress of the project, identifying information that needs to be gathered, devising strategies to generate that information, and evaluating individual and group social skills. During group work, teachers monitor students' progress, assess growth in social and cognitive abilities, and mediate both the intellectual skills required of the task and the cooperative group skills.
- Total group engagement in listening to presentations by, and interacting with, the teacher, resource people, media, and other students. Such total-group interactive strategies as the Socratic, the dialectic, and class meetings are also employed when the teacher or a student raises a dilemma, problem, or discrepancy for all to participate in debating and resolving.

To learn to think, students must engage in, discuss, and come to value thinking. If schools are to value thinking, they must engage students in interacting individually, in small groups, and in total groups with problem-solving and creative activities that students design and evaluate themselves.

Response Behaviors That Create a Climate for Thinking

Teachers can create a classroom climate for thinking. It is the quality of certain teacher-student interactions that determines the degree of trust, risk taking, level of cognition, warmth, rapport, openness, and psychological safety in the classroom (Kahn and Weiss 1973). And *response behaviors* are an important part of those interactions; response behaviors are the actions teachers take after a student answers a question or follows directions: The teacher initiates a behavior through questioning or structuring, the student performs the behavior, then the teacher responds to the student's performance.

Lowery and Marshall (1980) found that *how* the teacher responds influences students' behavior more than *what* the teacher asks or tells students to do. This is because students are constantly anticipating how the teacher will respond to their actions. Flanders (1965) found that teacher responses greatly influence the development of students' self-concept, their attitude toward learning, their achievement, and their classroom rapport.

Response behaviors may be put in one of two categories, according to their effects on students: (1) those that tend to terminate or close down thinking and (2) those that maintain, open up, and extend thinking. There are six behaviors that can be classified under those two categories:

Terminal or closed responses:

1. criticism (and other put-downs)
2. praise

Open or extending responses:

3. using silence (wait time)
4. accepting—passively, actively, or empathetically
5. clarifying—of both concept and process
6. facilitating data acquisition

Much research accumulated over several years supports the beneficial effects on students when teachers use these behaviors selectively.

Criticism (and Other Put-Downs)

Criticism may be defined as negative value judgments. When teachers respond to students' performance with the use of such negative value words as "poor," "incorrect," or "wrong," students tend to give up and stop thinking. Negative value judgments may sometimes be inferential or subtle signals of inadequacy—for instance, "You're almost right," "Who has a *better* answer?" or "You're getting *close*." They may also be value judgments in the form of ridicule: "What a dumb idea" or "You're not good enough."

Other put-downs include responses that, through the teacher's voice intonation or inflection, imply sarcasm or rejection and thus tell students that their performance was inadequate: "Who would want to help you when you act that way?" "Where on earth did you get *that* idea?" "Now that Mary is finished, who will show us the way it *should* be done?"

An abundance of research demonstrates that negative criticism is not helpful in promoting cognitive or affective learning. Soar (1972) synthesized much research on the effects of criticism and found no evidence to support negative criticism as positively affecting learning. In fact, Flanders (1970) found that greater teacher criticism was related to less positive pupil attitudes and lower pupil achievement.

Criticizing students and making them experience failure obviously do not enhance thinking. There are numerous responses that are more helpful in promoting student thinking.

Praise

Praise may be defined as the opposite of criticism in that it employs the use of positive value judgments such as "good," "excellent," "great," and so forth.

Surprisingly, while many teachers advocate the use of praise in attempts to reinforce behaviors and to build self-worth, the research on praise seems to indicate that, in reality, the opposite is more often the case: Praise tends to make students depend on others for their worth rather than on themselves. It builds conformity at a time when our goal is diversity.

Some teachers use praise so often and so indiscriminately that it becomes a meaningless response that provides little benefit. Under certain conditions, though, praise does seem to be appropriate. Teachers should learn to use praise sparingly and judiciously—in only those circumstances, with only those students, and for only those objectives for which it is suitable. Teachers can replace praise with an enlarged repertoire of response behaviors that research indicates are more conducive to developing students' thinking skills.

Following are some circumstances in which praise seems warranted:

1. *Reluctant, unmotivated, dependent learners.* Some students are difficult to motivate. They depend on the teacher for reinforcement and need constant reminders to stay on task. These are often students who have a limited attention span and, when given an assignment, soon lose interest and quickly seek redirection. Although praise often helps this type of learner, teachers should try to eliminate external reinforcement and develop students' internal motivation; therefore, the amount and frequency of praise must gradually be reduced and replaced with the satisfaction derived from solving intriguing problems, completing tasks accurately and with craftsmanship, and contributing to group accomplishment. Often when new or difficult learning is begun, praise will need to be used again briefly until the student has a feeling of confidence and mastery.

2. *Lower grade level students.* Kohlberg (1981) has described a sequence through which students grow in their understanding of social justice and moral reasoning. During early stages, children understand right and wrong because of the rewards and punishments given by adults and others

in authority. These rewards and punishments are the consequences of their behavior. In later life, students can understand the consequences of their behavior because they see the effect on others or because they understand morally ethical behavior.

While students are still in the early stages of moral development, praise and rewards may be appropriate. These stages are not necessarily determined by age, but rather by observation of students' behavior in situations requiring social decision making and by analyzing discussions with children about appropriate behavior in varying problem situations. Students will develop higher-level, more autonomous, and more appropriate, kind, and just behaviors if they are involved in decisions and problem situations that require making choices. It is helpful if teachers, parents, and peers can discuss and analyze these behaviors with them, and if significant adults in their environment model the appropriate social behaviors.

Even though praise is appropriate for young, morally immature students, we want to help students progress beyond that stage. Teachers, therefore, must help students develop the type of internal motivation system that is consistent with the higher stages of moral development.

3. *Low-level cognitive tasks.* As indicated earlier, input questions help a student confirm or produce an answer from memory or from sensory observations. In these instances, it is probable that the answer the student gives is predictable and therefore "correct." Teachers should follow these guidelines in using praise for low-level cognitive tasks:

- *Give the criteria or rationale for the value judgment.* What makes an act "good" or "excellent" must be communicated along with the praise. The student then understands why the act is acceptable and can repeat the performance.
- *Help students analyze their own answers.* For example, a teacher could say, "Jane says San Francisco is the largest city in California. Bill says Los Angeles is the largest. Would each of you please tell us the population of each of the two cities? One way to find out is to compare our data."

In the long run, the teacher's goal should be to decrease the use of terminal behaviors, replacing them with response behaviors that have a more instructive effect on students' cognitive development.

Which instructional objectives warrant praise? Flanders (1970) states:

> The pupil growth index which involves memory, a relatively low level cognitive task, can tolerate lower levels of teacher indirectness . . . yet higher levels of cognitive reasoning are associated with more indirect . . . teacher influence patterns: Creativity appears to flourish most with the most indirect patterns.

McGraw (1978) and Condry and Chambers (1978) found that student performance on routine, familiar procedures was not adversely affected by rewards and praise. In fact, when students did not particularly like assignments that were repetitious and of a practice nature, rewards enhanced their performance. In contrast, McGraw (1978) and Thomas (1980) found that rewards had a detrimental effect on student performance of tasks requiring higher-level problem solving. Condry and Chambers (1978) emphasize that the learning process is different from the learning product and indicate that the process is detrimentally affected by rewards. They suggest that effects of rewards differ depending on the extent to which the student had already learned the subject matter. Thus, rewards for tasks already learned are not detrimental because learning has already occurred and the focus is now on learner production of what he or she already knows.

In contrast, the process of learning *is* detrimentally affected by rewards. The performance of new tasks, skills, and processes requires cognitive risks and exploration, which are inhibited by praise and promised reward. Thus, these findings seem to indicate that rewards are best administered for well-learned tasks where specific rules need to be followed, as opposed to tasks that are in the process of being learned or are problem-solving or exploratory in nature. Seatwork, which is of a practice nature, is likely to be facilitated by rewards, while rewards for learning a new skill are likely to have a detrimental effect.

Silence

Rowe (1974) found observable differences in the classroom behaviors of students whose teachers waited after asking a question or after a student gave an answer. If the teacher waits only a short time—one or two seconds—students give short, one-word responses. On the other hand, if the teacher waits for longer periods, students tend to respond with whole sentences and complete thoughts. There is a perceptible increase in the creativity of the response as shown by greater use of descriptive and modifying words. There is also increased speculativeness in the students' thinking. Research has also shown that student-to-student interaction is greater, the number of questions students ask increases, and shy students begin to contribute.

Good and Brophy (1973) report that teachers communicate their expectancies of students through the use of silence. Teachers who ask a question and then wait for a student's answer demonstrate that they not only expect an answer but also that they have faith in the student's ability to answer, given enough time. Teachers who ask a question, wait only a short time, and then give the answer, call on another student, or give a hint demonstrate their belief that the student really can't answer the question and is considered too poor a student to offer an answer or to reason independently.

Accepting Responses

Teachers who are accepting are those who are nonevaluative and nonjudgmental. They give no clues through posture, gesture, or words as to whether the student's idea, behavior, or feeling is good or bad, better or worse, right or wrong. The intent of accepting is to provide a psychologically safe climate in which students can take risks, are entrusted with the responsibility of deciding for themselves, and can explore the consequences of their own actions. An accepting atmosphere in a classroom encourages students to examine and compare their own data, values, ideas, criteria, and feelings with those of others—not just those of the teacher. Even though students' values and feelings may differ from those of teachers, teachers can still accept these difference because they know that only the students are able to modify them and make them consistent with their reality.

Thus, an alternative way of responding to a student's answer is by paraphrasing it, applying it, acknowledging it, comparing it with another idea, or summarizing what was said. Among the numerous ways of demonstrating acceptance are passive acceptance, active acceptance, and empathetic acceptance.

Passive acceptance is demonstrated when the teacher merely receives and acknowledges what the student says, without making a value judgment. It demonstrates that the student's ideas have been heard. Passive acceptance might be:

— Verbal, by saying "Um-hmm," "That's one possibility," "Could be," or "I understand";

— Nonverbal, by nodding the head or writing the student's statement on the chalkboard.

Active acceptance demonstrates an understanding of what the student says or does. The teacher actively accepts by reflecting (not merely repeating), rephrasing, paraphrasing, recasting, translating, or summarizing what the student said or did. The teacher extends, builds on, compares, or gives an example based on the student's response. While the teacher may use different words, she strives to maintain the intent and accurate meaning of the student's idea. Active acceptance is more useful than passive acceptance because the teacher demonstrates not only that the student's message has been received, but also that the message is understood. Examples of active acceptance are:

— "Your explanation is that if the heat were increased, the molecules would move faster and therefore disperse the food coloring faster."

— "I understand. Your idea is that we should all write to our legislators rather than send them one letter from the group."

Empathetic acceptance demonstrates that the teacher hears not only the student's ideas but also the *emotions* underlying the ideas. Often teachers can show empathy when they express similar feelings from their own experiences. Some examples of empathetic acceptance are:

— "I can see why you're confused. Those directions are unclear to me, too."

— "You're frustrated because you didn't get a chance to share your idea. We've all got to take turns, and that requires patience. It's hard to wait when you're anxious to share."

— The student enters the room and slams a math workbook on the desk. The teacher responds by saying, "Something must be upsetting you today. Did you have difficulty with the assignment?"

Empathetic acceptance does not mean that the teacher condones acts of aggression or destructive behavior. It does, however, demonstrate an understanding and acceptance of the emotions that produce those behaviors.

Clarifying

Clarifying is similar to accepting in that both behaviors reflect the teacher's concern for fully understanding the student's idea. Whereas active acceptance demonstrates that the teacher truly *does* understand what the student is saying, clarifying means that the teacher *does not* understand and, therefore, needs more information.

Rosenshine and Furst (1971) report that when a teacher responds to students' comments by encouraging them to elaborate, there is a significant and positive correlation with student achievement.

Klevan (1968) found that when teachers use clarification, students tend to increase their consistency of thinking as measured on a scale-of-beliefs test. Students become more purposeful in their thinking and behaving.

Flanders' research (1960) supports the use of clarifying behavior. It shows that achievement is higher in classrooms where teachers use, build on, extend, or clarify students' ideas.

One of the most compelling reasons for clarifying is that it contributes to the development of students' metacognitive abilities. Brown (1978) found a correlation between the degree of metacognitive awareness and the level of performance on complex problem-solving tasks. Students seem to become better problem solvers if they are able to become aware of and talk about the strategies and steps they use to solve problems.

Often, though, students follow instructions or perform tasks without questioning why they are doing what they are doing. They seldom question themselves about their own learning strategies or evaluate the efficiency of their own performance. They may have virtually no idea what they are doing when they perform a task and are often unable to explain their strategies in solving problems (Sternberg and Wagner 1982).

When the teacher clarifies by asking students to explain their answers and how they arrived at them or to share the rationale behind them, the teacher causes students to think about their thinking. Much evidence suggests that causing students to talk about their thinking processes and problem-solving strategies before, during, and after the actual thinking process enhances their ability to think. Evidently, thinking and talking about thinking beget more thinking (Whimbey 1980; Bloom and Broder 1950).

Facilitating the Acquisition of Data

If one of the objectives of cognitive education is for students to process data by comparing, classifying, inferring, or drawing causal relationships, then students must be able to acquire data for processing. To help students acquire data, the teacher must perceive students' information needs and provide data or make it possible for students to do so themselves. By responding to these needs, the teacher creates a climate that promotes students' quest for information. This can be done in a variety of ways:

- By providing data (feedback) about a student's performance: "No, 3 x 6 is not 24; 3 x 8 is 24." "Yes, you have spelled 'rhythm' correctly."
- By providing personal information or data (self-divulgence), usually in the form of "I" messages: "I want you to know that chewing gum in this classroom really disturbs me." "John, your pencil tapping is disturbing me." "The way you painted the tree makes me feel like I'm on the inside looking out."
- By making it possible for students to experiment with equipment and materials to find data or information for themselves: "Here's a larger test tube if you'd like to see how your experiment would turn out differently." "We can see the film again if you want to check your observations."
- By making primary and secondary sources of information accessible: "Mary, this almanac gives information you will need for your report on the world's highest mountain ranges." "The best way to verify the spelling is to look it up. Here's the dictionary."
- By responding to a student's request for information: "What's this thing called?" asks a student. "This piece of equipment is called a bell jar," replies the teacher.
- By surveying the class for their feelings or observations: "On this chart we have made a list of what you observed in the film. We can keep this chart in front of us so that we can refer to it as we classify our observations." "Let's go around the circle and share some of the feelings we had when we found out the school board decided to close our school."
- By labeling students' performance of a cognitive operation: "When you shared your crayons, that was an example of *cooperation*." "Your statement 'If there is water on Mars, then there could be life' is a *hypothesis*." "That was an *assumption* you made."

Knowledge of results is the single most important variable governing the acquisition of skillful habits (Irion 1966). Teachers need to keep that in mind when they reward students' behavior. Rewards can either control behavior or give information about competence. If students perceive the teacher's rewards as controlling, their intrinsic motivation will likely decrease. If students perceive rewards as providing feedback about their knowledge or competence, however, their intrinsic motivation is likely to increase (Deci 1976, 1978).

Feedback to students' behavior should be given within seconds if learning is to progress rapidly (Kimble and Hilgard 1961). Feedback need not always come from the external situation but may arise from other concepts, data, and principles recalled or gathered by the learners themselves—for example, by students' checking their work against a teacher's model problem or by their comparing their answers with other students' answers or with rules stated in the instructions (Feuerstein 1980). In other words, the teacher needs to provide an opportunity for students to check their ideas against the data being gathered so that they can decide for themselves if their ideas or answers are correct. This self-checking can furnish some immediate feedback and satisfaction that in turn reinforces learning (Gagne 1967).

Suchman (1964), in his studies of inquiry training, found that students need a "responsive environment." Data of all kinds need to be available in great abundance. Inquiring students should be able to obtain whatever data they want as easily and quickly as possible from many sources: manipulation of materials, tools, and references; the teacher; and other resource people (Andre 1979).

In Summary

In a poll conducted by the University of Northern Colorado, 87 percent of the parents surveyed said that teachers needed the ability to communicate, understand, and relate. Students who were surveyed felt that no one cared and no one listened to their needs. The Colorado Department of Education concluded that high school students' top concern was teachers' lack of acceptance and involvement (*Education U.S.A.* 1978).

The primary reason that all the open response behaviors described in this chapter create a warm climate for learning is that they require teachers to listen. The teacher's use of silence communicates to students the value of reflective, thoughtful, crafted answers over impulsive answers. The use of accepting behaviors demands that teachers be sensitive to and understand students' ideas. Clarifying and probing demonstrate a desire to go deeper and to further explore the students' ideas. Helping students acquire data requires teachers to listen and to sense the students' need for information so that the proper data may be supplied. And performing all these behaviors gives students a model of the types of rational behaviors that teachers want them to develop as well.

Modeling: Behavior Consistent with Cognitive Goals and Objectives

Actions, not words, are the true criterion.

—George Washington, *Social Maxims: Friendship* (c. 1790)

Students are quick to pick up the inconsistencies between what a teacher says and what a teacher does. Powerful teachers of thinking constantly strive to bring their words, actions, beliefs, values, and goals for students into harmony.

Research in modeling substantiates the fact that children acquire much of their behavior, feelings, attitudes, and values not through direct instruction but through imitation of both adult and peer models (Bandura and Walter 1963; Good and Brophy 1973). A considerable number of studies conclude that students adopt new behavior patterns or modify their own behavior on the basis of observation alone. Thus, since there is such extended contact between teacher and student, the teacher is one of the most significant and influential models in a student's life.

Modeling tends to reinforce students' perceptions of the values and goals stated by the teacher or by the school. And by exhibiting the kinds of behavior desired in students, adults can strongly influence students' behavior patterns. For example:

- If listening to one another is a valued behavior, teachers who listen to students will greatly enhance the probability of achieving this objective.
- If solving problems in a rational, scientific manner is valued, students must observe teachers and administrators using rational, scientific ways to solve problems that arise in the school or classroom (Belcher 1975).
- If restraining impulsivity is a characteristic of intelligent problem solving, students must witness teachers and administrators reacting calmly and patiently during stressful situations.
- If teachers want students to accept one another's points of view, values, and difference (overcoming egocentrism), they will accept students' differences.
- If teachers want students to become enthusiastic about thinking, they will show enthusiasm for challenges, puzzles, and complex tasks requiring thought (Rosenshine 1970).

Emulating others is a basic way of learning. Young people, especially, are very quick to imitate behavior. If we become "do as I say, not as I do" educators, we can make students feel hostile, frustrated, and confused. Our goal as educators should be to facilitate students' development of their own behavior, since in the end, each person is responsible for what he or she does.

Bibliography

Andre, T. (Spring 1979). "Does Answering Higher Level Questions While Reading Facilitate Productive Learning?" *Review of Educational Research* 49, 2: 280–318.

Bandura A., and R. H. Walter. (1963). *Social Learning and Personality Development*. New York: Holt, Rinehart and Winston.

Belcher, T. (June 1975). "Modeling Original Divergent Responses: An Initial Investigation." *Journal of Educational Research* 67, 3: 351–358.

Bloom, B. S., and L. J. Broder. (1950). *Problem-Solving Processes of College Students*. Chicago: University of Chicago Press.

Borg, W. R. (1980). "Time and School Learning." In *Time to Learn*, edited by C. Denham and A. Lieberman. Washington, D.C.: National Institute of Education.

Brophy, J. E. (1982). "Supplemental Group Management Techniques." In *Helping Teachers Manage Classrooms*, edited by D. Duke. Alexandria, Va.: Association for Supervision and Curriculum Development.

Brophy, J. E. (1981). "Teacher Praise: A Functional Analysis." Occasional Paper No. 28. East Lansing: Michigan State University Institute for Research on Teaching.

Brown, A. L. (1978). "Knowing When, Where, and How to Remember: A Problem of Meta-Cognition." In *Advances in Instructional Psychology*. Hillsdale, N.J.: Lawrence Erlbaum.

Bruner, J., J. J. Goodnow, and G. A. Austin. (1956). *A Study of Thinking*. New York: Wiley.

Cole, R. A., and D. Williams. (November 1973). "Pupil Responses to Teacher Questions: Cognitive Level, Length, and Syntax." *Educational Leadership* 31, 2: 142–145.

Condry, J., and J. Chambers. (1978). "Intrinsic Motivation and the Process of Learning." In *The Hidden Cost of Rewards: New Perspectives on the Psychology of Human Motivation*, edited by M. Lepper and D. Greene. New York: Lawrence Erlbaum.

Costa, A. (November 1984). "Mediating the Metacognitive." *Educational Leadership* 43, 3: 57–62.

Daily, F. (1970). "A Study of Female Teachers' Verbal Behavior and Peer-Group Structure Among Classes of Fifth-Grade Children." Doctoral diss., Kent State University.

Davis, O. L., and D. Tinsley. (February 1967). "Cognitive Objectives Revealed by Classroom Questions Asked by Social Studies Student Teachers." *Peabody Journal of Education* 45: 21–26.

Deci, E. L. (1978). "Application of Research on the Effect of Rewards." In *The Hidden Cost of Rewards: New Perspectives on the Psychology of Human Motivation*, edited by M. Lepper and D. Greene. New York: Lawrence Erlbaum.

Deci, E. L. (1976). *Intrinsic Motivation*. New York: Plenum Press.

Dewey, J. (1944). *Democracy in Education*. New York: Macmillan.

Dillon, J. (November 1984). "Research on Questioning and Discussion." *Educational Leadership* 42, 3: 50–56.

Dunn, R., and K. Dunn. (1978). *Teaching Students Through Their Individual Learning Styles*. Reston, Va.: Reston Publishing Company.

Ebbinhous, H. (1913). *Memory*. New York: Teachers College, Columbia University.

Education U.S.A. (1978). Arlington, Va.: National School Public Relations Association.

Feuerstein, R. (1980). *Instrumental Enrichment*. Baltimore, Md.: University Park Press.

Flanders, N. (1970). *Analyzing Teacher Behavior*. Reading, Mass.: Addison-Wesley.

Flanders, N. (1965). *Teacher Influence, Pupil Attitudes and Achievement*. Cooperative Research Monograph 112, OE 25040. Washington D.C.: Department of Health, Education, and Welfare.

Flanders, N. (1960). "Teacher Effectiveness." In *Encyclopedia of Educational Research*, 4th ed., edited by R. Elbell. New York: Macmillan.

Foley, J. J. (1971). "Teaching and Learning in the Affective Domain." In *Removing Barriers to Humaneness in the High School*, edited by J. G. Saylor and J. L. Smith. Washington, D.C.: Association for Supervision and Curriculum Development.

Furth, H. (1981). *Piaget and Knowledge: Theoretical Foundations*. Chicago: University of Chicago Press.

Gage, N. L. (Spring 1976). "A Factorially Designed Experiment on Teacher Structuring, Soliciting, and Reacting." *Journal of Teacher Education* 27, 1: 35–38.

Gagne, R. (1967). *Conditions for Learning*. New York: Holt, Rinehart and Winston.

Gallagher, J., and M. J. Ashner. (1963). "A Preliminary Report: Analysis of Classroom Interaction." *Merill Palmer Quarterly* 9: 183–194.

Good, T. L., and J. E. Brophy. (1973). *Looking in Classrooms*. New York: Harper and Row.

Good, T. L., and D. Grouws. (May/June 1977). "Teacher Effects: A Process-Product Study in Fourth-Grade Mathematics Classrooms." *Journal of Teacher Education* 27, 3: 49–54.

Goodlad, J. A. (1984). *A Place Called School: Prospects for the Future*. New York: McGraw-Hill.

Irion, A. L. (1966). "A Brief History of Research on the Acquisition of Skill." In *Acquisition of Skill*, edited by E. A. Belodeau. New York: Academic Press.

James, M., and D. Jongeward. (1971). *Born to Win*. Reading, Mass.: Addison–Wesley.

Johnson, R., D. Johnson, E. Holubec, and P. Roy. (1984). *Circles of Learning: Cooperation in the Classroom*. Alexandria, Va.: Association for Supervision and Curriculum Development.

Jones, H. E. (November 1923). "Experimental Studies of College Teaching." *Archives of Psychology* 68: entire issue.

Kahn, S. B., and J. Weiss. (1973). "The Teaching of Affective Responses." In *Second Handbook of Research on Teaching*, edited by R. Travers. Chicago: Rand McNally.

Kimble, G. A., and E. R. Hilgard. (1961). *Conditioning and Learning*. New York: Appleton–Century Crofts.

Klevan, A. (1968). "An Investigation of a Methodology for Value Clarification: Its Relationship to Consistency of Thinking, Purposefulness, and Human Relations." Doctoral diss., New York University.

Kohlberg, L. (1981). *The Philosophy of Moral Development: Moral Stages and the Idea of Justice*. San Francisco: Harper and Row.

Kounin, J. S. (1970). *Discipline and Group Management in Classrooms*. New York: Holt, Rinehart and Winston.

Lepper, M., and D. Greene, eds. (1978). *The Hidden Costs of Rewards: New Perspectives on the Psychology of Human Motivation*. Hillsdale, N.J.: Lawrence Erlbaum.

Lowery, L., and H. Marshall. (1980). *Learning About Instruction: Teacher Initiated Statements and Questions*. Berkeley: University of California.

McDonald, F. J. (Spring 1976). "Report on Phase II of the Beginning Teacher Evaluation Study." *Journal of Teacher Education* 27, 1: 39–42.

McGraw, K. (1978). "The Detrimental Effects of Rewards on Performance: A Literature Review and Prediction Model." In *The Hidden Costs of Rewards: New Perspectives on the Psychology of Human Motivation*, edited by M. Lepper and D. Greene. New York: Lawrence Erlbaum.

Measel, W., and D. Mood. (November 1972). "Teacher Verbal Behavior and Teacher and Pupil Thinking in Elementary School." *Journal of Educational Research* 66, 3: 99–102.

Newton, B. (March/April 1978). "Theoretical Bases for Higher Cognitive Questioning—An Avenue to Critical Thinking." *Education* 98, 3: 286–291.

Paul, R. (1985). "Dialectical Reasoning." In *Developing Minds*, edited by A. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Redfield, D., and E. Rousseau. (Summer 1981). "A Meta-Analysis on Teacher Questioning Behavior." *Review of Educational Research* 51: 234–245.

Rosenshine, B. (August 1970). "Enthusiastic Teaching: A Research Review." *School Review* 78, 4: 279–301.

Rosenshine, B., and N. Furst. (1971). "Current and Future Research on Teacher Performance Criteria." In *Research on Teacher Education, A Symposium*, edited by B. O. Smith. Englewood Cliffs, N.J.: Prentice-Hall.

Rowe, M. B. (Spring 1974). "Wait Time and Rewards as Instructional Variables: Their Influence on Language, Logic and Fate Control." *Journal of Research in Science Teaching* 11, 2: 81–84.

Soar, R. (1972). "Pupil-Teacher Interaction." In *A New Look at Progressive Education*, edited by J. Squire. Washington, D.C.: Association for Supervision and Curriculum Development.

Sprinthall, N., and L. Theis-Sprinthall. (1983). "The Teacher as an Adult Learner: A Cognitive Developmental View." In *Staff Development*, edited by G. Griffin. 82nd Yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press.

Stallings, J., and D. Kaskowitz. (1974). *Follow Through Classroom Observation Evaluation, 1972–1973*. Menlo Park, Calif.: Stanford Research Institute.

Sternberg, R., and R. Wagner. (1982). "Understanding Intelligence: What's in It for Education?" Paper submitted to the National Commission on Excellence in Education.

Suchman, J. R. (1964). *The Elementary School Training Program in Scientific Inquiry*. Urbana: University of Illinois.

Taba, H., S. Levine, and F. Elzey (1964). *Thinking in Elementary School Children*. Cooperative Research Project No. 1574. San Francisco: San Francisco State College.

Thomas, J. (Summer 1980). "Agency and Achievement: Self-Management and Self-Regard." *Review of Educational Research* 50, 2: 213–240.

Wallen, N. J., and J. H. Woodke. (1963). *Relationships Between Teacher Characteristics and Student Behavior, Part I*. Salt Lake City: University of Utah, Department of Educational Psychology.

Wasserman, S. (1978). *Put Some Thinking in Your Classroom*. New York: Benefic Press.

Whimbey, A. (April 1980). "Students Can Learn to Be Better Problem Solvers." *Educational Leadership* 37, 7: 56–65.

38

Reflective Teaching for Thoughtfulness

John Barell

A teacher is best who is always there—when students barely recognize they are being helped, not so good when students watch and say yes, worse when they intimidate or belittle. But of a good teacher who talks little—when their work is done, their aim fulfilled, students will say, we did it ourselves.

—Lao-tze

Life is, in part, composed of "messy, indeterminate situations" (Schon 1987) that are radically different from what school curriculums contain: situations with clearly defined problems to solve with memorized rules. This mismatch between life's problematic situations and school curriculums is the focus for the reflective teacher.

The reflective teacher is one who continually plans, monitors, and evaluates her own decision-making processes as she designs learning environments that enhance her students' abilities to deal with life's ill-structured problems. One quality that helps us deal productively with these kinds of situations is mindfulness (Langer 1989). The mindful person is one who overcomes thinking in stereotypic ruts and categories to consider alternative pathways toward dealing with these "messy" situations. Mindful persons are more self-directed, in control of their own destinies, and less likely to act like passive pawns in someone else's hands.

But the reflective teacher can stress more than mindfulness; she can also enhance students' thoughtfulness. Being thought*ful* suggests not only being deliberate in our thoughts, but also possessing those dispositions that foster and enhance our acting intelligently. One such disposition is having the confidence in ourselves that we can solve problems; another is an openness and ability to listen to the thoughts and feelings of others (Barell 1991). *Thoughtfulness*, therefore, integrates domains too long kept separate from each other: the head and the heart, our thoughts and our feelings.

Model: Mary Mulcahy shares how she thinks through life's dilemmas with her 1st and 2nd graders, and they, in turn, pose and resolve problems related to real situations they encounter (e.g., graffiti on school walls) and in the literature they read. Ultimately, her students reflect on their thinking processes to decide what a "good problem solver" does:

1. Take the parts out of the problem that you don't really need and get to the main problem. . . .
2. Look at the problem from different angles. . . .
3. Add on to someone else's thinking. . . .
4. Work it out on a piece of paper. . . .

As a result of Ms. Mulcahy's modeling the essence of reflective teaching, these students are generating their own characteristics of intelligent persons. Reflective teaching includes: (1) listening empathically; (2) modeling thinking; (3) collaborating with students; (4) designing learning as problem solving and experimentation; (5) planning, monitoring, and evaluating progress; and (6) empowering students toward self-direction.

All teachers plan, design, and evaluate instruction. The reflective practitioner (Schon 1987) is one who, in the process, communicates with her students in such a way that they, together, create a "community of inquiry" (Lipman, Sharp, and Oscanyan 1980), where teachers and students learn from and teach one another (Freire 1974).

Listening Empathically

One of our first tasks as reflective teachers is to establish the community of inquiry where participants are invited to become mindful of alternative points of view and solutions. "It may surprise us to learn that both wrong and right answers and smart and dumb pupils bear listening to" (Dillon 1988), because only through listening to students explain their thought processes and associated feelings can we come to understand the foundations of their responses. To do this, we can use the following strategies:

Teachers Listening to Students. Present problems and dilemmas from day one and show students you listen to their answers with these kinds of responses:

- Clarify: "Are you saying . . .?"
- Expand: "Can we add on to your ideas . . .?"
- Inquire: "I'm not sure I understand."
- Relate: "Who can relate a similar experience (in the subject or in your personal life?")
- Empathize: "You seem to be feeling . . ."
- Transfer: "How can we apply these principles to our experiences elsewhere?"

Students Listening to Each Other. Research (Johnson and Johnson 1979) indicates that students encountering conflicts and discrepant experiences with peers fosters inquiry and reconsideration of past beliefs, practices, and points of view.

We can help students learn one another's names and respond to each other directly through such internalized scripts as:

- "I agree/disagree with your statement, David, because . . ."
- "I don't understand what you're saying, Susan."
- "I can empathize with your experience, Gary."
- "I can add on to Marcia's idea by . . . "

By helping students respond directly to one another, we foster the kinds of mental development that result from encountering different ideas (Sigel, Copple, and Saunders 1984) and, if these experiences are conducted within cooperative settings, we help students enhance their problem-solving abilities by listening to and incorporating alternative strategies into their own repertoires.

Modeling Thinking

"Learning cognitive skills can be facilitated simply by having models verbalize their thought strategies aloud as they engage in problem solving activities" (Bandura 1986). As we listen, we abstract key processes and fashion them for our own future use. We can share our thinking with students in two ways: retrospective modeling and real time modeling.

Retrospective Modeling. "I was driving to work and encountered a roadblock. I had to figure out how to get here and not be late." Here the teacher describes a problem and how she figured out what to do. Intense thinking inevitably occurs during such moments when we don't know precisely what to do (Baron 1985) or when we reach a violated expectation (Sigel, Copple, and Saunders 1984).

After sharing the thought-provoking event, the teacher invites students to describe, analyze, and evaluate her thinking processes. This involves problem-solving strategies like identifying the problem, representing and relating it to others, generating alternatives, projecting consequences, using criteria to select an alternative, acting, and evaluating.

Real Time Modeling. "Here is a problem historians (physicists, poets, etc.) often face. Let me think it through aloud and listen to how I go about doing it."

Repeated experiences of this kind, where thinking is perceived as experimenting with different pathways toward solving problems (Ryle 1979), clarify teachers' thinking and help students risk behaving more thoughtfully about alternatives within an environment where experimentation and inquiry are valued.

Collaborating with Students

Collaborating with students means involving them in making decisions about their own learning. Goodlad (1984) suggests that students seldom play such roles, and Langer (1989) notes that offering choices and decision opportunities are ways of "increasing mindfulness. . . . The opportunity to make choices increases our motivation . . . and makes us freer to map our own course." Here are some effective strategies:

Set High Expectations.

1. Use physical space: "How should we arrange our space in order to make learning fun and more enriching?"
2. Create classroom constitutions: "What are rules? Why do we need them? What rules should we establish in our classroom?"
3. See all persons as resources: "This is *our* classroom and we will all learn here and if you can't do it yourself we will all help."

Plan Instructional Practices.

One effective strategy is to involve students in planning a unit of instruction: "What do you know about the beach? What do you want to find out? How will we go about reaching these objectives?" These questions, asked by one 3rd grade teacher, gave her students a stake in their own learning and helped them set their own goals for learning (Barell 1991).

Designing Learning as Problem Solving and Experimentation

Reflective teaching for thoughtfulness calls upon us to find within our various curriculums problematic situations that students and teachers can analyze and speculate about, for thinking begins with doubts and perplexities (Dewey 1933; Baron 1985).

Teacher Generated Problems. Here are examples from four subjects:

- Literature: If you were Macbeth, how would you have responded to Lady Macbeth's urgings to "screw your courage to the sticking place"?
- History: "What were George Washington's problems in forming a new government in 1789, and how do your solutions compare with his?
- Science: How can we prevent our environment from being despoiled by human mismanagement?
- Math: How many different ways are there to add 8 and 6? At least four, according to some children (Peterson, Fennema, and Carpenter 1988/1989).

Student Generated Problems and Goals. Foster students' questions by encouraging them to identify their curiosities. All students can act like Viola Stanley's 5th and 6th graders when asked to identify their wonderings before, during, or after studying a unit: "I wonder why, if the sun is so bright, the sky is so dark at night" asked one 5th grader. The thoughtful person always has questions and we find too little time within the curriculum to foster them (Sternberg 1987) and use them for instructional or curricular planning.

Planning, Monitoring, and Evaluating Progress

Reflective teachers will make the thinking within a lesson explicit:

> *Prior* to any learning activity, teachers should point out strategies and steps for attacking problems. . . . *During* the activity, teachers can invite students to share their progress, thought processes and perceptions of their own behavior. . . . Then *after* the learning activity teachers can invite students to evaluate how well the rules were obeyed, how productive the strategies were (Costa 1984).

The essence of reflective teaching and learning consists of this three-part metacognitive process of *planning* (What is my problem and how will I solve it?), *monitoring* (How well am I doing now?), and *evaluating* (How well did I do?) Strategies for engaging students in this self-reflective process include:

Thinking Journals. Questions such as the following help students reflect on their progress toward a product (Barell, Liebmann, and Sigel 1988):

- What is my problem or task?
- How did I solve or perform it? (Here the emphasis is on one's thinking processes, not the specific solutions)
- How well did I do? What are my criteria for judgment?
- What would I do differently next time and why?
- Where outside of school are there similar situations where I can use these thinking processes, concepts, and attitudes?

The last question is very important, for we cannot assume that thinking and learning in school automatically transfer to life beyond the classroom walls (Perkins and Salomon 1988).

Teachers' Probing Questions. These questions focus on students' moving toward improved awareness and control of their thinking about themselves and their task, not only on attaining the right answer (Baird and White 1984; Marzano, Brandt, Hughes, Jones, Presseisen, Rankin, and Suhor 1988):

- What questions are you asking yourself about this situation? What feelings do you have about the situation? What is your commitment to the task?
- How do you plan to go about answering your own questions?
- How well are you doing now? Do you need to rethink your strategy?
- How well have you done? How did you go about solving your problem?

Empowering Students Toward Self-Direction

Langer (1989) has demonstrated that decision making contributes to mindfulness, as well as to mental and physical health. Classrooms where students make decisions about goals and strategies for their own learning and self-development can be established. Students engaged in such processes grow to realize that, as one 6th grader noted, "different problems require different kinds of strategies." Students who set their own goals are more likely to achieve academic success (Thomas 1980) and "consider themselves to be agents who can control their own fates" and not mindlessly regard themselves simply as "pawns in some impossible-to-control system" (Pressley, Goodchild, Fleet, Zaichowski, and Evans 1987).

Students who have lived within communities of inquiry nurtured by such strategies have reflected on their own progress:

6th grade science students: "I can ask myself questions and make my own plans. . . . When you do your own plan, you become more interested and work harder. . . . If you really think about all of the steps in our plans, then we can figure out why they succeeded or did not succeed" (Kamlet 1989).

High school math students: "I do not want to be dependent on others to help me solve my problems. My dad usually helps me by asking me questions about problems. I guess what I should learn to do is ask myself similar questions.

"You [the teacher] taught me how to ask good questions when I didn't know what to do" (Liebmann 1989).

High school art students: "[Writing about my thinking as I painted] showed me what I was doing and why. I thought it just comes out, and the way it comes, it comes. . . . I thought I'd never even ask myself questions until you pointed them out to me" (Kuhlmann 1989).

These students, together with Mary Mulcahy's 1st and 2nd graders, are becoming more self-directed because of the reflective teachers who created environments in which students could identify problems, set goals and strategies, and continually reflect upon their performance. They are becoming more "wide-awake" to their own thinking and to the possibilities for inquiry and self-determined explorations (Greene 1973).

Reflective teaching for life is to be forever designing experiences that help students pose a wide variety of "what if" questions, for life is not a predictable endeavor but one characterized by continual experimentation—acting "in order to see what follows" (Schon 1987)—in order to control our own destinies.

References

Baird, J., and R. White. (1984). "Improving Learning Through Enhanced Metacognition: A Classroom Study." Paper presented at the annual meeting of the American Educational Research Association, New Orleans, La.

Bandura, A. (1986). *Social Foundations of Thought and Action, A Social Cognitive Theory.* Englewood Cliffs, N.J.: Prentice-Hall.

Barell, J. (1991). *Pathways to Thoughtfulness.* New York: Longman.

Barell, J., R. Liebmann, and I. Sigel. (April 1988). "Fostering Thoughtful Self-Direction in Students." *Educational Leadership.* 45, 7: 14–17.

Baron, J. (1985). *Rationality and Intelligence.* Cambridge, Mass.: Cambridge University Press.

Dewey, J. (1933). *How We Think.* Lexington, Mass.: D. C. Heath.

Costa, A. (Nov. 1984). "Mediating the Metacognitive." *Educational Leadership* 42, 3: 57–62.

Dillon, J. T. (1988). *Questioning and Teaching.* New York: Teachers College Press.

Freire, P. (1974). *Pedagogy of the Oppressed.* New York: Seabury Press.

Goodlad, J. (1984). *A Place Called School.* New York: McGraw-Hill.

Greene, M. (1973). *Teacher as Stranger.* Belmont, Calif.: Wadsworth.

Johnson, R., and D. Johnson. (Winter 1979). "Conflict in the Classroom." *Review of Educational Research* 49, 1: 51–70.

Kamlet, R. (1989). "Enhancing Students' Metacognitive Awareness." Masters thesis, Montclair State College, Montclair, N.J.

Kuhlmann, M. (1989). "Creative Success Enhanced through Critical Thinking." Masters thesis, Montclair State College, Montclair, N.J.

Langer, E. (1989). *Mindfulness.* Reading, Mass.: Addison-Wesley.

Liebmann, R. (1989). "Writing Improves Problem Solving in Mathematics." Unpublished manuscript.

Lipman, M., A. Sharp, and F. Oscanyan. (1980). *Philosophy in the Classroom.* Philadephia: Temple University Press.

Marzano, R., R. Brandt, C. S. Hughes, B. F. Jones, B. Z. Presseisen, S. C. Rankin, and C. Suhor. (1988). *Dimensions of Thinking.* Alexandria, Va.: Association for Supervision and Curriculum Development.

Perkins, D., and G. Salomon. (September 1988). "Teaching for Transfer." *Educational Leadership* 46, 1: 22–32.

Peterson, P., E. Fennema, and T. Carpenter. (December 1988/January 1989). "Using Knowledge of How Students Think about Mathematics." *Educational Leadership* 46, 4: 42–46.

Pressley, M., F. Goodchild, J. Fleet, R. Zaichowski, and E. Evans. (1987). "What Is Good Strategy Use and Why Is It Hard to Teach? An Optimistic Appraisal of the Challenges Associated with Strategy Instruction." Paper presented at the annual meeting of the American Educational Research Association, Washington, D. C.

Ryle, G. (1979). *On Thinking.* Totowa, N.J.: Rowman and Littlefield

Schon, D. (1987). *Educating the Reflective Practitioner.* San Francisco: Jossey-Bass.

Sigel, I., C. Copple, and R. Saunders. (1984). *Educating the Young Thinker.* Hillsdale, N.J.: Lawrence Erlbaum.

Sternberg, R. (January 1987). "Questioning and Inelligence." *Questioning Exchange* 1, 1: 11–14.

Thomas, J. (Summer 1980). "Agency and Achievement: Self-Management and Self-Regard." *Review of Educational Research* 50, 2: 213–241.

39

Mediating the Metacognitive

Arthur L. Costa

There are one-story intellects, two-story intellects, and three-story intellects with skylights. All fact collectors who have no aim beyond their facts are one-story men. Two-story men compare, reason, generalize, using the labor of fact collectors as their own. Three-story men idealize, imagine, predict—their best illumination comes from above the skylight.

—Oliver Wendall Holmes

Try to solve this problem in your head: How much is one-half of two plus two? Did you hear yourself talking to yourself? Did you have to decide if you should take one-half of the first two or if you should sum the two's first?

If you caught yourself having an inner dialogue inside your brain, and if you had to evaluate your own decision-making/problem-solving processes, you were experiencing metacognition. Metacognition is our ability to know what we know and what we don't know. It occurs in the cerebral cortex and is thought by some neurologists to be uniquely human.

Metacognition is our ability to plan a strategy for producing what information is needed, to be conscious of our own steps and strategies during the act of problem solving, and to reflect on and evaluate the productivity of our own thinking. While inner language, thought to be a prerequisite, begins in most children around age 5, metacognition—a key attribute of formal thought—flowers at about age 11. Interestingly, not all humans achieve the level of formal operations (Chiappetta 1976). And, as Luria, the Russian psychologist found, not all adults metacogitate (Whimbey and Whimbey 1976).

This chapter is adapted from A. L. Costa, "Mediating the Metacognitive," *Educational Leadership* 42, 3 (November 1984): 57–62.

Students often follow instructions or tasks *without* wondering why they are doing what they are doing. They seldom question themselves about their own learning strategies or evaluate the efficiency of their own performance. Some children have virtually no idea of what they are doing when they perform a task and are often unable to explain their strategies for solving problems (Sternberg and Wagner 1982). There is much evidence, however, to demonstrate that those who persevere in problem solving; who think critically, flexibly, and insightfully; and who can consciously apply their intellectual skills are those who possess well-developed metacognitive abilities (Bloom and Broder 1950; Brown 1978; Whimbey 1980). Such people also effectively manage their intellectual resources. These resources include: (1) basic perceptual-motor skills; (2) language, beliefs, knowledge of content, and memory processes; and (3) purposeful and voluntary strategies intended to achieve a desired outcome (Aspen Systems 1982).

If we wish to develop intelligent behavior as a significant outcome of education, instructional strategies purposefully intended to develop children's metacognitive abilities must be infused into our teaching methods, staff development, and supervisory processes (Costa 1981). Interestingly, *direct* instruction in metacognition *may* not be beneficial. When strategies of problem solving are imposed rather than generated by the students themselves, their performance may be impaired. Conversely, when students experience the need for problem-solving strategies, induce their own, discuss them, and practice them to the degree that they become spontaneous and unconscious, their metacognition seems to improve (Sternberg and Wagner 1982). The trick, therefore, is to teach metacognitive skills without creating an even greater burden on students' ability to attend.

Probably the major component of metacognition is developing a plan of action and then maintaining that plan in mind over time. Planning a strategy before embarking on

ERIC

a course of action assists us in keeping track of the steps in the sequence of planned behavior at the conscious awareness level for the duration of the activity. It facilitates making temporal and comparative judgments; assessing readiness for more or different activities; and monitoring our interpretations, perceptions, decisions, and behaviors. An example of this is what superior teachers do daily: develop a teaching strategy for a lesson, keep the strategy in mind throughout the instruction, then reflect upon the strategy to evaluate its effectiveness in producing the desired student outcomes.

Rigney (1980) identified these self-monitoring skills as necessary for successful performance on intellectual tasks:

- Keeping one's place in a long sequence of operations.
- Knowing that a subgoal has been obtained.
- Detecting errors and recovering from them by making a quick fix or by retreating to the last known correct operation.

Such monitoring involves both looking ahead and looking back. Looking ahead includes:

- Learning the structure of a sequence of steps.
- Identifying areas where errors are likely.
- Choosing a strategy that will reduce the possibility of error and will provide easy recovery.
- Identifying the kinds of feedback that will be available at various points and evaluating their usefulness.

Looking back includes:

- Detecting errors previously made.
- Keeping a history of what has been done so far and therefore what should come next.
- Assessing the reasonableness of the present immediate outcome for task performance.

A simple example of this might be drawn from a reading task. It is a common experience while reading a passage to have our minds wander from the words. We see the words, but no meaning is being produced. Suddenly we realize that we are not concentrating and that we've lost contact with the meaning of the text. We recover by returning to the passage to find the place where we stopped concentrating, matching it with the last thought we remember; once having found it, we read on with connectedness. This inner awareness and the strategy of recovery are components of metacognition.

Strategies for Enhancing Metacognition

Teachers can use a variety of strategies[1] to enhance metacognition, independent of grade level and subject area.

1. *Planning Strategy.* Prior to any learning activity, teachers should point out strategies and steps for attacking problems, rules to remember, and directions to follow. Time constraints, purposes, and ground rules under which students must operate should be identified and internalized. Making these guidelines explicit helps students keep them in mind during the lesson and gives them a way to evaluate their performance afterwards.

During the activity, teachers can invite students to share their progress, thought processes, and perceptions of their own behavior. Asking students to indicate where they are in their strategy, to describe their trail of thinking up to that point, and to define alternative problem-solving pathways they intend to pursue next helps them become aware of their own behavior. It also provides teachers with a diagnostic cognitive map of students' thinking, which can be used to give more individualized assistance.

Then, *after* the learning activity, teachers can invite students to evaluate how well the rules were obeyed, how productive the strategies were, whether the instructions were followed correctly, and whether alternative, more efficient strategies could be used in the future.

I know a kindergarten teacher who begins and ends each day with a class meeting. During the morning, children make plans for the day. They decide upon what learning tasks to accomplish and how to accomplish them. They allocate classroom space, assign roles, and develop criteria for appropriate conduct. Throughout the day the teacher calls attention to the plans and ground rules made that morning and invites students to compare what they are doing with what was agreed. Then, before dismissal, another class meeting is held to reflect on, evaluate, and plan further strategies and criteria.

2. *Generating Questions.* Regardless of the subject area, it is useful for students to pose study questions for themselves prior to and during their reading of textual material. This self-generation of questions facilitates comprehension and encourages students to pause frequently and think about whether, for instance, they know main characters or events, if they are grasping the concept, if they can relate it to what they already know, if they can give other examples, and whether they can use the main idea to explain other ideas or predict what may come next. They must then decide what strategic action to take to remove any obstacles to their comprehension. All of this helps students become more self-aware and to take conscious control of their own studying (Sanacore 1984).

3. *Choosing Consciously.* Teachers can promote metacognition by helping students explore the consequences of their choices and decisions prior to and during the act of deciding. Students will then be able to perceive causal relationships among their choice, their actions, and the results they achieved. Providing nonjudgmental feedback to students about the effects of their behaviors and decisions on others and on their environment helps them become aware of their own behaviors. For example, a teacher's

statement, "I want you to know that the noise you're making with your pencil is disturbing me," will better contribute to metacognitive development than the command, "John, stop tapping your pencil!"

4. *Evaluating with Multiple Criteria.* Teachers can enhance metacognition by causing students to reflect upon and categorize their actions according to two or more sets of evaluative criteria. An example would be to invite students to distinguish what was done that was helpful and hindering; what they liked and didn't like; or what were pluses and minuses of the activity. Thus, students must keep the criteria in mind, apply them to multiple classification systems, and justify their reasons accordingly.

5. *Taking Credit.* Teachers may cause students to identify what they have done well and invite them to seek feedback from their peers. The teacher might ask, "What have you done that you're proud of?" and "How would you like to be recognized for doing that?" (Name on the board, hug, pat on the back, handshake, applause from the group, and so on). Students will become more conscious of their own behavior and apply a set of internal criteria for those behaviors that they consider good.

6. *Outlawing "I Can't."* Teachers can inform students that their excuses—"I can't"; "I don't know how to . . ."; or "I'm too slow to . . ."—are unacceptable behaviors in the classroom. Instead, students should be asked to identify what information is required, what materials are needed, or what skills are lacking in their ability to perform the desired behavior. This helps students identify the boundaries between what they know and what they need to know. It develops a perseverant attitude and enhances the student's ability to create strategies that will produce needed data.

7. *Paraphrasing or Reflecting Back Students' Ideas.* Some examples of paraphrasing, building upon, extending, and using the students' ideas might be to say: "What you're telling me is . . ."; "What I hear in your plan are the following steps . . ."; or "Let's work with Peter's strategy for a moment." Inviting students to restate, translate, compare, and paraphrase each other's ideas causes them to become not only better listeners to other's thinking, but better listeners to their own thinking as well.

8. *Labeling Students' Behaviors.* When teachers place labels on students' cognitive processes, students become conscious of their own actions: "What I see you doing is making out a plan of action for . . ."; "What you are doing is called an experiment"; "You're being very helpful to Mark by sharing your paints. That's an example of cooperation."

9. *Clarifying Students' Terminology.* Students often use hollow, vague, and nonspecific terminology. For example, in making vague judgments, students might say, "It's not fair," "He's too strict," "It's no good." Teachers need to clarify these values: What's too strict? What should be more fair?

Students sometimes use nominalizations: "They're mean to me." —Who are they? "We had to do that." —Who is we? "Everybody has one." —Who is everybody? Asking such clarifying questions causes students to operationally define their terminology and to examine the premise on which their thinking is based.

It is also helpful to clarify students' problem-solving processes. Causing students to describe their thinking while they are thinking seems to beget more thinking. Teachers can invite students to talk aloud as they are solving a problem; discuss what is going on in their heads, for example, when they decode an unfamiliar word while reading; or ask what steps they are going through in deciding whether to buy something.

After a problem is solved, teachers can invite clarification of the processes used: "Sarah, you figured out that the answer was 44; Shaun says the answer is 33. Let's hear how you came up with 44; retrace your steps for us." Clarifying helps students to reexamine their own problem-solving processes, to identify their errors, and to self-correct. The teacher might ask, "How much is three plus four?" The student may reply "12." Rather than merely correcting the student, the teacher may choose to clarify: "Gina, how did you arrive at that answer?" "Well I multiplied four and three and got . . . Oh, I see, I multiplied instead of added."

10. *Role Playing and Simulations.* Role playing can promote metacognition because when students assume the roles of other persons, they consciously maintain the attributes and characteristics of that person. Dramatization serves as a hypothesis or prediction of how that person would react in a certain situation. Taking on another role contributes to the reduction of ego-centered perceptions.

11. *Journal Keeping.* Writing and illustrating a personal log or a diary throughout an experience causes students to synthesize thoughts and actions and to translate them to symbolic form. The record also provides an opportunity to revisit initial perceptions, to compare changes in those perceptions, to chart the processes of strategic thinking and decision making, to identify the blind alleys and pathways taken, and to recall the successes and the tragedies of experimentation. (A variation on writing journals is making video and/or audio tape recordings of actions and performances).

12. *Modeling.* Of all the instructional techniques suggested, the one that probability has the greatest influence on students is teacher modeling. Since students learn best by imitating the adults around them, the teacher who publicly demonstrates metacognition will probably produce students who metacogitate. Indicators of teachers' public metacognitive behavior include: sharing their planning—describing

their goals and objectives and giving reasons for their actions; making human errors and then illustrating recovery from those errors by getting back on track; admitting they do not know an answer, but designing ways to produce an answer; seeking feedback and evaluation of their actions from others; having a clearly stated value system and making decisions consistent with that system; being able to self-disclose—using adjectives that describe their own strengths and weaknesses; and demonstrating understanding and empathy by listening to and accurately describing the ideas and feelings of others.

Evaluating Growth in Metacognitive Abilities

We can determine if students are becoming more aware of their own thinking as they are able to describe what goes on in their heads when they are thinking. When asked, they can list the steps and tell where they are in the sequences of a problem-solving strategy. They can trace the pathways and dead ends they took on the road to problem solution. They can describe what data are lacking and their plans for producing those data.

We should see students becoming more perseverant when the solution to a problem is not immediately apparent. This means that they have systematic methods of analyzing a problem, knowing ways to begin, knowing what steps must be performed and when they are accurate or in error. We should see students taking more pride in their efforts; becoming self-correcting, striving for craftsmanship and accuracy in their products, and becoming more autonomous in their problem-solving abilities.

Teaching for thinking was the great educational discovery of the '80s. Metacognition is an indicator of the "educated intellect" and must be included in the curriculum if thinking is to become a durable reality for the '90s and beyond.

NOTE

[1]For several of these techniques I am deeply indebted to Fred Newton, Superintendent of Schools, Multnomah County, Oregon; Juanita Sagan, a therapist in Oakland, California; and Ron Brandt, Executive Editor, ASCD.

REFERENCES

Aspen Systems (April 1982). *Topics in Learning and Learning Disabilities* 2, 1.

Bloom, B. S., and L. J. Broder (1950). *Problem-Solving Processes of College Students.* Chicago: University of Chicago Press.

Brown, A. L. (1978). "Knowing When, Where, and How to Remember: A Problem of Meta-Cognition." In *Advances in Instructional Psychology,* edited by R. Glaser. Hillsdale, N.J.: Lawrence Erlbaum.

Chiappetta, E. L. (April–June 1976). "A Review of Piagetian Studies Relevant to Science Instruction at the Secondary and College Level." *Science Education* 60, 2: 253–261.

Costa, A. L. (October 1981). "Teaching for Intelligent Behavior." *Educational Leadership* 39, 1 :29–31.

Rigney, J. W. (1980). "Cognitive Learning Strategies and Qualities in Information Processing." In *Aptitudes, Learning, and Instruction, Vol. 1,* edited by R. Snow, P. Federico, and W. Montague. Hillsdale, N.J.: Lawrence Erlbaum

Sanacore, J. (May 1984). "Metacognition and the Improvement of Reading: Some Important Links." *Journal of Reading*: 27, 8: 706–712.

Sternberg, R., and R. Wagner. (1982). "Understanding Intelligence: What's In It for Education." Paper submitted to the National Commission on Excellence in Education.

Whimbey, A. (April 1990). "Students Can Learn to Be Better Problem Solvers." *Educational Leadership* 37, 7: 560–565.

Whimbey, A., and L. S. Whimbey. (1976). *Intelligence Can Be Taught.* New York: Bantam.

40

Teaching for Transfer

D. N. Perkins and Gavriel Salomon

Give me a fish and I will eat today. Teach me to fish and I will eat for a lifetime.

—Chinese proverb

Facing a move across town and concerned with economy, you rent a small truck to transport your worldly possessions. You have never driven a truck before and wonder whether you can manage it. However, when you pick the truck up from the rental agency, you find yourself pleased and surprised. Driving the truck is an experience unfamiliar, yet familiar. You guide the vehicle through the city traffic with caution, yet growing confidence, only hoping that you will not have to parallel park it.

This everyday episode is a story of transfer—something learned in one context has helped in another. The following line of poetry from Shakespeare also shows transfer: "Summer's lease hath all too short a date." Regretting the decline of summer in his Sonnet 18, Shakespeare compares it to, of all things, a lease. The world of landlords and lawyers falls into startling juxtaposition with the world of dazzling days, cumulus clouds, and warm breezes.

Your experience with the truck and Shakespeare's metaphor differ in many ways. From driving a car to driving a truck is a short step, while from leases to summer seems a long step. One might speak roughly of "near transfer" versus "far transfer." In the first case, you carry a physical skill over to another context, whereas in the second, Shakespeare carries knowledge associated with leases over to another context. One might speak of transfer of skill versus transfer of knowledge, and, although here we will focus on those two, other sorts of things might be transferred as well—for instance, attitudes or cognitive styles. Finally, the first case is everyday, the second a high achievement of a literary genius. Nonetheless, despite these many contrasts, both episodes illustrate the phenomenon of transfer. In both, knowledge or skill associated with one context reaches out to enhance another. (It is also possible to speak of negative transfer, where knowledge or skill from one context interferes in another.)

Transfer goes beyond ordinary learning in that the skill or knowledge in question has to travel to a new context—from cars to trucks, from lawyers to summer, or across other gaps that might in principle block it. To be sure, that definition makes for a fuzzy border between transfer and ordinary learning. For example, if car to truck is a gap, so in some sense is automatic transmission to standard transmission, or Ford automatic to Chrysler automatic. But the last two, and especially the last, do not seem intuitively to be different enough to pose a significant gap. In practice, we have a rough sense of what gaps might be significant and, although that sense may not always be accurate, nothing in this article will depend upon drawing a perfectly sharp line between transfer and ordinary learning.

If transfer figures in activities as diverse as moving across town and writing sonnets, it is easy to believe that transfer has at least a potential role in virtually all walks of life. But transfer does not take care of itself, and conventional schooling pays little heed to the problem. With proper attention, we can do much more to teach for transfer than we are now doing.

Why Is Transfer Important to Education?

Any survey of what education hopes to achieve discloses that transfer is integral to our expectations and aspirations for education. First of all, the transfer of basic skills is a routine target of schooling. For example, students learn to

This article is adapted from D. N. Perkins and G. Salomon, "Teaching for Transfer," *Educational Leadership* 46, 1 (September 1988): 22–32.

read *Dick and Jane* or *A Tale of Two Cities* not just for the sake of reading other texts but in preparation for a much wider range of reading—newspapers, job applications, income tax forms, political platforms, assembly instructions, wills, contracts, and so on. Students learn mathematical skills not just for the sake of figuring Sammy's age when it is two-thirds of Jane's, but for smart shopping in the supermarket, wise investment in the stock market, understanding of statistical trends, and so on.

Another expectation of education concerns the transfer of knowledge. The "data base" students acquire in school ought to inform their thinking in other school subjects and in life outside of school. For example, European and American history should help students to think about current political events—the traditions that shape them, the economic and political factors that influence them, the reasons why one votes or acts in certain ways in the political arena. Literary studies should help students to think about fundamental problems of life—the cycle of birth and death, the struggle for dominance, the quest for love, and how one's own life incarnates those eternal dramas. Science instruction should help students to understand the world around them—the branch waving in the wind as an oscillator, a city as an artificial ecology, the threat and promise of nuclear power or genetic engineering.

Finally, transfer plays a key role in an aspiration of education that lately has attained great prominence: the teaching of thinking skills. As with basic skills and knowledge, here again the aim is not just to build students' performance on a narrow range of school tasks. One hopes that students will become better creative and critical thinkers in the many contexts that invite a thoughtful approach—making important life decisions, casting votes, interacting with others equitably, engaging in productive pursuits such as essay writing, painting, and so on.

Why Is Transfer Worrisome in Education?

The implicit assumption in educational practice has been that transfer takes care of itself. To be lighthearted about a heavy problem, one might call this the "Bo Peep" theory of transfer. "Let them alone and they'll come home, wagging their tails behind them." If students acquire information about the Revolutionary War and the Westward emigration, if they learn some problem-solving skills in math and some critical thinking skills in social studies, all this will more or less automatically spill over to the many other contexts in and out of school where it might apply, we hope.

Unfortunately, considerable research and everyday experience testify that the Bo Peep theory is inordinately optimistic. While the basic skills of reading, writing, and arithmetic typically show transfer (for reasons to be discussed later), other sorts of knowledge and skill very often do not.

For example, a great deal of the knowledge students acquire is "inert" or "passive." The knowledge shows up when students respond to direct probes, such as multiple choice or fill-in-the-blank quizzes. However, students do not transfer the knowledge to problem-solving contexts where they have to think about new situations. For example, Bransford and his colleagues have demonstrated that both everyday knowledge and knowledge acquired in typical school study formats tend to be inert (Bransford, Franks, Vye, and Sherwood 1986; Perfetto, Bransford, and Franks 1983). Studies of programming instruction have shown that a considerable portion of beginning students' knowledge of commands in a programming language is inert even in the context of active programming, where there is hardly any gap to transfer across (Perkins and Martin 1986; Perkins, Martin, and Farady 1986). Studies of medical education argue that much of the technical knowledge student physicians acquire from texts and lectures is inert—not retrieved or applied in the diagnostic contexts for which it is intended (Barrows and Tamblyn 1980).

It has often been suggested that literacy is one of the most powerful carriers of cognitive abilities. Olson (1976), for example, has argued that written language permits patterns of thinking much more complex than can be managed within the limited capacity of human short-term memory. Moreover, written texts, in their presentational and argumentative structures, illustrate patterns of thinking useful for handling complex tasks. Literacy, therefore, ought to bring with it a variety of expanded cognitive abilities. To put the matter in terms of transfer, literacy should yield cognitive gains on a number of fronts, not just the skills of reading and writing per se.

The difficulty with testing this hypothesis is that people usually learn to write in school at the same time that they learn numerous other skills that could affect their cognitive abilities. This dilemma was resolved when Scribner and Cole (1981) undertook a detailed study of the Vai, an African tribe that had developed a written language that many members of the tribe learned and used, but that maintains no tradition of formal schooling. Remarkably, the investigators' studies disclosed hardly any impact of Vai literacy on the cognitive performance of Vai who had mastered the written language. The hypothesized transfer did not appear.

Another source of discouraging evidence about transfer comes from contemporary studies of the impact of computer programming instruction on cognitive skills. Many psychologists and educators have emphasized that the richness and rigor of computer programming may enhance students' cognitive skills generally (e.g., Feurzeig, Horwitz, and Nickerson 1981; Linn 1985; Papert 1980). The learning of programming demands systematicity—breaking problems into parts, diagnosing the causes of difficulties, and so on. Thinking of this sort appears applicable to nearly any domain. Moreover, as Papert (1980) has urged, programming languages afford the opportunity to learn about the nature of procedures, and procedures in turn provide a way of thinking about how the mind works. While all this may be true, the track record of efforts to enhance cognitive skills via programming is discouraging. Most findings have been negative (see reviews in Clements 1985b; Dalbey and Linn 1985; Salomon and Perkins 1987).

Another well-investigated aspect of learning has been the effort to teach somewhat retarded individuals the basic cognitive skills of memory. Learning some basic strategies of memory familiar to any normal individual can substantially improve the performance of retarded learners. However, in most cases, the learners do not carry over the strategies to new contexts. Instead, it is as though the memory strategies are "contextually welded" to the circumstances of their acquisition (Belmont, Butterfield, and Ferretti 1982).

With this array of findings contrary to the Bo Peep theory, it is natural to ask why transfer should prove so hard to achieve. Several explanations are possible. Perhaps the skill or knowledge in question is not well learned in the first place. Perhaps the skill or knowledge in itself is adequately assimilated, but when to use it is not treated at all in the instruction. Perhaps the hoped-for transfer involves genuine creative discovery—as in the case of Shakespeare's metaphor—that we simply cannot expect to occur routinely.

While all these explanations have a commonsense character, one other contributed by contemporary cognitive psychology is more surprising: there may not be as much to transfer as we think. The skills students acquire in learning to read and write, the knowledge they accumulate in studying the American Revolution, and the problem-solving abilities they develop in math and physics may be much more specific to those contexts than one would imagine. Skill and knowledge are perhaps more specialized than they look. This is sometimes called the problem of "local knowledge"; that is, knowledge (including skill) tends to be local rather than general and crosscutting in character.

The classic example of this problem of local knowledge is chess expertise, which has been extensively researched. Chess is an interesting case in point because it appears to be a game of pure logic. There is no concealed information, as in card games: all the information is available to both players. It seems that each player need only reason logically and make the best possible move within his or her mental capacity.

However, in contrast with this picture of chess as a general logical pursuit, investigations have disclosed that chess expertise depends to a startling degree on experience specifically with the game. Chess masters have accumulated an enormous repertoire of "schemata"—patterns of a few chess pieces with significance for play (de Groot 1965; Chase and Simon 1973). One pattern may indicate a certain threat, another a certain opportunity, another an avenue of escape. Skilled play depends largely on the size of one's repertoire. A chess master may be no more adept at other intellectual pursuits, such as solving mysteries or proving mathematical theorems, than any layperson.

Must We Choose Between Cultural Literacy and Critical Thinking?

From certain quarters today comes a wave of pessimism about the prospects of transfer and the potentials of teaching for general cognitive skills. One recent and popular spokesperson for a negative position is E. D. Hirsch, Jr. (1987), who offers in his *Cultural Literacy* an eloquent plea for turning away from general skills and equipping youngsters with the varied basic knowledge that makes one culturally literate.

Such a response is quite understandable in the face of the naive approach to problems of learning and transfer typically found in schools. Often, educators have expected broad global nonspecific transfer from highly specialized activities such as the study of Latin or computer programming, as though these activities exercised up some generic mental muscle. Often, educators have not focused on exactly *what* about such activities might transfer nor made efforts to decontextualize the transferable aspects and bridge them to other contexts. Often, educators have sought to impart lengthy lists of "microskills" for reading or other performances, an approach that seems doomed to sink in the quicksand of its own complexity.

On the other hand, Hirsch and others who would turn their back on general skills overmake their case. Hirsch, for example, adopts a strong local knowledge position, asserting that the prospects for transfer are meager. However, we argue for the considerable potentials of transfer if attention is paid to fostering it. Throughout *Cultural Literacy*, Hirsch periodically snipes at the teaching of critical thinking, intimating that attention to such general skills pays no dividend. But we emphasize that some aspects of critical thinking plainly call for attention—thinking on the other side of the case, for example.

Ironically, in framing his argument, Hirsch commits one of those lapses of critical thinking he sees no need for schools to address: he creates a false dichotomy, treating as contraries factors that are compatible and indeed complementary. This is one of the most common slips of critical thinking, one that well-designed education could help us all to become more mindful of. Specifically, although basic knowledge of our culture has a commonly neglected importance, as Hirsch argues, this does not imply that critical thinking and other kinds of general knowledge and skill are unimportant. Plainly, more than one thing can be important at the same time. Of course, an articulate monolithic view such as his makes better press. It may even work to correct the opposite excess better than would a balanced appraisal. But it rarely captures the real complexity of human skill and knowledge.

Findings of this sort are not limited to chess. They have emerged in virtually every performance area carefully studied with the question in mind, including problem solving in math (Schoenfeld and Herrmann 1982), physics (Chi, Feltovich, and Glaser 1981; Larkin 1983; Larkin, McDermott, Simon, and Simon 1980), and computer programming (Soloway and Ehrlich 1984), for example.

In summary, diverse empirical research on transfer has shown that transfer often does not occur. When transfer fails, many things might have gone wrong. The most discouraging explanation is that knowledge and skill may be too "local" to allow for many of the expectations and aspirations that educators have held.

When Does Transfer Happen?

The prospects of teaching for transfer might be easier to estimate with the help of some model that could explain the mechanisms of transfer and the conditions under which transfer could be expected. Salomon and Perkins (1984) have offered such an account, the "low road/high road" model of transfer. The model has been used to examine the role of transfer in the teaching of thinking (Perkins and Salomon 1987), to forecast the impact of new technologies on cognition (Perkins 1985), and to review the findings on transfer of cognitive skills from programming instruction (Salomon and Perkins 1987).

At the heart of the model lies the distinction between two very different mechanisms of transfer—low road transfer and high road transfer. The way learning to drive a car prepares one for driving a truck illustrates low road transfer. One develops well-practiced habits of car driving over a considerable period. Then one enters a new context, truck driving, with many obvious similarities to the old one. The new context almost automatically activates the patterns of behavior that suit the old one: the steering wheel begs one to steer it, the windshield invites one to look through it, and so on. Fortunately, the old behaviors fit the new context well enough so that they function quite adequately.

To generalize, low road transfer reflects the automatic triggering of well-practiced routines in circumstances where there is considerable perceptual similarity to the original learning context. Opening a chemistry book for the first time triggers reading habits acquired elsewhere, trying out a new video game activates reflexes honed on another one, or interpreting a bar graph in economics automatically musters bar graph interpretation skills acquired in math. This low road transfer trades on the extensive overlap *at the level of the superficial stimulus* among many situations where we might apply a skill or piece of knowledge.

High road transfer has a very different character. By definition, high road transfer depends on deliberate, mindful abstraction of skill or knowledge from one context for application in another. Although we know nothing directly of Shakespeare's mental processes, it seems likely that Shakespeare arrived at his remarkable "Summer's lease hath all too short a date" not by tripping over it, but by deliberate authorial effort, reaching mentally for some kind of abstract metaphorical match with the decline of summer. After all, in contrast with the resemblance between car and truck cabs, no superficial perceptual similarity exists between the summer's end and leases to provoke a reflexive connection.

Whatever the case with Shakespeare, more everyday examples of high road transfer are in order. It is useful to distinguish between at least two types of high road transfer—forward reaching and backward reaching. In forward-reaching high road transfer, one learns something and abstracts it in preparation for applications elsewhere. For instance, an enthusiastic economics major learning calculus might reflect on how calculus could apply to economic contexts, speculate on possible uses, and perhaps try out some, even though the calculus class does not address economics at all and the economics classes the student is taking do not use advanced math. A chess player might contemplate basic principles of chess strategy, such as control of the center, and reflectively ask what such principles might mean in other contexts—what would control of the center signify in a business, political, or military context?

In backward-reaching high road transfer, one finds oneself in a problem situation, abstracts key characteristics from the situation, and reaches backward into one's experience for matches. The same examples applied in reverse can illustrate this pattern. A different economics major, facing a particular problem, might define its general demands, search her repertoire, and discover that calculus can help. A young politician, developing strategies for the coming campaign, might reflect on the situation and make fertile analogies with prior chess experience: capture the center of public opinion and you've captured the election.

As these examples show, whether forward-reaching or backward-reaching, high road transfer always involves reflective thought in abstracting from one context and seeking connections with others. This contrasts with the reflexive, automatic character of low road transfer. Accordingly, high road transfer is not as dependent on superficial stimulus similarities, since through reflective abstraction a person can often "see through" superficial differences to deeper analogies.

The low road/high road view of transfer helps in understanding when it is reasonable or not to expect transfer because it clarifies the conditions under which different sorts of transfer occur. To be sure, *sometimes* transfer happens quite automatically in accordance with the Bo Peep theory; but that is by the low road, with the requirements of well-practiced skills or knowledge and superficial perceptual similarity to activate the skills or knowledge. Moreover, the transfer is likely to be "near" transfer, since the contexts have that surface perceptual similarity. High road transfer can bridge between contexts remote from one another, but it requires the effort of deliberate abstraction and connection-making and the ingenuity to make the abstractions and discover the connections.

Can Failures of Transfer Be Explained?

We reviewed a number of worrisome failures of transfer earlier. It is by no means the case, though, that conventional education affords no transfer at all. As mentioned earlier, most students learn to read more or less adequately and do bring those reading skills to bear when introduced to new areas. They do apply their arithmetic skills to income tax forms and other out-of-school tasks. Can the low road/high road model help us to understand why education sometimes succeeds but all too often fails in achieving transfer?

Broadly speaking, the successes fit the description of low road transfer. For example, students fairly readily carry over their basic reading skills to many new contexts. But the surface characteristics of those new contexts strongly stimulate reading skills—text appears in front of one's eyes, so what else would one do but read it? Arithmetic skills also transfer readily to such contexts as filling out income tax forms or checking bills in restaurants and stores. But again, the stimulus demand is direct and explicit: the tax forms provide places for sums, differences, and products; the bill displays addition.

Consider now one of the failures: the problem of inert knowledge. For instance, when students fail to interpret current events in light of their historical knowledge, what can be said about the problems of transfer? First, there is an issue of initial learning: the skill students have learned through their study of history is not the skill they need when they consider today's newspapers. We want them to make thoughtful interpretations of current events, but they have learned to remember and retrieve knowledge on cue. We can hardly expect transfer of a performance that has not been learned in the first place!

However, that aside, what about the conditions for low and high road transfer? As to the low road, there is little surface resemblance between the learned knowledge and the new contexts of application. For example, why should recent strife between Iraq and Iran automatically remind a student of certain of the causes of the Civil War, when the surface features are so different? As to the high road, this would require explicit, mindful abstraction of historical patterns and applications in other settings, to break those patterns free of their accidental associations in the Civil War or other settings. Conventional history instruction does little to decontextualize such patterns, instead highlighting the particular story of particular historical episodes.

Consider another failure: the impact of programming instruction on general cognitive skills. As for low road transfer, in most of the studies seeking transfer from computer programming, the students have not learned the programming skills themselves very well, failing to meet the condition of practice to near automaticity. Moreover, there is a problem with the surface appearance condition for low road transfer. In the context of programming, one might learn good problem-solving practices such as defining the problem clearly before one begins. However, the formal context of programming does not look or feel very much like the tense context of a labor dispute or the excited context of hunting for a new stereo system. Accordingly, other contexts where it is important to take time in defining the problem are not so likely to reawaken in students' minds their programming experiences.

As to high road transfer from programming, this would demand emphasis on abstracting from the programming context general principles of, for instance, problem solving and transporting those principles to applications outside of programming. Most efforts to teach programming, however, include virtually no attention to building such bridges between domains; instead, they focus entirely on building programming skills. So the conditions for high road transfer are not met.

Similar accounts can be given of the other cases of failure of transfer discussed earlier. In summary, conventional schooling lives up to its earlier characterization as following the Bo Peep theory of transfer—doing nothing special about it but expecting it to happen. When the conditions for low road transfer are met by chance, as in many applications of reading, writing, and arithmetic, transfer occurs—the sheep come home by themselves. Otherwise, the sheep get lost.

To be sure, meeting the low road and high road conditions for transfer is not the whole story. There remains the deeper problem of "local knowledge." The most artful instructional design will not provoke transfer if the knowledge and skills in question are fundamentally local in character, not really transferable to other contexts in the first place. This problem will be revisited shortly.

Can We Teach for Transfer?

Besides accounting for failure of transfer, the foregoing explanations hold forth hope of doing better: by designing instruction to meet the conditions needed to foster transfer, perhaps we can achieve it. In broad terms, one might speak of two techniques for promoting transfer—"hugging" and "bridging."

"Hugging" means teaching so as to better meet the resemblance conditions for low road transfer. Teachers who would like students to use their knowledge of biology in thinking about current ecological problems might introduce that knowledge in the first place in the context of such problems. Teachers who want students to relate literature to everyday life might emphasize literature where the connection is particularly plain for many students—*Catcher in the Rye* or *Romeo and Juliet*, for example.

"Bridging" means teaching so as to better meet the conditions for high road transfer. Rather than expecting students to achieve transfer spontaneously, one "mediates" the needed processes of abstraction and connection making (Delclos, Littlefield, and Bransford 1985; Feuerstein 1980). For example, teachers can point out explicitly the more general principles behind particular skills or knowledge or, better, provoke students to attempt such generalizations themselves: "What general factors provoked the American Revolution, and where are they operating in the world today?" Teachers can ask students to make analogies that reach outside the immediate context: "How was treatment of blacks in the U.S. South before the Civil War like or unlike the treatment of blacks in South Africa today?" Teachers can directly teach problem solving and other strategies and provoke broad-spectrum practice reaching beyond their own subject matters: "You learned this problem-defining strategy in math, but how might you apply it to planning an essay in English?"

Such tactics of hugging and bridging will sound familiar. Teachers already pose questions and organize activities of these sorts from time to time. However, rarely is this done persistently and systematically enough to saturate the context of education with attention to transfer. On the contrary, the occasional bridging question or reading carefully chosen to "hug" a transfer target gets lost amid the overwhelming emphasis on subject-matter-specific, topic-specific, fact-based questions and activities.

There is ample reason to believe that bridging and hugging together could do much to foster transfer in instructional settings. Consider, once again, the impact of programming on cognitive skills. As emphasized earlier, findings in general have been negative. However, in a few cases, positive results have appeared (Carver and Klahr 1987; Clements 1985a, 1985b; Clements and Gullo 1984; Clements and Merriman in press; Littlefield, Delclos, Lever, and Bransford in press). These cases all involved strong bridging activities in the instruction.

The same story can be told of efforts to teach retarded persons elementary memory skills. As noted earlier, transfer was lacking in most such experiments—but not in all. In a few experiments, the investigators taught learners not only the memory strategies themselves but habits of self-monitoring, by which the learners examined their own behavior and thought about how to approach a task. This abstract focus on task demands—in effect a form of bridging—led to positive transfer results in these studies (Belmont et al. 1982).

Even without explicit bridging, hugging can have a substantial impact on transfer. For example, inert knowledge has been a serious problem in medical education, where traditionally students memorize multitudinous details of anatomy and physiology outside the context of real diagnostic application. In an approach called "problem-based learning," medical students acquire their technical knowledge of the human body in the context of working through case studies demanding diagnosis (Barrows and Tamblyn 1980). Experiments in science education conducted by John Bransford and his colleagues tell a similar story: when science facts and concepts were presented to students in the context of a story where they figured in resolving a problem or illuminating a question, the students proved much more able to transfer these facts and concepts to new problem-solving contexts (Bransford et al. 1986; Sherwood, Kinzer, Bransford, and Franks 1987). In both the medical context and the science work, the instruction hugged much closer to the transfer performance than would instruction that simply and straightforwardly presented information.

Taken together, the notions of bridging and hugging write a relatively simple recipe for teaching for transfer. First, imagine the transfer you want—let's say, interpretation of contemporary and past conduct of societies and nations or perhaps problem solving where care is taken to define the problem before seeking solutions. Next, shape instruction to hug closer to the transfer desired. Teach history not just for memorizing its story but for interpretation of events through general principles. Teach programming or mathematical problem solving with emphasis on problem defining. Also, shape instruction to bridge to the transfer desired. Deliberately provoke students to think about how they approach tasks in and outside of history, programming, or math. Steal a little time from the source subject matter to confront students with analogous problems outside its boundary. Such teamwork between bridging and hugging practically guarantees making the most of whatever potential transfer the subject matter affords.

Moreover, there is an opportunity to go even further: aside from how one teaches, one can help students develop skills of *learning for transfer.* Students can become acquainted with the problem of transfer in itself and the tactics of bridging and hugging. Students can develop habits of doing considerable bridging and hugging for themselves, beyond what the instruction itself directly provides. Accordingly, a major goal of teaching for transfer becomes not just teaching particular knowledge and skills for transfer but teaching students in general how to *learn for transfer.*

Is Knowledge Too Local for Transfer?

Encouraging as all this is, it nonetheless leaves untreated the nagging problem of "local knowledge." If by and large the knowledge (including skills) that empowers a person in a particular activity is highly local to that activity, there are few prospects for useful transfer to other activities. What, then, can be said about this contemporary trend in theorizing about expertise and its implications for the potentials of teaching for transfer?

The suggestion is that, while the findings supporting a "local knowledge" view of expertise are entirely sound, the implications drawn from those findings against the prospects of transfer are too hasty. Despite the local knowledge results, there are numerous opportunities for transfer. At least three arguments support this viewpoint: (1) Disciplinary boundaries are very fuzzy, not representing distinct breaks in the kinds of knowledge or skill that are useful; (2) while much knowledge is local, there are at least a few quite general and important thinking strategies; (3) there are numerous elements of knowledge and skill of intermediate generality that afford some transfer across a limited range of disciplines.

The fuzziness of disciplinary boundaries. Even if knowledge and skill are local, are their boundaries of usefulness the same as the boundaries we use to organize disciplines and subject matters? For a case in point, history and current events might be treated in schools as different subjects, and, because they are partitioned off from each other, one might find scant transfer between them without special attention. Yet it seems plain that the kinds of causal reasoning and types of causes relevant to explaining historical happenings apply just as well to contemporary happenings. For another case in point, literature is a subject to study, life a "subject" to live. Yet plainly most literature treats fundamental themes of concern in life—love, birth, death, acquisition and defense of property, and so on. The relationships between literature and life offer an arena for reflection upon both and for transport of ideas from one to the other and back again.

To generalize a close look at conventional disciplinary boundaries discloses not a well-defined geography with borders naturally marked by rivers and mountain ranges but, instead, enormous overlap and interrelation. If knowledge and skill are local, the boundaries surely are not the cleavages of the conventional curriculum. Yet because these cleavages are there as part of the organization of schooling, tactics of bridging and hugging are needed to take the numerous opportunities for fertile transfer across the conventional subject matters.

The existence of important crosscutting thinking strategies. There are certainly some strategic patterns of thinking that are important, neglected, and cross-disciplinary in character (see e.g., Baron 1985a, 1985b; Baron and Sternberg 1986; Chipman, Segal, and Glaser 1985; Nickerson, Perkins, and Smith 1985; Perkins 1986a, 1986b, 1986c). For example, in virtually all contexts people tend not to give full attention to the other side of the case—the side opposite their own—in reasoning about a claim. People also tend to be "solution minded," orienting too quickly to a problem and beginning to develop candidate solutions at once, when often it would be more effective to stand back from the problem, explore its nature, define exactly what the problem is, seek alternative ways to represent it, and so on. And people tend not to monitor their own mental processes very much, when doing so would garner the perspective and leverage of greater metacognitive awareness.

To be sure, exactly how to consider the other side of the case, explore a problem, or self-monitor is somewhat a matter of local knowledge that will differ significantly from context to context. However, the strategy of allocating attention and effort to considering the other side of the case, exploring a problem, or self-monitoring is fully general. Accordingly, when developing such strategies in any domain, one can then hope to transfer them to others.

Patterns of thinking of intermediate generality. Finally, if we do not demand universal generality, there are numerous kinds of knowledge and skill of intermediate generality that cut across certain domains and provide natural prospects for transfer. For example, many considerations of measurement, methodology, and the role of evidence apply fairly uniformly across the hard sciences. Any art yields interesting results when examined through the categories of style and form, though to be sure, the particular styles and forms of importance will vary from art to art. Psychological concepts such as motive, intention, inner conflict, the unconscious, and so on have an obvious role to play in interpreting literature, history, current events, and everyday life, and they perhaps even have some part to play in examining scientific discovery.

Of course, conventional subject matter boundaries usually inhibit the emergence of these patterns of thinking of intermediate generality because the style of instruction is so very local that it does not decontextualize the patterns. Bridging and hugging are needed to develop out of the details of the subject matters the overarching principles.

Members of the Same Team

Instead of worrying about which is more important—local knowledge or the more general transferable aspects of knowledge—we should recognize the synergy of local and more general knowledge. To be sure, students who do not know much about history are unlikely to enrich their thinking about the causes of the American Revolution by the general strategy of trying to reflect on both sides of the case, American and British. And students who do not have the habit of reflecting on both sides of a case will not get much depth of understanding out of the history they do know. Similarly, students who lack an understanding of key mathematical concepts will not gain much from the general strategy of trying to define and represent a problem well before they start. But students who lack the habit of trying to define and represent a problem well will often misuse the mathematical concepts they know when the problem is not routine.

So general and local knowledge are not rivals. Rather, they are members of the same team that play different positions. Proper attention to transfer will make the best of both for the sake of deeper and broader knowledge, skill, and understanding.

REFERENCES

Baron, J. B., and R. S. Sternberg, eds. (1986). *Teaching Thinking Skills: Theory and Practice*. New York: W. H. Freeman.

Baron J. (1985a). *Rationality and Intelligence*. New York: Cambridge University Press.

Baron, J. (1985b). "What Kinds of Intelligence Components are Fundamental?" In *Thinking and Learning Skills. Volume 2: Current Research and Open Questions*, edited by S. S. Chipman, J. W. Segal, and R. Glaser. Hillsdale, N.J.: Lawrence Erlbaum.

Barrows, H. S., and R. M. Tamblyn. (1980). *Problem-Based Learning: An Approach to Medical Education*. New York: Springer.

Belmont, J. M., E. C. Butterfield, and R. P. Ferretti. (1982). "To Secure Transfer of Training, Instruct Self-Management Skills." In *How and How Much Can Intelligence Be Increased?*, edited by D. K. Detterman and R. J. Sternberg. Norwood, N.J.: Ablex.

Bransford, J. D., J. J. Franks, N. J. Vye, and R. D. Sherwood. (June 1986). "New Approaches to Instruction: Because Wisdom Can't Be Told." Paper presented at the Conference on Similarity and Analogy, University of Illinois.

Carver, S. M., and D. Klahr. (April 1987). "Analysis, Instruction, and Transfer of the Components of Debugging Skill." Paper presented at the biennial meeting of the Society for Research in Child Development. Baltimore, Maryland.

Chase, W. C., and H. A. Simon. (1973). "Perception in Chess." *Cognitive Psychology* 4: 55–81.

Chi, M., P. Feltovich, and R. Glaser. (1981). "Categorization and Representation of Physics Problems by Experts and Novices." *Cognitive Science* 5, 2: 121–152.

Chipman, S. F., J. G. Segal, and R. Glaser, eds. (1985). *Thinking and Learning Skills. Volume 2: Current Research and Open Questions*. Hillsdale, N.J.: Lawrence Erlbaum.

Clements, D. H. (April 1985a). "Effects of Logo Programming on Cognition, Metacognitive Skills, and Achievement." Presentation at the American Educational Research Association conference, Chicago.

Clements, D. H. (1985b). "Research on Logo in Education: Is the Turtle Slow but Steady, or Not Even in the Race?" *Computers in the Schools* 2, 2/3: 55–71.

Clements, D. H., and D. F. Gullo. (1984). "Effects of Computer Programming on Young Children's Cognition." *Journal of Educational Psychology* 76, 6: 1051–1058.

Clements, D. H., and S. Merriman. (In press). "Componential Developments in Logo Programming Environments." In *Teaching and Learning Computer Programming: Multiple Research Perspectives*. Hillsdale, N.J.: Lawrence Erlbaum.

Dalbey, J., and M. C. Linn. (1985). "The Demands and Requirements of Computer Programming: A Literature Review." *Journal of Educational Computing Research* 1, 3: 253–274.

de Groot, A. D. (1965). *Thought and Choice in Chess*. The Hague: Mouton.

Delclos, V. R., J. Littlefield, and J. D. Bransford. (1985). "Teaching Thinking Through Logo: The Importance of Method." *Roeper Review* 7, 3: 153–156.

Feuerstein, R. (1980). *Instrumental Enrichments: An Intervention Program for Cognitive Modifiability*. Baltimore: University Park Press.

Feurzeig, W., P. Horwitz, and R. Nickerson. (1981). *Microcomputers in Education* (Report No. 4798). Cambridge, Mass.: Bolt, Beranek, and Newman.

Hirsch, E. D., Jr. (1987). *Cultural Literacy: What Every American Needs to Know*. Boston: Houghton Mifflin.

Larkin, J. H. (1983). "The Role of Problem Representation in Physics." In *Mental Models*, edited by D. Gentner and A. I. Stevens. Hillsdale, N.J.: Lawrence Erlbaum.

Larkin, J. H., J. McDermott, D. P. Simon, and H. A. Simon. (1980). "Modes of Competence in Solving Physics Problems." *Cognitive Science* 4: 317–345.

Linn, M. C. (May 1985). "The Cognitive Consequences of Programming Instruction in Classrooms." *Educational Researcher* 14, 5: 14–29.

Littlefield, J., V. Delclos, S. Lever, and J. Bransford. (In press). "Learning Logo: Method of Teaching, Transfer of General Skills, Attitudes Toward Computers." In *Teaching and Learning Computer Programming: Multiple Research Perspectives*. Hillsdale, N.J.: Lawrence Erlbaum.

Nickerson, R. D., N. Perkins, and E. Smith. (1985). *The Teaching of Thinking*. Hillsdale, N.J.: Lawrence Erlbaum.

Olson, D. R. (1976). "Culture, Technology, and Intellect." In *Nature of Intelligence*, edited by L. B. Resnick. Hillsdale, N.J.: Lawrence Erlbaum.

Papert, S. (1980). *Mindstorms: Children, Computers, and Powerful Ideas.* New York: Basic Books.

Perfetto, G. A., J. D. Bransford, and J. J. Franks. (1983). "Constraints on Access in a Problem Solving Context." *Memory & Cognition* 11, 1: 24–31.

Perkins, D. N. (1985). "The Fingertip Effect: How Information-Processing Technology Changes Thinking." *Educational Researcher* 14, 7: 11–17.

Perkins, D. N. (1986a). *Knowledge as Design.* Hillsdale, N.J.: Lawrence Erlbaum.

Perkins, D. N. (1986b). "Thinking Frames." *Educational Leadership* 43, 8: 4–10.

Perkins, D. N. (1986c). "Thinking Frames: An Integrative Perspective on Teaching Cognitive Skills." In *Teaching Thinking Skills: Theory and Practice,* edited by J. B. Baron and R. S. Sternberg. New York: W. H. Freeman.

Perkins, D. N., and F. Martin. (1986). "Fragile Knowledge and Neglected Strategies in Novice Programmers." In *Empirical Studies of Programmers,* edited by E. Soloway and S. Iyengar. Norwood, N.J.: Ablex.

Perkins, D. N., F. Martin, and M. Farady. (1986). *Loci of Difficulty in Learning to Program* (Educational Technology Center technical report). Cambridge, Mass.: Educational Technology Center, Harvard Graduate School of Education.

Perkins, D. N., and G. Salomon. (1987). "Transfer and Teaching Thinking." In *The Second International Conference,* edited by D. N. Perkins, J. Lochhead, and J. Bishop. Hillsdale, N.J.: Lawrence Erlbaum.

Salomon, G., and D. N. Perkins. (August 1984). "Rocky Roads to Transfer: Rethinking Mechanisms of a Neglected Phenomenon." Paper presented at the Conference on Thinking, Harvard Graduate School of Education, Cambridge, Massachusetts.

Salomon, G., and D. N. Perkins. (1987). "Transfer of Cognitive Skills from Programming: When and How?" *Journal of Educational Computing Research* 3, 2: 149–169.

Schoenfeld, A. H., and D. J. Herrman. (1982). "Problem Perception and Knowledge Structure in Expert and Novice Mathematical Problem Solvers." *Journal of Experimental Psychology: Learning, Memory, and Cognition* 8: 484–494.

Scribner, S., and M. Cole. (1981). *The Psychology of Literacy.* Cambridge, Mass.: Harvard University Press.

Sherwood, R. D., C. K. Kinzer, J. D. Bransford, and J. J. Franks. (May 1987). "Some Benefits of Creating Macro-Contexts for Science Instruction: Initial Findings." *Journal of Research in Science Teaching* 24, 5: 417–435.

Soloway, E., and K. Ehrlich. (1984). "Empirical Studies of Programming Knowledge." *IEEE Transactions on Software Engineering* SE-10, 5: 595–609.

Authors' note: Some of the ideas discussed herein were developed at the Educational Technology Center of the Harvard Graduate School of Education, operating with support from the Office of Educational Research and Improvement (contract #OERI 400-83-0041). Opinions expressed herein are not necessarily shared by OERI and do not represent office policy.

41

Graphic Organizers: Frames for Teaching Patterns of Thinking

John H. Clarke

"I see what you mean." We often use this expression in casual conversation as a way to convey understanding or emerging agreement. Of course, the workings of the human mind always remain invisible to the human eye. We may see only traces of the mind's effort—for example, in student essays, tests, and discussions. Still, the processes leading to these "products" remain largely hidden. For teachers, whose task it is to improve the way students manage information, making the mind's work visible would bring obvious advantages. It would be convenient to see how students are thinking as they struggle with information or work through problems. To help students learn to visualize and control the work of their minds, we need better vehicles to represent different kinds of mental effort (McTighe and Lyman 1988).

Graphic organizers, or frames, give students and teachers a way to "see" how they are thinking about content in the subject areas. What is a graphic frame? It is "an organizing pattern students can use to represent relationships in the information they confront in school" (Jones, Palincsar, Ogle, and Carr 1987). How can graphic organizers support learning and teaching?

As any photographer knows, the frame of the viewfinder organizes the image within it, creating a visual statement where, without the frame, one might see only clutter. And, as any builder knows, the frame of a building supports its totality. Both metaphors highlight a crucial feature of thinking frames: They support and organize thought, but they do not do the thinking. They are guides, not recipes (Perkins 1987).

Teachers can use graphic organizers as a practice field on which students work out the process of making sense of a subject. Different "frames" give them ways to manage different kinds of mental operation.

A graphic organizer has movable parts, letting us control the process of making or finding connections. Students and teachers can create graphic organizers with lines, circles, pictures, and words represented on index cards, on handouts, or in student-designed study guides. Developed by a whole class, organizers can also grow into an elaborate network of pictures, artifacts, newspaper articles, and words on index cards linked with colored string—covering a whole wall or stretching down a school corridor. Using different patterns to connect information, students and teachers may find different ways to organize their study of a content area (Clarke 1990).

A graphic organizer gives students and teachers a way to display simple relationships among basic facts and ideas—and to manipulate those facts and ideas to better understand their relationship. When students use graphic organizers in classroom learning, teachers gain a visual medium for helping them:

- *Develop a clear purpose for studying* the content,
- *Represent what they already know* as a basis for learning more,
- *Become actively involved* in proposing and testing possible relationships in the subject matter,
- *Control the process of their thinking* as they apply different organizational patterns, and

• *Develop a medium for communication and deliberation* among themselves and with their teacher.

Most research on graphic organizers treats them like individual study tactics or research tools (Dansereau and Holley 1984; Novak and Gowin 1984). Research on classroom applications of graphic organizers has been considerably more limited. It appears that different graphic frames may be required for different learning tasks in different subjects (Donald 1983). Jones, Pierce, and Hunter (1989) and Clarke (1990) have begun to assemble and categorize graphic organizers to support different patterns of thinking.

Organizers for Thinking Patterns

Different subjects appear to depend on different patterns of organization. Success in many subject areas, such as literature, history, and some natural sciences, often depends on a student's ability to think inductively: to gather facts, identify relationships among the facts, and draw conclusions supported by facts. Success in other subjects, such as mathematics and physical sciences, more often may depend on deductive thinking: selecting or developing a rule or procedure and then applying that rule to a particular situation. Learning to think about any subject requires the flexible application of inductive and deductive thinking strategies, tailored specifically to specific problems and content.

Teachers can introduce different kinds of graphic organizers to help students practice different kinds of inductive or deductive thinking, as illustrated in Figure 1. Teachers also can help students learn to choose between alternative graphics, depending on the purpose of the strategy and the type of information available. Simple graphics can then become the basis for elaborate strategies that combine several basic forms. When students have gained confidence in their ability to organize information to meet different needs, they may dispense with graphic organizers altogether.

Organizers for Inductive Thinking

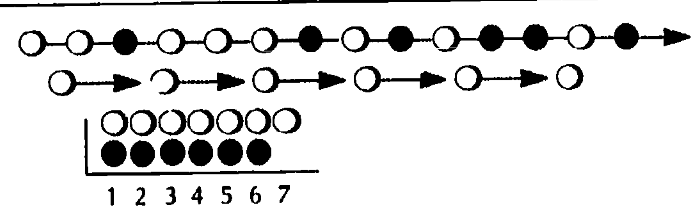
Frames for inductive thinking help students organize facts and search for meaningful relationships among the facts. If a teacher wants students to follow the development

FIGURE 1
Graphic Organizers for Different Patterns of Thinking

PATTERNS FOR INDUCTIVE THINKING
Helping Students Organize and Analyze Events

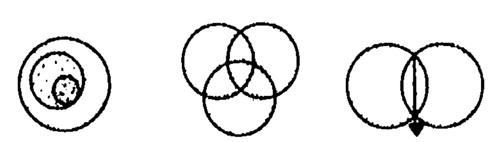
Scanning and Selecting Information

Serial order	Timelines
Causal order	Trendlines
Recurring events	Graphs and data grids



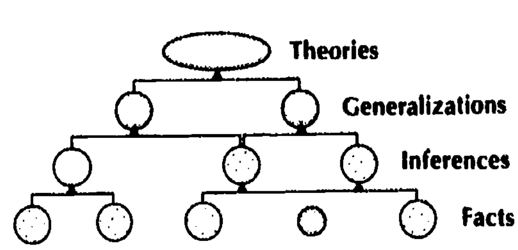
Creating Categories and Concepts

Concept development	Circle diagrams
Comparison and contrast	Euler diagrams
Dialectical reasoning	Venn diagrams
Metaphoric thinking	



Developing Statements of Relationship

Drawing inferences	
Theory development	Inductive towers
Hypothesis development	Vee maps
Abduction	

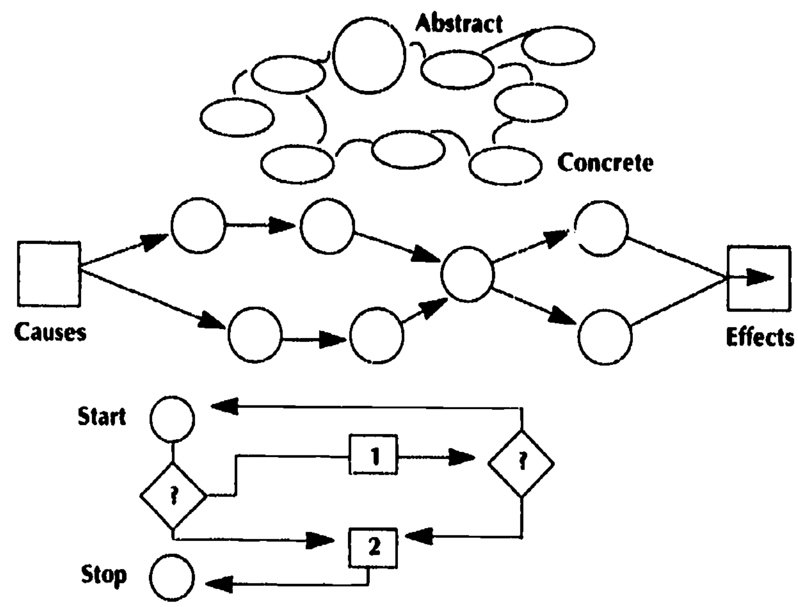


(Continued)

(Figure 1, continued)

PATTERNS FOR DEDUCTIVE THINKING
Helping Students Relate, Predict, Plan, and Solve Problems

Developing Concept Networks Proposing cause/effect links Defining concepts Relating concepts to facts	Web diagrams Concepts maps
Applying Causal Thinking If/then logic Analyzing cause/effect links Predicting events Proposing solutions	Schematizations Backmaps Causal chains Planning maps
Planning and Solving Problems Planning steps Defining procedures Analyzing tasks Analyzing word problems	Flowcharts Diagrams/drawings



of a story in the newspaper, for example, pasting clippings into a timeline might help the class keep its focus and search for trends. Timelines also help students identify important influences and trace the development of important themes. By counting up similar events, students can make graphs or data grids, perhaps the most common graphic organizer for data. If students need to make distinctions—for example, between different countries of the world, different forms of life, or different characters in a play—then "Venn diagrams," with lapped circles holding bits of evidence, might be more appropriate. Teachers use Venn or circle diagrams to help students think with categories or develop new concepts.

Carol Bourbeau, a mathematics teacher at Rice Memorial High School in Burlington, Vermont, created the diagram in Figure 2 to help students see relationships between different "shapes" and to clarify their conception of "shape" as a category. Working singly or in groups, students could draw pictures of the shapes indicated and then search for similarities and differences among them. In grouping similar shapes, they were thinking inductively. The circle diagram asks students to label the categories they discovered.

To help students organize a vast array of factual material, teachers can use inductive "towers." A tower of facts and inferences can help students connect scattered bits of information, within which many different interpretations are possible—as when students are reading a long novel or poring over statistical information (Clarke, Gilberts, and Raths 1989).

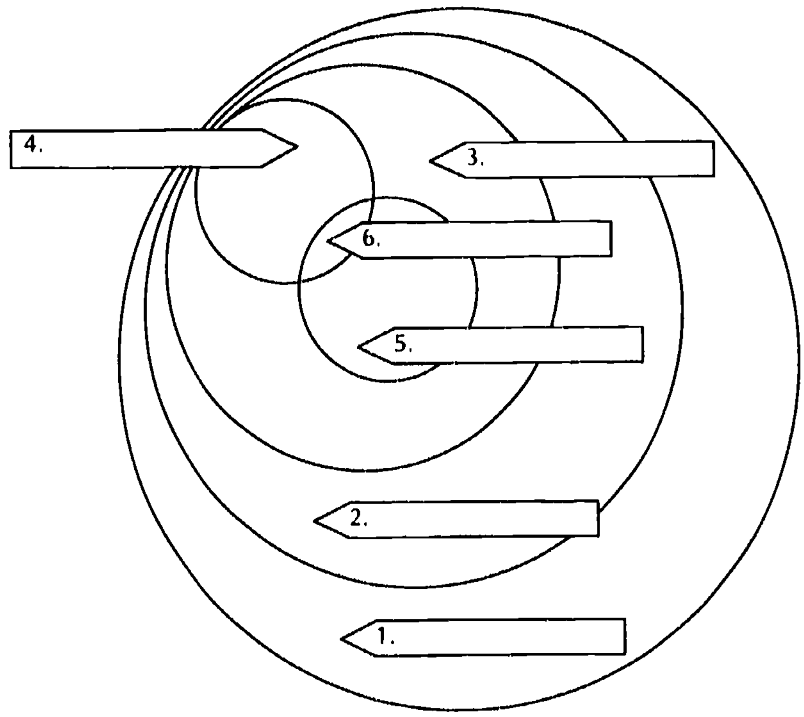
Sharon James, a mathematics teacher at Winooski High School in Vermont, created the inductive tower in Figure 3 to help Algebra 2 students manage the process of solving a word problem. By showing them how to link facts from the problem and draw inferences about rates, distances, and times, she could lead them to define variables and develop algebraic equations to solve the problem. The tower helps students avoid impulsive thrashing and reason through the elements of the problem in a set of inductive steps.

Organizers for Deductive Thinking

Frames for deductive thinking may help students organize and apply information related to a central concept, rule, or procedure. If students are studying a theme, concept, or abstract idea, for example, a concept map can help them relate the concept to specific instances. Causal maps, or "chain maps," can help students represent relationships of cause and effect among facts or ideas. Parallel chains may represent simultaneous causes or complex causal relationships. Causal chain maps are useful for making predictions based on facts or planning out a sequence of events. Finally, flowcharts give students a way to describe a procedure as a sequence of separate steps and decisions. Students can use flowcharts to map out an approach to solving word problems in mathematics or to design a new study strategy for themselves. Frames for deductive thinking help students relate general rules to specific situations, develop solutions for problems, or generate new ideas.

Sandy Williams, a 4th grade teacher at Highgate Elementary School in northern Vermont, helped her students

FIGURE 2
Circle Diagram Supporting Concept Development for "Shapes" in Geometry I



DIRECTIONS:
Draw a picture of the following shapes and then label the diagram to express their relationship:

parallelogram
polygon
quadrilateral
rectangle
rhombus
square
trapezoid

Source: Carol Bourbeau, Rice Memorial High School, Burlington, Vermont.

develop the concept map in Figure 4 as a way to understand connections between different kinds of simple tools. Her students constructed their maps by locating "Simple Machines" in the center of the page and then drawing pictures of basic structures, such as gears, screws, and inclined planes. Williams could then ask students to look around for specific examples of each machine to anchor the concept. The concept maps gave her a vision of what the students understood—as well as what they did not understand, such as the principles explaining how similar machines work.

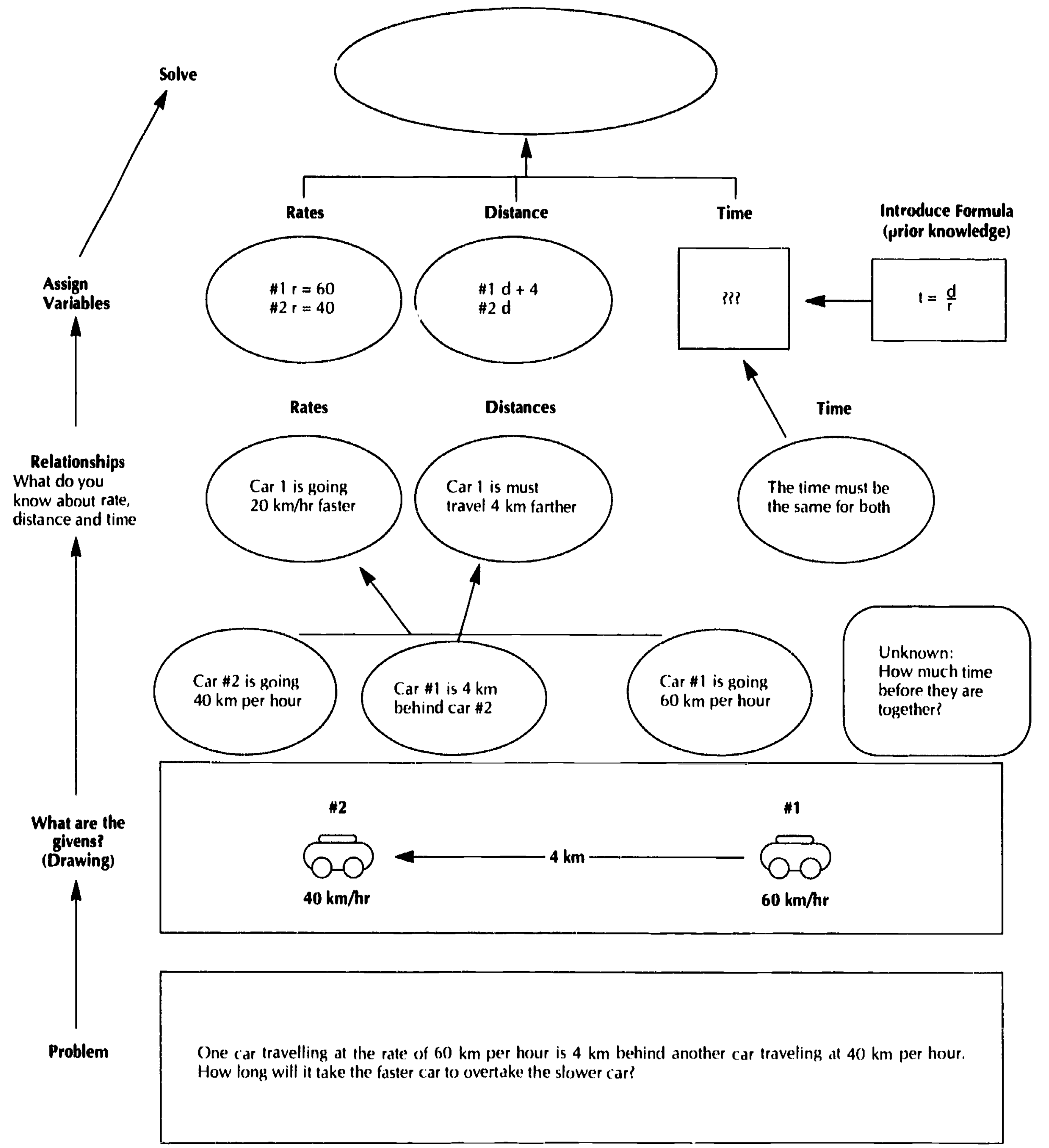
A Thinking Wheel: Metaphor for a Circular Process

In helping students learn to better manage the work of their minds, teachers may find it best to introduce only a few distinctive patterns, such as the six patterns described in Figure 1. These organizers, of course, do not supply all the tools we need to think. Teaching 6 patterns, or even 20, should only convey a larger idea—that the mind creates miracles by flexing its approach to fit new situations. Many more patterns are possible. None of them occurs as a separate entity in the seamless flow of natural thought. To succeed, we need to control the processes we use to think. Graphic organizers may help us gain control.

Figure 5, adapted from one that appeared in the first edition of *Developing Minds* (Costa, Hanson, Silver, and Strong 1985, p. 167) is a graphic organizer relating the three inductive and deductive patterns in Figure 1 to each other. As students create strategies for complex thinking, they may also see that thinking is circular in form. We improve our thinking by processing thoughts over and over again, changing patterns and content as we work toward more satisfying results. Thinking is recursive. The mind works better by working things over ceaselessly.

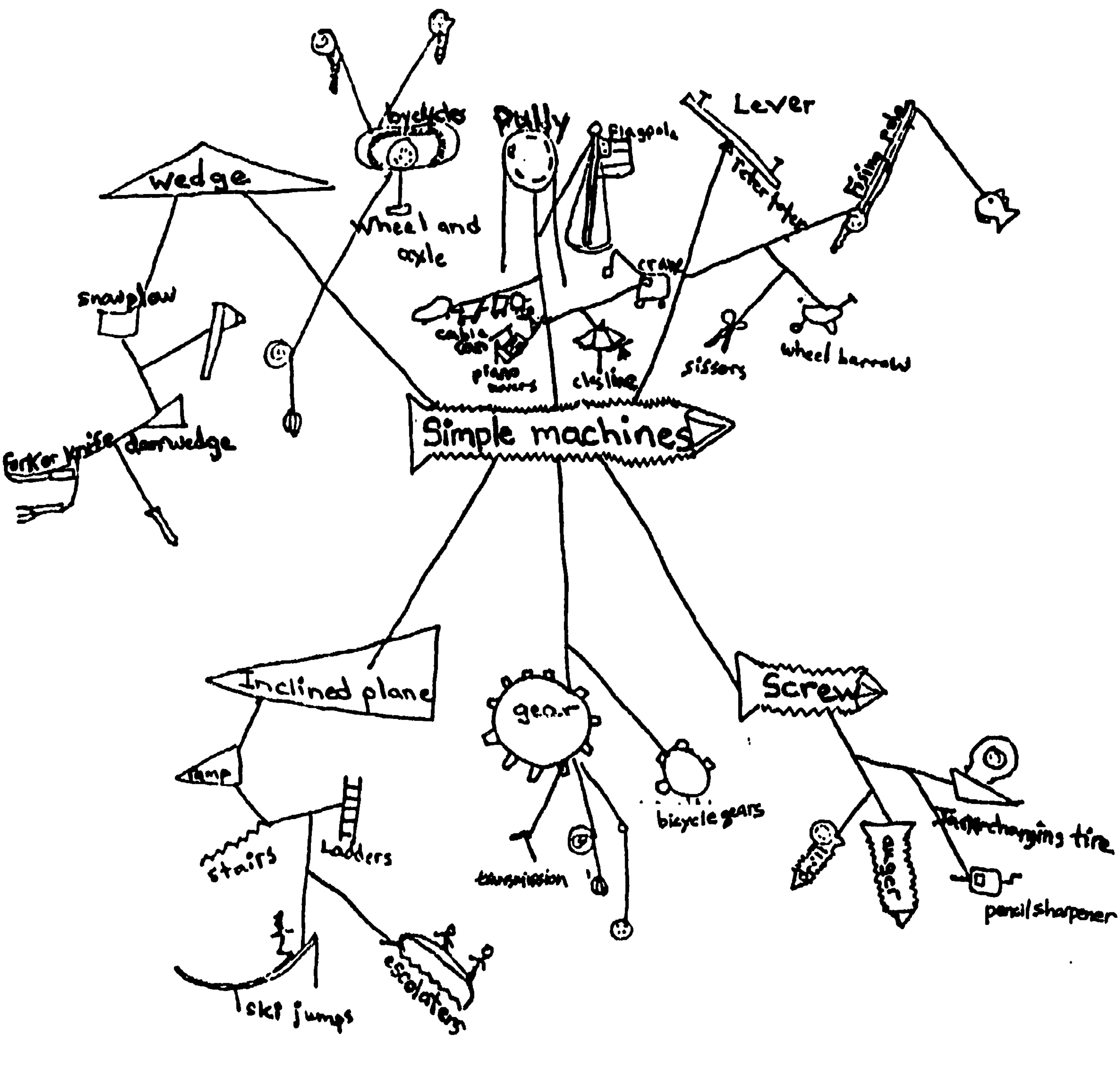
How can teachers use the thinking wheel as a graphic organizer for the recursive patterns of thinking? One approach simply helps students see recursive patterns in the

FIGURE 3
Inductive Tower Guiding a Word Problem in Algebra II



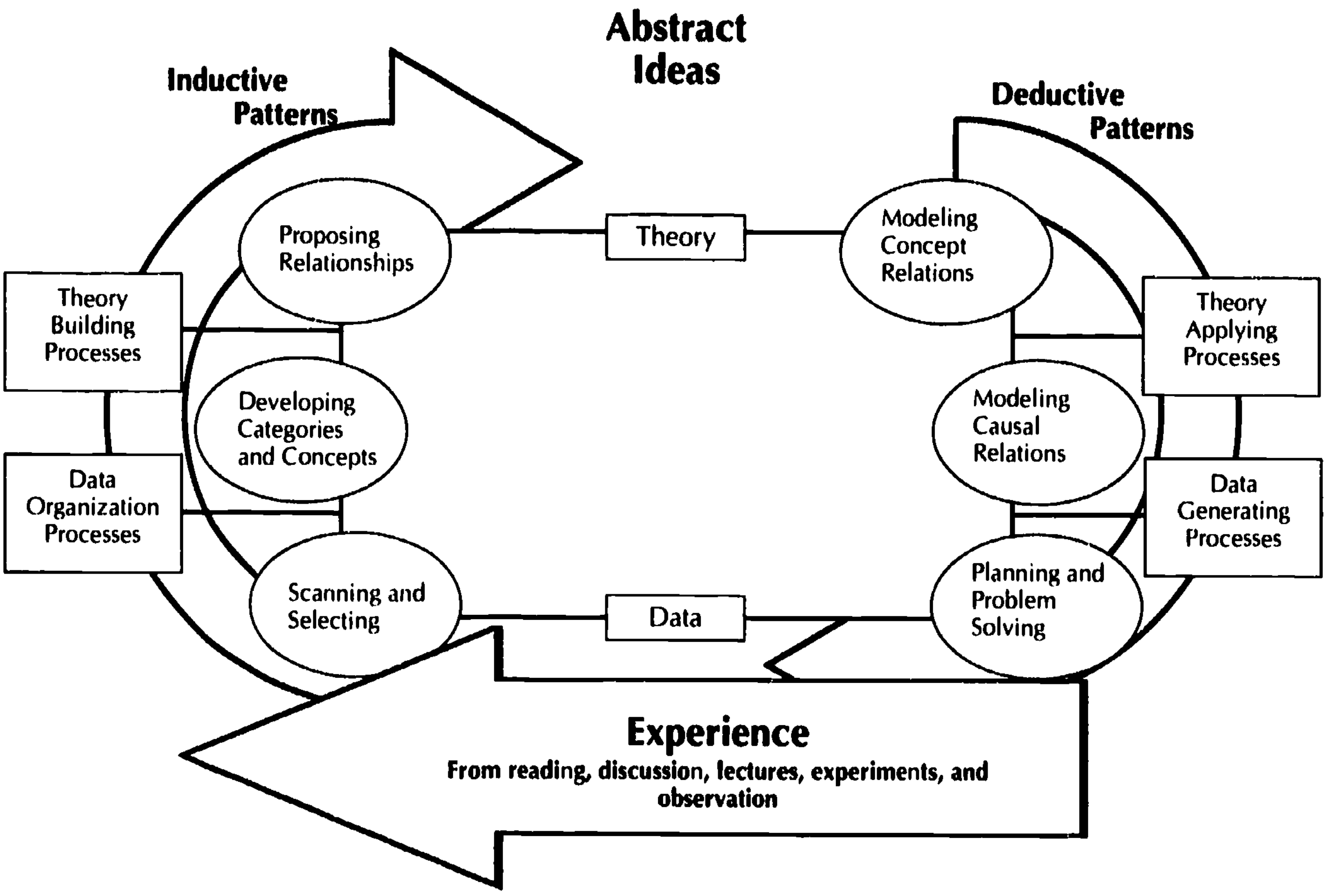
Source: Sharon James, Winooski High School, Burlington, Vermont.

FIGURE 4
4th Grade Concept Map: Simple Machines



Source: Sandy Williams, Highgate Elementary School, Vermont

FIGURE 5
.he Thinking Wheel: Relating Inductive to Deductive Patterns



Attributed to Ben Strasser by Costa, et al. 1985.

thinking of others. With some adaptation, the thinking wheel is an expression of "the scientific method." In scientific thinking, a hypothetical problem or theory may suggest a specific procedure or method of investigation. Such investigations generate data that must be grouped and reorganized to be understood. The conclusions often provoke new concepts or a reconceptualization of the problem. So the wheel of science turns. The pattern of the wheel is also visible in familiar examples of "great thinking," such as Jefferson's Declaration of Independence and many of Shakespeare's sonnets. David Kolb (1977) has developed a learning style inventory that lets students identify a preferred starting point within a cycle of inquiry.

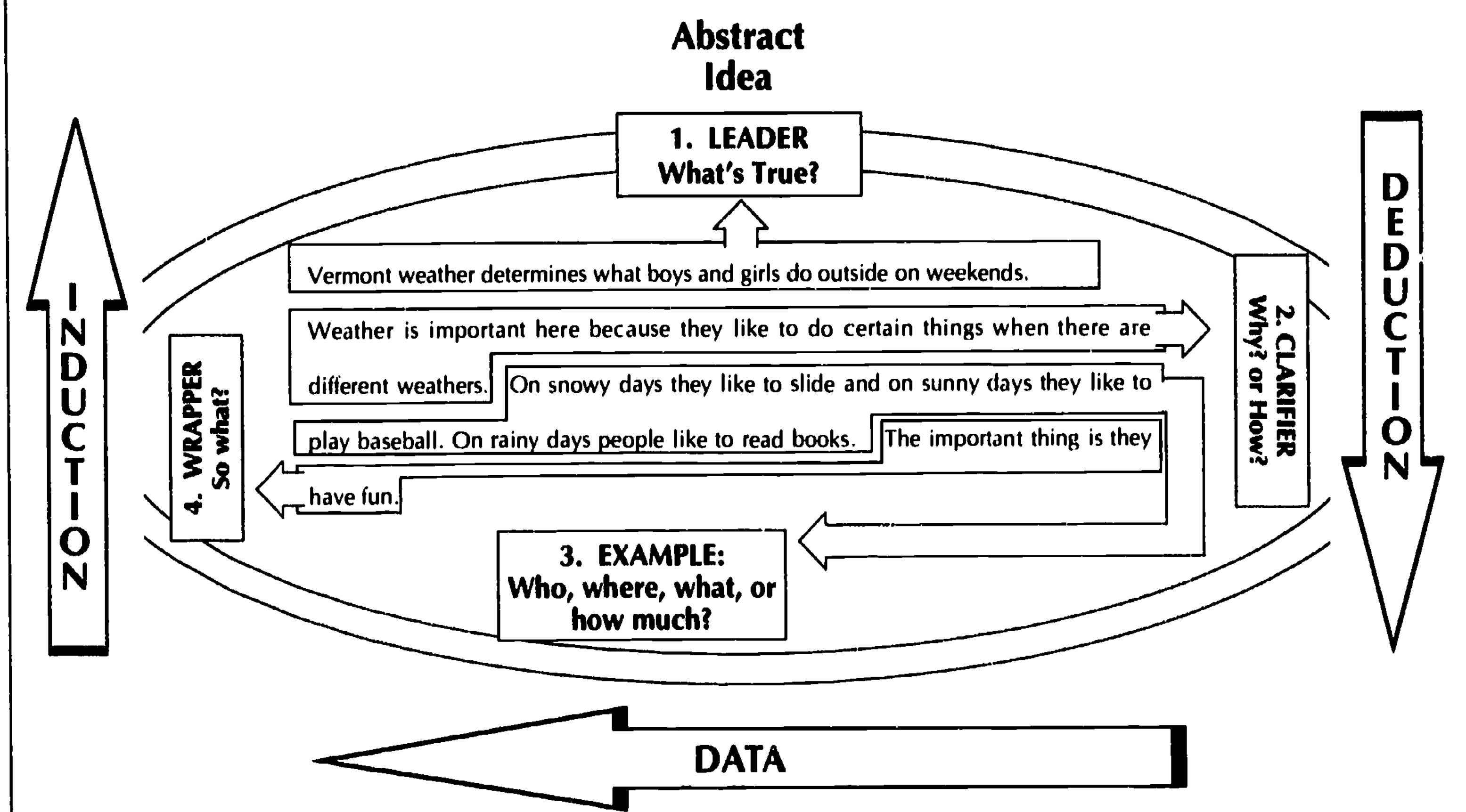
Both the expository essay and the paragraph form are often taught as variants of the thinking wheel (Clarke 1980). In generating paragraphs, a writer may devote one sentence to defining a conceptual relationship, the next sentence to clarification of that relationship ("how" or "why" it is true), the next sentence to an example from experience, and a final sentence to interpretation of the example. Figure 6 is a paragraph written by a 3rd grade student using four questions on such a wheel as a guide. Showing students how to pattern their paragraphs using a cycle of questions from the thinking wheel does not produce flawless writing. It may help them produce writing with a clear purpose and plan.

If graphic organizers are to provide reliable support for teaching thinking across subject areas, considerably more research and development in the field will be necessary. Many other patterns of thinking may come to light and prove useful. A good part of that exploration may be conducted by teachers themselves, who learn to "see" patterns of thinking in both their students and the subject matter they teach. The question of transfer is particularly important: Do students generalize patterns of thinking taught in parallel fashion in several subject areas?

As students practice using graphic organizers to think about information in a subject area, they may begin to see their own thinking as "strategic." That is, the teacher can point out different purposes for thinking and different strategies that can be used to carry out those purposes. In this

FIGURE 6

3rd Grade Paragraph Guided by Questions from the Thinking Wheel



kind of teaching, the goal is not to train students to use graphic organizers to think, but to help them to become more strategic in designing a response to problems they face in learning or life. To become strategic thinkers, students should practice transferring patterns from one subject to another, adapting simple patterns to fit more complex challenges or designing new learning strategies for unique situations (Jones et al. 1987). Through work with graphic organizers, students may grow more intentional in their approach to classroom learning.

REFERENCES

Clarke, J. (1990). *Patterns of Thinking: Integrating Thinking Skills in Content Teaching.* Boston: Allyn and Bacon.

Clarke, J., G. Gilbert, and J. Raths, J. (1989). "Inductive Towers: Helping Students See How They Think." Journal of Reading 33, 2: 86–95.

Clarke, J. (Fall 1980). "The Learning Cycle: Frame of Discourse for Paragraph Development." *Leaflet* (New England Association of Teachers of English) 79, 3: 3–11.

Costa, A., R. Hanson, H. F. Silver, and R. W. Strong. (1985). "Other Mediative Strategies." In *Developing Minds: A Resource Book for Teaching Thinking*, edited by A. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Dansereau, D. F., and C. Holley. (1984). *Spacial Learning Strategies: Techniques, Applications and Related Issues.* Orlando, Fla.: Academic Press.

Donald, J. G. (1983). "Knowledge Structures: Methods for Exploring Course Content." *Journal of Higher Education* 54, 1: 31-41.

Jones, B. F., A. S. Palincsar, D. S. Ogle, and E. G. Carr. (1987). *Strategic Thinking and Learning: Cognitive Instruction in the Content Areas.* Alexandria, Va.: Association for Supervision and Curriculum Development.

Jones, B. F., J. Pierce, and B. Hunter. (1989). "Teaching Students to Construct Graphic Representations." *Educational Leadership* 46, 4: 21–25.

Kolb, D. (1977). *Learning Style Inventory* (Manual). Cambridge, Mass.: McBer and Associates.

McTighe, J., and F. T. Lyman, Jr. (1988). "Cueing Thinking in the Classroom: The Promise of Theory Embedded Tools." *Educational Leadership* 45, 7: 18–25.

Novak, J. D., and D. B. Gowin. (1984). *Learning How to Learn.* Cambridge: Cambridge University Press.

Perkins, D. N. (1987). "Thinking Frames: An Integrating Perspective on Teaching Cognitive Skills." In *Teaching Thinking Skills: Theory and Research*, edited by J. Baron and R. Sternberg. New York: W. H. Freeman and Sons.

42

The Thinking Log: The Inking of Our Thinking

Robin Fogarty

Journal + Notebook = Thinking Log

A thinking log is much like a footprint. Both are uniquely personal impressions that mark one moment in time. Yet, whereas the footprint may disappear with the wind, the thinking log cements the thought-filled page for all of time.

The log is a hybrid created from the personal journal and the traditional class notebook. A journal is usually a daily barometer of events and feelings that are evoked by day-to-day happenings, while a notebook typically is a collection of classroom notes and doodles, permanently recorded on paper in a personalized shorthand that is all too soon indecipherable. Neither the journal nor the notebook offers the scope of the thinking log, for between the pages of the log are spontaneous, gut reactions to learning that just occurred.

Teachable Moments: Inking Our Thinking

By planning for youngsters to process their thinking in written form, teachers ultimately have at their disposal a versatile and valuable teaching tool.

Taking advantage of the teachable moment, students process reflectively by logging their thinking. They catch the freshness of first impressions; jot down the milieu of ideas swarming about their heads; explore for understanding; analyze for clarity; synthesize into personal meaning; apply functionally; judge worth; and make the critical connections between new data and past experience.

This chapter is adapted from the pamphlet *Inking Our Thinking: How to Use Journals to Stimulate Reflective Thinking in Your Students No Matter What the Subject Area* (Palatine, Ill.: IRI/Skylight Publishing, Inc., 1990). Copyright © 1990 by Skylight Publishing, Inc.

The Look of the Log

The writing in the thinking log may take many forms. It may be a narrative, a quote, an essay, jottings, a drawing, a cartoon, a diagram, webs or clusters, a soliloquy, a riddle, a joke, doodles, an opinion, a rebuttal, a dialogue, a letter, a flowchart, or just an assortment of phrases and ideas.

The entries may be reflective, evaluative, questioning, personal, abstract, introspective, cynical, incomplete, revealing, humorous, communicative, thoughtful, poetic, rambling,

FIGURE 1

Entries on Various Concepts

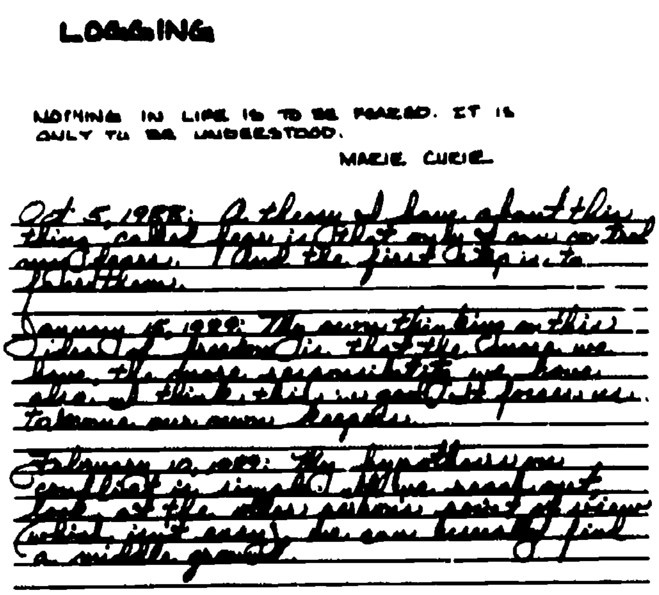
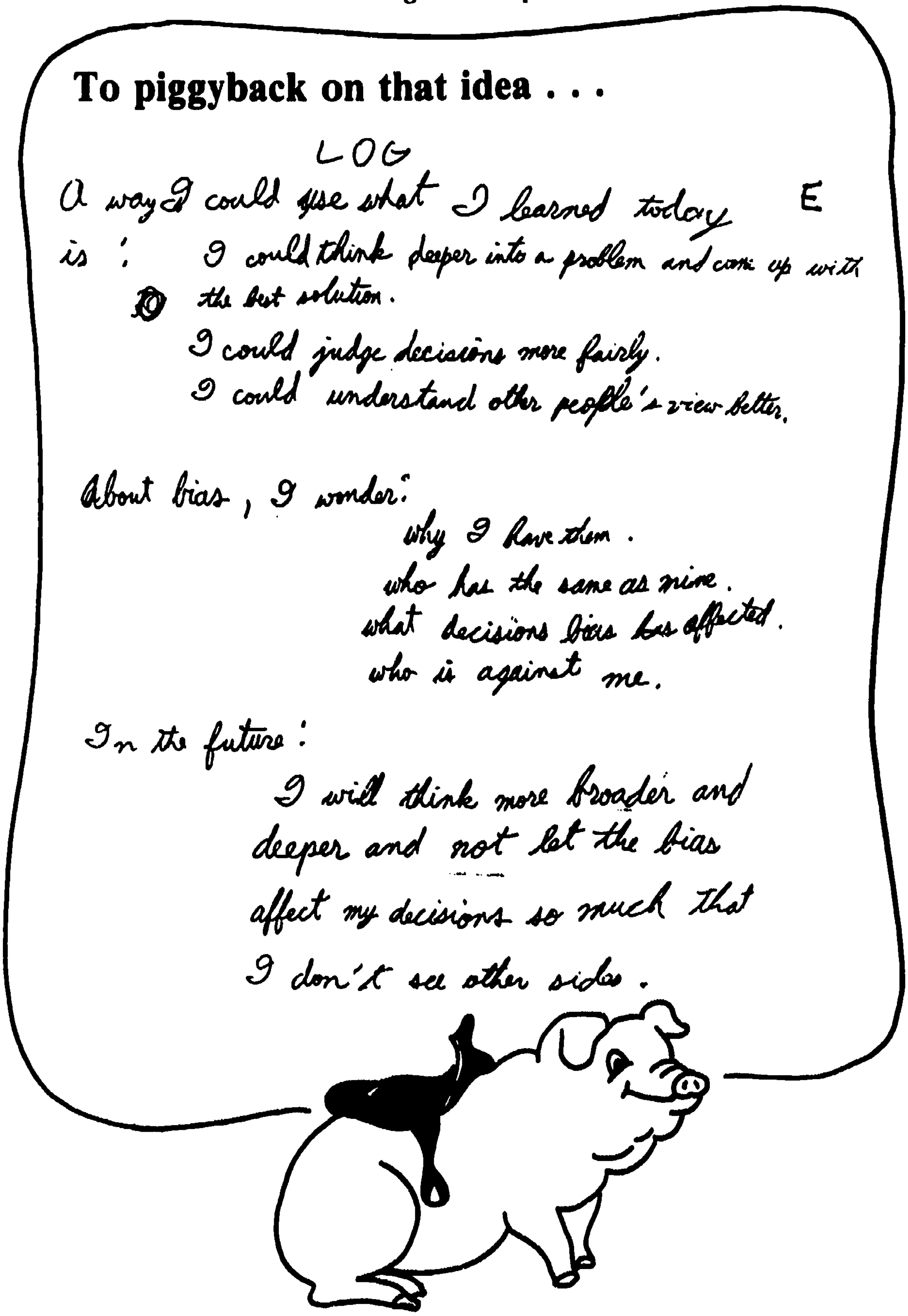


FIGURE 2

A Series of Entries on a Single Concept: Bias



formative, philosophical, or none of the above. There are no right or wrong ways to do the log. It's just a log of one's thinking—whatever that thinking may be. It's a personal record of the connections being made within the framework of students' cognitive capacities and experiences.

FIGURE 3

Sketches of Thinking Log Entries

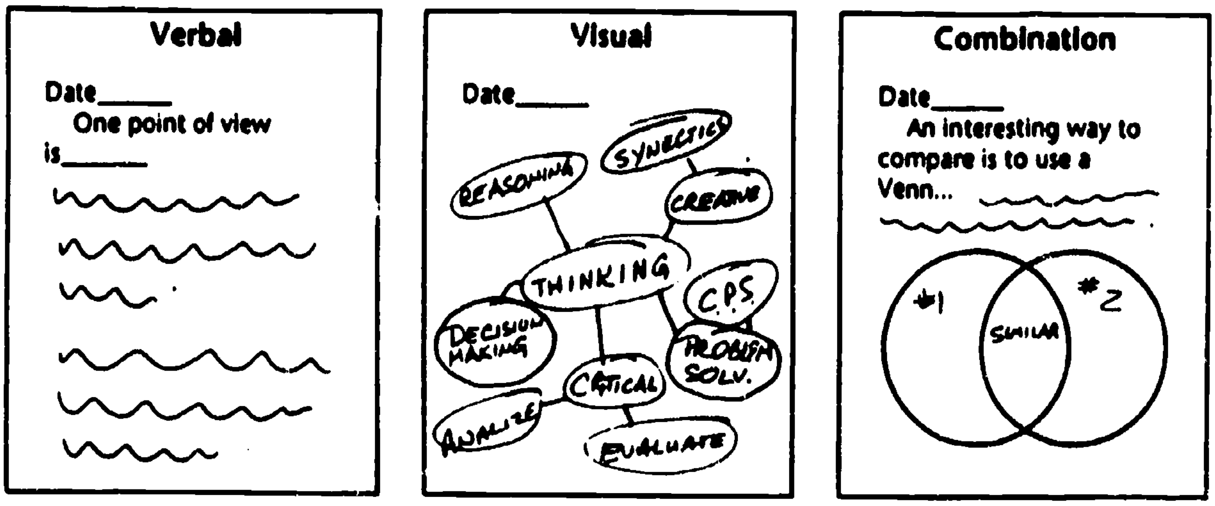


FIGURE 4

Visual and Verbal Thinking Log Entries

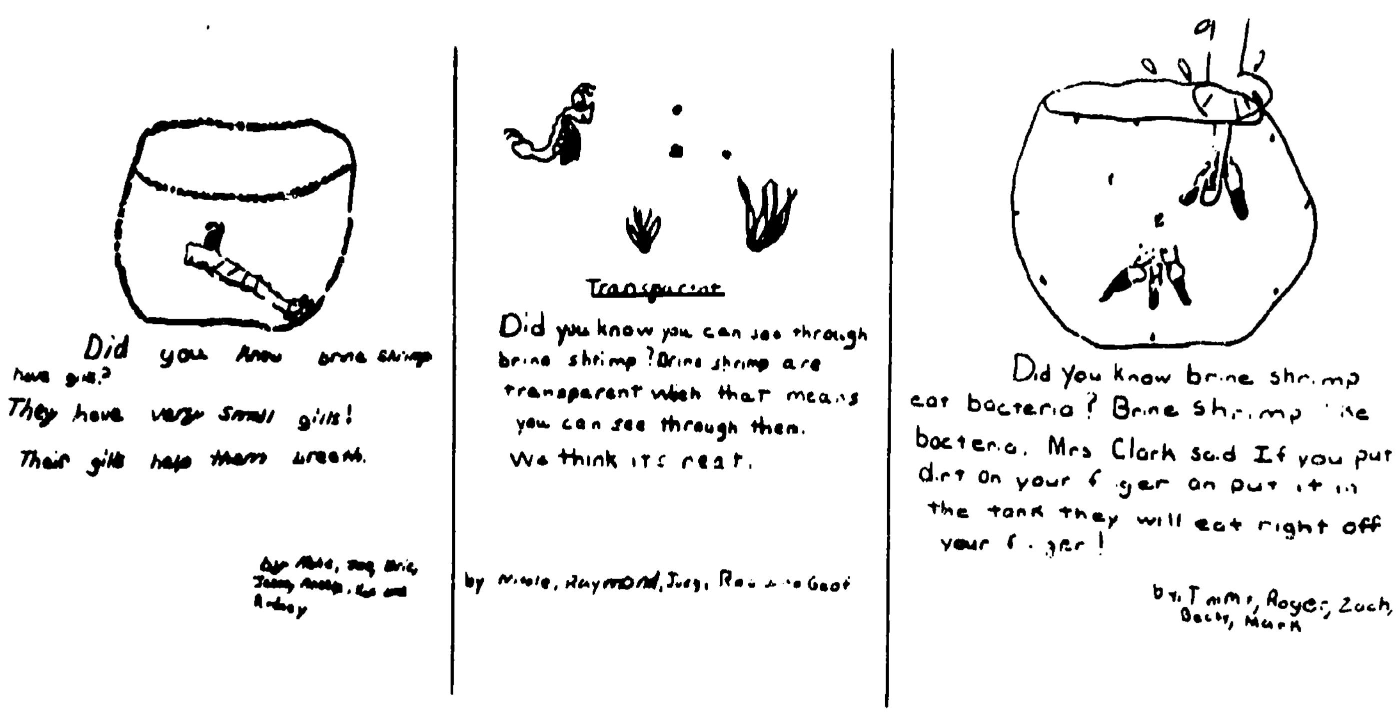
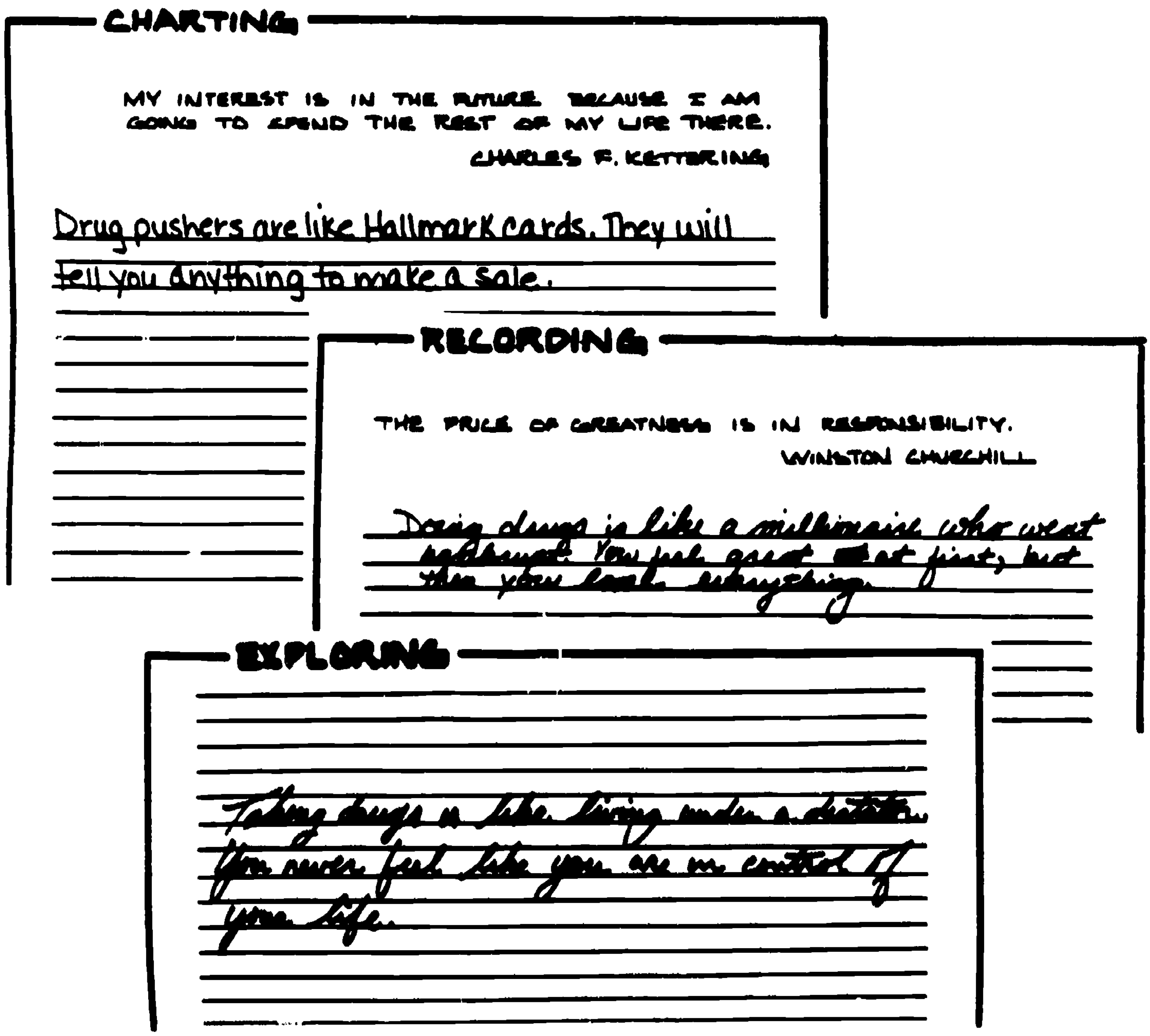


FIGURE 5

Entries Sampled from Several Students



A Time to Think

The few minutes immediately following a lesson are ideal for using the thinking log. This transitional time allows flexibility for the "fast finishers" and for the students who need a minute or two more.

The log may be used solely in one subject area or as a focused follow-up at randomly selected spots of the lessons presented throughout the day. It can be structured formally with designated sections for information or it can be informally structured through student preference and use.

Lead-ins for Logging

Thinking log "lead-ins" can draw students into higher-level thinking processes and provide the versatility needed to develop alternative patterns for thinking. The lead-in dictates to some degree the mode of thought. For example,

FIGURE 6

Log Entries in One Subject Area

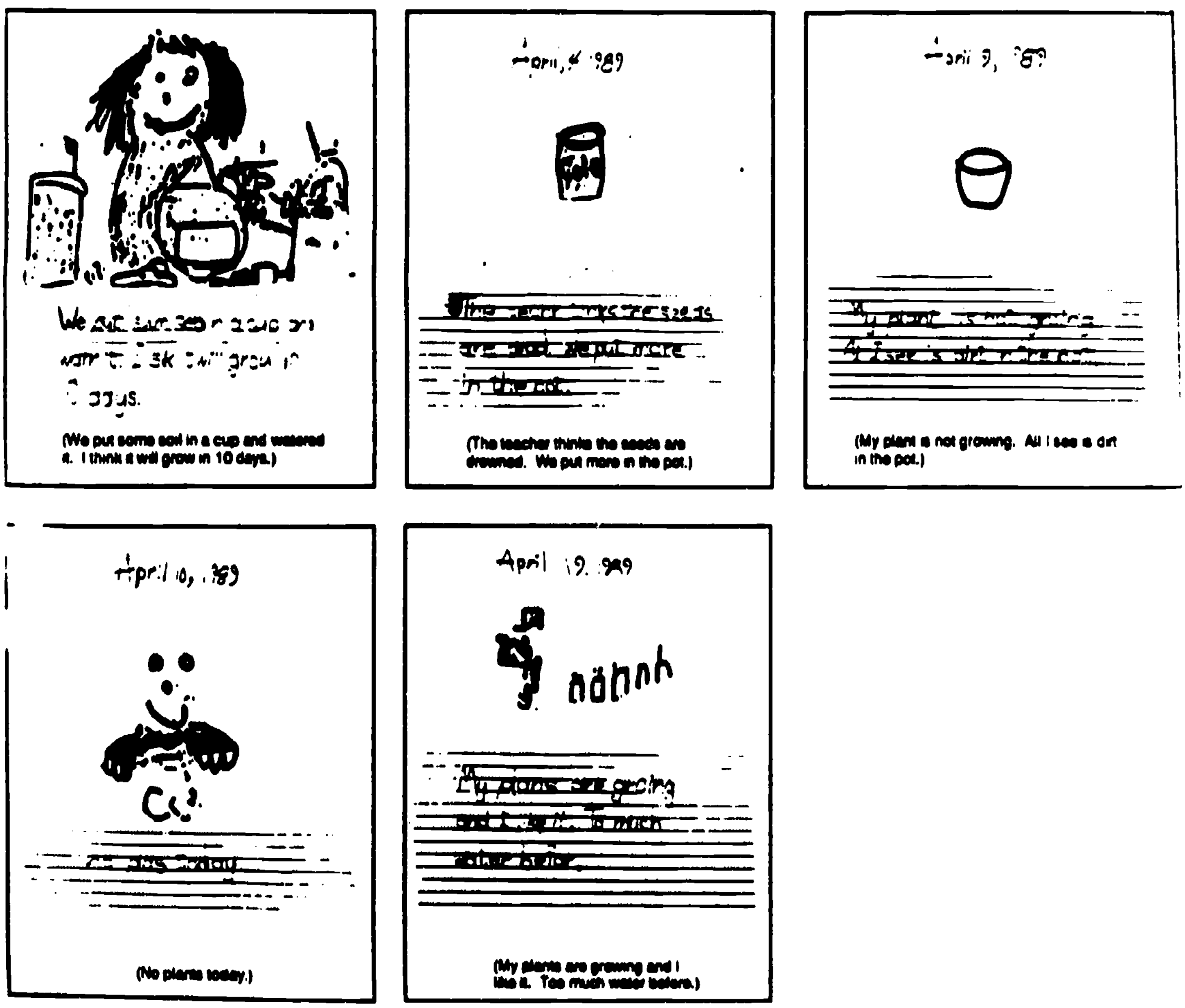


Figure 7

Lead-ins That Promote Thinking at Higher Levels

Analysis

Compared to . . .
The best part . . .
On the positive side . . .
An interesting part is . . .
Take a small part like . . .
A logical sequence seems to be . . .
On the negative side . . .
Similarly . . .
By contrast . . .

Application

Backtracking for a minute . . .
A way to . . .
I want to . . .
A connecting idea is . . .
A movie this reminds me of is _____ because . . .
If this were a book, I'd title it _____
I think this applies to . . .
Does this mean . . . ?

Synthesis

Suppose . . .
Combine . . .
Possibly . . .
Imagine . . .
Reversed . . .
What if . . .
I predict . . .
How about . . .
I wonder . . .

Problem Solving

I'm stuck on . . .
The best way to think about this . . .
I conclude . . .
I'm lost with . . .
I understand, but . . .
I'm concerned about . . .
My problem is . . .
A question I have is . . .

Evaluation

How . . .
Why . . .
It seems irrelevant that . . .
One point of view is . . .
It seems important to note . . .
The best . . .
The worst . . .
If _____ then . . .

Decision Making

I disagree with _____ because . . .
I prefer _____ because . . .
If I had to choose . . .
I believe . . .
My goal is . . .
I hate . . .
One criticism is . . .
I can't decide if . . .

lead-ins can encourage responses that are analytic, synthetic, or evaluative. They can also be used to promote problem solving and decision making, or to foster a particular style of learning. Figures 7 and 8 suggest some possibilities to illustrate the focus flexibility of lead-ins.

As students grapple with new material and struggle with fleeting, disconnected thoughts, the thinking log helps students in yet another way. Students begin to become aware of the thought process itself. Again, the sensitive teacher captures the moment by prodding students to think about

FIGURE 8

Lead-ins That Promote Different Styles of Thinking

Visual Representations

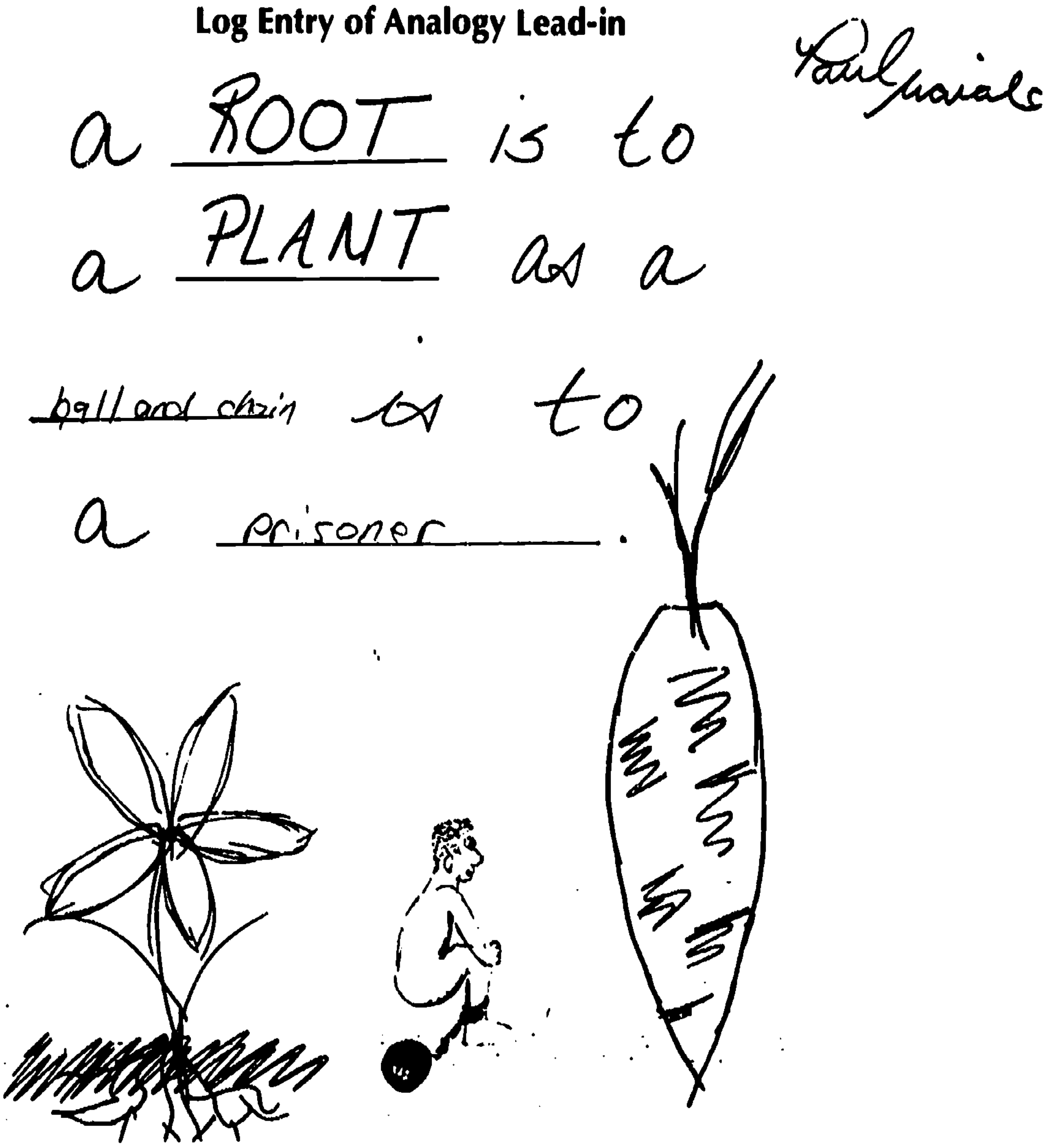
Try to visualize . . .
My picture of this . . .
A diagram of this idea looks like . . .
I feel like . . .
A chart . . .
I'm _____ like _____ because . . .
A "map" of my perception of this is . . .
This cartoon . . .

Verbal Representations

Another way of saying this is . . .
I learned . . .
I discovered . . .
A quote that seems to fit is . . .
I want to read _____ because . . .
I want to talk to _____ because . . .
I want to ask _____ about . . .
Synonyms to describe . . .

FIGURE 9

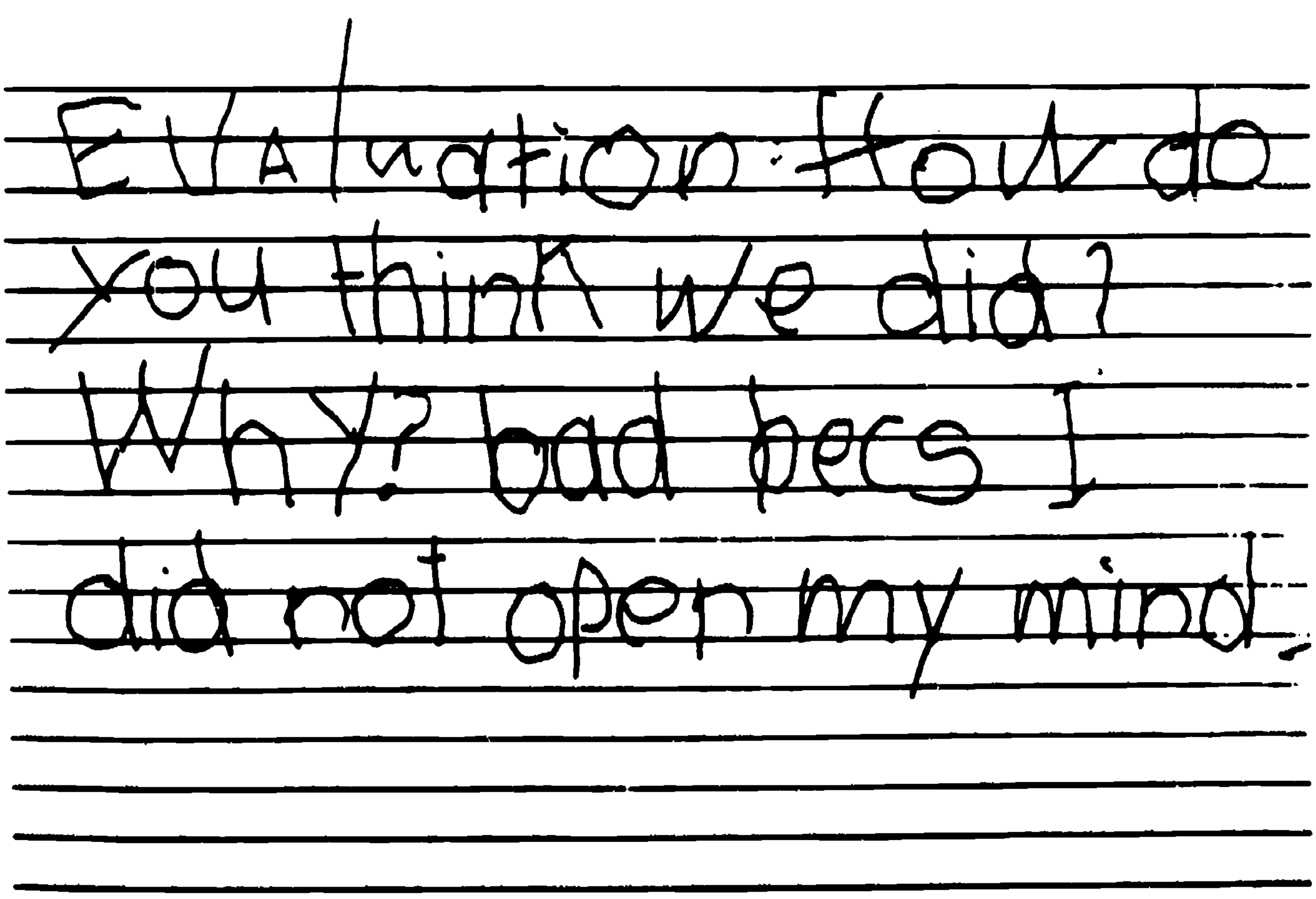
Log Entry of Analogy Lead-in



their thinking in deliberate and intentional metacognitive discussions. Kids start to see that they do have patterns for thinking as they find the words to articulate their thought processes. They assign labels to these processes, labels that identify strategies like reasoning by analogy, classification, logical thought, and intuitive leaps. They begin to choose HOW they want to process new ideas. They begin to build a repertoire of thinking patterns as they express their ideas in writing. In short, they begin inking their thinking.

FIGURE 10

Metacognitive Log Entry


EvAluation: How do you think we did? Why? bad becs I did not open my mind.

(Evaluation: How do you think we did? Why? Bad, because I did not open my mind.)

FIGURE 11

Log Entries That Promote Problem Solving

Feb. 7, 1989 Judy
1. What is the problem?
We were solving how to
get to school.
2. How did we go about
solving problem? I made list.
3. How do you think you did?
I did great because I thik
I had good iders and alot
of queshens
4. What woud you do next time?
The same but do more.

(1. What is the problem? We were solving how to get to school. 2. How did we go about solving problem? I made list. 3. How do you think you did? I did great because I think I had good ideas and alot of questions. 4. What would you do next time? The same but do more.)

FIGURE 12

Reflective Log Entries

16 June Readings

Handout on member roles was a real eye-opener for me — especially applying ideas immediately in "observer" role! In reading definitions and watching real interaction, it was obvious how FLUID these roles really are...

FIGURE 13

Log Entry Dialogue

11/20

Being aware of the level of transfer and talking about this has made me take a careful look at my own transfer.

SN

I'm excited about your raised consciousness about transfer. It will also be interesting to start tracking your students' transfer.

12/16

The log also becomes an indicator for instructional assessment, as teachers note the inner language of the thinking mind, for the students have deliberately and consciously been given modern society's most precious commodity—time. Time to think. Time to wrestle, even if but momentarily, with new ideas. Time to grasp threads of information and begin to weave them into the tapestry of personal experiences.

Tracking the Inking of Our Thinking

Initially, students log their thinking and record an immediate reaction to an experience. In a later reading, they have a chance to ponder the first interpretation and to modify or enhance it with a seasoned second look. And, in the final analysis, with their writing providing the "track sheet," they have "logged" evidence to learn about HOW THEY THINK. Their favored patterns for thinking are revea' d as they leaf through their logs. And that, perhaps, is the most significant outcome of all: kids that can articulate not only WHAT they are thinking, but HOW they arrive at that thinking . . . for they have a log of their thinking.

Logs for Adult Learning

One last note about thinking logs concerns the value of this reflective tool for both youngsters and adults. Using the thinking log concept as a means of processing ideas is becoming a common practice in staff development. Both individual reflection and peer-partner dialogues are viable models

BIBLIOGRAPHY

Applebee, A. (Winter 1984). "Writing and Reasoning." *Review of Educational Research* 54, 4: 577–596.

Bellanca, J., and R. Fogarty. (1989). *Patterns For Thinking, Patterns For Transfer.* Palatine, Ill.: Illinois Renewal Institute Group.

Costa, A. L. (November 1984). "Mediating the Metacognitive." *Educational Leadership 41, 3: 57–62.*

Crowhurst, M. (October 1979). "The Writing Workshop. An Experiment In Peer Response Writing." *Language Arts* 56: 757–762.

Elbow, P. (1973). *Writing with Power.* New York: Oxford University Press.

Elbow, P. (1973). *Writing Without Teachers.* New York: Oxford University Press.

Fulweiler, T., A. Young, eds. (1982). *Language Connection: Writing and Reading Across the Curriculum.* Urbana Illinois: National Council of Teachers of English.

Healy, M. K. (1984). "Writing in a Science Class: A Case Study of the Connection Between Writing and Learning." Doctoral diss., New York University.

Killian, J. P., and G. R. Todnem. (Summer 1989). "Mentorship Through Journal Writing As a Means of Professional Development for Staff Developers." *Journal of Staff Development* 10, 3: 22–26.

Mayher, J. S., N. B. Lester, and G. M. Pradl. (1983). *Learning To Write/Writing To Learn.* Upper Montclair, New Jersey: Boynton-Cook.

Moffett, J., and B. J. Wagner. (1976). *Student-Centered Language Arts & Reading, K–13.* 2nd ed. Boston: Houghton Mifflin.

Rico, G. L. (1983). *Writing the Natural Way.* Boston: J. P. Tarcher.

Sanders, A. (February 1985). "Learning Logs: A Communication Strategy for All Subject Areas." *Educational Leadership* 42, 5: 7.

Wotring, A. M., and R. Tierney. (1982). *Using Writing To Learn Science.* Berkeley, California: Bay Area Writing Project, University of California.

Wayzata Senior High School
Plymouth, Minnesota

January 22, 1990

Dear Art,

After attending your workshop two years ago, it occurred to me that there could be more done than just learning algorithms in my mathematics classes. Specifically, I started having students do more than just learn methods to solve for one right answer by having students use writing and higher level questions.

For example, I am requiring calculus students to write, in organized detail, solutions for zero to a function and the zeros of the 1st and 2nd derivative as they relate to each other and to the graph of the function. Another is to compare and contrast how the integration necessary to do work is obtained from the limit of the sums.

As a result of including some of these kinds of questions students seem to understand concepts rather than rote memorization and recalling algorithms. I have no research-designed data for support but more of our students are scoring higher on the Advanced Placement Calculus Examinations. Just thought you would like to know some of the outcomes from your seminar.

Sincerely,
Gary Kollofski, Teacher

43

Cueing Thinking in the Classroom: The Promise of Theory-Embedded Tools

Jay McTighe and Frank T. Lyman, Jr.

Throughout history, human progress has been propelled by the development and use of tools. The wheel, telegraph, microscope, computer—these and other tools greatly extend human capabilities. How can the concept of tools help to accelerate progress in education? Nathaniel Gage (1974) has proposed that teachers use "tools of the trade," tangible teaching/learning devices that are material embodiments of theoretically valid teaching/learning ideas. According to Gage, these tools should have:

- *Psychological validity*—they reflect what is known about teaching and learning;
- *Concreteness*—they embody knowledge in materials and equipment;
- *Relevance to teachers*—they have practical value in the classroom;
- *Differentiation by type of learning*—a relationship exists between the type of tool and the way that a skill, concept, process, or attitude is best learned.

Successful classroom applications demonstrate that tool-assisted instruction is indeed a medium for blending theory and practice. Here we describe six tools for creating classroom conditions conducive to thinking.

This chapter is adapted from Jay McTighe and Frank T. Lyman, Jr., "Cueing Thinking in the Classroom: The Promise of Theory-Embedded Tools," *Educational Leadership* 45, 7 (April 1988): 18–24.

Think–Pair–Share

After the teacher asks a question, 1st graders think for 10 seconds and then talk in pairs as the teacher moves an arrow on a cue chart from think *to* pair.

Over 20 years of research on "wait time" has confirmed numerous benefits from allowing three or more seconds of silent thinking time after a question has been posed (Wait Time I) as well as after a student's response (Wait Time II). These benefits include longer and more elaborate answers, inferences supported by evidence and logical argument, greater incidence of speculative responses, increased student participation in discussion, and improved achievement (Rowe 1986). Also, the use of cooperative learning structures promotes student involvement and increased verbal interaction, resulting in positive effects on attitude and achievement (Slavin 1981; Johnson and Johnson 1984). The Think–Pair–share method (Lyman 1981b, 1989) combines the benefits of wait time and cooperative learning.

Think–Pair–Share is a multi-mode discussion cycle in which students listen to a question or presentation, have time to *think* individually, *talk* with each other in *pairs*, and finally *share* responses with the larger group. The teacher signals students to switch from listening to *think*, to *pair*, and to *share* modes by using cues (Figure 1).

Cueing enables teachers to manage students' thinking by combating the competitiveness, impulsivity, and passivity

FIGURE 1
Cues for Think-Pair-Share

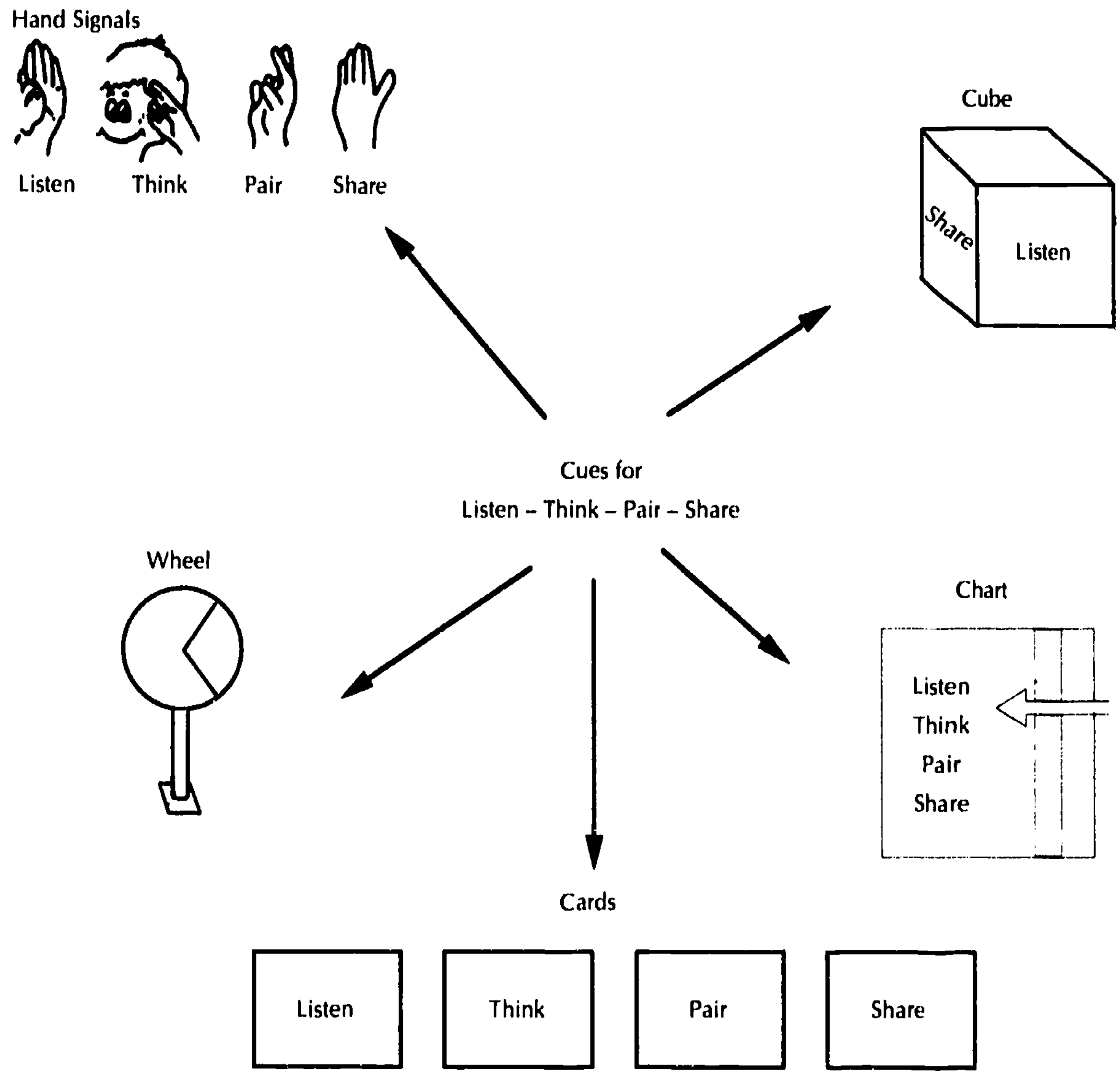
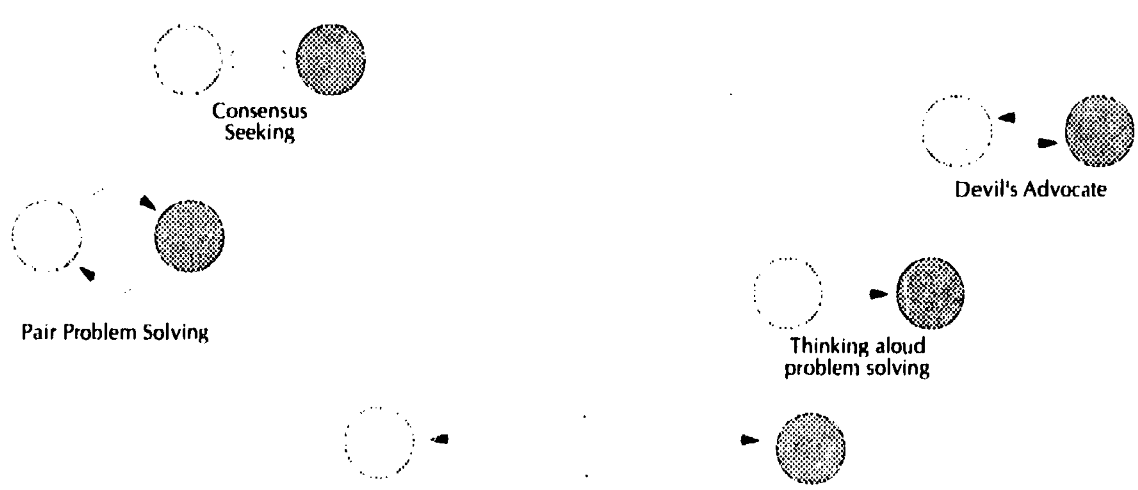


FIGURE 2
Think-Pair-Share Structures



present in the timeworn recitation model. Both Wait Time I and Wait Time II can be consistently achieved with Think–Pair–Share, since students raise their hands only on signal, not directly after the question or a response. Students, individually and in pairs, may write or diagram their thoughts. Other cues give options for *how* students are to think or work in pairs. For instance, teachers may cue them to reach consensus, engage in problem solving, or assume the role of devil's advocate (Figure 2). The overall effect of these coordinated elements is a concrete, valid, and practical system, made manageable, and thereby acceptable to teachers, by cueing devices.

Questioning/Discussion Strategies Bookmark

During classroom discussion of the limits of First Amendment rights, a high school social studies teacher glances at a laminated bookmark he's holding and assumes the role of devil's advocate in response to student comments.

Over 2,000 years ago, Socrates demonstrated the power of questioning to stimulate thinking. Educators today know that the way a teacher structures a question influences the nature of the thinking required to respond. We also know that follow-up discussion strategies, such as asking for elaboration, influence the degree and quality of classroom discussion. Despite this knowledge, however, Goodlad (1983) reports that most classroom questions require only factual responses and that, in general, students are not involved in thought-provoking discussions.

Teachers can integrate effective questioning and discussion strategies into their daily repertoires by referring to a "cueing" bookmark (McTighe 1985), which features question starters on one side and discussion strategies on the other (Figure 3). During classroom discussion, the bookmark reminds teachers to use these promising strategies.

Thinking Matrix

After looking at a game board thinking matrix, a 5th grade boy asks his classmates: "What caused the hero's death, . . . I mean, what was there about his life that made you think he had to die that way?"

In addition to learning to ask questions that promote thinking (see Gall 1970; Hare and Pulliam 1980), teachers are recognizing a need to help students generate their own questions. Generating their own questions facilitates students' comprehension (Davey and McBride 1986) and encourages them to focus attention, make predictions, identify relevant information, and think creatively about content.

The thinking matrix, or Think-trix, is a device to aid teachers and students in generating questions and responses (Lyman 1987; see Figure 4). The vertical axis of the matrix contains symbols of types of thought; the horizontal axis lists categories that give points of departure for inquiry, which vary according to the subject area. For example, using the matrix in language arts, teachers or students point to an intersection such as *cause/effect* and *event or character* and ask a question about the cause of the hero's death; in social studies, they could point to the intersection of *idea to example* and *theme or concept* and ask for historical examples of balance of power.

The Think-trix has many uses in the classroom. Students can analyze classroom questioning or discourse; or they can create, analyze, and answer their own questions using a desk-size matrix as a game board. Using a poster-size matrix, teachers can make up their own questions, teach question design to students, show students how to respond to information using different thinking types, and point out the possible visual representations, or cognitive mappings, of each thinking type. In essence, the thinking matrix allows for shared metacognition in which teacher and students have a common framework for generating and organizing thought as well as for reflecting upon it.

Ready Reading Reference

While reading about sea lions in a recent issue of National Geographic World, *a 5th grader looks at his bookmark and creates a visual image of what he has just read.*

Analysis of the differences between good and poor readers points out the importance of the strategic behaviors that good readers spontaneously employ before, during, and after their reading. For example, they concentrate on their purpose for reading, monitor their comprehension, and adjust their approach when necessary. Poor readers, on the other hand, are less mindful of such effective strategies. In fact, they tend to perceive reading as "decoding" rather than as the construction of meaning (Garner 1980; Garner and Reis 1981).

The "Ready Reading Reference" bookmark (Kapinus 1986) was developed to summarize knowledge about "good reader" strategies (Paris and Jacobs 1984). The bookmark serves as a tangible instructional tool and a concrete cue for students during independent reading (Figure 5).

Problem-Solving Strategies Wheel

As students in an algebra II class struggle to solve a word problem, their teacher points to a poster of problem-solving

FIGURE 3
Cueing Bookmark

Front

QUESTIONING FOR QUALITY THINKING

Knowledge—Identification and recall of information
Who, what, when, where, how ______?
Describe ______.

Comprehension—Organization and selection of facts and ideas
Retell ______ in your own words.
What is the main idea of ______?

Application—Use of facts, rules, principles
How is ______ an example of ______?
How is ______ related to ______?
Why is ______ significant?

Analysis—Separation of a whole into component parts
What are the parts or features of ______?
Classify ______ according to ______.
Outline/diagram/web ______.
How does ___ compare/contrast with ___?
What evidence can you list for ______?

Synthesis—Combination of ideas to form a new whole
What would you predict/infer from ______?
What ideas can you add to ______?
How would you create/design a new ___?
What might happen if you combined ___ with ______?
What solutions would you suggest for ___?

Evaluation—Development of opinions, judgments, or decisions
Do you agree ______?
What do you think about ______?
What is the most important ______?
Prioritize ______.
How would you decide about ______?
What criteria would you use to assess ___?

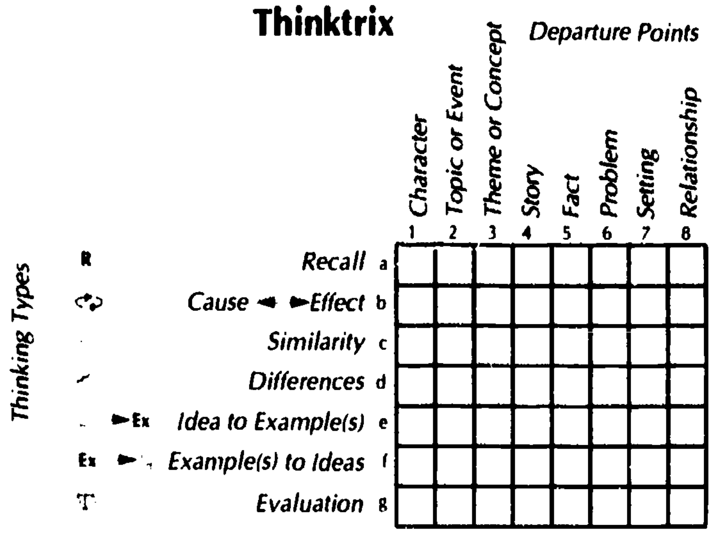
Back

STRATEGIES TO EXTEND STUDENT THINKING

- **Remember "wait time I and II"**
  Provide at least three seconds of thinking time after a question and after a response
- **Utilize "think-pair-share"**
  Allow individual thinking time, discussion with a partner, and then open up the class discussion
- **Ask "follow-ups"**
  Why? Do you agree? Can you elaborate? Tell me more. Can you give an example?
- **Withhold judgment**
  Respond to student answers in a non-evaluative fashion
- **Ask for summary (to promote active listening)**
  "Could you please summarize John's point?"
- **Survey the class**
  "How many people agree with the author's point of view?" ("thumbs up, thumbs down")
- **Allow for student calling**
  "Richard, will you please call on someone else to respond?"
- **Play devil's advocate**
  Require students to defend their reasoning against different points of view
- **Ask students to "unpack their thinking"**
  "Describe how you arrived at your answer." ("think aloud")
- **Call on students randomly**
  Not just those with raised hands
- **Student questioning**
  Let the students develop their own questions
- **Cue student responses**
  "There is not a single correct answer for this question. I want you to consider alternatives."

Source: Language and Learning Improvement Branch, Division of Instruction, Maryland State Department of Education.

FIGURE 4
Thinktrix



strategies and suggests that they consider strategy #5, draw a diagram.

Math and science teachers often experience frustration when students who demonstrate an understanding of basic facts and concepts cannot apply this knowledge to word problems. Fortunately, inquiry into the problem-solving behaviors of experts and novices has revealed important strategic distinctions with implications for problem-solving instruction. Effective problem solvers spend time understanding a problem before attacking it. To this end, they may create various representations or models. Expert problem solvers also report using problem-solving strategies, or heuristics, such as breaking the problem into subproblems. They also engage in metacognitive behaviors, including monitoring progress and checking the final solution (Schoenfeld 1979, 1980; Mayer 1983; Suydam 1980).

Teachers who wish to improve student problem solving can spend classroom time examining the solution *process* along with the final answer, model their own strategic reasoning by "thinking aloud," and provide explicit instruction in problem-solving heuristics using a Problem-Solving Strategies Wheel (Figure 6). Frequently found in the form of a large classroom poster, such an instructional tool is a visible cue that reminds teachers and students of the strategies of experts.

Cognitive Mapping

Upon completing a character analysis map as part of a "prewriting" activity, an 8th grader comments, "I like graphic organizers because they help me see what I'm thinking."

The ability to generate and organize information and ideas is fundamental to effective thinking. Cognitive maps and other visual organizers are effective tools for helping students to generate ideas and to organize their thoughts. Cognitive maps provide a visual, holistic representation of facts and concepts and their relationships within an organized framework. They help students to:

- Represent abstract or implicit information in more concrete form,
- Depict the relationships among facts and concepts,
- Generate and elaborate ideas,
- Relate new information to prior knowledge,
- Store and retrieve information.

Cognitive mapping techniques show demonstrated success in improving retention of information (Armbuster and Anderson 1980; Dansereau 1979; Davidson 1982; Vaughn 1982); and teachers using the process approach to writing often use cognitive mapping during prewriting (Gemake and Sinatra 1986).

Cognitive map prototypes are now in use in classrooms from kindergarten through university levels. Perhaps the most widely used design is the web. Others include sequence steps or chains, vector charts for cause and effect, story maps, analogy links, and flowcharts for decision making and problem solving (Figures 7, 8, and 9). Such cognitive maps become blueprints for oral discourse and written composition, particularly when used in conjunction with Think–Pair–Share and metacognitive cues, such as those on the Think-trix and the bookmarks (Lyman, Lopez, and Mindus 1986).

Through their regular use of cognitive mapping, students come to recognize that thought can be shaped, teachers discover a set of powerful tools for rendering the invisible process of thinking visible, and both experience the benefits of shared metacognition.

Why Instructional Tools Are Effective

The tools just described serve as catalysts for creating a responsive, "thinking" classroom. At least four factors may help explain the success of these and similar instructional tools: they provide an aid to memory, a common frame of reference, a practical incentive to act based on sound educational theory, and an inherent permanence.

1. *An aid to memory.* Thinking tools serve as tangible cues for teachers and students. They provide immediate access to theoretical knowledge when it is needed most: at the point of decision making. In the complex and distracting dynamics of school, the concreteness and stability of these tools remind teachers and students to use what they know to enhance their thinking.

2. *A common frame of reference.* Thinking tools provide a mutually understood frame of reference for teachers and students by offering common terminology (e.g., the thinking types on the Think-trix) and specific cues for action (e.g., the signals associated with Think–Pair–Share). The tools provide congruence that can improve carryover from one classroom and subject area to others, resulting in consistency of approach within a school.

3. *Incentive to act.* Teachers are bombarded by advice and mandates, many of which appear to complicate their work. On the other hand, they welcome new ideas and materials that they think have practical value. The thinking tools described here have been enthusiastically received, in part because they are ready for immediate use.

4. *Permanence.* Even successful innovations are difficult to maintain in schools. These thinking tools, visible and concrete, may help to hold an innovation in place. Another dimension of permanence may be achieved through "mental templating": teachers and students frequently remember the message embedded in the tool even when the tool itself is

FIGURE 5

Ready Reading Reference Bookmark

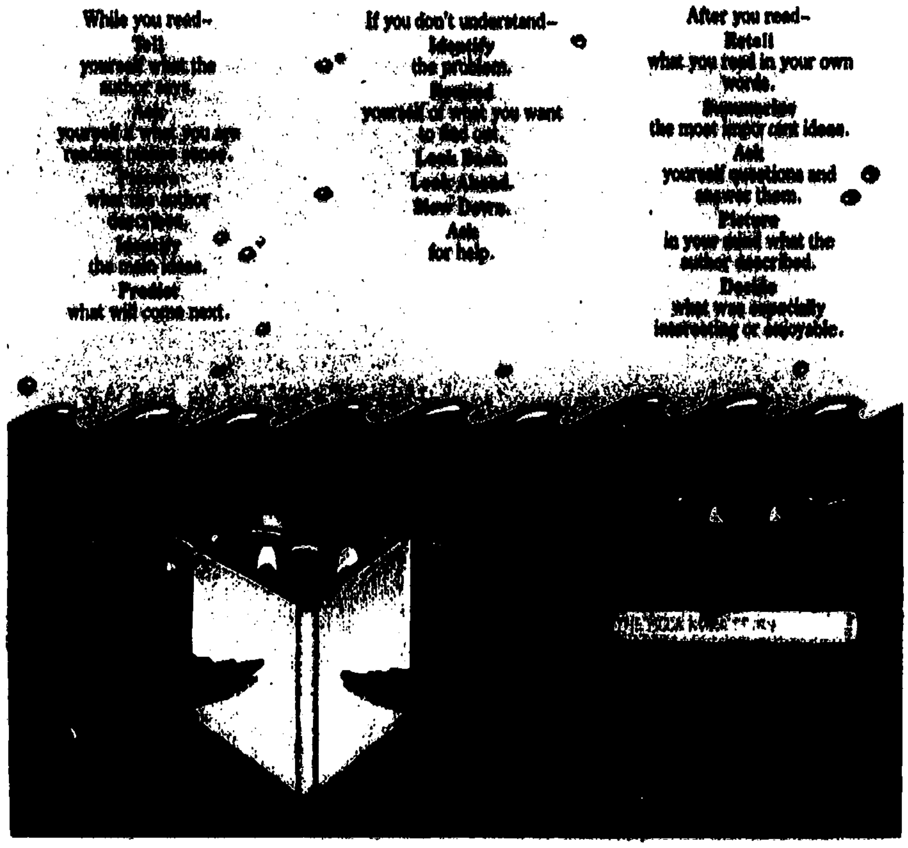


FIGURE 6

Problem-Solving Strategies Wheel

FIGURE 7
Flow Chart

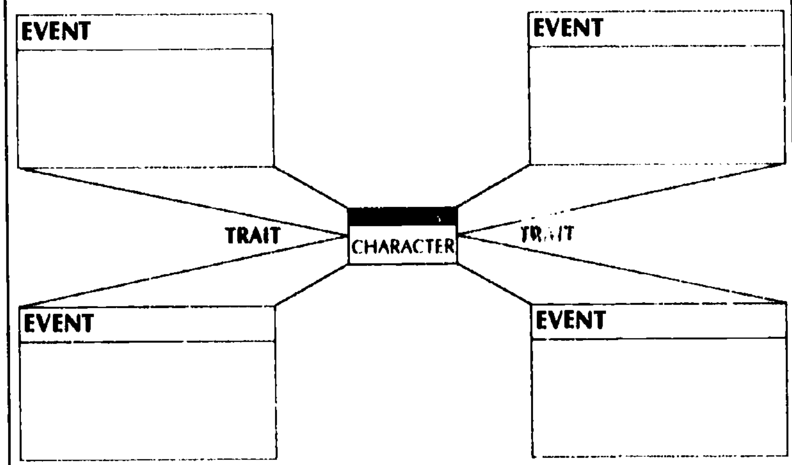


FIGURE 8
Decision-Making Model

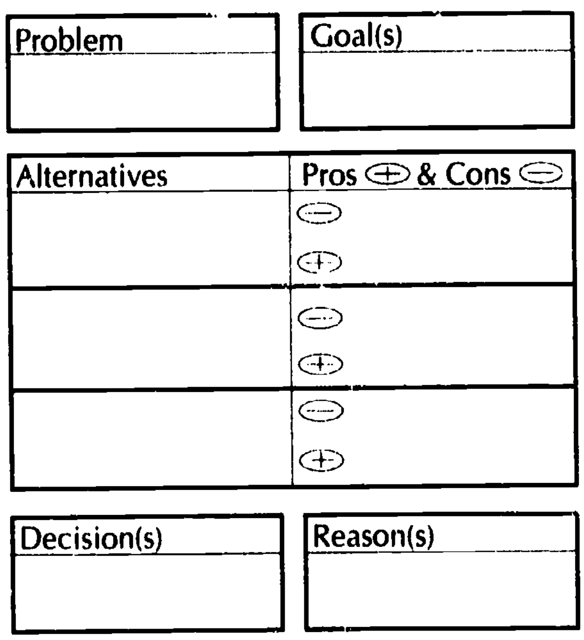
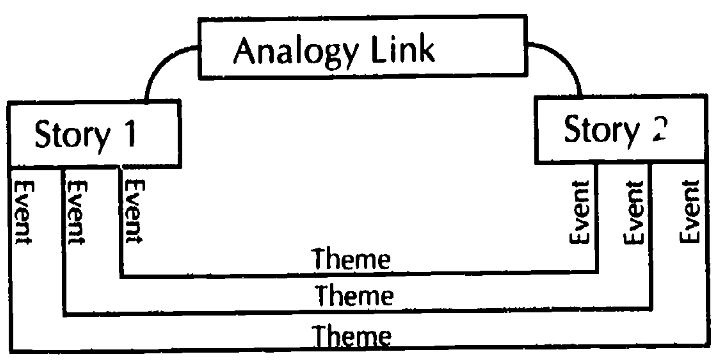


FIGURE 9
Decision-Making Model



not present. As a result, memories of ways to think and act may persist beyond the classroom.

The Promise of Theory-Embedded Tools

Instructional tools present a concrete, practical, and valid system for involving students from nursery school through graduate school in the active processing of ideas. Their use enables teacher educators to send novice teachers into the field with practical embodiments of theory. Staff developers who encourage the invention and use of instructional tools will see the elusive theory-into-practice connection made and maintained.

Furthermore, as Gage (1974) suggests, research on tools will test theory in practice and expand the knowledge base. These theory-embedded cueing devices promise to bring classroom teaching into closer harmony with known principles of effective instruction, thereby improving the quality of thinking and learning for all students.

REFERENCES

Armbuster, B. B., and T. H. Anderson. (1980). "The Effect of Mapping on the Free Recall of Expository Test." (Technical Report 160). Center for the Study of Reading, University of Illinois, Urbana-Champaign.

Dansereau, D., et al. (February 1979). "Development and Evaluation of a Learning Strategy Training Program." *Journal of Educational Psychology* 71, 1: 64–73.

Davey, B., and S. McBride. (1986). "Effects of Question-Generation Training on Reading Comprehension." *Journal of Educational Psychology* 78, 4: 256–262.

Davidson, J. L. (October 1982). "The Group Mapping Activity for Instruction on Reading and Thinking." *Journal of Reading* 26, 1: 53–56.

Gage, N.L. (1974). *Teacher Effectiveness and Teacher Education: The Search for a Scientific Basis.* Palo Alto, Calif.: Pacific Books.

Gall, M. (1970). "The Use of Questions in Teaching." *Review of Educational Research* 40: 707–721.

Garner, R. (1980). "Monitoring of Understanding: An Investigation of Good and Poor Readers." *Journal of Reading Behavior* 12: 55–64.

Garner, R., and R. Reis. (1981). "Monitoring and Resolving Comprehension Obstacles: An Investigation of Spontaneous Text Lookbacks Among Upper-Grade Good and Poor Comprehenders." *Reading and Research Quarterly* 16, 4: 569–582.

Gemake, J., and R. Sinatra. (November–December 1986). "Using Maps to Improve Writing." *Early Years.*

Goodlad, J. I. (1983). *A Place Called School.* New York: McGraw-Hill.

Hare, V., and C. Pulliam. (1980). "Teacher Questioning: A Verification and an Extension." *Journal of Reading Behavior* 12: 69–72.

Johnson, D., and R. Johnson. (1984). "Cooperative Small-Group Learning." *Curriculum Report* 14, 1: 1–6.

Kapinus, B. (1986). *Ready Reading Readiness.* Baltimore, Md.: Maryland State Department of Education.

Lyman, F. T., Jr. (September–October 1989). "Rechoreographing: The Middle Level Minuet." *The Early Adolescence Magazine (TEAM)*: 4, 1: 22–24.

Lyman, F. T., Jr. (1987). "The Think-Trix: A Classroom Tool for Thinking in Response to Reading." In *Reading: Issues and Practices, Yearbook of the State of Maryland International Reading Association Council.* Vol. 4. Westminster, Md.: State of Maryland International Reading Association Council, pp. 15–18.

Lyman, F. T., Jr. (Spring 1981a). "The Development of Tools." *Maryland A.T.E Journal* 1: 20–21.

Lyman, F.T., Jr. (1981b). "The Responsive Classroom Discussion: The Inclusion of All Students." In *Mainstreaming Digest*, edited by A. Anderson. College Park, Md.: University of Maryland.

Lyman, F. T., Jr., C. Lopez, and A. Mindus. (1986). "Think-Links: The Shaping of Thought in Response to Reading." Unpublished manuscript. Columbia, Md.

Mayer, R. (June 1983). "Implications of Cognitive Psychology for Instruction in Mathematic Problem Solving." Paper presented at the Conference on Teaching Mathematical Problem Solving, San Diego State University.

McTighe, J. (speaker). (1985). *Questioning for Quality Thinking* (audiotape side 1) and *Strategies for Extending Student Thinking* (side 2). Baltimore: Maryland State Department of Education.

Paris, S., and J. Jacobs. (December 1984). "The Benefits of Informed Instruction for Children's Reading Awareness and Comprehension Skills." *Child Development* 55, 6: 2083–2093.

Rowe, M. B. (January–February 1986). "Wait Time: Slowing Down May Be a Way of Speeding Up!" *The Journal of Teacher Education* 31, 1: 43–50.

Schoenfeld, A. (1979). "Can Heuristics Be Taught?" In *Cognitive Press Instruction*, edited by J. Lochhead and J. Clement. Philadelphia, Pa.: Franklin Institute Press.

Schoenfeld, A. (1980). "Heuristics in the Classroom." In *Problem Solving in School Mathematics, 1980 Yearbook*, edited by S. Krulik and R. E. Reys. Reston, Va.: National Council of Teachers of Mathematics, pp. 9–22.

Slavin, R. E. (1981). "Synthesis of Research on Cooperative Learning." *Educational Leadership* 38, 8: 655–660.

Suydam, M. (1980). "Untangling Clues from Research on Problem Solving." In *Problem Solving in School Mathematics*, edited by S. Krulik and R. E. Reys. Reston, Va.: National Council of Teachers of Mathematics.

Vaughn, L., Jr. (February 1982). "Use the Construct Procedure to Foster Active Reading and Learning." *Journal of Reading.*

44

Teaching the Language of Thinking

Arthur L. Costa and Robert Marzano

Schools should not be organized for teachers to teach, but for children to learn.

—McLean Briggs

Teaching and learning are predominantly linguistic phenomena; that is, we accomplish most of our learning through the vehicle of language, the daily exchange of words in classrooms. Therefore, language is a tool that teachers can use to enhance cognitive development. If we are to develop a successful program for teaching thinking, we must also develop a language of cognition.

The Linguistic Nature of Instruction

According to Feuerstein (1980), the teacher's interactive role is crucial in the mediated learning experience of children's cognitive development. In their major review of studies of linguistic interactions in classrooms, Green and Smith (1982) conclude that language is used by teachers to "frame" the presentation of content, the tasks students are to perform, and the norms of acceptable and unacceptable conduct. In other words, teachers tell students what to do, when to do it, and how to behave when they do it.

Language also creates classroom culture, which is defined as the set of important understandings that class members share. For example, Parelius (1980) and Purkey and Smith (1982) have identified such classroom culture variables as "tone of orderliness" and "atmosphere of acceptance" as keys to effective teaching. Burger (1977) asserts that culture actually "lives in language."

Labeling is another fundamental characteristic of language (Condon 1968). When people create a name or a label for something, they also create a reality that previously did not exist for them. Condon uses the example of taking a course in astronomy. Before taking a course, a person will look at a night sky and see only stars. After a few weeks of instruction, he or she will begin to see *super novae*, *white dwarfs*, and *galaxies*. Thus, when we create labels, we structure our perceptions. New labels foster new perceptions. As Condon (1968) observed, "For better or for worse, when names are learned we see what we had not seen, for we know what to look for."

Given the nature and importance of language, creating a classroom language of cognition necessarily involves redefining terminology and perhaps inventing new terminology for specific situations. We have identified seven starting points.

Using Precise Vocabulary

Teachers often admonish students to "think hard." They sometimes criticize students for not having the inclination to think: "These kids just go off without thinking."

The term *think* covers a range of thought processes. Students may fail to think because the vocabulary is foreign to them or because they may not know how to perform the specific skill implied. Thus, teachers should use specific cognitive terminology and show students how to perform particular skills. For example, instead of saying, "Let's *look* at these two pictures," say, "Let's *compare* these two pictures"

This chapter is adapted from Arthur L. Costa and Robert Marzano, "Teaching the Language of Thinking, *Educational Leadership* 45, 2 (October 1987): 29–33.

(Figure 1), and then demonstrate how to find similarities and differences in them.

As children hear these terms daily and develop the cognitive processes that these labels signify, they will internalize the words and use them as part of their own vocabularies. Teachers can also provide specific instruction in cognitive processes so that students will attach precise, shared meaning to the terms (Beyer 1985). Teaching students what goes on in th head when comparisons are made, what are helpful steps in a decision-making process, and what techniques cause creative juices to flow when writing a story are examples of ways teachers can provide specific instruction in thinking skills.

FIGURE 1

PRECISE TERMINOLOGY

Instead of Saying:	Say:
"Let's look at these two pictures."	"Lets *compare* these two pictures."
"What do you think will happen when . . . ?	"What do you *predict* will happen when . . . ?
"How can you put into groups . . . ?"	"How can you *classify* . . . ?"
"Let's work this problem."	"Let's *analyze* this problem."
"What do you think would have happened if . . . ?	"What do you *speculate* would have happened if . . . ?
"What did you think of this story?"	"What *conclusions* can you draw about this story?"
"How can you explain . . . ?"	"What *hypotheses* do you have that might explain . . . ?"
"How do you know that's true?"	"What *evidence* do you have to support . . . ?"
"How else could you use this . . . ?	"How could you *apply* this . . . ?"

Posing Critical Questions

Teachers often make decisions about which classroom behaviors to discourage and which to reinforce. They do this by posing questions that cause children to examine their behavior, consider the consequences of that behavior, and choose more appropriate actions (Bailis and Hunter 1985). For example, instead of saying, "Be quiet," the teacher can say, "The noise you're making is disturbing us. Is there a way you can work so that we don't hear you?" (Figure 2).

Discussions with children about appropriate behavior, classroom and school rules, and courtesy are necessary if students are to learn respect for other people. The language of thinking will help students determine which behaviors "work" within the culture of the classroom.

FIGURE 2

Questions That Encourage Appropriate Behavior

Instead of saying:	Say:
"Be quiet."	"The noise you're making is disturbing us. Is there a way you can work so that we don't hear you?"
"Sarah, get away from Shawn."	"Sarah, can you find another place to do you best work?"
"Stop interrupting."	"Since it's Maria's turn to talk, what do you need to do?"
"Stop running."	"Why do you think we have the rule about always walking in the halls?"

Providing Data, Not Solutions

Sometimes teachers rob children of the opportunity to take responsibility for their behavior by providing solutions, consequences, and appropriate actions for them. Teachers can teach responsibility by giving data and sending "I" messages (Figure 3). By providing data as input for children to process, teachers will encourage them to act more autonomously, to become aware of the effects of their behavior on others, and to become more empathetic by sensing verbal and nonverbal cues from others.

FIGURE 3

Data for Autonomous Decision Making

When Children: (for example)	Say:
Make noise by tapping their pencils.	"I want you to know that your pencil tapping is disturbing me."
Interrupt.	"I like it when you take turns to speak."
Whine.	"It hurts my ears."
Are courteous.	"I liked it when you came in so quietly and went right to work."
Chew gum.	"I want you to know that gum chewing in my class disturbs me.

Giving Directions

When giving directions, teachers often spoonfeed students by providing so much information that they can comply without having to infer meaning (Figure 4). Instead, teachers can ask questions that require students to analyze a task, identify what is needed to complete the task, and then perform the task.

FIGURE 4

Instructions that Teach Meaning

Instead of Saying:	Say:
"For our field trip, remember to bring spending money, comfortable shoes, and a warm jacket."	"What must we remember to bring with use on the field trip?"
"The bell has rung; it's time to go home. Clear off your desks quietly and line up at the door."	"The bell has rung. What must we do to get ready to go home?"
"Get 52 cups, 26 scissors, and 78 sheets of paper. Get some butcher paper to cover the desks."	"Everyone will need two paper cups, a pair of scissors, and three sheets of paper. The desk tops will need to be protected. Can you figure out what you'll need to do?"
"Remember to write your name in the upper right-hand corner of your paper."	"So that I can easily tell who the paper belongs to, what must you remember to do?"

Probing for Specificity

Oral language is rife with omissions, vagueness, and generalizations. It is conceptual rather than operational; value laden; and sometimes deceptive. To encourage careful thinking, teachers should try to get students to define terms, be specific about actions, make precise comparisons, and use accurate descriptors (Laborde 1984). They should be alert to vague or unspecified terms, which fall into several categories:

- Universals including *always, never, all, everybody*;
- Vague actions such as *know about, understand, appreciate*;
- Comparisons such as *better, newer, cheaper, more nutritious*;
- Unreferenced pronouns such as *they, them, we*;
- Unspecified groups such as *teachers, parents, things*; and
- Assumed rules or traditions including *ought, should,* or *must.*

Critical thinkers are characterized by their ability to use specific terminology, to refrain from overgeneralization, and to support their assumptions with valid data (Ennis 1985) (Figure 5).

FIGURE 5

Avoiding Generalizations

When You Hear:	Say:
"He *never* listens to me."	"Never? Never, ever?"
"*Everybody* has one."	"Everybody? Who, exactly."
"*Things* go better with . . ."	"Which things, specifically?"
"Things *go* better with . . ."	"Go? GO-HOW, specifically?"
"Things go *better* with . . ."	"Better than what?"
"You *shouldn't* do that . . ."	"What would happen if you did?"
"The *parents* . . ."	"Which parents?"
"I want them to *understand* . . ."	"What exactly will they be doing if they understand"?
"This cereal is *more nutritious*."	"More nutritious than what?"
"*They* won't let me . . ."	"Who are they?"
"*The administrators* . . ."	"Which administrators?"

Developing Metacognition

Thinking about thinking begets more thinking (Costa 1984). When teachers ask children to describe the thought processes they are using, the data they need, and the plans they are formulating, students learn to think about their own thinking—to metacogitate. WhimbeyWhimbey, Arthur (1985) refers to this as "talk aloud problem solving" (Figure 6).

As teachers require students to describe what's going on "inside their heads," students become aware of their thinking processes. Similarly, as they listen to their classmates describing their metacognitive processes, they develop flexibility of thought and an appreciation for the variety of ways to solve the same problem. Teachers, too, may share their thinking by making their inner dialogue external. Verbalizing questions they are asking themselves about ways to solve problems and sharing their lessons plans and how they check their own accuracy are ways teachers can model their metacognitive processes to students.

Analyzing the Logic of Language

Effective thinking can be fostered by having students analyze the logic implied by linguistic expressions. Certain

ERIC

FIGURE 6

Thinking about Thinking

When Children Say:	Teachers Say:
"The answer is 43 pounds, 7 ounces."	"Describe the steps you took to arrive at that answer."
"I don't know how to solve this problem."	"What can you do to get started?"
"I'm ready to begin."	"Describe your plan of action."
"We're memorizing our poems."	"What do you do when you memorize?"
"I like the large one best."	"What criteria are you using to make your choice?"
"I'm finished."	"How do you know you're correct?"

words and phrases—linguistic cues—indicate logical relationships between ideas (Figure 7).

By examining these linguistic cues (*and, or, but, after, because*), students can learn to identify related ideas in a sentence between the ideas (*addition, comparison, contrast, sequence,* or *causality*).

How to Grow Intelligent Behavior

Teaching students to be alert to the cognitive processes embedded in written and spoken language can help them become aware of their own language and thought. It can help them decode the syntactic, semantic, and rhetorical signals found in all languages; and it can help them integrate the complex interaction of language, thought, and action (Marzano and Hutchins 1985). By asking questions, selecting terms, clarifying ideas and processes, providing data, and withholding value judgments, teachers can stimulate and enhance the thinking of their students.

REFERENCES

Bailis, R., and M. Hunter. (August 1985). "Do Your Words Get Them To Think?" *Learning* 14, 1.

Beyer, B. (1985). "Practical Strategies for the Direct Teaching of Thinking Skills." In *Developing Minds: A Resource Book for Teaching Thinking*, edited by A. L. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Burger, H. G. (1977). "Panculture: A Hominization-Derived Processed Taxonomy from Murdock's Universal Basics." In *The Concept and Dynamics of Culture*, edited by B. Bernardi. Netherlands: The Hague.

Condon, J. C. (1968). *Semantics and Communication*. New York: MacMillan.

Costa, A. (November 1984). "Mediating the Metacognitive." *Educational Leadership* 42, 3: 57–62.

Ennis, R. (1985). "Goals for a Critical Thinking Curriculum." In *Developing Minds: A Resource Book for Teaching Thinking*, edited by A. L. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

Feuerstein, R. (1980). *Instructional Enrichment*. Baltimore, Md.: University Park Press.

Green, J. L., and D. C. Smith. (February 1982). "Teaching and Learning: A Linguistic Perspective." Paper presented at the Conference on Research on Teaching: Implications for Practice, Warrenton, Va.

Laborde, G. (1984). *Influencing with Integrity*. Palo Alto, Calif.: Syntony Press.

Marzano, R., and C. L. Hutchins. (1985). *Thinking Skills: A Conceptual Framework*. Aurora, Colo.: Mid-Continent Regional Educational Laboratory.

Parelius, R. J. (1980). *Faculty Cultures and Instructional Practices*. New Brunswick, N.J.: Rutgers University Press.

Purkey, S. C., and M. S. Smith. (1982). *Effective Schools: A Review*. Madison, Wis.: Wisconsin Center for Educational Research, University of Wisconsin.

Whimbey, A. (1985). "Test Results from Teaching Thinking." In *Developing Minds: A Resource Book for Teaching Thinking*, edited by A. L. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

FIGURE 7

Linguistic Cues

Relationship	Description	Example of Linguistic Cue
Addition	Two ideas go together in some way.	"He is intelligent *and* he is kind."
Comparison	Common attributes are shared.	"Shawn *and* Sarah *both* play the violin.
Contrast	Two ideas don't go together.	"He is healthy, *but* he doesn't exercise."
Sequence	One event happens before, during, or after another event.	"He is healthy, *but* he doesn't exercise." "He went home, *then* he went to the library, checked out some books, and returned to school."
Causality	One event occurs as a result of another.	"*Since* no one was home, he went to the gym."

45

A Strategy to Support Metacognitive Processing

Gwen Fountain and Esther Fusco

Developing students' *metacognition*, or awareness and control of their own thinking processes, is a critical component of integrating thinking into the classroom. Metacognition involves students' actively assembling, coordinating, integrating, monitoring, and evaluating knowledge as they learn it (Flavell 1979; Brown 1978; Paris, Jacobs, and Cross 1987). Successful students seem to instinctively reflect on and regulate their learning, although they usually don't know why they do it or how it helps them. Less successful students seem almost unaware of the "little voice in their head" and how they can use it to help themselves learn. Thus, we began to devise strategies that we could use to help all students develop this awareness and control over their own thought processes.

As elementary and college teachers, we had successfully used questioning as a teaching strategy in our classrooms. We therefore decided to think about questions students might ask themselves while processing information. In essence, we were attempting to create not only an awareness of the process of thinking, but also a method that students could use to control this process (Lawson 1984; Peterson and Swing 1983). As we developed and used questions in our classrooms, we began to see changes in the ways that students approached their learning tasks. For example, one student wrote that

> these are wonderful questions [to use] in thinking out a decision or problem. . . . By having steps to go through in solving a problem, it makes it a lot easier to work out. . . . These questions can be helpful in everyday life and problem solving on the job. I am glad I have learned them so that I will have them not only to help me now, but also later on.

The students enjoyed using these "executive control processes" (Belmont, Butterfield, and Ferretti 1982; Brown 1985) and found them to be a helpful means of structuring their learning.

The use of generalized questions or steps to structure student learning has been proposed often in the literature on metacognition (Sternberg 1983; Butterfield, Wambold, and Belmont 1973; Markham 1985; Meichenbaum 1985; Beyer 1987). In fact, Brown (1978) advocates training for

> metacognitive skills which could have broad generality across a variety of problem-solving situations. . . . Perhaps it would be possible to train the child to stop and think before attempting a problem, to ask questions of himself and others to determine if he recognizes the problem, to ask questions of himself and check his solutions . . . and to monitor his attempts to learn to determine if they are working or are worth the effort (p. 139).

Meichenbaum (1985, p. 412) makes similar suggestions in his review of cognitive-behavior studies when he notes the importance of instructing children in self-management strategies.

With these ideas in mind, we designed a series of questions that would support metacognitive processing at any grade level, kindergarten through college; we also tried to identify the subset of metacognitive processes used in each question, as shown in Figure 1.

In developing these questions, we drew from our own experiences in supporting students' thinking in classrooms, from strategies used in problem solving (Brightman 1980; Wales and Stager 1977; Bransford and Stein 1984), and from the writing process (Graves 1984; Burtis, Bereiter, Scardamalia, and Tetroe 1981; Collins and Gentner 1980). These questions also incorporate Costa's (1984) notion of tasks having *before* (questions 1–4), *during* (questions 5 and 6), and *after* (questions 7–9) components. Additionally, the questions stimulate the use of such skills as information

ERIC

FIGURE 1

QUESTION	PROCESS
1. What am I doing?	1. Create a focus (access short-term memory)
2. Why am I doing it?	2. Establish a purpose
3. Why is it important?	3. Create reason(s) for doing it.
4. How/Where does it fit in with what I already know?	4. Recognize appropriate context or interrelationships or analogous situations (connect into long-term memory).
5. What questions do I have?	5. Discover what is still unknown.
6. Do I need a specific plan to understand or learn about this?	6. Design a possible structure or method of approaching the topic.
7. How can I use this information in other areas of my life?	7. Consider application to other situations (further connect into long-term memory).
8. How effective have I been in this process?	8. Evaluate progress.
9. Do I need to do more?	9. Monitor need for further action.

gathering, organizing, remembering, and generating (questions 5 and 6); and analyzing, integrating, and evaluating (questions 7–9). According to experts (Marzano, Brandt, Hughes, Jones, Presseisen, Rankin, and Suhor 1988; Beyer 1987), these skills are part of the overall "dimensions of thinking" and are among the core thinking skills needed by students.

Our questions work because they create both an affective (motivational involvement) and a cognitive structure for students' learning (Bandura 1977, 1978; Piaget 1962; Zimmerman 1981). As students begin to use the questions, they become more actively involved in, and responsible for, their learning. It's likely, then, that students are attending to knowledge in short-term memory. And our design of the process component of this system motivates students to look at their learning in a contextual framework, which furthers the possibility that students may more effectively store knowledge in long-term memory for later retrieval (Marzano et al. 1988; Kirby 1984).

For example, suppose a student is using the metacognitive questions as she reads over a passage. She begins by asking, "What am I doing?" This act creates a focus for the reading. As she reads, she establishes a purpose and creates a reason for reading by asking, "Why am I reading this?" and "Why is it important?" This monitoring gives her the opportunity to grasp the essence of the reading and enables her to assemble and coordinate the inferential, as well as the factual, information in order to comprehend the passage in a more complete manner.

The range and sequence of the metacognitive questions allow students to construct a plan for moving from the simple to the complex, creating a structure that can be used to build the interconnection of concepts. For example, answering questions 4–8 can help students transfer information across a range of topics, thus increasing the probability that they will retain what they learn in a specific context.

We found that monitoring students as they practiced these specific strategies enhanced their use of the questions and their retention of both the questions and the content with which they were used. Brown and Palincsar (1987) also found this to be true, as did Borkowski (1985) and Belmont, Butterfield, and Ferretti (1982).

As we taught students the metacognitive questions, we discovered that the questions needed to be tempered by a developmental perspective so that students could reflect more successfully. (This is consistent with the work of Beyer (1987); Borckowski (1985); Brown (1978); Case 1985; Siegler and Klahr 1982; and Peterson and Swing 1983.) Thus, in kindergarten, 1st grade, and 2nd grade, students ask themselves, "What am I doing?" and "Why am I doing it?"; in 3rd grade, the questions expand, and students ask, "Why is it important?" We believe that by grades 7–9, students should be asking themselves all nine questions.

The use of all nine questions with 18-year-olds promoted more effective learning. One of our students wrote in her journal:

> Before I never thought about having a routine or series of steps to help in problem solving. The questions are a great idea. They make you think about every aspect of a problem, which in turn, makes the problem easier to solve.

When the metacognitive questions are introduced in a meaningful way, in a logical order, and at a developmentally appropriate time, they strengthen students' ability to be reflective monitors of their thinking processes. Use of the questions also assists teachers in strengthening their monitoring ability. An elementary teacher noted:

> I think about the individuals I have in my class and I assess their developmental levels. Knowing their level compels me to also stop and think, "What am I teaching and why am I teaching it?"

We have used these questions in two distinct settings. In one instance, the process was introduced as part of a schoolwide program called "Stop and Think" (Fusco and Kiebler in press). Elementary students were asked to stop, wait, and reflect on the questions "What am I doing?" and "Why am I doing it?" The questions were asked in all settings of the school in both academic and nonacademic (playground, lunchroom, etc.) environments. The students' questioning strategies were reinforced by teachers modeling both examples of the process and strategies for generating answers. Since the process pervaded the school environment, most students stopped, thought, and answered the questions as they confronted problematic situations during their school day. Teachers, administrators, and other students provided continual reinforcement.

Almost all students answered the questions with prompting, most did so when met with silence, and many seemed to have internalized the questions as part of their personal repertoire. Teachers, parents, and visitors to the school reported that these activities led to less impulsivity, more child-to-child problem-solving intervention, and a more thoughtful school environment in which children feel more in control of their learning and their lives. This change is more clearly illustrated by a 1st grade teacher's reaction when asked, "In observing our children, what differences do you notice now that we use wait time?" The teacher stated:

> The children take more time to think before taking action and tend to show more care and concern for their peers when they are sharing. Children also show more responsibility for their thoughts and actions.

With groups of older students, the results have been somewhat less dramatic, though still very positive. The shorter length of intervention, the less pervasive nature of the intervention, the lower consistency of intervention, the real or feigned sophistication of the students (Schoenfeld 1979), and the greater complexity of using all the questions may have led to the difference in results (Meichenbaum 1985).

The primary interventions thus far have taken place over one semester in two classes of college freshmen and one class of junior and senior college students. All nine questions were used at both levels as a part of thinking about the content of two different courses. The questions were introduced, referred to during the semester, and modeled by the teacher when confronted with complex questions in class. The teacher also organized lessons and assignments around the structure of the questions, although this organizational structure was not always pointed out to the students. In the college freshmen classes, strategies were articulated and tied to the use of the questions, and this seemed to help students apply the questions more effectively. Some students seemed to have difficulty in using such an ordered "structure" of questions and used only a few questions in varying contexts (according to Meichenbaum, this should be both expected and encouraged). Because of the evolutionary nature of these first attempts at using the questions, we can hypothesize that these difficulties could be due to differences in learning preferences or ways of knowing (Butler 1986; Briggs-Meyers 1980; Belenky, Clinchy, Goldberger, and Tarule 1986), levels of cognitive development (Perry 1970; Belenky et al. 1986), difficulties in transfer (Perkins and Solomon 1988), or the presence of other preferred and useful strategies (Schoenfeld 1979; Peterson and Swing 1983).

In any event, our results have encouraged us to continue using and refining these questions. Students appear to be more motivated and now take more active responsibility for their learning. The metacognitive questions help them control and structure their thinking processes, so that they see learning as a series of related concepts rather than isolated pieces of information. Both the structuring of their approach to learning and the interconnecting of concepts seem to help students learn more effectively and better retain what they have learned.

Bibliography

Bandura, A. (1978). "The Self System in Reciprocal Determinism," *American Psychologist* 33: 344–358.

Bandura, A. (1977). *Social Learning Theory*. Englewood Cliffs, N.J.: Prentice-Hall.

Belenky, M. F., B. M. Clinchy, N. R. Goldberger, and J. M. Tarule. (1986). *Women's Ways of Knowing*. New York: Basic Books.

Belmont, J., E. Butterfield, and R. Ferretti. (1982). "To Secure Transfer of Training, Instruction, and Self-Management Skills." In *How and How Much Can Intelligence Be Increased*, edited by D. K. Detterman and R. J. Sternberg. pp. 147–154.

Beyer, B. K. (1987). *Practical Strategies for the Teaching of Thinking*. Boston Mass.: Allyn and Bacon.

Borkowski, J. G. (1985). "Signs of Intelligence: Strategy Generalization and Metacognition." In *The Growth of Reflection in Children*, edited by S. R. Yussen. Madison: University of Wisconsin Press, Academic Press.

Bransford, J. D., and B. S. Stein. (1984). *The IDEAL Problem Solver*. New York: Freeman.

Briggs-Meyers, I. (1980). *Gifts Differing*. Palo Alto, Calif.: Consulting Psychologists Press.

Brightman, H. J. (1980). *Problem Solving: A Logical and Creative Approach*. Atlanta: Georgia State University, College of Business Administration, Business Publishing Division.

Brown, A. L. (1985). "Mental Orthopedics, Training Cognitive Skills: An Interview with Alfred Binet." In *Thinking and Learning Skills, Volume II: Research and Open Questions*, edited by J. W. Segal, S. Chipman, and R. Glaser. Hillsdale, N.J.: Erlbaum.

Brown, A. L. (1978). "Knowing When, Where, and How to Remember: A Problem in Metacognition." In *Advances in Instructional Psychology*, edited by R. Glaser. Hillsdale, N.J.: Erlbaum.

Brown, A. L. (1974). "The Role of Strategic Behavior in Retardate Memory." In *International Review of Research in Mental Retardation*, Vol. 1, edited by N. R. Ellis. New York: Academic Press.

Brown, A. L., and A. S. Palincsar. (1987). "A Natural History of One Program for Enhancing Learning." In *Intelligence and Exceptionality: New Directions for Theory, Assessment and Instructional Practices*, edited by J. D. Day and J. G. Borkowski. Norwood, N.J.: Ablex.

Butler, K. (1986). *Learning and Teaching Style: In Theory and In Practice.* Maynard, Mass.: Gabriel Systems.

Burtis, P. J., C. Bereiter, M. Scardamalia, and J. Tetroe. (1981). "The Development of Planning in Writing." In *Explorations in the Development of Writing*, edited by G. Wells and B. M. Kroll. New York: Plenum.

Butterfield, E., C. Wambold, and J. Belmont. (March 1973). "On the Theory and Practice of Improving Short-Term Memory." *American Journal of Mental Deficiency* 77, 5: 654–669.

Case, R. (1985). "A Developmentally Based Approach to the Problem of Instructional Design." In *Thinking and Learning Skills, Volume II: Research and Open Questions*, edited by J. W. Segal, S. Chipman, and R. Glaser. Hillsdale, N.J.: Erlbaum.

Collins, A., and D. Gentner. (1980). "A Framework for a Cognitive Theory of Writing." In *Cognitive Processes in Writing*, edited by W. Gregg and E. Steinberg. Hillsdale, N.J.: Erlbaum.

Costa, A. L. (November 1984). "Mediating the Metacognitive." *Educational Leadership* 42, 3: 57–67.

Flavell, J. H. (1979). "Metacognitive Aspects of Problem Solving." In *The Nature of Intelligence*, edited by L. Resnick. Hillsdale, N.J.: Erlbaum.

Fusco, E., and D. Kiebler. (In press). "Overcoming Classroom Isolation."

Graves, D. H. (1984). *A Researcher Learns to Write.* Portsmouth, N.H.: Heinemann Educational Books.

Kirby, J. R. (1984). "Educational Roles of Cognitive Plans and Strategies." In *Cognitive Strategies and Educational Performance*, edited by J. Kirby. New York: Academic Press.

Lawson, M. J. (1984). "Being Executive About Metacognition." In *Cognitive Strategies and Educational Performance*, edited by J. R. Kirby. New York: Academic Press.

Markham, E. M. (1985). "Comprehension Monitoring: Developmental and Educational Issues." In *Thinking and Learning Skills, Volume II: Research and Open Questions*, edited by J. W. Segal, S. Chipman, and R. Glaser. Hillsdale, N.J.: Erlbaum.

Marzano, R. J., R. S. Brandt, C. S. Hughes, B. F. Jones, B. Z. Presseisen, S. C. Rankin, and C. Suhor. (1988). *Dimensions of Thinking: A Framework for Curriculum and Instruction.* Alexandria, Va.: Association for Supervision and Curriculum Development.

Meichenbaum, D. (1985). "Teaching Thinking: A Cognitive-Behavioral Perspective." In *Thinking and Learning Skills, Volume II: Research and Open Questions*, edited by J. W. Segal, S. Chipman, and R. Glaser. Hillsdale, N.J.: Erlbaum.

Meichenbaum, D., S. Burland, C. Gruson, and R. Cameron. (1985). "Metacognitive Assessment." In *The Growth of Reflection in Children*, edited by Y. Tassen. New York: Academic Press.

Paris, S., J. E. Jacobs, and D. R. Cross. (1987). "Toward an Individualistic Psychology of Exceptional Children." In *Intelligence and Exceptionality: New Directions for Theory, Assessment, and Instructional Practice*, edited by J. D. Day and J. G. Borkowski. Norwood, N.J.: Ablex.

Perkins, D. N., and G. Solomon. (September 1988). "Teaching for Transfer." *Educational Leadership* 46, 1: 22–32.

Perry, W. G. (1970). *Forms of Intellectual and Ethical Development in the College Years: A Scheme.* New York: Holt, Rinehart and Winston.

Peterson, P. L., and S. R. Swing. (1983). "Problems in Classroom Implementation of Cognitive Strategy Instruction." In *Cognitive Strategy Research*, edited by M. Pressley and J. R. Levin. New York: Springer-Verlag.

Piaget, J. (1962). "The Relation of Affectivity to Intelligence in the Mental Development of the Child." *Bulletin of Menniger Clinic* 26: 129–137.

Schoenfeld, A. H. (May 1979). "Explicit Heuristic Training as a Variable in Problem-Solving Performance," *Journal for Research in Mathematics Education* 10, 3: 173–187.

Siegler, R. S., and D. Klahr. (1982). "When Do Children Learn the Relationship Between Existing Knowledge and the Acquisition of New Knowledge?" In *Advances in Instructional Psychology*, Vol. 2, edited by R. Glaser. Hillsdale, N.J.: Erlbaum.

Sternberg, R. J. (1983). "Components of Human Intelligence." *Cognition* 15: 1–48.

Wales, C. E., and R. A. Stager. (1977). *Guided Design.* Morgantown: Center for Guided Design, West Virginia University.

Zimmermann, B. J. (1981). "Social Learning Theory and Cognitive Constructivism." In *New Directions in Piagetian Theory and Practice*, edited by J. E. Sigel, D. M. Brodzinsky, and R. M. Golinkoff. Hillsdale, N.J.: Erlbaum.

46

Learning Dramas: An Alternative Curricular Approach to Using Computers with At-Risk Students

Stanley Pogrow

You cannot teach a man anything, you can only help him find it within himself.

—Galileo

Are you beginning to have second thoughts about your investment in computers—particularly if you purchased them in the hope that they would significantly enhance the learning of at-risk students? Now that the initial euphoria is over for you and the students, are you seeing a substantial change in the quality of their work? Have they become sophisticated learners? Now that they have word processed, have they become good writers? Is the stuff starting to look like expensive worksheets? Has the expenditure significantly lessened the at-risk problem in your school or district?

While some are having success with using computers, many concerns are well founded. Research is finding that conventional computer use has little overall effect with at-risk students beyond the 3rd grade, and may even widen learning gaps.[1] Indeed, the at-risk problem has substantially increased over the past decade while educators have spent hundreds of millions of dollars on computers. Seven years ago I started out to develop a more effective approach to using computers with at-risk students—particularly during the critical years of grades 4–7. The result is a new curricular approach that combines two of the oldest pedagogical traditions—Socratic dialogue and drama—with the newest forms of technology and learning theory. The techniques that emerged for using computers with at-risk students are the opposite of conventional approaches and have been demonstrated on a large scale to be very effective.

The Conventional Curricular Approach to Using Computers

Conventional approaches to using software rely on its explicit goal to produce learning. For example, if we were teaching students the concept of "average," we would use software explicitly designed to provide practice in that instructional goal. Such software would be expected to independently increase the students' knowledge of calculating and using averages. The only curricular concern would be to coordinate the use of that software with the learning objective of the school's content. This is usually referred to as integrating computers into the curriculum.

This chapter is adapted from Stanley Pogrow, "Learning Dramas: An Alternative Curricular Approach to Using Computers with At-Risk Students," in *Technology in Today's Schools*, ed. Cynthia Warger (Alexandria, Va.: Association for Supervision and Curriculum Development, 1990), pp. 103–118.

Using software with the explicit goal of teaching content is most commonly referred to as "computer-assisted instruction" or CAI. While CAI is usually associated with drill and practice, the new computer tools, such as word processors, spreadsheets, and simulations generally end up being used as CAI because the goal of the software is expected to produce learning.[2] Word processors are expected to increase students' writing ability, and a simulation of chemical titration is expected to enhance students' knowledge of the specific chemical reactions that are modeled. Learning is presumed to occur when students successfully use the software.

This belief has so dominated the use of computers since their inception that there are virtually no articles on alternative curricular approaches to using them. If computers can enhance learning by simply integrating software into the curriculum, there's no need or incentive to rework the curriculum or change instructional or curricular approaches. Unfortunately, integrating literal uses of software into the curriculum has generally failed to help at-risk students except at the earliest grade levels.

One of the problems with relying on the explicit goal of software with at-risk students is that the approach is simply not practical. Matching software goals to the ever-increasing number of curricular objectives, and negotiating with all the different vendors, is a logistical nightmare. The more objectives that students need help with, the worse the logistics. The second problem is that CAI incorrectly assumes that the fundamental learning problem of at-risk students is that they have not internalized concepts because they simply haven't had enough practice using them, or that the practice provided is too boring to have an effect. CAI also assumes—again, incorrectly—that providing additional computer-based practice increases chances that the concepts will be internalized.

Brown (1982) concludes that the primary cause of learning problems of at-risk students is inadequate metacognition skills. (A simple definition of metacognition is the ability to consciously apply and test strategies when solving problems and engaging in normal thinking activities such as reading comprehension.) My own conclusion is that an additional key problem is that at-risk students do not understand "understanding." They have no idea how to think about the types of ideas used in school. They do not even seem to know what it means to understand something that involves the use of symbols (Pogrow 1990a). Thus, CAI solves the wrong problem. Simply practicing a problem more efficiently on a computer screen is not going to help students with metacognition and understanding deficits. Students who do not read books with comprehension, and who do not spontaneously metacognize about what they are reading with regular text, will not do so with text presented on a computer screen. Curricular approaches that depend on the literal goal of software cannot help with these problems. CAI can only help those students who already spontaneously construct linkages and understandings—those students who are already performing well. As such, conventional uses of computers, whether for drill and practice or for word processing, will only widen learning gaps.

A Learning Drama Approach to Using Software

The result of my work to develop the thinking and understanding skills of at-risk students is a curricular program called Higher-Order Thinking Skills (HOTS), which combines the use of software, Socratic dialogue, and dramatic techniques in ways suggested by information processing theories of learning. The resulting techniques are called "learning dramas." These techniques have been demonstrated to produce larger gains than remedial approaches with Chapter 1 students in grades 4–7. The results were validated by the review panel for the Federal National Diffusion Networks.

Definition of Learning Dramas

The five key characteristics of learning dramas are:

1. Instead of being taught concepts from software, students learn indirectly from special conversations about *learning to use* the software. The explicit goal of the software has nothing to do with what is taught or learned.

2. There is virtually no discussion of technical issues about how to use software. Students are expected to figure that out on their own from textual clues. Discussions focus on ideas designed to develop key thinking skills.

3. Dramatic techniques are used in the lessons to heighten the students' curiosity and motivation.

4. Teachers are trained in how to systematically probe students' answers in a Socratic manner to produce understanding.

5. Thinking is not "taught." Rather, it evolves from extensive, consistent patterns of interaction about ideas.

In learning dramas, the explicit goal of the software is viewed only as a student motivator, an interesting goal for students to achieve. Learning comes from Socratic conversations around other aspects of the software. Words and concepts in the menus and instructions on the screen provide opportunities to invent questions that enable students to practice key thinking activities, regardless of whether such questions help students achieve the goal of the software. These are called "invented" or "incidental" questions.

Specific content objectives are built indirectly into these discussions. Situations are created in which it is important to talk about the content concept as a means to an end. Suppose, for example, you wanted students to learn the concept of average. Instead of using software designed to teach averages (a CAI approach), a learning drama approach would find a piece of software that would be of interest to the students, and around which a situation could be invented that would require the use of averages. Any problem that produces a numerical score and requires the use of a strategy can be used. The learning drama scenario goes like this:

The teacher tells the students: "In the game we played yesterday you got some very good scores, but also some poor ones. That means that you were guessing. If, on the other hand, you have a good strategy you will get good *overall* scores." Students play the game a few times, and then the teacher says: "An 'average' tells you how good your *overall* score is and, therefore, how good your strategy is." The teacher then quickly shows students how to calculate an average, and has students go back to playing the game. Thereafter, the teacher discusses with students whether their averages are improving, and what strategies they are using to get better averages.

Tying the concept of "average" to an interesting problem-solving activity using software intended to "teach" something else produces greater understanding and retention with just a small amount of discussion than continued CAI practice with software whose explicit goal is to teach the concept of "average." In addition, as students read clues and talk about their strategies, they practice reading comprehension and metacognition, which simultaneously develops their reading and thinking skills. Indeed, one of the surprising findings from the research is that you do not need to cover a great many objectives in this manner to enhance the learning of all content objectives in the classroom.

The Importance of the Conversations

To produce substantial learning, the invented conversations cannot be talk for the sake of talking or thinking for the sake of thinking. The conversations must consistently model key thinking skills. Information processing theory suggests focusing on the following thinking skills:

- *Metacognition*—consciously applying strategies to solve problems.
- *Inference from context*—figuring out unknown words and information from the surrounding information.
- *Decontextualization*—generalizing ideas from one context to another.
- *Information synthesis*—combining information from a variety of sources and identifying the key pieces of information needed to solve a problem.

While the terminology sounds intimidating, learning dramas turn these skills into fun for both the students and the teacher. *Metacognition* is taught by asking students what strategy they used for solving a problem, how they know the strategy is a good one, what strategies they found that did not work, how they could tell if a strategy did not work, and what a better strategy might be, and so on.

Inference from context is modeled in two ways. The first is to have students read a computerized twist-a-plot story that combines text with graphics and allows students to control the direction of the story. These dynamic features increase students' absorption of what they read on the screen, particularly if it is an interesting adventure story that will involve students in the suspense of finding the outcome. Teachers then heighten student involvement by introducing the setting in a dramatic fashion—such as warning the students that they will encounter many dangers in the story. The dramatic element builds a high level of engagement—a prerequisite for thinking.

The second technique involves words in key places that students do not understand. (It does not matter which words or whether the words are in the students' regular curriculum.) Students are told that every time they come to a word they do not understand, they should: (a) write down the sentence in which it appears, (b) circle the word, and (c) call the teacher over and make a guess about what the word means. The teacher lists the sentences the students have pulled out of the story on the board and asks them to explain what they think the circled words mean from the readings and pictures, and why. Students are also asked to compare their predictions about what twists the story will take with what actually happened.

The conversations begin and student answers are probed. These rich conversations model prediction comprehension processes that good readers spontaneously engage in and provide experience in information synthesis and metacognition, as well as in inference from context.

The second technique can be used around any piece of software where unknown or ambiguous words appear in the instructions. Teachers constantly ask students to figure out what the unknown words mean and what strategy they used for figuring it out. The visual clues make it easier initially for students to build up confidence in their inference skills. Inference then becomes a normal part of learning how to use any piece of software.

Decontextualization is also taught in two ways. In the first, the teacher uses words that appear on the computer screen that students are familiar with from their everyday experience. Students are then asked to make predictions about what the words are likely to do in the context of that program. For example, the graphics program *Dazzle Draw* has a menu choice called "Flood Fill." Students are asked to predict what will happen if they make that choice based on what they know about the word "flood." Students then go to the computers to test their predictions. ("Flood Fill" fills an area of the screen with a chosen color.)

The second technique involves discussing concepts with several different meanings as a theme across several different pieces of software. For example, the theme of "perspective" is discussed when flying a hot-air balloon, writing a story, and viewing a given situation. Students are asked about how the uses of the concept in the different programs are alike and different.

Information synthesis is done by creating situations where students have to use information from a variety of sources, or several different types of information, to solve a problem or develop a strategy. For example, in the program *Where in the World is Carmen San Diego* by Broderbund, students have to combine information from an almanac, dictionary, and the screen to solve a case.

Developing Curricular Materials

Curriculum is developed by taking a piece of software that will be of interest to students (games and adventure stories are always good), and inventing a series of questions that will provide experience in all of the above and link concepts to other pieces of software. In a very popular simulation called *Oregon Trail*, the explicit goal is for students to reach Oregon along the Old Oregon Trail, which pioneers used to travel from Independence, Missouri, to Oregon City, Oregon. They have to budget food and supplies appropriately in order to make it safely through a variety of problems that the computer throws at them, including attacks, bad weather, and floods.

The learning drama questions discussed by students are incidental to the goal of reaching Oregon. They are based on words or phrases in the instructions. The questions are asked to initiate discussions that provide experience in the four key thinking skills. The quality of discussions about the answers to these questions is far more important to the learning process than the quality, or successful use, of the software. Indeed, the newer, technologically jazzy version of *Oregon Trail* is not as good for learning dramas as the old, black and white classic version.[3] It is this focus on discussions around tangential questions, which model key thinking processes, that distinguishes learning dramas from conventional CAI.

While using technology expressly to create a setting around which to invent other types of learning seems counter-intuitive, the success of this approach has been demonstrated by John Bransford (1989) at Vanderbilt. Bransford used laserdisk technology to show a segment of Indiana Jones jumping across a pit (i.e., to set an interesting visual context that was familiar to students), followed by a discussion of the physical forces and mathematics that makes such an act possible. He found that using the visual setting provided by the technology to set the context for a follow-up discussion was a more effective way to teach math to at-risk students than using the technology to teach or present the concepts. Indeed, Bransford found that using technology indirectly to merely establish a context, which is the basis of learning dramas, was even more effective than one-on-one instruction.

Applying Dramatic Techniques

Learning dramas must, of course, be dramatic. The dramatic element is designed to engage and intrigue students. Teachers often wear costumes, tell jokes, and so forth. In addition, much as a good stage drama involves the audience in the situation and emotion of the story and characters, learning dramas are created to involve students emotionally in the tasks. Such emotion deepens the learning process. Every piece of software has unintended uses that a clever curriculum can develop into dramatic situations. For example, in the popular game program *Word Master*, students have to turn a pointer to match words quickly on the screen in order to win. A word on the bottom of the screen indicates the matching rule (i.e., synonyms, antonyms) The intended CAI use of the software is a vocabulary drill-and-practice program. In the HOTS curriculum, this software is used to teach the importance of understanding rules and using clues to determine what the rules are. The sequence of lessons works as follows:

On the first day, the teacher sets the program to match antonyms and points out the word antonym on the bottom of the screen. The students proceed to play the game and earn good scores. The next day, the students come in confident that they are going to get very high scores. The teacher, however, has switched the computers to synonym matches and does not tell the students. The students go to their computers and quickly become dismayed and start to complain that the machines are broken. Their natural certainty about how to master the environment quickly turns to feelings of outrage that the computers are not working. The teacher calmly explains that the computer is working perfectly, and if they think carefully, the information they need is available. When finally convinced that things are not going to work, they start to look at the screen carefully and notice that the word on the bottom is now "synonym." They then make the adjustment, get good scores, and feel proud of themselves. The next day, the teacher engages them in a conversation about the importance of words in understanding what the rules are and how developing strategies depends on first reading the available information carefully, or in the case of the classroom, listening to the information provided by the teacher. This is learning in the context of very high drama, with excitement turning to despair, then once again to excitement and joy.

After that day, the students are unlikely to forget about the importance of rules and are attentive during future discussions about rules. Letting students experience and discover on their own the importance of concepts in dramatic situations is more effective than lecturing.

Research has demonstrated that interaction about ideas in socially meaningful situations . critical to their internalization (Vygotsky 1978). Choreographing situations that generate passion about new ways to think about ideas leads to powerful forms of learning.

Of course, developing a curriculum in which students discover the need for a concept and become involved in figuring out how to manipulate it is far more difficult than simply telling them what to do. In learning dramas, the situations must be carefully choreographed.

Implementing Socratic Dialogue Techniques

At the heart of learning dramas are the conversations between teacher and student and among students. Even the best curriculum only provides the potential for appropriate forms of conversation to exist. While the curriculum provides the questions to initiate the conversations, the teacher's follow-up questions and reactions are even more critical. Teachers must react to student questions and answers in ways that maintain the types of ambiguities, probes, and clues that lead students to construct meaning on their own. If teachers do not question or respond to student answers appropriately, the most sophisticated curriculum and software become rote learning activities.

The most misunderstood concept about the use of technology with at-risk students is that *producing sophisticated learning is a function of the sophistication of conversation that surrounds the use of the technology—not the sophistication of the technology.* That was true of television, it is true of calculators and lab experiments (McPartland and Wu 1988), it is true of computers, and will be true of the next generation of shiny boxes—no matter how powerful or how many flashing lights they have.

A major emphasis of learning dramas is training teachers in Socratic dialogue techniques. Teachers have to learn how to be a guide rather than a provider of information, to listen to student answers in terms of understanding (rather than right or wrong answers), and to probe student responses to help students construct their own understanding.

Becoming skilled in engaging students in Socratic dialogue is not easy, even with good curriculum and a good system. Unfortunately, I cannot begin to describe in words why it is so difficult to listen for understanding and then to spark understanding with follow-up questions. Making an understanding connection between teacher and student is the most critical of all skills—and the least practiced in American education.

It takes a week of practice to train even good teachers to start to become Socratic. The training techniques are modeled after how actors and actresses learn to interpret their roles. Just as performers learn how to interact through practice readings, teachers spend a week teaching lessons from the HOTS curriculum to each other. Over the course of a week, each teacher encounters each of the key dialogue situations many times. At the end of each teaching session there is a debriefing as to whether the appropriate Socratic strategy was used. Tying the learning of the techniques to specific experiences is as important for teachers as it is for students.

The practice and feedback gained during training enable teachers to become metacognitive about their teaching; that is, they learn how to examine what they are doing and consciously reflect on the appropriateness of how they handle a given situation. The hardest situation to learn to deal with is when students give logically correct but unexpected and inconvenient answers. Although good teachers can effectively implement the techniques immediately, they report that it takes a year of monitoring themselves before the techniques become automatic. At the same time, student involvement in learning dramas produces widespread learning gains so that it is only necessary to train a core group of teachers in the Socratic techniques, a core that will at some point reach most students.

Why Are Learning Dramas So Effective?

I have suggested that you should spend extra money to buy computers, you should spend more money to buy software, and then you should use them both in ways that they were not intended to be used. Why go to all this expense when you will still have to go to the trouble of developing curriculum and training teachers in complicated pedagogical techniques? The justification is that the combination of curricular techniques and Socratic dialogue around technology has been demonstrated to be more effective with at-risk students than explicit uses of software or non-technology-based interventions.[4]

The question remains, however, as to why learning dramas work so well. Indeed, I was initially surprised that a set of techniques designed to develop thinking skills was producing gains on standardized test scores that doubled the national average for Chapter 1 students. How could such techniques produce substantial gains in content learning without extensive linkage to the curriculum or test?

After seven years of working with the techniques (there are now close to 25,000 students in the HOTS program) and talking to teachers and students, I have reached several conclusions that have general implications for curriculum development:

1. Learning dramas stimulate complex thinking processes much in the same manner as children learn to talk—by imitating adult actions. Social imitation is one of the most powerful forms of learning. Students will imitate the behaviors and actions of adults if they are consistently modeled in situations that students deem significant. By constantly modeling the processes that are critical to knowledge transfer and fundamental to content learning, learning dramas stimulate imitative behaviors. Indeed, some teachers report that students even imitate their hand gestures.

Teaching thinking strategies will not work since they will be viewed in isolation, as all the other content is. Rather, the act of thinking in a certain way must be experienced sufficiently in social situations of interest to the student that it becomes acculturated.

2. There appears to be no need to build extensive content objectives into the learning drama curriculum or to use integration or scope-and-sequence techniques. Providing extensive experience in applying some objectives in more sophisticated ways enables students to learn the other content objectives of the classroom far more effectively the first time they are taught. Once students understand what it means to link ideas, they seem to spontaneously construct the types of understandings that enable them to learn all content better.

3. Learning dramas simultaneously generate multiple types of learning.

4. Learning dramas need to be maintained over time in order for students to internalize the key thinking skills. The best approach with at-risk students in grades 4–7 seems to be to provide learning dramas in self-contained settings, 35 minutes a day for 2 years. Thereafter, students are able to benefit from learning dramas built into classroom content learning, and will benefit more from traditional curricular and CAI techniques. In other words, learning dramas enable students to eventually benefit from other good curricular approaches.

The learning drama curricular approach is very flexible but requires high levels of discipline and creativity. It can be adapted to meet many needs and incorporate new techniques. The HOTS curriculum designed for Chapter 1 students is also effective with gifted students—albeit at earlier grade levels.

Learning dramas can also be used to construct content courses, and thereby develop thinking-in-content skills. The HOTS project is currently developing a two-year thinking-in-mathematics course for the middle school. The goal is to extend the learning drama approach to the learning of traditional mathematics objectives. The course will use a completely different approach to mathematics, and will seek to increase content learning through problem solving. All activities will involve the four key thinking skills. In addition, all the activities will be organized around 4–10 key mathematical themes, such as proportional reasoning.

The HOTS project is also developing new software that enables students to create their own math problems if they are able to organize the language needed to express them. This will allow mathematical understanding to be derived from language comprehension.

The first year of the planned mathematics curriculum should be available for the Apple II GS by August 1991, and for IBM and Macintosh by July 1992. Schools can also extend learning dramas to other grade levels or content areas on their own. Specific curriculums and interaction procedures must be developed and learned. Developing original learning dramas requires: (a) a team of individuals to select the key thinking activities that are to be modeled, (b) selecting software to be used, and (c) writing the key questions that are to be used on a daily basis over a 1- to 2-year period to model the key thinking activities. A detailed guide is available to help districts with this process (Pogrow 1990b).

NOTES

[1]Research reviews of the effectiveness of CAI—such as Bangert-Drowns, Kulik, and Kulik (1985) and Niemiec and Walberg (1987)—find that the major effects from CAI have been demonstrated at the early elementary grade levels and then decline rapidly. Haller, Child, and Walberg (1988) found that metacognition (without technology) has twice the effect of CAI. Finally, Hativa (1988) found that when high- and low-performing students both use CAI, the technology widens learning gaps. Nor is there any evidence that word processing improves the writing of at-risk students.

[2]Most computer specialists will object to characterizing tools such as word processors as CAI because they go to great pains to distinguish their use from drill-and-practice applications. At the same time, there is no functional difference between how word processors tend to be used in schools and how drill-and-practice software is used. Both depend on the function of the software to produce learning.

In addition, the term "CAI" will be used even though many make fine distinctions between that and other terms such as "Computer-Based Education," or CBE, and "Tool Use." These and other terms used all share the same basic characteristic of primary reliance on the explicit goal of software.

[3]The new version of *Oregon Trail* is far more elaborate than the older version. It uses color graphics and provides many more decision-making situations. Unfortunately, its potential for metacognition is much lower since it takes an hour for students to find out if they have successfully reached Oregon as compared to ten minutes in the old version. Since metacognition requires students to speculate about whether a strategy did or did not work in terms of getting to Oregon, the new version is of little value. This

illustrates how advances in software can in fact be detrimental to the development of key thinking activities once those key activities have been identified.

[4]In the report to the National Diffusion Network, the results showed that HOTS students gained almost twice as much in reading and math as the national average for Chapter 1 students. Since that study was conducted, a newer version of the techniques has been developed, and sites are reporting gains that exceed those produced in the original study. In addition, when one teacher compared the use of the HOTS techniques against a commercial CAI drill-and-practice program in two of her groups, HOTS students did better in reading and math on the vendor's own test.

References

Bangert-Drowns, R., J. Kulik, and C. Kulik. (Summer 1985). "Effectiveness of Computer-Based Education In Secondary Schools." *Journal of Computer-Based Instruction* 12, 3: 59–68.

Bransford, J., et al. (1989). "Mathematical Thinking." In *Teaching for Evaluating Mathematical Problem-Solving*, edited by R. Charles and E. Silver. Reston, Va.: National Council of Teachers of Mathematics.

Brown, A. (April 1982). "Inducing Strategic Learning from Text by Means of Informed, Self-Control Training." *Topics in Learning and Learning Disabilities* 2, 1: 1–17.

Haller, E., D. Child, and H. Walberg. (December 1988). "Can Comprehension be Taught? A Quantitative Synthesis of 'Metacognitive' Studies." *Educational Researcher* 17, 9: 5–8.

Hativa, N. (Fall 1988). "Computer-Based Drill and Practice in Arithmetic: Widening the Gap Between High- and Low-Achieving Students." *American Educational Research Journal* 25, 3: 366–397.

McPartland, J., and S. Wu. (July 1988). "Instructional Practice in the Middle Grades: National Variations and Effects." Baltimore, Md.: Johns Hopkins University.

Niemiec, R., and H. Walberg. (1987). "The Comparative Effects of Computer-Assisted Instruction: A Synthesis of Reviews." *Journal of Educational Computing Research* 3, 1: 19–37.

Pogrow, S. (January 1990a). "Challenging At-Risk Students: Findings from the HOTS Program." *Phi Delta Kappan* 71, 5: 389–397.

Pogrow, S. (In press, October 1990b). *HOTS: A Validated Thinking Skills Approach to Using Computers with At-Risk Students*. New York: Scholastic.

Pogrow, S. (April 1988a). "Teaching Thinking to At-Risk Elementary Students." *Educational Leadership* 45, 7: 79–85.

Pogrow, S. (1988b). "The Computer Coverup." *Electronic Learning* 7, 7: 6–7.

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Boston, Mass.: Harvard University Press.

47

Expanding the Range, Dividing the Task: Educating the Human Brain in an Electronic Society

Robert Sylwester

Recent developments in both brain research and computer technology pose complex curricular issues. We are currently laboring hard to teach students many skills that small, readily available calculators and computers can process more efficiently and effectively. Rather than continue this traditional practice, we should base our curriculum decisions on an understanding of the brain's capabilities, limitations, and interests.

New technologies have always emerged out of the limitations and interests of the brain's sensory/motor and problem-solving mechanisms—narrowing the distance between what we can do and what we would like to do. Typewriters, telescopes, telephone books, and trigonometry are but four of the rich complex of technologies that we have developed to expand the brain's ability to gather/process/interpret/use information. Schools, though, lag far behind society in adopting new information technologies. For example, the typewriter has existed for well over a century, the word processor for about a quarter of a century. Although they've transformed written communication in our society, we've provided K–12 classrooms with few of them.

This chapter provides background information on five properties of the brain that are central to the issues of how best to divide educational tasks between minds and machines and how to create curriculums that will help students understand the complementary relationship between the brain and the supportive machines that human brains develop. I will argue that the curriculum should focus principally on knowledge/skills/values that (1) most characterize and enhance our brain's capabilities and (2) teach students how best to use appropriate technologies on tasks that characterize the brain's limitations.

To succinctly state the differences, the human brain is currently much better than computers at conceptualizing ambiguous problems—at identifying definitive and value-laden elements that it can incorporate into an acceptable general solution. Conversely, computers are much better at rapidly, accurately, and effectively processing complex sequences of clearly defined facts and processes that would otherwise require a high level of sustained mental attention and precision.

Or to state it in classroom terms, teaching is generally a delightful experience when we focus on activities that student brains enjoy doing, and do well—such as exploring concepts, creating metaphors, estimating and predicting, cooperating on group tasks, and discussing moral/ethical issues. Conversely, teaching loses much of its luster when we force students to do things their brains don't enjoy doing, and do poorly—such as reading textbooks that compress content, writing and rewriting reports, completing repetitive

This chapter, except for the list of selected readings, originally appeared in Robert Sylwester, "Expanding the Range, Dividing the Task: Educating the Human Brain in an Electronic Society," *Educational Leadership* 48, 2 (October 1990): 71–78.

worksheets, and memorizing facts they consider irrelevant. Now let's examine five key capabilities and limitations of the brain and the computer.

Rigid sensory/motor controls underscore human brain activity. They limit input and output to narrow ranges; and they limit our ability to make fine discriminations within those ranges—but our curiosity has led us to vigorously explore the universe beyond those limitations.

Sensory limitations/expansions. The information that our brains' specialized sensory receptors receive from the surrounding environment is somewhat meaningless initially—variations in temperature, touch, and air pressure, reflected light rays, and the chemical composition of air/water/food. Further, our sense organs function within relatively narrow ranges (e.g., 10 octaves of sound, about 30 odor-producing molecules, the narrow band of visible light in the broad electromagnetic spectrum).

It doesn't seem like much, but those variations are the source of all the external information that our brains transform into cognitive representations of the world. An exceptional sense of taste and smell can provide a wine taster with a vocation, and psychedelic drugs can briefly expand our sensory range—but we normally function within a narrow, genetically determined sensory range.

It makes sense. Our brains couldn't possibly process all the information that the surrounding molecules and vibrations carry. However, we've always been curious about what exists beyond our sensory range, and so we've developed such technological extensions as microscopes and telescopes, and oscilloscopes that transduce unhearable sounds into visible patterns.

Computers have materially broadened our knowledge of the universe by expanding the range and precision of such sensory technology. The curriculum should help students understand and master this technology. but it should also examine the social value of information that exists beyond the brain's limitations. For example, a computerized camera can now identify the winner in a race by differences of hundredths of a second, when our visual systems and less precise brains would have called it a dead heat. The curriculum should encourage students to ask: How important is such expensive accuracy to the human spirit, when a race is but a game? Does precise information become important to an imprecise brain simply because it's technologically available?

Motor limitations/expansions. Conscious and unconscious brain mechanisms operate our jointed motor system. This system is similarly limited in its range/speed/strength, but it can directly and technologically send information far beyond our immediate body ranges.

We've long engaged in competitions to discover the limits of our own movement capabilities. Some people devote their youth to such goals as trying to jump a fraction of an inch higher than anyone else. Further, mechanical and computerized technologies, such as cars and telephones, that materially increase the range and speed of human movement and communication seem almost to define our current culture and economy.

Our brain's motor system drives the communication skills that dominate the curriculum. Relatively complex brain mechanisms and muscle groups control the mouth and hand movements we use in interpersonal communication. Our voices are directed to hearing, and hand/finger movements primarily to vision (generally via paper). Both muscle groups are most efficient when they function automatically—when the conscious brain can focus on the content of the message rather than on the vehicle of expression.

Thus, we have long taught cursive writing because its automatic flowing nature permits writing speeds between 15 and 30 words a minute. But with much less instruction time, elementary students can learn to touch-type well beyond that speed, and in the years ahead, word processors with spelling checkers and superb editing capabilities will be readily available for any extended writing students will do.

This information suggests that we should phase out cursive writing as our principal technique for extended automatic writing. Rather, we should teach elementary students to compose stories/reports/letters directly on word processors and to use manuscript or cursive writing primarily for shorter notes and forms. Composing on a keyboard, like writing with a pencil, is an acquired skill. Its speed and rhythm are often more tuned to the speed of our thought processes than is cursive writing. Indeed, writing composed directly on a word processor tends to become conversational in style.

Developments in oral communication technologies further complicate this issue. In our increasingly oral society, one could ask how important it is to write fast when the telephone is even faster. Further, voice input/output capability in computers is also developing rapidly. Its advent will be a curricular boon for handicapped students, but it will also create curricular adjustments for those with normal proficiency in language. For example, clear diction and correct syntax will become more important when we speak into computers that require them than when we talk to people, whose brains can easily adapt to errors in speech and syntax.

Our brains can quickly identify potentially important incoming information—separating foreground from background information—and it can briefly hold elements of the foreground information in its short-term memory.

The brain is designed to merely monitor most of the low-contrast sensory information that flows into it (e.g., blank walls/single tones), but it automatically attends to high-contrast information (e.g., lines, edges, movement, oscillating sounds, a blast of cold air). For example, your brain is currently aware of the paper that constitutes this page (background), but it focuses its attention on the high-contrast lines that make up these words (foreground). Long before brain researchers discovered that the information in lines is sent into the brain with more strength than the information in solid areas, we humans had exploited this property by creating written languages that used combinations of lines on paper to represent words.

This initial automatic separation of foreground from background at the point of contrast certainly simplifies the critically important analysis task that follows within our brains. Our limited short-term memory buffer can briefly hold potentially important information from the current sensory field while we decide whether to attend to it further and/or store it in long-term memory. But we must decide quickly because the continual influx of new information will delete anything not consciously held.

Since short-term memory space is limited to perhaps a half dozen units of information at any one time, we must rapidly combine related bits of foreground information into single units by identifying similarities, differences, and patterns that can simplify and consolidate an otherwise confusing sensory field. The need to respond quickly has enhanced our ability and willingness to estimate, certainly one of our brain's major strengths.

Our conscious brain thus monitors the total sensory field while it simultaneously searches for and focuses on familiar/interesting/important elements—separating foreground from background. Even an infant can easily outperform an advanced computer in quickly recognizing its parents in a group of people. Extensive experience in a field develops these rapid editing skills to the expert level. Thus, the curriculum enhances this remarkable brain capability when it focuses on the development of classification and language skills that force students to quickly identify the most important elements in a larger unit of information.

The strong appeal of computerized video games may well lie in their lack of explicit directions to the players, who suddenly find themselves in complex electronic environments that challenge them to quickly identify and act on the important elements. Failure sends the player back to the beginning, and success brings a more complex (albeit attractive) challenge in the next electronic environment.

I watch in amazement as my 5-year-old grandson zips through the complexities of the electronic world that the Super Mario Brothers inhabit, and I wonder how eagerly he'll respond to the paper worksheets he'll shortly confront in kindergarten. Their directions will be clearly stated; their information will be static and uncomplicated; and, alas, their level of mental stimulation will generally be much lower.

We can't always mentally keep up with the rapid flow of information. Class notes and tape recorders testify to the limitations of our short-term memories to delay and hold the flow of complex experiences. Good class notes are active and selective and thus enhance the development of critically important rapid synthesizing skills. Conversely, a tape recorder passively stores everything the microphone picks up, and so it can reduce the stimulating mental pressure the listener would otherwise feel during the presentation to identify and write down the important elements immediately (without the security of instant replay via tape recorder).

Students need many opportunities to develop their short-term memory capabilities through experiences such as debates and games that require them to rapidly analyze complex information and briefly hold it. When textbooks and teachers highlight all the important information and software is too user-friendly, learning becomes more efficient, perhaps, but students also experience a reduction in the necessary challenge and enjoyment they get from continuously separating foreground information from background.

Our brains have a limited interest and attention span. We tend to focus on novel and intense information because of their strong contrast and emotional content, and we are stimulated by the successful completion of challenging tasks. Thus, the lack of contrast in routine and repetitive tasks bores us, and we do them inefficiently and ineffectively.

We have turned many of these tasks into low-paying service jobs and/or developed computerized machines to do them for us—and we can expect this trend to continue. For example, supermarket checkers who formerly responded mentally and rapidly to a cart full of groceries now merely run the items across a visual scanner. Many fast-food checkers now use cash registers that have replaced numbers with pictures of hamburgers/french fries/soft drinks on programmed price keys. Telephone operators who used to talk to the people who needed their help now activate voice synthesizers that provide computerized responses to common questions.

The long-term curricular and occupational implications of this development in computer technology will be disquieting unless we develop alternate challenging activities that enhance the estimating and pattern recognizing skills that contribute heavily to an effective short-term memory.

Our brains can store potentially useful information at multiple levels of long-term memory representation that successively reduce the role of emotion, context, and the conscious regulation of recall.

When important and potentially recurring events occur, our brains may develop representations of the object or experience within long-term memory assemblies, which are specialized networks of neurons that our brains alter to function as a unit during recognition or recall.

It's possible that sleep and relaxation enhance the physical altering of these synaptic connections, since they are periods of less potential interference from sensory/motor and problem- solving activity (think of detours during road repair). Some powerful emotion-laden memories develop almost immediately after a single event, while other (often less effective) memories may require much effort over many trials.

Since a memory is a neural representation of an object and/or event, it is often tied to the context in which it occurred, and emotionally important contexts create powerful memories. Objects and events that registered in several sensory modalities can be stored in several interrelated memory assemblies, and such memories become more accessible and powerful, since each sensory memory checks and extends the others.

Recognition is easier than recall, since recognition often occurs in the original (or a similar) context of the memory. If the emotional setting in which a memory originally occurred is tied to the memory, recreating the original emotional setting enhances the recall of the memory and related memories (e.g., family arguments tend to spark memories of prior related disagreements). Thus, emotional multisensory school activities such as games/role playing/simulations/arts experiences can create powerful memories.

Our brains process several interrelated types of memory systems. For example, *declarative long-term memories* are factual label-and-location memories—knowing the name of my computer, where it's located. They define named categories, and so are verbal/conscious. *Episodic* declarative memories are very personal—intimately tied to a specific episode or context (my first attempt to run my computer, my joy at discovering how it simplified writing). *Semantic* declarative memories are more abstract—symbolic and context-free. They can be used in many different settings and so are important in teaching for transfer (knowing how to use function keys and software). My semantic understanding of the typewriter and its keyboard simplified my moves from manual typewriter to electric typewriter to word processor.

Initial skill learning, such as learning to type, is often episodic—the memories contain both foreground and background elements of the experience. When I learned to type, my teacher/classroom/typewriter provided an important easily remembered emotional context during the initial learning period. It would have been inefficient for me to continue to recall all of these background elements whenever I typed, however, and so my teacher used class/home drills and different typewriters to help me eliminate the context of the learning (background) from the execution of the skill (foreground).

My typing knowledge and skill had thus become semantic—more abstract, but also more useful in a wide variety of keyboard settings and tasks (background). In effect, my brain erased the background information from my memory by reducing its frequency and significance, and thus strengthened the foreground information by focusing on it.

My typing speed was limited, however, by my continued simultaneous conscious spelling of words and activation of keys, and so I also had to eliminate this conscious behavior through a transfer of skills from semantic declarative memory to procedural memory—to master automatic touch typing.

Procedural long-term memories are automatic skill sequences—knowing how to touch type. They do not rely on conscious verbal recall (except to initiate/monitor/stop the extended movement sequence), and so they are fast and efficient. They are difficult to master and to forget. They are best developed through observation of experts, frequent practice, and continual feedback. As a skill develops, the number of actions processed as a single behavioral unit increases, and prerequisite skills are integrated into advanced skills.

Thus, when I was learning to type, I knew where all the keys were and I was slow. Today, I don't consciously know where any of the keys are, and I'm a fast, efficient typist. My fingers have now become an automatic extension of my brain's language mechanisms.

Our brain is most efficient at recalling and using episodic memories that have important personal meanings. It is much less efficient at mastering the important context-free semantic and procedural memories. That's why the curriculum has to spend so much time/energy on worksheet-type facts and skills that are isolated from specific contexts. Conversely, computers, reference books, and so on are very reliable with facts and procedures, but they lack the emotional context that make our value-laden episodic memories so rich.

This knowledge suggests that we should teach students how to solve problems by combining their brains' subjective episodic strengths and emotional integrity with the objective semantic and procedural strengths of the new information technologies. For example, my decision to develop this article evolved principally out of the rich context of my personal studies and experiences—but my writing of the article also drew heavily on the university library, my own reference library, my ability to select the ideas that best fit the focus of the article and to write them clearly, and the superior letter-formation and technical editing capabilities of my word processor/printer.

Students should not be overwhelmed by the power of computerized machines simply because the machines are fast and efficient. They need to realize that being able to do something efficiently isn't the same as knowing whether or not it should be done. Our generation has tended to reduce the discussion of the importance of a problem when we've developed an efficient technical solution to it. The curriculum must help the next generation to move beyond that tendency.

Our brains can solve problems at multiple decision points, but we seem oriented toward making early decisions with limited information.

The brain's problem-solving mechanisms appear to be located principally in the large frontal lobes, the part of the brain that matures last. We have more frontal lobe capacity than we normally need to survive, because our brain's problem-solving mechanisms must be sufficient for crisis conditions (just as furnaces must be able to function effectively on the coldest day of the year).

Since our survival doesn't require our problem-solving mechanisms to operate at capacity most of the time, we've invented social and cultural problems to keep them continually stimulated and alert. Games, the arts, and social organizations provide pleasant metaphoric settings that help to develop and maintain our brain's problem-solving mechanisms. They are not trivial activities, in life or in the curriculum. Jean Piaget's suggestion that play is the serious business of childhood attests to the important developmental and maintenance roles that such activities play in problem solving.

Our brain can rapidly process ambiguities/metaphors/abstractions/patterns/changes. It can quickly categorize 100 leaves as maple leaves even though no two of the leaves are identical, and it can recognize a classmate at a 25th reunion despite all the changes that occurred. This capacity permits us to succeed in a world in which most of the problems we confront require a quick general response rather than detailed accuracy. Thus, we quickly classify objects into general categories and estimate general solutions to our problems. We then adapt our preliminary decisions to any new information we might gather and use reference materials and machines to achieve further levels of precision, if they are necessary.

Our brains are better, therefore, at discovering conceptual relationships than at processing the accurate details that computers handle so well. We call it intuition, common sense—and we depend on it for much of what we do. It can lead to mistakes and to the overgeneralizations of stereotyping and prejudicial behavior—and also to music, art, drama, invention, and a host of other human experiences that open us to the broad exploration of our complex world.

Language itself evolved out of these capabilities/limitations. It's a response to our need to develop a simple sequential coding system that can rapidly represent a complex information system and thus simplify problem solving and the need to communicate that often accompanies it. Our language uses only about 50 sounds and 50 visual symbols (letters/punctuation marks/digits/math symbols) to create its vocabulary of half a million words. It does this by coding meaning into precise letter sequences and word lengths (do/dog/god/good) and not into the 100 sounds and symbols themselves. Verbal language is thus similar to our genetic language, whose DNA coding system also uses sequence and length to assemble combinations of 20 different amino acids into the vast number of protein molecules that join to form a living organism—a solved problem.

Thus, our imprecise brains have adapted the basic structure of an existing internal genetic code into a precise external verbal code (although Mark Twain once suggested that only an uncreative person can think of only one way to spell a word). Our language has become so complex because we continually add words all across the general-to-precise continuum—from the general term *car* to the more precise *sports coupe*, from *man* to *Robert Alfred Sylwester*.

We can anticipate that computer technology will further expand the basic properties of genetic/verbal languages into new forms of technological language. The curriculum should therefore expand from its current focus on merely teaching students how to use language correctly to a broader extent that also teaches them the fundamental nature of information and language.

The rapid development of precise computerized information suggests another change in curricular focus. We should concentrate more on developing students' ability to quickly locate/estimate/organize/interpret information, and we should teach them how to use the superior speed and accuracy of available information technologies whenever a complex problem requires an accurate solution. Hypercards, spread sheets, statistical programs, and spelling checkers are only a few examples of the rapidly developing software literature that can assist our imprecise brains to solve problems and communicate ideas with detailed accuracy.

Because these software programs eliminate problem-solving steps we formerly did mentally, we have a legitimate concern that students who learn how to solve a class of problems via such software won't understand important steps in the solution. It isn't enough to suggest that many people who drive cars don't understand the internal combustion engine. We must develop curriculums that effectively explain the complete solution process while teaching the student how to use a computer to solve the problem.

Most of the brain's development is adapted to the challenges of the environment in which we live, and a stimulating environment that includes much social interaction enhances this development.

The brain's principal activity is to change itself. Early brain development focuses on the stable, preprogrammed automatic mechanisms and processes that are dedicated to biological survival and to the smooth operation of the body and its movements (circulation/respiration/walking).

Childhood and adolescent development focus on environmentally dependent and adaptable neural networks that are dedicated to the learned exploration of the inner self and the external environment (language/memory/problem solving/ socialization skills). Most children are born capable of easily mastering any of the world's 3,000 languages, and American children must learn an average of almost a dozen new words a day to reach the normal vocabulary of a high school graduate.

A stimulating social environment enhances this later development, since our brains develop and alter many of their mechanisms in response to environmental challenges. Children reared or educated in a limited and boring environment will not develop the efficient broad-based brain mechanisms they'll need for effective behavior within a complex social environment. Interactions with other people seem to stimulate us more than anything else—and we have a marvelous capacity for love and commitment to one another.

Our mass culture cries out for cooperative learning and doing. Computers always function within human information networks, and so they can enhance or diminish our potential for cooperative behavior. Teachers can enhance this potential by asking students to collaborate on activities that incorporate computers, by discussing social issues that emerge out of computer use, and by emphasizing human values when information is processed electronically.

An interesting development has emerged in the schools' use of word processors. When students use a paper and pencil or a typewriter, classroom writing is essentially a solitary act because the writing can't be easily read by anyone other than the writer. With their upright, brightly lit screens, word processors make writing more of a public act in a classroom. That other students read/discuss/edit the text can enhance the collaborative activities that add context to acquired knowledge.

What is an appropriate stimulating environment for the developing brain of a contemporary child? Electronic information technologies can now create high-resolution graphic representations of real and imaginary worlds far beyond traditional verbal and visual representations, but they distort time, space, and reality in the process. Still, such things as instant replay, special effects, and computer joy sticks have become such an integral distortion of the real world that they are probably a necessary element in the education of students—whether we like it or not.

Our Curricular and Staff Development Challenges

We won't return to an earlier simpler world in which our brains had to do almost everything within themselves—with the sometime assistance of information stored in the increasingly complex and cumbersome print-oriented collection our society had amassed. We've now developed a class of powerful portable electronic machines that rapidly do the things our brains don't want to do—and don't do well. These technologies move our brain well beyond its normal range/speed/power. In doing so, they create a new set of problems about the value of the gain in relation to the effort and cost that our schools haven't faced before. Are things worth doing simply because we can do them?

Stress- and drug-related illnesses are part of the personal and social costs of educational and technological efforts to force our brains to function well beyond their normal capabilities—whether that be to require students to use paper and pencil to solve math problems they don't understand and consider irrelevant or to use an equally incomprehensible computer program.

Our profession must seriously examine the dramatic developments in cognitive science and computer technology. Doing so will enable us to identify and redesign the obsolete elements of our generation's version of The Saber-Tooth Curriculum, which because it had evolved into such an effective curriculum, continued to teach tiger-killing skills after all the tigers had been killed.[1]

This chapter has suggested a general approach—and explored it through five brain capabilities/limitations that relate to emerging curricular issues. Use this general introduction to focus your own thinking and to initiate discussions with colleagues that focus on your specific professional assignments. If our profession is going to move toward broadly accepted curricular policies and practices, however, we must engage in vigorous study that will move a critical mass of educators to a reasonable understanding of educationally significant developments in the cognitive sciences and to a hands-on understanding of new developments in computer technology. Join that critical mass.

NOTE

[1] H. Benjamin, (1939), *The Saber-Tooth Curriculum* (New York: McGraw-Hill).

SELECTED READINGS

Allman, W. (1989). *Apprentices of Wonder: Inside the Neural Network Revolution.* New York: Bantam.

Bloom, F., L. Hofstadter, and A. Lazerson. (1984). *Mind and Behavior.* New York: Freeman.

Changeaux, J. (1985). *Neuronal Man.* New York: Pantheon.

Churchland, P. S. (1986). *Neurophilosophy: Towards a Unified Science of Mind and Brain.* Boston: MIT Press.

Diamond, M. (1988). *Enriching Heredity: The Impact of the Environment on the Anatomy of the Brain.* New York: Free Press.

Friedman, S., K. Klivington, R. Peterson, eds. (1986). *The Brain, Cognition, and Education.* Orlando, Fla.: Academic Press.

Gazzaniga, M. (1988). *Mind Matters: How the Mind and Brain Interact to Create Our Conscious Lives.* Boston: Houghton-Mifflin.

Kent, E. (1981). *The Brains of Men and Machines.* New York: McGraw-Hill.

Minsky, M. (1986). *The Society of Mind.* New York: Simon and Schuster.

Sylwester, R. (April 1985). "Research on Memory: Major Discoveries, Major Educational Challenges." *Educational Leadership.* 42, 7: 69–75.

Sylwester, R. (September 1986). "Syntheses of Research on Brain Plasticity: The Classroom Environment and Curriculum Enrichment." *Educational Leadership.* 44, 1: 90–93.

PART VII
Teaching Strategies

From the discussion in Part III, it becomes obvious that a well-developed thinking skills program has many different goals. We want students to be able to work both independently and in groups, using a variety of thinking abilities, including creative, critical, and strategic, to solve problems historical and futuristic, analytical and intuitive, practical and hypothetical. We want students to employ scientific, aesthetic, social, physical, emotional, and even spiritual ways of knowing. And we want students to cultivate attitudes and dispositions, as well as develop simple skills and complex problem-solving strategies.

To achieve these goals, we need many and various ways and settings in which to engage students in learning. The accomplished teacher of thinking will command a range and repertoire of instructional strategies and techniques to help students develop many dimensions of thinking abilities.

A teaching strategy is a sequential pattern of instructional activities that is employed over time and is intended to achieve a desired student learning outcome. Incorporated within a teaching strategy are specific teaching skills such as questioning, communicating directions, structuring, and responding to students' answers. Within a teaching strategy, the teacher also employs a repertoire of instructional techniques, such as unique classroom arrangements and grouping patterns, ways of causing interaction, and various approaches to the use of instructional materials.

You will find, therefore, that the basic instructional skills described in Part VII—questioning, structuring, responding, and modeling—are present in each of the teaching strategies described. They are used, however, in differing amounts, sequences, and combinations, and for different purposes.

Generally, there are four distinct categories of teaching strategies:

Directive strategies help students acquire and retain important knowledge about thinking and provide practice of procedural thinking skills. Such strategies include drill and practice, mastery learning, and direct instruction. These strategies are particularly useful for the direct teaching of thinking skills.

Mediative strategies are intended to help students learn how to apply their knowledge to solve problems; make decisions; identify underlying assumptions; evaluate the adequacy of claims assumptions, conclusions, and propositions; and reason through ethical and moral disparities. The strategies cause the student to become aware of the metacognitive processes of problem solving.

Mediative strategies include dialectical reasoning, concept attainment, concept formation, inquiry, values awareness, and open-ended discussion.

Generative strategies help students know how to behave when the situation demands creativity, insightfulness, originality, inventiveness, and novel solutions to problems. Some examples are brainstorming, mind mapping, synectics, lateral thinking, and creativity by design.

Collaborative strategies are intended to help students learn the social skills necessary to think together and to solve problems as a member of a group. Some examples are cooperative learning, Student Teams–Achievement Divisions (STAD), Teams–Games–Tournaments (TGT), Jigsaw, pairs problem solving, and class meetings.

The distinguishing characteristics of these four categories are their differences in purposes, the varied roles in which the students and teacher are cast, and the human motivations to learn on which each strategy capitalizes. All four categories are discussed in this section.

48

Practical Strategies for the Direct Teaching of Thinking Skills

Barry K. Beyer

Many teachers today believe that they teach thinking skills. In most instances, however, what they actually do involve putting students into situations where they are simply made to think and expected to do it as best as they can. Most methods teachers customarily use to "teach" thinking are indirect, rather than direct (Cornbleth and Korth 1980, 1981). These methods are based on the questionable assumption that by doing thinking, students automatically learn how to engage in such thinking.

Educational researchers have pointed out time and again that learning how to think is not an automatic by-product of studying certain subjects, assimilating the products of someone else's thinking, or simply being asked to think about a subject or topic (Taba 1965; de Bono 1983; McPeck 1981; Glaser 1941; Oliver and Shaver 1966; Shaver 1962). Nor do youngsters learn how to engage in skillful thinking effectively by themselves (Russell 1956). As Anderson (1942) has noted, there is little reason to believe that competency in thinking can be an incidental outcome of instruction that is directed, or that appears to be directed, at other ends. By concentrating on the detail of the subject matter being studied, most common approaches to teaching thinking so obscure the skills of how to engage in thinking that students fail to master them.

If we want to improve student proficiency in thinking, we must use more direct methods of instruction than we now use (Hudgins 1977; Rosenshine 1979; Glaser 1941). First, we must establish as explicit goals of instruction the attitude, skill, and knowledge components of thinking—as Glaser (1941) recommended. Second, we must employ direct, systematic instruction in these skills prior to, during, and following student introduction to and use of these skills in our classrooms.

A Framework for Teaching Thinking Skills

Research on skill learning and teaching suggests that teachers should, for example, provide students with opportunities to identify examples of a skill—or products of its use—before asking them to use the skill to develop similar products of their own (Tyler 1930; Hudgins 1977). Teachers should also introduce components of a skill as systematically as possible (Hudgins 1977) and explicitly introduce and demonstrate its basic attributes and procedural operations. Additionally, students should frequently discuss these operations and how to employ them (Taba 1965; Russell 1956; Posner and Keele 1973; Brown et al. 1981; Sternberg 1984a). They need repeated practice in the skill over an extended period of time with corrective feedback provided by peers or teacher and by self-analysis of how they used the skill (Posner and Keele 1973). Skills need to be broadened beyond their original components and operations. At this point more subtle or content-specific components need to be added, and the skills should be used in combination with other skills (Dwyer 1967; Hudgins 1977). To facilitate generalization and transfer, students need to apply and prac-

This chapter is adapted from Barry K. Beyer, "Teaching Critical Thinking: A Direct Approach," *Social Education* 49, 4 (April 1985): 297–303. Copyright © 1990 by Barry K. Beyer.

tice skills—with instructional guidance—in a variety of settings and with a variety of data and media (Hudgins 1977; Simon 1980; Perkins and Salomon 1988). Finally, teachers should present lessons in a skill using the course content (Morse et al. 1971). What we should do, in a nutshell, is keep the teaching/learning focus continuously and explicitly on the skills we are trying to teach and not let them get smothered by the content with which we use them, at least until students demonstrate mastery of them.

Teachers can apply these principles by organizing instruction in any thinking skill in terms of a five-stage framework:

1. Where appropriate, teachers should provide students with several opportunities to select examples of a specific skill in use by focusing on the products of that skill rather than on the skill itself. This helps develop readiness for more specific instruction in the skill.

2. In a single 30- to 40-minute lesson, teachers should introduce, present, and demonstrate the skill in as much step-by-step detail as possible.

3. Three or more lessons that provide guided, instructive practice should then follow, each with explicit reference to the skill components as originally introduced and each using data and media identical in form and type of content to those used when the skill was introduced.

4. Next, in a new 20- to 30-minute lesson, teachers should review and transfer the skill to media or data that differ from those used when the skill was introduced.

5. Finally, teachers should provide students with additional opportunities to apply the skill—with appropriate corrective feedback—until they can individually initiate and employ the skill and evaluate their use of it.

Over the duration of any course, then, a single newly introduced skill may well be the focus of 8 to 12 lessons, at least. Suggested strategies for conducting key lessons in this framework follow.

Strategies for Introducing a Thinking Skill

Each stage of teaching any thinking skill is important to effective instruction and learning. However, the introduction is the most important stage. A detailed introduction should focus specifically on the skill's attributes and make the skill a subject of the students' continuing and conscious attention. Two kinds of classroom teaching strategies can serve this purpose. The first, an inductive strategy, allows students to articulate for themselves the key attributes of the skill. The second, a more directive strategy, gives students the components of the skill right from the start. Teachers may vary or combine the two strategies to avoid monotony in learning, as well as to suit the content, the specific skill, or students' ability levels and learning styles.

An Inductive Introduction

In executing an inductive strategy, teachers and students can proceed through five major steps:

The teacher:

1. Introduces the skill.

Next, the students:

2. Execute it.

3. Reflect on and articulate what they did mentally as they executed the skill.

4. Apply their new knowledge of the skill to use it again.

5. Review what they did in their heads as they executed the skill and bridge the skill to other settings.

All of this can be done in a way that advances subject matter learning. Such a lesson need not be a special event or in a "content-free" context. It can—and indeed should—be presented when using a new skill is necessary in order to understand the content being taught (Morse et al. 1971).

Suppose, for example, a teacher is introducing the skill of detecting bias in written documents in a world history course. The students have already studied the causes of England's late 18th century industrial revolution and are about to investigate its results. This subject provides an excellent opportunity for the teacher to introduce this skill and help students learn how to use it. Students are motivated to attend to this learning objective because they need to be able to find out the real impact of this economic and social revolution.

Step 1. To *introduce* the skill, the teacher states its label, defines it or has the students define it, gives or has the students give a synonym or two and several examples. Such an introduction provides a purpose for learning and a focus for the lesson. It also helps students get set mentally to carry out the skill.

Step 2. Without any further instruction, the students *execute* the skill—use it—as best they can to achieve a substantive learning goal, in this case, determining the impact of the industrial revolution. Given an excerpt from a historical document, students examine it to see if it is biased:

FIGURE 1

Excerpt "A" from Historical Document

Some of these lords of the loom . . . employ thousands of miserable creatures . . . [who are] kept, fourteen hours in each day, locked up, summer and winter, in a heat of from *eighty to eighty-four degrees*. . . .

What then must be the situation of these poor creatures who are doomed to toil day after day...? Can any man, with a heart in his body . . . ,refrain from cursing a system that produces such slavery and cruelty?

. . . These poor creatures have no cool room to retreat to...[and] are not allowed to send for water to drink;...even the rain water is locked up, by the master's order. . . .Any spinner found with his window open . . . is to pay a fine. . . .

. . . The notorious fact is, that well constitutioned men are rendered old and past labour at forty. . .and that children are rendered decrepit and deformed. . .before they arrive at the age of sixteen . . . (Cobbett 1824, italics in original).

Step 3. Students then *reflect* on how they carried out this skill. At this point, most remark that this document certainly is biased. They usually cite the numerous emotionally charged terms—"miserable creatures," "locked up," "poor creatures," "doomed," "slavery," "rendered decrepit"—all with exploitative connotations and all identified with the workers. On the other hand, terms such as "lords of the loom" and "masters" are applied to the factory owners or their actions, thus putting them in a rather negative light. Overgeneralizations ("any spinner") also lead to this judgment. Moreover, even the rhetorical question ("Can any man with a heart...?") seems loaded. And the author's emphasis (italicized words) show bias even more. "Is there," students ask, "nothing of merit on the side of the mill owners?" One-sided accounts might w l indicate bias.

As students share how they carried out their analyses, they articulate procedures for finding such clues and making sense of them. As this occurs, they begin to articulate inductively some of the major attributes of the skill of detecting bias.

Step 4. Using another documentary excerpt (Figure 2), the students next deliberat y *apply* and "test out" the clues and procedures they have just inferred and discussed to see if they are getting a handle on this skill.

FIGURE 2

Excerpt "B" from Historical Document

I have just visited many factories . . . and I never saw . . . children in ill-humor. They seemed to be always cheerful and alert, taking pleasure in the light play of their muscles—enjoying the mobility natural to their age. The scene of industry . . . was exhilarating. It was delightful to observe the nimbleness with which they pieced the broken ends as the mule carriage began to recede from the fixed roller-beam and to see them at leisure after a few seconds exercise of their tiny fingers, to amuse themselves in any attitude they chose. . . . The work of these lively elves seemed to resemble a sport. . . . They evidenced no trace of exhaustion on emerging from the mill in the evening, for they . . . skip about any neighborhood playground . . . (Ure 1861, p. 301).

Step 5. Finally, the students *review* what they did as they used for the second time clues and procedures of detecting bias—as they have identified them—to clarify the components of this particular skill. They can conclude by giving examples of where this skill can be employed in other subjects and out of school.

By the end of this introductory lesson, students have articulated the key attributes of the skill of detecting bias as well as discussed effects of the industrial revolution. Both kinds of knowledge can be used in future assignments and serve as the basis for subsequent lessons, but what they have expressed about the skill of detecting bias is crucial, and it is on this note that the lesson should conclude. By engaging in these five steps—introduction, execution, reflection, application, and review—students and teacher have, in effect, articulated some major attributes of the skill and begun to learn how to execute it. This strategy allows field-independent students to share their intuitive insights about a skill with their field-dependent peers, who rely more often on teacher direction to accomplish a task (Martorella 1982).

A Directive Introduction

A more direct introduction may prove useful for teachers who know the essential attributes of a skill, or when a new skill is complex and students require additional guidance. Here the teacher:

1. Introduces the skill.
2. Explains the procedure and rules of which the skill consists.
3. Demonstrates how the skill is used.

Then the students:

4. Apply the skill.
5. Reflect on what occurs as they execute the skill.

Here's how a teacher might use a directive strategy to introduce world history students to the same thinking skill described above, that of detecting bias:

Step 1. The teacher can *introduce* the skill by writing its name on the chalkboard and defining it in terms of examples and synonyms. Dictionary definitions are also useful at this point. This introduction allows students sufficient time to prepare to deal with this skill by recalling anything they might know about bias and by making connections to previously learned or related knowledge or experience. Students can contribute to this effort as they are able.

Step 2. The teacher should *explain* the key procedures and clues that constitute the skill, writing these on the chalkboard or sharing a ditto outline of them with the students. In addition to listing clues that distinguish this skill (use of loaded words, overgeneralizations, one-sidedness, and so on), the teacher can also outline a procedure by which students can execute this skill. For example:

1. State your goal: to see if something is biase .
2. Identify some clues to bias.
3. Search the material line-by-line or phrase-by-phrase to find these clues.
4. Identify any pattern of relationships among these clues.
5. State and give evidence to support the extent to which the source is biased

Step 3. Using an example of biased data—in this instance, Excerpt A—the teacher can *demonstrate* the skill by walking the students step-by-step through the above procedure and then reviewing the process.

Step 4. The students, individually or in pairs, then can *apply* the skill as modeled by the teacher to examine a second example of biased information (Excerpt B), deliberately employing the procedures, rules, and clues presented and demonstrated by the teacher.

Step 5. Finally, students should *reflect* on what they did in executing the skill in order to articulate its essential attributes. Such reviews serve to set up further learning that requires using the newly introduced skill to achieve further content objectives. They also facilitate transfer.

The directive strategy starts with attributes of the skill to be introduced already known to the teacher and presented explicitly to the students—not as the *only* attributes of this skill, but as basic ones to be used, learned, and then modi.ied as students practice the skill in future lessons. Like the inductive approach, this strategy should not be used all the time nor with all skills. The complexity of the skill, the teacher's knowledge of the skill, and the kinds of data needed or available, as well as student abilities and teacher instructional goals, determine where and when this strategy should be used.

Guidelines for Introducing Thinking Skills

These two introductory teaching strategies are useful not simply because they may appeal to different personal teaching styles, but because they also incorporate important findings of research on and thoughtful practice of skill teaching and learning. To minimize the negative effects of interference, both strategies place obvious and continuing emphasis on the skill being produced. Student attention is repeatedly focused on the skill throughout each strategy. To enhance student motivation and to make learning the skill easier, teachers introduce students to the skill when they need competence in it to accomplish a content-related task. Students also either invent a model of the skill or participate in a "dry run," consciously attempting to articulate components of the skill. Each strategy includes repeated student discussion of the skill, which take precedence over discussion of subject matter—although as students discuss the skill they simultaneously talk about the subject matter. Each strategy also gives students an opportunity to apply the skill and receive immediate feedback.

These two strategies have subtle implications for teachers. For example, use of a directive introductory strategy presupposes that a teacher knows the skill. Such knowledge is not easy to come by, however. Descriptions of the key attributes of thinking skills are exceedingly sparse. Yet there are several ways teachers can identify them. One, of course, is to search for descriptions in the literature or in instructional materials. Another is to perform the skill and reflect on the results in order to articulate the steps employed and the rules or principles followed (Berlak 1965). Third, students or adults who demonstrate competence in a particular skill may engage in the skill and report aloud what they are thinking or mentally doing and why (metacognition). A subsequent analysis of their transcribed remarks, usually called protocols, can help identify key elements of the skill. All of these approaches take time, of course, and additional resources (Beyer 1984).

Teachers may also "discover" key attributes of a skill by joining their students in studying and practicing the skill. Using the inductive strategy as a jumping-off point, teachers can use student responses and their own insights to hypothesize a description of a skill's major procedures and rules. As teachers reintroduce the skill via this same strategy in successive classes, they can gain additional insights and continue to build and refine a more detailed concept of the skill. The inductive introductory strategy thus serves two major functions: to aid teachers and students in inventing a hypothetical skill model, and to serve as a strategy for providing introductory instruction in a skill.

Although transfer is not inherent in these two strategies, it is a crucial aspect of skill teaching. Notice that in each example introductory lesson, the data used in the second task application are identical in form and genre to those used in the initial demonstration or inference-making task. The reason for this is important: transfer is best facilitated when students initially *overlearn* the skill; this initial learning requires repeated guided practice in the *same context* (form and media) as that in which it was introduced (Hudgins 1977). However, once students have demonstrated mastery of a skill in a given context, the teacher can then vary the context to include those cues needed to facilitate transfer to new contexts.

Strategies for Guided Practice in Thinking Skills

Teaching thinking, of course, requires more than a lesson using one of the introductory strategies outlined here. Use of either introductory strategy does not eliminate the need for repeated follow-up, guided practice. Guided practice consists of students' reviewing the skill attributes before they use the skill, while they use it, and after they have used it. Through deliberate attention to the skill at these three points of a practice lesson, students can become more aware of what goes on in their minds as they engage in thinking.

Teachers can use at least two different strategies to guide students in such reflective skill practice. In the first, teachers:

1. Introduce the skill.
2. Have students review the skill procedure, rules, and associated knowledge.
3. Have students employ the skill to achieve the assigned subject matter objective.

4. Help students reflect on and review what they did in their minds as they executed the skill, and why.

A second strategy engages students in even more deliberate reflective analysis of their think'ng. In this strategy teachers have students:

1. State what they expect to achieve by using a specific thinking skill.

2. Describe the procedure and rules they plan to use as they employ the skill.

3. Predict the results of their use of the skill.

4. Check the procedure they use as they employ the skill.

5. Evaluate the outcome of using the skill and the way they employed it.

This latter strategy helps students become more aware of their own thinking and thus, gain the kind of conscious control over it that skill teaching experts claim is crucial to learning thinking skills (Bereiter 1984; Sternberg 1984b; Segal and Chipman 1984; Bondy 1984; Brown et al. 1981).

Initiating Transfer of a Skill

Our wishes to the contrary, thinking skills simply don't transfer of their own accord, nor do most students seem able to transfer them on their own initiative. Rather, thinking skills, like other skills, are closely tied to the contexts in which they are initially encountered or introduced. Teachers and students need to make special efforts to transfer a thinking skill from one setting to another (Perkins and Salomon 1988).

Such transfer can build on the repeated use of synonyms and generation of examples of where the skill can be used in the preceding introductory and guided practice lessons. But it still needs to be initiated rather explicitly by a lesson devoted exclusively to this end. Such lessons can use either an inductive or directive teaching strategy, as described above, with one significant addition.

This addition is a step immediately following the introduction to the skill. Here the students *review* what they recall about the skill before they try to execute it in the new context (as in the inductive strategy) or hear and see it explained and demonstrated (as in the directive strategy). The remainder of this lesson can then proceed exactly as in the appropriate introductory lesson. Students need help in seeing how a previously learned thinking skill works in a new context and why it works that way. A transfer lesson provides this help.

Thereafter, students benefit from a number of guided practice lessons in which they apply the skill—with instructor and peer feedback and guidance—in the new context. Eventually, this guidance can be slowly withdrawn and students can execute the skill in both the original and the new contexts on their own. A similar sequence of transfer and guided practice lessons can then extend the skill into an additonal context. As this is done over the course of several years, students can be helped to generalize the skill to the point where they can use it on their own initiative wherever it is appropriate to do so.

Additional Strategies for Teaching Thinking

Student mastery of various thinking skills requires continued instruction beyond a single course. In lower grades, the skill teaching framework should extend across a sequence of courses and over a period of years—starting, as Dwyer suggests, with a simplified version of the skill at a readiness and then introductory level. More attributes, applications to new data, and student-initiated use of the skill can follow in later years (Dwyer 1967; McPeck 1981; Hudgins 1977). Thinking skills grow and develop gradually as students have repeated experiences with them in a variety of contexts.

Thus, it may be most productive to introduce some skills before others. The skill of distinguishing statements of facts from value judgments, for example, ought to be introduced before that of detecting bias in data (Hudgins 1977; Morse et al. 1971). At first these skills can be practiced directly and explicitly as discrete skills. Then in subsequent grades, guided practice and extension of these skills can be integrated with other thinking processes as the skills are themselves broadened by instruction in their subtleties and more complex attributes and used with a variety of content and media.

No one engages in thinking by employing a single cognitive thinking skill. We do not separate relevant from irrelevant data, for instance, and then stop. This skill may be used with other thinking skills, such as identifying unstated assumptions, separating statements of verifiable facts from value judgments, and so on. Instruction needs to focus eventually on how to know when it is appropriate to use a particular skill and how to apply skills in combination in order to make meaning. The directive or inductive strategies described here can be used to introduce such skill instruction. Guided practice in identifying where and when to employ specific thinking skills should follow. Students need instruction and guided practice in thinking as a whole as well as in the discrete skills that constitute thinking.

Teaching thinking skills also involves teaching students the analytical concepts that inform these skills (Hudgins 1977). This means providing instruction in the knowledge base in which they are to be employed. McPeck (1981) and others (Morse et al. 1971; Hudgins 1977; Burton et al. 1960; and Berlak 1966) assert that thinking is immediately connected with the specific fields of knowledge in which it is used; it cannot be taught—or learned—in complete isolation from any body of content. The better informed we are about a subject, the better able we are to think about it. How a specific skill may be used and when it is appropriate to use it are decisions closely tied to a specific body of information as well as to the goals of the individual learner (Berlak 1966).

Although we may not yet know all there is to know about teaching thinking skills, we can improve the teaching and learning of these skills if we use techniques of direct instruction. One way to do so is to employ the skill teaching framework, skill teaching strategies, and guidelines for teaching presented here. If these approaches can be incorporated into our teaching, I suspect that students can and will make major strides toward improving their competencies in thinking and in better understanding the world in which we live—both major goals of education today.

REFERENCES

Anderson, H., ed. (1942). *Teaching Critical Thinking in Social Studies.* Washington, D.C.: National Council for the Social Studies.

Bereiter, Carl. (September 1984). "How to Keep Thinking Skills from Going the Way of All Frills." *Educational Leadership* 42, 1: 76.

Berlak, H. (Spring 1965). "The Teaching of Thinking." *The School Review* 73, 1: 1–13.

Berlak, H. (March 1966). "New Curricula and the Measurement of Thinking." *Education Forum* 30, 3: 306.

Beyer, B. K. (Fall 1984). "What's In A Skill? Defining the Skills We Teach." *Social Science Record* 21, 2: 19–23.

Bondy, E. (March/April 1984). "Thinking About Thinking." *Childhood Education*: 234–238.

Brown, A., et al. (February 1981). "Learning to Learn: On Training Students to Learn from Texts." *Educational Researcher* 10: 14–21.

Burton, W. H., R. B. Kimball, and R. L. Wing. (1960). *Education for Effective Thinking.* New York: Appleton-Century-Crofts.

Cobbett, W. (November 20, 1824). *Political Register* LII.

Cornbleth, C., and W. Korth. (May 1980). "In Search of Academic Instruction." *Educational Researcher* 9, 5: 9.

Cornbleth, C., and W. Korth. (April 1981). "If Remembering, Understanding, and Reasoning are Important. . . ." *Social Education* 45, 4: 276, 278–279.

de Bono, E. (June 1983). "The Direct Teaching of Thinking as a Skill." *Phi Delta Kappan* 64, 10. 104.

Dwyer, F. M., Jr. (Spring 1967). "Adapting Visual Illustrations for Effective Learning." *Harvard Educational Review* 37, 2: 250–263.

Glaser, E. M. (1941). *An Experiment in the Development of Critical Thinking.* New York: Bureau of Publications, Teachers College, Columbia University.

Hudgins, B. (1977). *Learning and Thinking.* Itasca, Ill.: F. E. Peacock.

Martorella, P. (Fall 1982). "Cognition Research: Some Implications for the Design of Social Studies Instructional Materials." *Theory and Research in Social Education* X, 3: 1–6.

McPeck, J. E. (1981). *Critical Thinking and Education.* New York: St. Martin's.

Morse, H. T., and G. H. McCune with L. E. Brown and E. Cook. (1971). *Selected Items for the Testing of Study Skills and Critical Thinking: Bulletin 15.* 5th ed. Washington, D.C.: National Council for the Social Studies.

Oliver, D. W., and J. P. Shaver. (1966). *Teaching Public Issues in the High School.* Boston: Houghton Mifflin.

Perkins, D. N., and G. Salomon. (September 1988). "Teaching for Transfer." *Educational Leadership* 46, 1: 22–32.

Posner, M., and S. W. Keele. (1973). "Skill Learning." In *Second Handbook of Research on Teaching,* edited by R. M. W. Travers. Chicago: Rand McNally.

Rosenshine, B. V. (1979). "Content, Time and Direct Instruction." In *Research on Teaching,* edited by P. L. Peterson and H. J. Walberg. Berkeley: McCutchan.

Russell, D. (1956). *Children's Thinking.* Boston: Ginn.

Segal, J. W., and S. F. Chipman. (September 1984). "Thinking and Learning Skills: The Contributions of NIE." *Educational Leadership* 42, 1: 86.

Shaver, J. P. (January 1962). "Educational Research and Instruction for Critical Thinking." *Social Education* 26, 1: 14, 16.

Simon, H. A. (1980). "Problem Solving and Education." In *Problem Solving and Education: Issues in Teaching and Research,* edited by D.T. Tuma and F. Reif. Hillsdale, N.J.: Lawrence Erlbaum.

Sternberg, R. J. (1984a). "Teaching Intellectual Skills: Looking for Smarts in All The Wrong Places." Unpublished paper. Yale University.

Sternberg, R. J. (1984b). "How Can We Teach Intelligence?" *Educational Leadership* 42, 1: 47.

Taba, H. (May 1965). "Teaching of Thinking." *Elementary English* 42, 2: 534.

Tyler, R. (November 19, 1930). "Measuring the Ability to Infer." *Educational Research Bulletin* 9, 17: 475–480.

Ure, A. (1861). *The Philosophy of Manufacturers: or An Exposition of the Scientific, Moral and Commercial Economy of the Factory System of Great Britain.* 3rd ed. London: H. G. Bohn.

49
Dialogical and Dialectical Thinking

Richard W. Paul

It is far better to debate an issue without settling it, than to settle an issue without debating it.

—Joseph Joubert

Part I: Theory

When as a result of a trial, a jury issues a verdict of guilty or innocent; when as a result of political debate, we decide to vote for a candidate; when as a result of reading about alternative political systems, we conclude that one is superior; when as a result of hearing various sides of a family argument, we are persuaded that one side is more justified and accurate; when as a result of reading many reports on the need for educational reform, we are prepared to argue for one of them; when as a result of entertaining various representations of national security, we reason to a position of our own; when after reading and thinking about approaches to raising children, we conclude that one is better than the others; when after interacting with someone and reflecting on conflicting interpretations of his or her character, we decide to marry that person—we are reasoning dialectically.

When students discuss their ideas, beliefs, or points of view with other students or the teacher; when they role-play the thinking of others; when they use their thinking to figure out the thinking of another (say, that of the author of a textbook or story); when they listen carefully to the thoughts of another and try to make sense of them; when they arrange their thoughts, orally or in writing, in such a fashion as to be understood by another; when they enter sympathetically into the thinking of others or reason hypothetically from the assumptions of others—they are reasoning dialogically.

An open society requires open minds. One-sided egocentric and sociocentric thought, joined with massive technical knowledge and power, are not the foundations of a genuine democracy. This basic insight, formed over a hundred years ago by John Stuart Mill (1947, p. 3), is as true today, and as ignored, as it was when he first wrote it:

> In the case of any person whose judgment is really deserving of confidence, how has it become so? Because he has kept his mind open to criticism of his opinions and conduct. Because it has been his practice to listen to all that could be said against him; to profit by as much of it as was just, and expound to himself, and upon occasion to others, the fallacy of what was fallacious. Because he has felt, that the only way in which a human being can make some approach to knowing the whole of a subject, is by hearing what can be said about it by persons of every variety of opinion, and study.

This is the dialogical ideal. Dialogical and dialectical thinking involve dialogue or extended exchange between different points of view or frames of reference. Both are *multilogical* (involving many logics) rather than *monological* (involving one logic) because in both cases there is more than one line of reasoning to consider, more than one "logic" being formulated. Dialogue becomes dialectical when ideas or reasonings conflict and we need to assess their various strengths and weaknesses.

In general, students learn best in dialogical situations, under circumstances in which they must continually express

Copyright © 1990 by Richard W. Paul.

their views to others and try to fit others' views into their own. Even in dealing with monological problems (e.g., most math and science problems) students need to move dialogically between their own thinking and "correct" thinking on the subject before they come to appreciate the one "right" (monological) way to proceed. They cannot simply leap directly to "correct" thought; they need to think dialogically first.

Unfortunately, the dominant mode of education at all levels is still didactic: teaching by telling, learning by memorizing. The problem it creates is evident in this excerpt from a letter written by a teacher who has a master's degree in physics and mathematics:

> After I started teaching, I realized that I had learned physics by rote and that I really did not understand all I knew about physics. My thinking students asked me questions for which I always had the standard textbook answers, but for the first time made me start thinking for myself, and I realized that these canned answers were not justified by my own thinking and only confused my students who were showing some ability to think for themselves. To achieve my academic goals I had memorized the thoughts of others, but I had never learned or been encouraged to learn to think for myself.

Didactic teaching encourages monological thinking from beginning to end. There is little room for dialogical or dialectical thinking in the mind of the didactic teacher: The teacher, usually focused on content coverage, tells students directly what to believe and think about subject matter, while students, in turn, focus on remembering what the teacher said in order to reproduce it on demand. In its most common form, this mode of teaching falsely assumes that we can directly give students knowledge without their having to think their way to it, that knowledge can be implanted directly in students' minds through memorization. It confuses information with knowledge. And it falsely assumes that knowledge can be separated from understanding and justification. It also confuses the ability to state a principle with understanding it, the ability to supply a definition with comprehending it, and the act of saying something is important with actually recognizing its importance. Didactic instruction flourishes when it appears that life's problems can be solved by one-dimensional answers and that knowledge is ready-made for passive absorption. Without recognizing it, most teachers teach as if this were so.

Students today have very little experience in school of reasoning within opposing points of view. Indeed, students today have little experience with reasoning at all. Most students do not know what inferences are, what it is to make assumptions, what it is to reason from an assumption to one or more conclusions. In today's didactic classroom, the teacher is engaged in inculcating information. Classroom monologue (students passively listening) rather than active dialogue (students thoughtfully engaged) is the paradigm. Unfortunately, students then come away with the impression that knowledge can be obtained without struggle, without having to hear from more than one point of view, without having to identify or assess evidence, without having to question assumptions, without having to trace implications, without having to analyze concepts, without having to consider objections.

The result is students with no real sense of what the process of acquiring knowledge involves, students with nothing more than a scattering of information and beliefs, students with little sense of what it is to reason their way to knowledge. The result is teachers oblivious of the fact that knowledge must be earned through thought, who teach as if knowledge is available to anyone willing to commit information to short-term memory. The result is school as a place where knowledge is didactically dispensed and passively acquired, something found principally in books, something that comes from authorities.

But if gaining knowledge really is a fundamental goal—and all curriculums say it is—then most students should be spending most of their time actively reasoning. That is, most of the students most of time should be gathering, analyzing, and assessing information. They should be considering alternative competing interpretations and theories. They should be identifying and questioning assumptions, advancing reasons, devising hypotheses, thinking up ways to experiment and test their beliefs. They should be following up implications, analyzing concepts, considering objections. They should be testing their ideas against the ideas of others. They should be sympathetically entering opposing points of view. They should be role-playing reasoning different from their own. In short, they should be reasoning dialogically and dialectically.

Only when students have a rich diet of dialogical and dialectical thought do they become prepared for the messy, multidimensional real world, where opposition, conflict, critique, and contradiction are everywhere. Only through a rigorous exposure to dialogical and dialectical thinking do students develop intellectually fit minds.

Absolutistic Thinking in Early School Years

Young children do not recognize that they have a point of view. Rather, they tend to make absolute judgments about themselves and others. They are not usually given an opportunity to rationally develop their own thoughts. Their capacity to judge reasons and evidence is usually not cultivated. Their intellectual growth is stunted.

As a result, young children uncritically internalize images and concepts of what they and others are like, of what, for example, Americans are like, of what atheists, Christians,

ERIC

communists, parents, children, business-people, farmers, liberals, conservatives, left-wingers, right-wingers, salespeople, foreigners, patriots, Palestinians, Kiwanis Club members, cheerleaders, politicians, Nazis, ballet dancers, terrorists, union leaders, guerrillas, freedom fighters, doctors, Marines, scientists, mathematicians, contractors, and waitresses are like. They then "ego-identify" with their conceptions, which they assume to be accurate, spontaneously using them as guides in their day-to-day decision making.

Children need assignments in multilogical issues to break out of their uncritical absolutism. They need to discover opposing points of view in nonthreatening situations. They need to put their ideas into words, advance conclusions, and justify them. They need to discover their own assumptions as well as the assumptions of others. They need to discover their own inconsistencies as well as the inconsistencies of others. They do this best when they learn how to role-play the thinking of others, advance conclusions other than their own, and construct reasons to support them. Children need to do this for the multilogical issues—those involving conflicting points of view, interpretations, and conclusions—that they inevitably face in their everyday life. But they also need to do so for the disciplined monological questions that they must of necessity approach from within the context of their own undisciplined minds.

Because children are not exposed to dialogical and dialectical activities, children do not learn how to read, write, think, listen, or speak in such a way as to rationally organize and express what they believe. They do not learn how uncritically they are responding to the mass media nor to what extent the media reinforce their subconscious egocentric or sociocentric views. They feel deeply principally about egocentric concerns, justifying getting what they want, and avoiding what they do not want. If school is to prepare students for life as it is, if it is to empower children to become rational persons, it must cultivate dialogical engagement and reasoned judgment from the outset.

Fact, Opinion, and Reasoned Judgment

When critical thinking is introduced into the classroom, though very often it is not, it is usually approached monologically—for example, by having students divide a set of statements into "facts" and "opinions." Unfortunately, a taxonomy that divides all beliefs into either facts or opinions leaves out the most important category: reasoned judgment. Most important issues are not simply matters of fact, nor are they essentially matters of faith, taste, or preference. They are matters that call for reasoned reflection. They are matters that can be understood from different points of view through different frames of reference. We can, and many different people do, approach them with different assumptions, ideas and concepts, priorities, and ends in view. The tools of critical thinking enable us to grasp genuine strengthens and weaknesses in thought only when they are analytically applied to divergent perspectives in dialectical contexts. Dialogical and dialectical experience enables us to develop a sense of what is most reasonable. Monological rules do not. For example, it is exceedingly difficult to judge the case made by a prosecutor in a trial until we have heard the arguments for the defense. Only by stepping out of the perspective of the prosecutor and actually organizing the evidence in language designed to make the strongest case for the defense can we begin to grasp the true strength and weakness of the prosecutor's case.

This approach is the only proper way to deal with the important issues we face in our lives, and I am amazed that we and our textbooks refuse to recognize it. The most basic issues simply do not reduce to unadulterated fact or arbitrary opinion. True, they often have a factual dimension. But characteristically, some of what is apparently empirically true is also arguable. And we are often faced with the problem of deciding which facts are most important, which should be made central, and which should be deemed peripheral or even irrelevant. Finally, despite the common view, facts do not speak for themselves. They must be rendered meaningful by interpretation, by explanation, by construal. Make your own list of the ten most important issues and see if is not true (but beware of course the tendency to see your own answers to these issues as self-evident facts).

Part II: Pedagogy

Everyday life, in contrast to school, is filled with multilogical problems for which there are competing answers. Furthermore, even when subject matter can be algorithmically and monologically expressed, students need to approach that subject matter through dialogical thought that brings their own thinking into play. Teachers do not, by and large, recognize these facts, nor when it is pointed out to them do they know how to take them into account in the classroom. Being habituated to didactic instruction, dialogical instruction that does not result in predictable "correct" answers is a puzzle to them. They do not know how to foster it. They do not know how to assess it. They do not know how to use it to aid students in mastering content.

There are four interrelated things teachers need to learn: (1) how to identify and distinguish multilogical from monological problems and issues, (2) how to teach Socratically, (3) how to use dialogical and dialectical thought to master content, and (4) how to assess dialogical and dialectical thought. I should add that one does not master these understandings overnight, but only by degrees over an extended period of time. They cannot be taught, for example, in a one-day workshop. Let us consider each of these four learnings in order.

Learning to Identify and Distinguish Multilogical from Monological Problems and Issues

This involves distinguishing problems for which there is an established step-by-step procedure for solving them (e.g., *What is the square root of 653? What is the boiling point of water? In what year did the American Revolution begin?*) from problems and issues that can be analyzed from multiple different points of view leading to multiple competing answers, resolutions, or solutions (e.g., *Was the American revolution justified? Should the colonists have used violence to achieve their ends? When should you conform to group pressure and when should you resist that pressure? What is the meaning of this story? What would a true friend do in this situation? What caused World War II? Could it have been avoided? How important is it to get a good education? How important is it to make a lot of money? Is money the root of all evil? What kind of person are you? What are America's real values? How can you tell what to believe and what not to believe?*). These kinds of questions, we should note, can be raised from the earliest school years (e.g., *Who was right in your argument with your sister, she or you? When should you share your toys? Was it right for Jack, in "Jack and the Bean Stalk," to take the golden eggs and the harp as well? Should the big billy goat have killed the troll in "Billy Goat Gruff"? Is this the best rule to have to avoid accidents in the playground or can you think of a better one? Do the advertisements on TV for toys give you good information about toys or do they mislead you about them?*).

Socratic Questioning and Dialogical Discussion

Dialogical discussion will naturally occur if teachers learn to stimulate student thinking through Socratic questioning. This consists of teachers wondering aloud about the meaning and truth of student responses to questions. The Socratic teacher models a reflective, analytic listener. One who actively pursues clarity of expression. One who actively looks for evidence and reasons. One who actively considers alternative points of view. One who actively tries to reconcile differences of viewpoint. One who actively tries to find out not just what people think but whether what they think is actually so.

Socratic discussion allows students to develop and evaluate their thinking, comparing it to that of other students. Since students inevitably respond to Socratic questions within their own points of view, the discussion inevitably becomes multidimensional.

By routinely raising root questions and root ideas in a classroom setting, multiple points of view get expressed, but in context in which the seminal ideas, which must be mastered in order to master the content, are deeply considered and their interrelationships established.

Over time, students learn from Socratic discussions a sense of intellectual discipline and thoroughness. They learn to appreciate the power of logic and logical thinking. They learn that all thoughts can be pursued in at least four directions:

- *Their origin.* "How did you come to think this?" "Can you remember the circumstances in which you formed this belief?"
- *Their support.* "Why do you believe this?" "Do you have any evidence for this?" "What are some of the reasons why people believe this?" "In believing this aren't you assuming that such and so is true?" "Is that a sound assumption do you think?"
- *Their conflicts with other thoughts.* "But some people might object to your position by saying. . . . How would you answer them?" "But what do you think of this contrasting view?" "But how would you answer the objection that . . . ?"
- *Their implications and consequences.* "But what are the practical consequences of believing this? What would we have to do to put it into action?" "But what follows from the view that . . . ? Wouldn't we also have to believe that . . . in order to be consistent?" Are you implying that . . . ?"

Figure 1 shows an example of the how the thought "Most people are lazy" can be pursued using Socratic discussion.

Before a Socratic discussion, teachers should pre-think the issues and connections that underlie the area or subject to be discussed. Whenever possible, they should figure out in advance what the fundamental ideas are and how they relate to fundamental problems. For example, before leading a Socratic discussion on the question "What is history?", teachers should pre-think the issue so that they are clear about the essential insights that the Socratic discussion is to foster, for example, that history is selective (it is not possible to include all of the past in a book), that historians make value judgments about what to include and exclude, that history is written from a point of view, and that historians with different viewpoints often come to different historical judgments. Teachers should also recognize various related insights, for example, that all human thinking has a historical dimension (in that all our thinking is shaped by our life and times), that memory is a kind of internal historian, that the news is like the history of yesterday, that gossip is a form of historical thought, and so on. The pre-thinking enables teachers to

FIGURE 1

Socratic Discussion

There are *four directions* in which thought can be pursued.

CONFLICTING VIEWS

How does this student's thinking conflict with other points of view?

What would you say to someone who said that people basically *want* to accomplish things and learn about things, that people *need* to work and keep busy and feel that they contribute? Could there be other reasons why people seem lazy, like maybe people are afraid of messing up, and that's why they don't go out there and do stuff? Your history book is full of people who did things, worked hard, fought, and so on—how do you explain that?

ORIGIN OR SOURCE

How did the student come to form this point of view?

What makes you say that? Have you always thought that? (If not,) What made you change your mind? Why did that change your mind?

A student's main point

For example, ***"Most people are lazy."***

IMPLICATIONS & CONSEQUENCES

Where does this student's point take us, what follows from it?

If that's true, then should we let people be lazy? If not, how can we get people to do things? What makes some people different, not lazy? If most people are lazy because X (student's reason), then most people must be X—is that true?

SUPPORT, REASONS, EVIDENCE & ASSUMPTIONS

Can the student support his or her view with reasons or evidence?

Why do you think so? Are there certain kinds or groups of people that *aren't* lazy? Why are most people lazy? How do you know? How could we find out if that might be so? Do people choose to be lazy, or decide that it doesn't matter if they are lazy, or are they just that way naturally? Do you think most people think of themselves as lazy? Why?

ERIC Full Text Provided by ERIC

look for opportunities in discussion to help students make connections and see the implications of their own thinking about history and things historical.

Of course, teachers must also follow up on the insights that are fostered through Socratic discussion. Hence, once a Socratic discussion has been held on the nature of history, students should be encouraged to raise questions about their history text (e.g., *What sorts of things would you guess were left out of this account of the battle? What point of view does the writer seem to have? Which of the sentences in this paragraph state facts? Which of the sentences interpret the facts or draw a conclusion from them? If you were an American Indian do you think you would agree with this conclusion in your history text?*) They should also have follow-up assignments that require them to further develop the insights being fostered (e.g., *I'd like each of you to imagine that you are one of the colonists loyal to the king and to write one paragraph in which you list your reasons why you think that armed revolution is not justified.*)

No matter how much pre-thinking has been done, however, actual Socratic discussion will proceed, not in a predictable or straightforward direction, but in a criss-crossing, back-and-forth movement. Because Socratic instructors continually encourage students to explore how what they think about x relates to what they think about y and z, students' thinking moves back and forth between their own basic ideas and those being presented by the other students, between their own ideas and those expressed in a book or story, between their own thinking and their own experience, between ideas within one domain and those in another, in short, between any of a variety of perspectives. This dialogical process will sometimes become dialectical when ideas clash or are inconsistent.

Let us now look at a couple of excerpts from Socratic discussion carried out at different grade levels.

A 4th Grade Socratic Discussion

Teacher: How does your mind work? Where's your mind?

Student: In your head. (numerous students point to their heads).

Teacher: Does your mind do anything?

Student: It helps you remember and think.

Student: It helps, like, if you want to move your legs. It sends a message down to them.

Student: This side of your mind controls this side of your body and that side controls this other side.

Student: When you touch a hot oven it tells you whether to cry or say ouch!

Teacher: Does it tell you when to be sad and when to be happy? How does your mind know when to be happy and when to be sad?

Student: When you're hurt it tells you to be sad.

Student: If something is happening around you is sad.

Student: If there is lightning and you are scared.

Student: If you get something you want.

Student: It makes your body operate. It's like a machine that operates your body.

Teacher: Does it ever happen that two people are in the same circumstance but one is happy and the other is sad? Even though they are in exactly the same circumstance?

Student: You get the same toy. One person might like it. The other gets the same toy and he doesn't like the toy.

Teacher: Why do you think that some people come to like some things and some people seem to like different things?

Student: Because everybody is not the same. Everybody has different minds and is built different, made different.

Student: They have different personalities?

Teacher: Where does personality come from?

Student: When you start doing stuff and you find that you like some stuff best.

Teacher: Are you born with a personality or do you develop it as you grow up?

Student: You develop it as you grow up.

Teacher: What makes you develop one rather than another?

Student: Like, your parents or something.

Teacher: How can your parents' personality get into you?

Student: Because you're always around them, and then the way they act as if they think they are good, and they want you to act the same way, then they'll sort of teach you, and you'll do it.

Student: Like, if you are in a tradition. They want you to carry on something that their parents started.

Teacher: Does your mind come to think at all the way children around you think? Can you think of any examples where the way you think is like the way children around you think? Do you think you behave like other American kids?

Student: Yes.

Teacher: What would make you behave more like American kids than like Eskimo kids?

Student: Because you're around them.

Student: Like, Eskimo kids probably don't even know what the word *jump rope* is. American kids know what it is.

Teacher: And are there things that the Eskimo kids know that you don't know about?

Student: Yes.

Student: And also we don't have to dress like them or act like them, and they have to know when a storm is coming so they won't get trapped outside.

Teacher: OK, so if I understand you then, parents have some influence on how you behave and the kids around you have some influence on how you behave. Do you have some influence on how you behave? Do you choose the kind of person you're going to be at all?

Student: Yes.

Teacher: How do you do that do you think?

Student: Well, if someone says to jump off a five-story building, you won't say OK. You wouldn't want to do that. . . .

(Discussion continues)

A High School Socratic Discussion

Teacher: This is a course in biology. What kind of a subject is that? What do you know about biology already? Kathleen, what do you know about it?

Kathleen: It's a science.

Teacher: And what's a science?

Kathleen: Me? A science is very exact. They do experiments and measure things and test things.

Teacher: Right, and what other sciences are there besides biology? Marisa, could you name some?

Marisa: Sure, there's chemistry and physics.

Teacher: What else?

Blake: There's botany and math?

Teacher: Math . . . math is a little different from the others, isn't it? How is math different from biology, chemistry, physics, and botany? Blake, what would you say?

Blake: You don't do experiments in math.

Teacher: And why not?

Blake: I guess 'cause numbers are different?

Teacher: Yes, studying numbers and other mathematical things is different from studying chemicals or laws in the physical world or living things, and so forth. You might ask your math teacher about why numbers are different or do some reading about that, but let's focus our attention here on what are called the life sciences. Why are biology and botany called life sciences?

Peter: Because they both study living things.

Teacher: How are they different? How is biology different from botany? Jennifer, what do you think?

Jennifer: I don't know.

Teacher: Well, let's all of us look up the words in our dictionaries and see what is said about them.

(Students look up the words)

Teacher: Jennifer, what did you find for biology?

Jennifer: It says, "The science that deals with the origin, history, physical characteristics, life processes, habits, et cetera . . . of plants and animals: It includes botany and zoology.

Teacher: So what do we know about the relationship of botany to biology? Rick?

Rick: Botany is just a part of biology.

Teacher: Right, and what can we tell about biology from just looking at its etymology. What does it literally mean? If you break the word into two parts, "bio" and "logy". Blake, what does it tell us?

Blake: The science of life or the study of life.

Teacher: So, do you see how etymology can help us get an insight into the meaning of the word? Do you see how the longer definition spells out the etymological meaning in greater detail? Well, why do you think experiments are so important to biologists and other scientists? Have humans always done experiments do you think? Marisa.

Marisa: I guess not, not before there was any science.

Teacher: Right, that's an excellent point; science didn't always exist. What did people do before science existed? How did they get their information? How did they form their beliefs? Peter.

Peter: From religion.

Teacher: Yes, religion often shaped a lot of what people thought. Why don't we use religion today to decide, for example, what is true of the origin, history, and physical characteristics of life?

Peter: Some people still do. Some people believe that the Bible explains the origin of life and that the theory of evolution is wrong.

Teacher: What is the theory of evolution, Jose?

Jose: I don't know.

Teacher: Well, why don't you we all look up the name Darwin in our dictionaries and see if there is anything about Darwinian theory.

(Students look up the word)

Teacher: Jose, read aloud what you have found.

Jose: It says, "Darwin's theory of evolution holds that all species of plants and animals developed from earlier forms by hereditary transmission of slight variations in successive generations and that the forms which survive are those that are best adapted to the environment."

Teacher: What does that mean to you . . . in ordinary language? How would you explain that? Jose.

Jose: It means the stronger survive and the weaker die?

Teacher: Well, if that's true, why do you think the dinosaurs died out? I thought dinosaurs were very strong.

Shannon: They died because of the ice age, I think.

Teacher: So I guess it's not enough to be strong; you must also fit in with the changes in the environment. Perhaps fitness or adaptability is more important than strength. Well, in any case, why do you think that most people today look to science to provide answers to questions about the origin and nature of life rather than to the Bible or other religious teachings?

Shannon: Nowadays most people believe that science and religion deal with different things and that scientific questions cannot be answered by religion.

Teacher: And by the same token, I suppose, we recognize that religious questions cannot be answered by science. In any case, how were scientists able to convince people to consider their way of finding answers to questions about the nature of life and life processes. Kathleen, you've been quiet for a while, what do you think?

Kathleen: To me, science can be proved. When scientists say something, we can ask for proof and they can show us, and if we want, we can try it out for ourselves.

Teacher: Could you explain that further?

Kathleen: Sure. In my chemistry class we did experiments in which we tested out some of the things that were said in our chemistry books. We could see for ourselves.

Teacher: That's right. Science is based on the notion that when we claim things to be true about the world we should be able to test them to see if, objectively, they are true. Marisa, you have a question?

Marisa: Yes, but don't we all test things? We test our parents and friends. We try out ideas to see if they work.

Teacher: That's true. But is there any difference between the way you and I test our friends and the way a chemist might test a solution to see if it is acidic?

Marisa: Sure . . . But I'm not sure how to explain it.

Teacher: Blake, what do you think?

Blake: Scientists have laboratories; we don't.

Teacher: They also do precise measurements and use precise instruments, don't they? Why don't we do that with our friends, parents, and children? Adrian, do you have any idea why not?

Adrian: We don't need to measure our friends. We need to find out whether they really care about us.

Teacher: Yes, finding out about caring is a different matter than finding out about acids and bases, or even than finding out about animal behavior. You might say that there are two different kinds of realities in the world, the qualitative and the quantitative, and that science is mostly concerned with the quantitative, while we are often concerned with the qualitative. Could you name some qualitative ideas that all of us are concerned with? Rick, what do you think?

Rick: I don't know what you mean.

Teacher: Well, the word qualitative is connected to the word quality. If I were to ask you to describe your own qualities in comparison to your brother or sister, would you know the sort of thing I was asking you?

Rick: I guess so.

Teacher: Could you, for example, take your father and describe to us some of his best and some of his worst qualities, as you see them?

Rick: I guess so.

(Discussion continues)

In both cases a variety of follow-up activities and assignments would be necessary to build on the insights fostered in these discussions.

Using Cooperative Learning to Foster Dialogical and Dialectical Thinking

Cooperative learning fosters dialogical and dialectical thinking since individual students will inevitably have different points of view and will need to argue out those differences. The key is students learning to assess their own thinking so that they can make logical choices among the various proposals and suggestions they meet in cooperative learning. For example, we want students in cooperative groups to Socratically question each other in a supportive way. We want them to develop confidence in their capacity to reason together to find insightful answers to important questions. To do this, they must probe each other's ideas for their support and implications. Along the way, they must develop a sensitivity to what they and others are assuming. Most important, if cooperative learning is not to be cooperative *mis*learning, it is essential that students learn how to bring intellectual standards into their work.

Assessing Dialogical and Dialectical Thinking

Since dialogical and dialectical activities focus on the process rather than the product of thinking, it is essential that both students and teachers learn how to assess thought processes. To do this it is essential that definite standards for thinking be established. Unfortunately, few teachers have had an education that emphasized the universal standards for thought. This deficiency is linked with the fact that the logic of thinking is currently not emphasized in schooling. Teachers must learn—while already in the classroom—how to distinguish and explain the difference between clear and unclear, precise and imprecise, specific and vague, relevant and irrelevant, consistent and inconsistent, logical and illogical, deep and superficial, complete and incomplete, significant and trivial, open-minded and biased, adequate and inadequate reasoning and expression. Students, in turn, need to recognize their responsibility to express themselves in reasoning that is as clear, precise, specific, accurate, relevant, consistent, logical, deep, complete, and open-minded as possible, irrespective of the subject matter. These are deep and substantial, even revolutionary, understandings. They provide an entirely new perspective on what knowledge and learning are all about.

Figure 2

The Perfections and Imperfections of Thought

clear	vs	unclear
precise	vs	imprecise
specific	vs	vague
accurate	vs	inaccurate
relevant	vs	irrelevant
consistent	vs	inconsistent
logical	vs	illogical
deep	vs	superficial
complete	vs	incomplete
significant	vs	trivial
adequate (for purpose)	vs	inadequate
fair	vs	biased or one-sided

How to Use Dialogical and Dialectical Thinking to Master Content

Because students do not come to the classroom with a blank slate for a mind, because their thinking is already developing in some direction, because they have already formed ideas, assumptions, beliefs, and patterns of inference, and because they learn new ideas, assumptions, and beliefs only through the scaffolding of their previously formed thinking, it is essential that dialogical and dialectical thinking form the core of their learning. There is no way around the need of minds to think their way to knowledge. Knowledge is discovered by thinking, analyzed by thinking, interpreted by thinking, organized by thinking, extended by thinking, and assessed by thinking. There is no way to take the thinking out of knowledge, nor is there a way to create a direct step-by-step path to knowledge that all minds can follow. In science classes students should be learning how to think scientifically, in math classes how to think mathematically, in history classes how to think historically, and so forth. It is scientific thinking that produces scientific knowledge, mathematical thinking that produces mathematical knowledge, historical thinking that produces historical knowledge. Dialogical exchange and dialectical clash are integral to acquiring all these forms of knowledge. To this day we have refused to face this reality.

Taking Up the Challenge

Dialogical thinking refers to thinking that involves a dialogue or extended exchange between different points of view, cognitive domains, or frames of reference. Whenever we consider concepts or issues deeply, we naturally explore their connections to other ideas and issues within different domains or points of view. Critical thinkers need to be able to engage in fruitful, exploratory dialogue, proposing ideas, probing their roots, considering subject matter insights and evidence, testing ideas, and moving between various points of view. Socratic questioning is one form of dialogical thinking.

Dialectical thinking refers to dialogical thinking conducted in order to test the strengths and weaknesses of opposing points of view. Court trials and debates are dialectical in form and intention. They pit idea against idea, reasoning against counter-reasoning in order to get at the truth of a matter. As soon as we begin to explore ideas, we find that some clash or are inconsistent with others. If we are to integrate our thinking, we need to assess which of the conflicting ideas we will accept and which reject, or which parts of the views are strong and which weak, or, if neither, how the views can be reconciled. Students need to develop dialectical reasoning skills so that their thinking moves comfortably between divergent points of view or lines of thought, assessing the relative strengths and weaknesses of the evidence or reasoning presented. Dialectical thinking can be practiced whenever two conflicting points of view, arguments, or conclusions are under discussion.

Because at present both teachers and students are largely unpracticed in either dialogical or dialectical thinking, it is important to move instruction in this direction slowly and carefully as part of a reflectively designed, long-term staff development plan, one with a sufficiently rich theoretical base and pedagogical translation to allow for individual teachers to proceed at their own rate. I recommend an approach that focuses on lesson remodeling and redesign, and I have written four books to aid teachers in this redesign of instruction. Nevertheless, most teachers need to work with other teachers to carry through needed reforms. They need to work together with much encouragement and many incentives. Very few districts have taken up the challenge. Most have created the mere appearance of change. In most, didacticism remains, unchallenged in its arrogance, in its self-deception, in its fruitlessness.

REFERENCE

Mill, J. S. (1947). *On Liberty*. Arlington Heights, Ill.: AHM Publishing.

RECOMMENDED READINGS

Paul, R. (1990). *Critical Thinking: What Every Person Needs to Survive in a Rapidly Changing World*. Rohnert Park. Calif.: Center for Critical Thinking and Moral Critique, Sonoma State University.

Paul, R. W. (September 1984). "Critical Thinking: Fundamental To Education For a Free Society." *Educational Leadership* 42, 1:4–14.

Paul, R. W. (1987). "Dialogical Thinking: Critical Thought Essential to the Acquisition of Rational Knowledge and Passions." *Teaching Thinking Skills: Theory and Practice*, edited by J. Baron and R. Steinberg. Location: W. H. Freeman and Company.

Paul, R. W., A. J. A. Binker, and D. Weil. (1990). *Critical Thinking Handbook: K–3. A Guide for Remodelling Lesson Plans in Language Arts, Social Studies, and Science*. Rohnert Park, Calif.: Foundation for Critical Thinking, Sonoma State University.

Paul, R. W., A. J. A. Binker, K. Jensen, and H. Kreklau. (1990). *Critical Thinking Handbook: 4th–6th Grades. A Guide for Remodelling Lesson Plans in Language Arts, Social Studies, and Science*. Rohnert Park, Calif.: Foundation for Critical Thinking, Sonoma State University.

Paul, R. W., A. J. A. Binker, D. Martin, C. Vetrano, and H. Kreklau. (1989). *Critical Thinking Handbook: 6th–9th Grades. A Guide for Remodelling Lesson Plans in Language Arts, Social Studies, and Science*. Rohnert Park, Calif.: Center for Critical Thinking and Moral Critique, Sonoma State University.

Paul, R. W., A. J. A. Binker, D. Martin, C. Vetrano, and H. Kreklau. (1989). *Critical Thinking Handbook: High School. A Guide for Redesigning Instruction*. Rohnert Park, Calif.: Center for Critical Thinking and Moral Critique, Sonoma State University.

Scriven, M. (Winter 1985). "Critical for Survival." *National Forum* 65, 1: 9–12.

Siegel, H. (November 1980). "Critical Thinking as an Educational Ideal." *The Educational Forum* 45, 1: 7–23.

50

Concept Development

Sydelle Seiger-Ehrenberg

The art of teaching is the art of assisting discovery.
—Mark Van Doren

Despite much talk about concept-centered curriculum, too many students still just learn facts. Teachers report, and tests show, that even those students who seem to have learned concepts often fail to apply them to new but similar situations.

Let's explore some of the possible reasons.

Different Concepts of "Concept"

One reason may be that educators haven't been sufficiently clear and consistent about what they think a concept is. They haven't distinguished between concepts and other things they want students to learn, such as facts, principles, attitudes, and skills. Fuzziness or lack of common understanding among curriculum developers, teachers, and testers about what a concept is could account for disparity among what is taught, learned, and tested.

Lack of Understanding of Concept Learning/Teaching Processes

Another reason may be the assumption that concepts are learned (and therefore should be taught) in the same way facts are learned. While much attention has been given to differences in individual student learning "styles" (preferences related to *gathering* information), very little has been focused on the differences in various learning "strategies" (procedures for *processing* information). The processes for learning and teaching concepts differ significantly from those appropriate for fact, principle, attitude, and skill learning. Lack of understanding of those differences on the part of the curriculum developer or the teacher could certainly contribute to students' failure to learn concepts.

Inadequate or Inappropriate Curriculum Materials

Curriculum guides, teachers' manuals, and student materials may not contain enough of the right kind of information.[1] Neither commercial nor locally developed curriculum may be thorough enough in identifying, defining, and relating the concepts students are expected to learn; in outlining appropriate concept-learning processes; or in presenting the kind of information students need in order to form concepts. Too often, the concept is just "presented" (as though it were a fact). Teachers who have to work with an inadequate or inappropriate curriculum may well be misled as to how to help students learn concepts, or, if they know better, be burdened with the task of revising or even developing the curriculum from scratch.

These may not be the only reasons students are not learning concepts as well as we think they should, but since these factors are under our control, they should be addressed and, to the extent possible, eliminated.

Following are some ideas about concept learning and teaching, which, over the past 12 years, many educators have learned and successfully applied. Their success came not from merely reading about or listening to these ideas, but as a result of hard work during and after intensive training in a staff development program called BASICS (Ehrenberg and Ehrenberg 1978; Project Basics 1975). This program and its predecessor, *The Hilda Taba Teaching Strategies Program*, focus on the thinking strategies students need to learn to achieve each of the basic types of learning objectives of any

This chapter originally appeared in Sydelle D. Ehrenberg, "Concept Learning: How To Make It Happen In The Classroom," *Educational Leadership* 38, 1 (October 1981): 36–43.

curriculum: concepts, principles, attitudes, and skills (Durkin and Hardy 1972).

What Is a Concept?

Following are three *examples* of concepts.

1. Any plane, closed figure having just three sides
2. Any body of land bordered on all sides by water
3. Any invertebrate having just three body parts and exactly six legs

First, observe what each statement says. Note the *differences* among them. Then decide what is *true of all three statements.* What is true of all three is what makes all of them examples of "concept."

Now focus on the following three items. *None* of the three is a concept.

a. ABC is a plane, closed figure having three sides
b. island
c. ant

Consider items "a," "b," and "c" one at a time. Compare and contrast each with the concept examples (#1, #2, and #3) and decide why "a," "b," and "c" are not examples of "concept." Item "a" states certain facts about figure ABC—its characteristics—but it does not state the characteristics common to any and all examples of that type of figure. Item "b" gives the English label for a type of thing but does not state the set of characteristics common to any and all examples. Item "c" gives the name of one example of concept #3, insect, but it does not state the characteristics common to any and all examples of insects, distinguishing all insects from any non-insect.

Based on the above, consider the following definitions and examples.

Concept—the set of attributes or characteristics common to any and all instances (people, objects, events, ideas) of a given class (type, kind, category) *or* the characteristics that make certain items examples of a type of thing and that distinguish any and all examples from nonexamples.

Concept Label—one or more *terms* used to refer to any and all examples of a given concept.

Examples—any and all *individual items* that have the characteristics of a given concept (class).

Nonexamples—any and all *individual items* that may have some but not all the characteristics that make items examples of a given concept (class).

The concept is the set of characteristics, not the label. A person can know the label for a concept without knowing the characteristics of any and all examples and vice versa. A concept is not the same as a fact. A fact is verifiable information about an individual item, while a concept is a generalization in a person's mind about what is true of any and all items (even those the person has never seen) that are examples of the same class.

A few additional points about concepts:

All concepts are abstract. This is because a concept constitutes a generalized mental image of the characteristics that make items examples. However, the characteristics of individual items may be either concrete (*all* of the characteristics are perceivable, as in an apple) or represented in some way. A representation may be quite "concrete" (many of the characteristics are perceivable, as in a model, film, or photo) or quite "abstract" (few or none of the characteristics are perceivable, as in a diagram, symbol, or spoken or written description).

A common misconception is that young children cannot conceptualize because they cannot yet form abstract ideas. Actually, young children can and do conceptualize but only when the characteristics of examples of the concepts are perceivable directly through the senses and they have the opportunity to perceive those characteristics firsthand in several individual items. They need these sense perceptions to form the generalized mental picture of the characteristics.

FIGURE 1
Concept Examples

CONCEPT LABEL	CONCEPT CHARACTERISTICS	EXAMPLES	NONEXAMPLES
Compound Word	Any word whose meaning is a combination of the meaning of the root words of which it is composed.	Nightgown Oversee Doorknob	Carpet Begun Understood
Fruit	The part of any plant that contains the seed(s).	Apple Tomato Squash	Potato Celery Carrot
Improper Fraction	Any fraction whose numerator is equal or greater than its denominator.	8/7 16/16 4/1	7/8 4/16 1/4

(Is it any wonder that young children have so much trouble forming such concepts as "sharing" and "tidiness?")

Concepts cannot be verified, like facts, as being "right" or "wrong." Although it is difficult for us to realize, our concepts are not what is but what we have learned to think is. As a cultural group, over time, we decide what things are and what to call them. We store our current sets of characteristics and the concept labels that go with them in the dictionary and this becomes our "authority" to arbitrate any dispute. However, we all know how dictionaries differ and that dictionaries need to be updated periodically to keep up with our changing concepts that are newly developed and commonly agreed on.

If you want to test this idea about concepts, see how many different explanations you get when you ask several people whether each of the following is a "family" and why they think it is or is not:

— A husband and wife with no children

— Several friends sharing the same home

— Roommates at college

— A separated husband and wife each having one of their children

— A mother and grown daughter living together.

Concepts are hierarchical; that is, some classes include other classes. Living things include plants and animals; animals include vertebrates and invertebrates; vertebrates include mammals, fish, birds, amphibians, and reptiles; and so on. My dog Spot is a specific example of every one of the classes in the hierarchy until he separates out into the canine class because some of his characteristics distinguish him from examples of feline, equine, and so forth. Not only that but, by virtue of the unique characteristics that distinguish him from other mongrels in the world, Spot is himself a concept (in a class by himself).

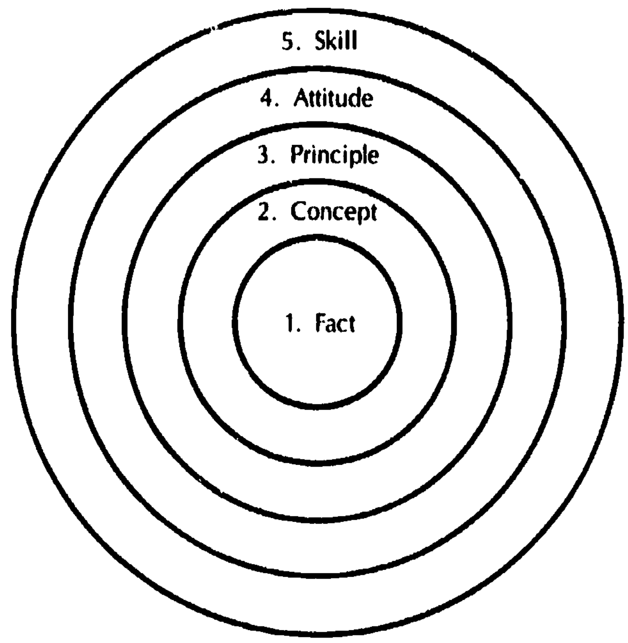
We've already made the distinction between "concept" and "fact." Let's now consider the relationship between concepts and other types of learning: principles, attitudes, and skills.

1. *Fact:* Verifiable information obtained through observing, experiencing, reading, or listening. Evidence of acquisition, comprehension, retention, and retrieval of information is the learner's expression of the specific, accurate, complete, relevant information called for.

2. *Concept:* Mental image of the set of characteristics common to any and all examples of a class. Evidence of conceptualization is the learner's demonstrated ability to consistently distinguish examples from nonexamples by citing the presence or absence of the concept characteristics in individual items.

3. *Principle:* Mental image of the cause-effect process which, under certain conditions, occurs between examples of two or more concepts. Evidence of understanding of the principle is the learner's demonstrated ability to make well-supported and qualified inferences of either cause or effect in new or changed situations.

FIGURE 2
Levels of Learning



4. *Attitude:* Mental set toward taking some action based on the desirability of anticipated consequences. Evidence of attitude learning is newly acquired willingness to take (or refrain from) an action based on the learner's concept of what the action is and predictions as to the desirable or undesirable effects of taking (or not taking) the action.

5. *Skill:* Proficiency and speed in performing a mental or physical action or set of procedures. Evidence of skill learning is the learner's performance of the action/procedure at the desired level of proficiency or speed and, where applicable, a product that meets desired standards for quality and/or quantity. This performance is based on the learner's concept of the action, predictions as to the effects of performing one way or another, and internalization of the procedures through repeated practice.

It is important to note (see Figure 2) that concept learning is distinctly different from any of the other levels of learning; therefore, the evidence of achievement is different. You can't, for example, appropriately test understanding of a concept by having the learners state facts or perform a skill. Note also that each level is prerequisite to and an important component of the next level of learning. This being the case, fact-learning is necessary but not sufficient to concept learning, and concept learning is necessary but not sufficient to the learning of principles, attitudes, and skills. (Paradoxically, the learner needs to develop a certain degree of thinking, listening, and reading *skill* before achieving even the fact-learning level).

What Learning/Teaching Strategies Develop Concepts?

Fundamental to helping students learn concepts is understanding that conceptualizing has to take place in the mind of the learner. That is, the learner needs to establish in a mental image of the set of characteristics that makes something an example of the concept and that distinguishes examples from nonexamples. If the learner has access only to the concept label and a definition (all words), the learner's mental image of the characteristics of examples of the concept may be vague, inaccurate, or nonexistent. Being able to accurately state a definition one has read or heard amounts only to fact-level learning, not conceptualization; the learner is only recalling words.

One who has conceptualized, on the other hand, is able to consistently identify new examples, create new examples, distinguish examples from nonexamples, change nonexamples into examples, and, in every case, is able to explain what they have done by citing the presence or absence of the concept characteristics. The learner can do this because he or she is guided by a clear mental image of the characteristics that should be there.

There are a number of strategies through which the learner can be guided so as to gather the appropriate information, process the information appropriately, and end up with a clear mental image of the concept characteristics.

For example, using an inductive strategy, a teacher might have students record on worksheets information the physical characteristics and life cycles of ants, grasshoppers, moths, and mantises. When the information has been reported, verified, and recorded on a large wall chart, the teacher might ask questions intended to direct students' attention to differences among the examples and then to characteristics common to all examples. Students would be asked to formulate a statement specifying "What is true of all invertebrates like these?"

After giving (or asking students for) the concept label "insect," the teacher might have students complete another worksheet calling for information about the characteristics of spiders, centipedes, scorpions, and earthworms. The learning sequence would be completed by having students respond to the following questions:

— According to this information, what are some of the characteristics of these invertebrates that make them like insects?

-- What is true of the insects that is not true of any of these other insect-like invertebrates?

— Based on what you've said here, finish the statement, "What makes insects different from other insect-like animals is."

— Identify the animals shown here that you think are insects and the ones you think are not. For each, be ready to tell what about the animal made you decide it was or was not an insect.

Using a deductive (classifying) strategy a teacher would first present information about characteristics of all examples of the concept (a definition) along with the concept label. For the concept "contraction," for instance, the teacher might ask students to state in their own words what they had read that was true of all contractions. Next, students would be asked to identify and verify the characteristics in each of several examples of the concept. For instance, the teacher might say, "In the sentence, 'The girl's here,' the word *girl's* is an example of a contraction. Referring to the definition we just discussed, what about *girl's* in this sentence makes it an example of a contraction?"

Next, students would be asked to note the absence of one or more of the concept characteristics in each of several nonexamples. For example, the teacher might say, "In the sentence, 'The girl's coat is here', the word *girl's* is not a contraction. Referring to our definition, what about *girl's* in this sentence makes it not a contraction?"

Then students would develop generalized personal statements giving characteristics of all examples of the concept and characteristics that distinguish examples from nonexamples. Finally, the teacher might have students identify which underlined words in a group of sentences were contractions and which were not. Students would be expected to explain what made each an example or a nonexample of contractions.

From these examples you can see there are certain common elements to concept-learning strategies:

1. Students must focus on several examples of the concept.

2. Students must gather and verify information as to the *concept-relevant characteristics* of each individual example and nonexample.

3. Students must note how the examples vary and yet are still examples of the concept.

4. Students must note what is *alike* about all the examples of the concept.

5. Students must generalize that what is alike about all the examples they've examined is also true of all other examples of the concept.

6. Students must note how nonexamples resemble examples, but particularly, how they *differ* from them.

7. Students must generalize about the characteristics that *distinguish* all examples of the concept from any item that might resemble them in some way.

What Should Curriculum Materials Provide?

You might find it useful and enlightening to check a number of curriculum guides and text materials to see how concepts are introduced. How often is there nothing more than words: the concept label and a definition? If examples are presented, are the concept characteristics clearly identified in each example, or is it assumed that the reader can and will identify the right ones?

There are fine guidelines for developing curriculum materials to promote concept development:

1. Concepts should be clearly identified as concepts (not facts, principles, attitudes, and skills).

2. Concepts should be clearly stated in terms of the set of characteristics by which examples are identified and by which examples can be distinguished from nonexamples.

3. Several good examples and nonexamples should be suggested or provided for use with students.

4. One or more appropriate concept development learning sequences should be outlined for each concept. These should clearly state what the learner needs to do at each step of the sequence and what the teacher might provide, do, or say to guide students through the conceptualizing process.

5. Appropriate concept testing and reinforcing activities should be included (as in our example of having students distinguish contractions from possessives). Each should require students not only to identify new examples but also to cite the presence (or absence) of the concept characteristics.

None of the foregoing ideas is new. Nor is reading and understanding them all that is needed to make concept learning a consistent reality in the classroom. To conceptualize these ideas, the reader needs to encounter and deal with a number of examples and nonexamples of their use in the classroom. To develop skill in the use of concept learning/teaching strategies requires not only conceptualization, but also firsthand experience with their results with students, willingness to take the required action to achieve the desired results, and enough practice and application to make the learning and teaching strategies an integral part of both curriculum and instruction.

References

Durkin, M., and P. Hardy. (1972). *The Hilda Taba Teaching Strategies Program*. Miami, Fla.: Institute for Staff Development.

Ehrenberg, S. D., and L. M. Ehrenberg. (1978). *BASICS: Building and Applying Strategies for Intellectual Competencies in Students, Participant Manual A*. Coral Gables, Fla.: Institute for Curriculum and Instruction.

Project BASICS. (1975). *Final Report*. Ann Arbor, Mich.: Washtenaw Intermediate School District.

51

Creativity by Design

D. N. Perkins

Education for creativity is nothing short of education for living.

—Erich Fromm

Courses that focus on creative thinking, address strategies, skills, and attitudes, and offer plenty of time-on-task can have a significant impact on creative thinking. Such courses, slipped into the curriculum where possible, would be worthwhile. But by far the better, although more difficult, path is to revise normal schooling to foster creative thinking in all subjects.

As noted earlier, part of the problem is that conventional instruction usually presents knowledge as given, when it should encourage a view of knowledge as the product of creative effort. An approach well suited to this aim can be summed up in three words: knowledge as design.

The notion is that pieces of knowledge are designs shaped by human invention, designs not so unlike a screwdriver or a can opener. Although this stance may seem peculiar at first, it offers a powerful metaphor for unifying the range of human productive activities under a common framework. To put it succinctly, virtually any product of human effort, including knowledge, can be understood better with the help of four design questions: What is the purpose? What is the structure? What are some model cases (concrete examples that bring the matter in question closer to perceptual experience)? What are the arguments for or against the design?

For instance, we can easily see a thumbtack as a structure adapted to a purpose. *The purpose:* temporarily attaching materials, usually paper, to surfaces like bulletin boards and walls. *The structure:* a short point and a wide head. *A model case:* an actual thumbtack. *The argument:* why is the head so wide? So the thumb can push it, and so it holds the paper well with its breadth. Why is the point so short? So the thumb can push the tack all the way in, and so that it isn't hard to remove. As this simple example shows, the design questions require that we understand the thumbtack as a design and from four perspectives at the same time: purpose, structure, model, and argument.

The design perspective is a flexible tool because abstract concepts can also be treated as designs. Consider the organization of a sentence as an invention. *The purpose:* to package linguistic information in an orderly way that promotes production and comprehension. The latter can be demonstrated by stripping syntax, sentence, and phrase divisions from text, which makes it much harder to read. *The structure:* nouns, verbs, adjectives, and so on put together in accordance with the rules of grammar. *Model cases:* the sentences in this paragraph, for instance. *The argument:* the structure of a simple sentence makes a neat package of information—what thing (the subject) exercises what action (the verb) on what other thing (the direct object) with what qualifications on the things (adjectives) and on the action (the adverbs)? The grammatical ordering and the case endings help the hearer to discern what does what to what, and which qualifiers limit which things and actions.

This example is far too sketchy to serve students well, of course. It is but an outline of what would be necessary for a thorough view of sentences from a design perspective. But perhaps it conveys a sense of how the design perspective could be used to discuss grammar.

Now consider a very different example—the Pythagorean theorem. *The structure:* the square of the hypotenuse of a right triangle equals the sum of the squares of the other sides. *Model case:* perhaps the most familiar model case is a right triangle with squares constructed on all

This is an excerpt from D. N. Perkins, "Creativity by Design." *Educational Leadership* 42, 1 (September 1984): 18–24.

three sides. *The argument:* one of the many proofs of the Pythagorean theorem is based on just such a construction.

As to *purpose*, this theorem has come to have a number of important purposes in mathematical contexts. It provides the basis for measuring distance in an *n*-dimensional Cartesian coordinate system. As such, it underlies vector calculus concepts such as the dot and cross products. The Pythagorean theorem plays a role in applying the calculus to compute the lengths of curves in space. The trouble is that it is difficult to convey this wide-ranging import to students encountering the theorem for the first time.

This difficulty is a pervasive problem in mathematics instruction, where quite commonly the purposes of newly introduced concepts and theorems do not become fully apparent until much later in the instructional sequence. But having some grasp of the purpose of anything is crucial to understanding it as a design and indeed, to feeling it to be important. Mathematics teachers must forecast and make vivid for students the import of mathematical findings and concepts when they are introduced, even by use of analogy and even if the message is not fully understood.

Virtually every other topic dealt with in schools can be viewed as a design and discussed as such; for example, historical claims, mathematical notations, Newton's laws, short stories and poems, legal codes, biological organisms, mathematical algorithms, newspaper layout, and moral principles. If all knowledge were presented and discussed from the perspective of design, education would yield a much more creative view of knowledge.

Learning to Design

If design provides a useful way of thinking about knowledge, it offers an even greater hold on the nature of creative thinking. One can view creative thinking as the process of designing something and provide advice on how to do so. This might be done in many ways; I will describe one.

Over the past few years, I have helped to develop a course on thinking skills for the 7th grade level in Venezuela (Final Report, Project Intelligence 1983). The course consists of six lesson series. The series on inventive thinking (Perkins and Laserna 1983) begins with nine lessons that teach students strategies for analyzing everyday designs (like chairs and tacks), evaluating them, planning improvements, and inventing useful gadgets that do not already exist. It continues with a second set of six lessons that takes the same approach to daily procedures, such as shopping, which can also be viewed as designs. The lesson series emphasizes most of the six characteristics of creative thinking identified earlier.

The extensive summative evaluation of the course, which yielded generally favorable results, included a design task administered both to students who had received the first nine inventive thinking lessons and the other lesson series and to control students. The students' designs were rated on a number of dimensions by two judges. The treatment group outperformed the control group considerably on a number of measures. For instance, treatment students included in their designs an average of two features to help solve the given problem, while control group students incorporated an average of only 1.2. Treatment students described their designs in much more detail, an average of 83 words as compared to the control students' average of 46. Treatment students also included much more detail in their sketches in a number of categories of detail (Final Report, Project Intelligence 1983).

Obviously, these results do not imply that students learned to be creative in the course of nine lessons. The treatment was not long enough nor comprehensive enough to warrant such a conclusion. But the students do appear to have learned some patterns of creative thinking as they apply to simple design tasks. The results suggest that with continued treatment to increase such skills and extend them to other contexts, creative thinking might be enhanced.

Wide-Ranging Products of Inquiry

One of the most interesting features of the above experiment is that it emphasized working on *whole* creative products—the designs of simple objects. After all, in real life the outcome of a creative endeavor is almost always a complex product rather than a brief answer to a question. School knowledge also deals largely in complex products. Theorems, theories, definitions, classification systems, arguments, analyses, field notes, interpretations, and evaluations are among many products of inquiry found in the study of the various disciplines. However, although students learn about scholars' products of inquiry, they do very little creating on their own. Students function primarily as consumers of products of inquiry, not producers.

A look at the kinds of products students normally attempt quickly reveals the limits. Broadly speaking, students are asked to produce three kinds of things: *short answers*, as in grammar or arithmetic exercises or fill-in-the-blank quizzes; *problem solutions*, as in physics or mathematics; and *essays*. The first of these hardly deserves to be called a product at all. Solving given problems does involve substantive thinking, but it is only a small part of the activity of the mathematician or scientist, who also routinely formulates problems, devises classification systems, constructs definitions, analyzes phenomena, and so on.

The essay is in principle an enormously flexible medium of expression. However, students do not know how to exploit its flexibility, and teachers do little to help them. Most students compose essays by writing what they know about a given topic. This "knowledge telling" approach, as researchers have called it (Bereiter and Scardamalia 1985), is a very narrow, not very creative use of the essay vehicle.

The narrow range of products of inquiry produced by students reflects tradition and convenience more than necessity. Here are some examples of assignments that call for rather different written products: an analysis, a prediction with argument, a classification system, a plan.

1. *Analysis of a tool according to physical principles.* After learning about basic physical principles such as the lever and the inclined plane, pick a tool—for instance, a screwdriver or a hammer—and write an analysis of how the tool works by identifying the physical principles underlying it. Many tools involve several such principles.

2. *Prediction of a political event.* Wait for an international incident, and then predict what actions the nations involved will take over the ensuing weeks. Base your predictions on as much information as you can find in newspaper accounts, plus historical analogies. Give not only your prediction but the argument for it. Then see what happens. If your prediction does not pan out, explain at what point events diverged and suggest why.

3. *A classification system for sources of slang.* Slang words enter the language in many ways. Special dictionaries often give their derivations. After learning some important characteristics of classification systems, use these special dictionaries as resources to design a classification system for the ways slang words arise.

4. *Strategic planning in history.* Select a famous battle, and learn as much as you can about it. Then, using hindsight, make the best plan you can for the strategy of the losing side. In light of this plan, might the losing side have won, or was the loss an inevitable consequence of resources and position. Present not only your plan but also your argument on this point.

As these examples show, it's relatively easy to formulate both short assignments, like analyzing a tool, and term projects, like the strategy planning project above, that engage students in designing products of inquiry. Note also that the rubric of design leads to a much broader concept of creative activity. When we think of creativity in school contexts, we usually think of creative writing and art, which are far too narrow. As soon as one thinks in terms of design, one realizes that all sorts of things in the various subject matters are designed and hence can become objects of creative thinking for students. Accordingly, a drastic expansion in the range of products of inquiry asked of students should be a key element in promoting creative thinking in schools.

Of course, an emphasis on products of inquiry is not enough. Just because students work on such products does not mean that they will do so creatively. But we can help them by providing instruction in various strategies, skills, and attitudes appropriate to creative thinking and design.

In summary, creative thinking turns out to have a discernible pattern that we can put to work throughout education. The passive view of knowledge fostered by conventional instruction can be replaced by the more active perspective of knowledge as design. Students can learn about the art and attitudes of design, and they can work on a far greater range of products of inquiry than they normally do.

Although questions certainly remain about creative thinking, it is no longer so mysterious as to excuse neglect on the grounds of ignorance. The only excuse is inertia—education's favorite, but not a good one. With a vigorous push, perhaps we can set schools in motion toward worlds of invention, which now seem not so far away.

References

Bereiter, C., and M. Scardamalia. (1985). "Cognitive Coping Strategies and the Problems of Inert Knowledge." In *Thinking and Learning Skills. Volume II: Research and Open Questions.* Edited by J. W. Segal, S. Chipman, and R. Glaser. Hillsdale, N.J.: Lawrence Erlbauma.

Final Report, Project Intelligence: The Development of Procedures to Enhance Thinking Skills. (1983). Cambridge, Mass.: Harvard University and Bolt Beranek and Newman.

Perkins, D. N., and C. Laserna. (1983). *Inventive Thinking. Lesson Series VI, Project Intelligence Course.* Cambridge, Mass.: Harvard University and Bolt Beranek and Newman.

52

Collaboration and Cognition

David W. Johnson and Roger T. Johnson

Cooperation, controversy, cognition, and metacognition are all intimately related. Cooperative learning provides the context within which cognition and metacognition best take place. The interpersonal exchange within cooperative learning groups, and especially the intellectual challenge resulting from conflict among ideas and conclusions (i.e., controversy), promotes critical thinking, higher-level reasoning, and metacognitive thought. Within this chapter cooperative learning is defined and its impact on cognition and metacognition is discussed.

What Is Cooperative Learning?

Cooperation is working together to accomplish shared goals and *cooperative learning* is the instructional use of small groups so that students work together to maximize their own and each other's learning. Within cooperative learning groups students are given two responsibilities: To learn the assigned material and make sure that all other members of their group do likewise. Their success is measured on a fixed set of standards. Thus, a student seeks an outcome that is beneficial to him- or herself *and* beneficial to all other group members.

Simply placing students in groups and telling them to work together does not in and of itself promote higher achievement and higher-level reasoning. There are many ways in which group efforts may go wrong (Johnson and Johnson 1989). In order to be productive, cooperative learning groups must be structured to include the essential elements of *positive interdependence* (each member can succeed only if all members succeed), *face-to-face interaction* during which students assist and support each other's efforts to achieve, *individual accountability* to ensure that all members do their fair share of the work, the *interpersonal and small group skills* required to work cooperatively with others, and *group processing* (groups must reflect on how well they are working together and how their effectiveness as a group may be improved).

Cooperative learning may be contrasted with competitive and individualistic learning. In a *competitive* learning situation, students work against each other to achieve a goal that only one or a few students can attain. Students are graded on a curve, which requires them to work faster and more accurately than their peers. Thus, students seek an outcome that is personally beneficial but detrimental to all other students in the class. In an *individualistic* learning situation, students work by themselves to accomplish learning goals unrelated to those of the other students. Individual goals are assigned, students' efforts are evaluated on a fixed set of standards, and students are rewarded accordingly. Thus, the student seeks an outcome that is personally beneficial and ignores as irrelevant the goal achievement of other students. In both competitive and individualistic learning situations, the interpersonal exchange so necessary to cognition and metacognition tends not to take place.

Cooperation's Impact On Cognition and Metacognition

Working cooperatively can have profound effects on students (Johnson and Johnson 1989). During the past 90 years over 600 studies have been conducted. Cooperative learning experiences promote higher achievement than do competitive and individualistic learning (effect sizes of 0.66 and 0.63 respectively). In addition to the mastery and retention of material being studied, achievement is indicated by the quality of reasoning strategies used to complete the assignment, the generation of new ideas and solutions (i.e., *process gain*), and the transfer of what is learned within one situation to another (i.e., *group-to-individual transfer*). The more conceptual the task, the more problem solving that is required, the more creative the answers need to be, and the more long-term retention is desired, the greater the superiority of cooperative over competitive and individualistic learning.

Many of the studies relating cooperative learning experiences and achievement have focused on quality of reasoning strategy, level of cognitive reasoning, and metacognitive strategies (Johnson and Johnson 1989). In studies on tasks that could be solved using either higher- or lower-level reasoning strategies a more frequent discovery and use of the higher-level reasoning strategies occurred within the cooperative than within competitive or individualistic learning situations (Gabbert, Johnson, and Johnson 1985; Johnson and Johnson 1981a; Johnson, Skon, and Johnson 1980; Skon, Johnson, and Johnson 1981). In a categorization and retrieval task, for example, first grade students were instructed to memorize 12 nouns during the instructional session and then to complete several retrieval tasks during the testing session the following day. The 12 nouns were given in random order and students were told to (1) order the nouns in a way that makes sense and aids memorization and (2) memorize the words. Three of the words were fruits, three were animals, three were clothing, and three were toys. Eight of the nine cooperative groups discovered and used all four categories, and only one student in the competitive and individualistic conditions did so. Even the highest-achieving students failed to use the category search strategy in the competitive and individualistic conditions. Studies on both Piaget's cognitive development and Kohlberg's moral development theories have indicated that the transition to higher-level cognitive and moral reasoning is promoted more frequently by cooperative than competitive or individualistic experiences (effect sizes = 0.79 and 0.97 respectively) (Johnson and Johnson 1989).

Why Cooperation Affects Cognition and Metacognition

Within performance situations considerable advantage may go to individuals who (a) engage in critical thinking and higher-level reasoning and (b) know what thinking strategies they are using and how to modify them in order to improve performance. There are a number of reasons why cooperative learning promotes the cognitive and metacognitive activity required to achieve.

First, the expectation that one will have to summarize, explain, and teach what one is learning impacts the strategies used. The way students conceptualize material and organize it cognitively is different when they are learning material to teach to others than when they are learning material for their own benefit (Annis 1979; Bargh and Schul 1980; Murray 1983). Material being learned to be taught to collaborators is learned using higher-level strategies more frequently than is material being learned for one's own use.

Second, the discussion within cooperative learning situations promotes more frequent oral summarizing, explaining, and elaborating of what one knows (Johnson and Johnson 1989). Orally summarizing, explaining, and elaborating one's information, ideas, and conclusions are necessary for the storage of information into the memory (through further encoding and networking) and the long-term retention of the information. Such oral rehearsal provides a review that seems to consolidate and strengthen what is known and to provide relevant feedback about the degree to which mastery and understanding have been achieved. In one of the earliest studies on this issue, Johnson (1971b) found that a person's understanding of and level of reasoning about an issue were enhanced by the combination of explaining one's knowledge and summarizing and paraphrasing the other person's knowledge and perspective. Subsequently, vocalizing what is being learned was more strongly related to achievement than was listening to other group members vocalize (Johnson, Johnson, Roy, and Zaidman 1986), summarizing the main concepts and principles being learned increased achievement and retention (Yager, Johnson, and Johnson 1985), and both explaining relevant information and disagreeing with another group member were positively related to individual achievement (Vasquez 1989). These and other studies support the conclusion that meaning is formulated through the process of conveying it. It is while students are orally summarizing, explaining, and elaborating that they cognitively organize and systematize the concepts and information they are discussing.

Third, cooperative learning groups are nourished by heterogeneity among group members. As students accommodate themselves to each other's different perspectives, strategies, and approaches to completing assignments, divergent thinking and creative thinking is stimulated. Learning experiences are enriched by the exchange of ideas and perspectives among students from high-, medium-, and low-achievement levels, handicapped and nonhandicapped students, and students from different cultural and ethnic backgrounds.

Fourth, in most cooperative learning situations students with incomplete information interact with others who have different perspectives and facts. In order to understand all the relevant information and the variety of perspectives and create a synthesis based on the best reasoning and information by everyone involved, students must (a) actively attempt to understand both the content of the information being presented and the cognitive and affective perspectives of the person presenting the information and (b) be able to hold both their own and other people's perspectives in mind at the same time. Cooperative experiences have been found to promote greater perspective-taking ability than did competitive or individualistic experiences (effect sizes = 0.57 and 0.44 respectively), and that perspective taking resulted in better understanding and retention of others' information and reasoning and perspectives (Johnson 1971a; Johnson and Johnson 1989). This evidence indicates that having information available does not ensure that it will be utilized. Utilization depends on students' ability to understand each other's perspectives.

Fifth, within cooperative learning groups members externalize their ideas and reasoning for critical examination. As a result, there tends to be considerable peer monitoring and regulation of one's thinking and reasoning. Exploration of ideas is stimulated and focused by groupmates. In comparison, individuals working by themselves more frequently get lost in lengthy and aimless wild goose chases. Individuals generally have difficulty monitoring their cognitive activity. Within a cooperative group, however, each member can monitor the reasoning of other members and help enhance their understanding of the issue or material. In essence, the cooperative experience serves as a training ground for metacognitive skills that are transferable to individual learning.

Sixth, within cooperative learning groups members may give each other feedback concerning the quality and relevance of contributions and how to improve one's reasoning or performance. Typically, personalized process feedback (as opposed to terminal feedback) is given continuously as part of the interaction among group members. In cooperative learning groups feedback is received from fellow group members and discussed face-to-face in ways that make clear its personal implications.

Finally, involved participation in cooperative learning groups inevitably produces conflicts among the ideas, opinions, conclusions, theories, and information of members (i.e., *controversy*) (Johnson and Johnson 1987). When teachers structure controversies within cooperative learning groups, students are required to research and prepare a position (reasoning both deductively and inductively); advocate a position (thereby orally rehearsing the relevant information and teaching their knowledge to peers); analyze, critically evaluate, and rebut information; take the perspective of others; and derive a synthesis and integration of positions. Controversies are resolved by engaging in the discussion of the advantages and disadvantages of proposed actions aimed at synthesizing novel solutions. In controversy there is advocacy and challenge of each other's positions in order to reach the highest quality decision possible based on the synthesis of both perspectives. There is a reliance on argumentative clash to develop, clarify, expand, and elaborate one's thinking about the issues being considered. When managed constructively, controversy promotes uncertainty about the correctness of one's views, an active search for more information, a reconceptualization of one's knowledge and conclusions, and, consequently, increased motivation to achieve, higher achievement and retention of the learned material, and greater depth in understanding.

Summary

Within cooperative learning groups there is a process of interpersonal exchange that promotes the use of higher-level thinking strategies, higher-level reasoning, and metacognitive strategies. Students working together cooperatively expect to teach what they learn to groupmates. They do in fact engage in a discussion that often includes the explaining and elaborating of what is being learning. When the group is heterogeneous, they are exposed to diverse perspectives and ideas. The cooperative context promotes their taking each other's perspectives. While they work together, they monitor each other's participation and contributions and give each other feedback about their ideas and reasoning. Finally, within cooperative groups intellectual conflict often occurs, especially if controversies are deliberately structured by the teachers. To promote higher-level reasoning, critical thinking, and metacognitive skills, teachers are well advised to first establish cooperative learning and then structure academic controversies.

REFERENCES

Annis, L. (1979). "The Processes and Effects of Peer Tutoring." *Human Learning* 2: 39–47.

Bargh, J., and Y. Schul. (1980). "On the Cognitive Benefits of Teaching." *Journal of Educational Psychology* 72: 593–604.

Gabbert, B., D. W. Johnson, and R. Johnson. (1986). "Cooperative Learning, Group-to-Individual Transfer, Process Gain, and the Acquisition of Cognitive Reasoning Strategies." *Journal of Psychology* 120: 265–278.

Johnson, D. W. (1971a). "Role Reversal: A Summary and Review of the Research." *International Journal of Group Tensions* 1: 318–334.

Johnson, D. W. (1971b). "Effectiveness of Role Reversal: Actor or Listener." *Psychological Reports* 28: 275-282.

Johnson, D. W., and R. Johnson. (1981). "Effects of Cooperative and Individualistic Learning Experiences on Interethnic Interaction." *Journal of Educational Psychology* 73: 454–459.

Johnson, D. W., and R. Johnson. (1989). *Cooperation and Competition: Theory and Research*. Edina, Minn.: Interaction Book Company.

Johnson, D. W., and R. Johnson. (1987). *Creative Conflict*. Edina, Minn.: Interaction Book Company.

Johnson, D. W., R. Johnson, P. Roy, and B. Zaidman. (1985). "Oral Interaction in Cooperative Learning Groups: Speaking, Listening, and the Nature of Statements Made by High-, Medium-, and Low-Achieving Students." *Journal of Psychology* 119: 303–321.

Johnson, D. W., L. Skon, and R. Johnson. (1980). "Effects of Cooperative, Competitive, and Individualistic Conditions on Children's Problem-Solving Performance." *American Educational Research Journal* 17: 83–94.

Murray, F. (1983). "Cognitive Benefits of Teaching on the Teacher." Paper presented at American Educational Research Association Annual Meeting, Montreal, Quebec.

Skon, L., D. W. Johnson, and R. Johnson. (1981). "Cooperative Peer Interaction versus Individual Competition and Individualistic Efforts: Effects on the Acquisition of Cognitive Reasoning Strategies." *Journal of Educational Psychology* 73: 83–92.

Vasquez, M. (1989). "The Impact of Cooperative versus Traditional Instruction on the Acquisition of Knowledge of Naval Air-Traffic Controller Trainees." Unpublished doctoral dissertation, University of Minnesota, Minneapolis.

Yager, S., D. W. Johnson, and R. Johnson. (1985). "Oral Discussion, Group-to-Individual Transfer, and Achievement in Cooperative Learning Groups." *Journal of Educational Psychology* 77: 60–66.

53

The Inquiry Strategy

Arthur L. Costa

The goal of the inquiry strategy is to help students become more aware of the range of problem-solving and critical-thinking behaviors available to them and to improve their ability to apply these behaviors when they are confronted with a problem to which they have no ready answer.

Critical Teacher Behaviors

The teacher or the student may initiate inquiry by posing or identifying a problem (problem focus) that is not explainable using the student's present knowledge; the problem is "discrepant" with the student's expectations, beliefs, or predictions. The teacher can then invite students to form theories to explain away the discrepancy and to gather or generate data to support their theories.

The teacher must establish and maintain a nonjudgmental environment in which students are free to offer theories or explanations that might resolve the problem. This means that the teacher should refrain from agreeing with or signaling the correctness or adequacy of students' explanations, since this would end the inquiry process. Rather, the teacher should help students take responsibility for building and testing their own theories or explanations by determining what data are needed and how these data may be obtained. The teacher should help students learn and know the techniques of data collection and theory formation.

The teacher can help students acquire needed information and data by giving them the opportunity to obtain firsthand data for themselves through experimentation and the observation of results; by providing other data sources such as maps, globes, atlases, dictionaries, tables, charts, and graphs; and by serving as a knowledgeable resource.

To ensure that students develop their metacognitive abilities, the teacher must refrain from influencing students' theories or explanations, avoid summarizing or judging their inquiry problem-solving processes and strategies, and resist stating his or her own explanation or solution to problems. Only then can students experience, become aware of, apply, and evaluate various inquiry problem-solving processes, questioning strategies, organizational skills, alternative strategic methods of reasoning, data production, experimentation, and conclusion drawing.

Evaluation

As a result of repeated experiences with the inquiry strategy, students may be observed to increase their ability to autonomously and voluntarily build and test theories and explanations to problems, and to discuss the strengths and weaknesses of various problem-solving strategies in a wide range of topic areas. They should demonstrate greater awareness of their own problem-solving strategies and spend more time planning rather than reacting impulsively. They should also demonstrate increased inventiveness in designing experimental approaches that will produce and verify the information needed to support a theory.

Background

In 1933 John Dewey described a process of teaching intended to develop the progressive states of what he called "reflective thinking": suggestion, formation of a problem, hypothesis, reasoning, and testing of the hypothesis. When learners engage in reflective thinking, they must use and process data to test the answers they have posed to problems. The inquiry approach to teaching and learning encourages students to ask questions that will lead them to the answers they seek.

In the models of intellectual functioning constructed by Bloom, Piaget, Taba, and others, learners must use significant skills in reflective thinking and go beyond the input-recall stage, into the higher levels of thinking; they must *process and apply* data. As learners make meaning of data through process and application, there is an increased chance that learning will enter long-term memory and become lasting, durable, and applicable to new situations.

The inquiry method of teaching purposely creates situations for students to use and extend the reflective thinking process. Fenton (1968) describes six major steps of inquiry:

1. Recognizing a problem from data
2. Formulating hypotheses
3. Recognizing the logical implications of hypotheses
4. Gathering data on the basis of logical implications
5. Interpreting, analyzing, and evaluating data
6. Evaluating the hypotheses in light of the data.

The process begins with a problem situation. The problem must be discrepant to students; that is, they should be unable to explain the problem with their existing knowledge. Thus, they must create a hypothesis to explain the problem and then gather, organize, and verify information to test the hypothesis for its power to explain and resolve the problem.

J. Richard Suchman (1966), who conceptualized inquiry as an instructional strategy, believed that the more active and autonomous the learner becomes in a learning process and the more he or she takes responsibility for decisions regarding the collection and interpretation of information, the more meaningful the learning becomes and the more motivated the learner becomes. In the inquiry method, the responsibility for initiative and control rests squarely with the inquirers. The individual learner controls the process so that cognitive gains match his or her own goals, thus building learner autonomy.

Members of the Teaching Strategies Center of the Los Angeles County Office of Education have further refined the teaching of inquiry by critically analyzing, classifying, and describing in detail the behaviors and tactics of inquiry teaching (Strasser, Babcock, Cowan, Dalis, Gothold, and Rudolph 1972).

According to Bruner (1961), the potential benefits of the inquiry process include an increase in learner motivation as inquiry brings a shift from extrinsic to intrinsic rewards plus an increased comprehension of the heuristics of discovery. Bruner also notes an increase in intellectual potency and the development of a useful aid to memory by helping the learner organize material according to his or her own interests and cognitive structures.

Goldmark (1968) suggests that the main value of the inquiry method is that it teaches learners how to learn. The objective of the method should be to develop in learners a commitment to inquiry as a useful process. To gain maximum insight into their thinking, Goldmark would include in the process a step in which learners analyze what they do, how they do it, and how an inquiry would differ if they were to take a different viewpoint or pose the problem in a different context.

To teach for inquiry, the teacher must create and sustain the conditions that stimulate the process. Learners must be faced with an event that is discrepant with their idea of the universe. The teacher may manage the presentation of the problem, but must not provide an explanation that narrows the learners' thinking. Working in a climate that allows freedom to successfully gather data and test ideas, learners are allowed to come to grips with the problem in their own terms.

REFERENCES

Bruner, J. S. (Winter 1961). "The Act of Discovery." *Harvard Educational Review* 31, 1: 21–32.

Dewey, J. (1933). "Reflective Thinking." In *How We Think: A Restatement of the Relation of Reflective Thinking to the Educative Process.* Boston: Heath.

Fenton, E. (1968). "Inquiry and Structure." In *Inquiry in the Social Sciences*, edited by R. Allen, J. Fleckenstein, and P. Lyon. Washington, D.C.: National Council for the Social Studies.

Goldmark, B. (1968). *Social Studies: A Method of Inquiry.* Belmont, Calif.: Wadsworth Publishing Co.

Strasser, B., R. Babcock, R. Cowan, G. Dalis, S. Gothold, and J. Rudolph. (1972). *Teaching Toward Inquiry.* Washington, D.C.: National Education Association.

Suchman, J. R. (1966). *Developing Inquiry.* Chicago: Science Research Associates.

54

Making Connections: Toward a Unifying Instructional Framework

Jay McTighe and Rochelle Clemson

During recent years, a number of educational "movements" have affected instructional practice. Each of these instructional approaches has responded to identified educational needs and has provided specific pedagogical prescriptions for addressing those needs, particularly the need for students to develop their thinking skills. Among the most prominent of these models are Cooperative Learning, Direct Instruction, Invitational Education, and Learning Styles.

The widespread dissemination of these models has left practitioners both enthusiastic and confused. The enthusiasm is grounded in the recognition that each of these approaches offers something practical and significant to teachers and students. The confusion lies in what may be referred to as the "coherence problem." The coherence problem appears when two or more of these instructional approaches are introduced into a school or a district. Since they vary in terms of goals, terminology, research base, and pedagogical features, practitioners must frequently choose from among them or attempt some measure of synthesis. In many school districts, the advocates of different models compete for "favorite son" status in terms of available funding, staff development time, and curriculum attention. At the classroom level, teachers are pressured by the differing instructional expectations of peers, department chairs or team leaders, principals, and supervisors. And educators at all levels often hear comments like these:

• "I'm interested in addressing student learning styles, but my supervisor expects me to follow a six-step lesson plan."

• "I'm not sure how the techniques of cooperative learning fit in with our school focus on critical thinking."

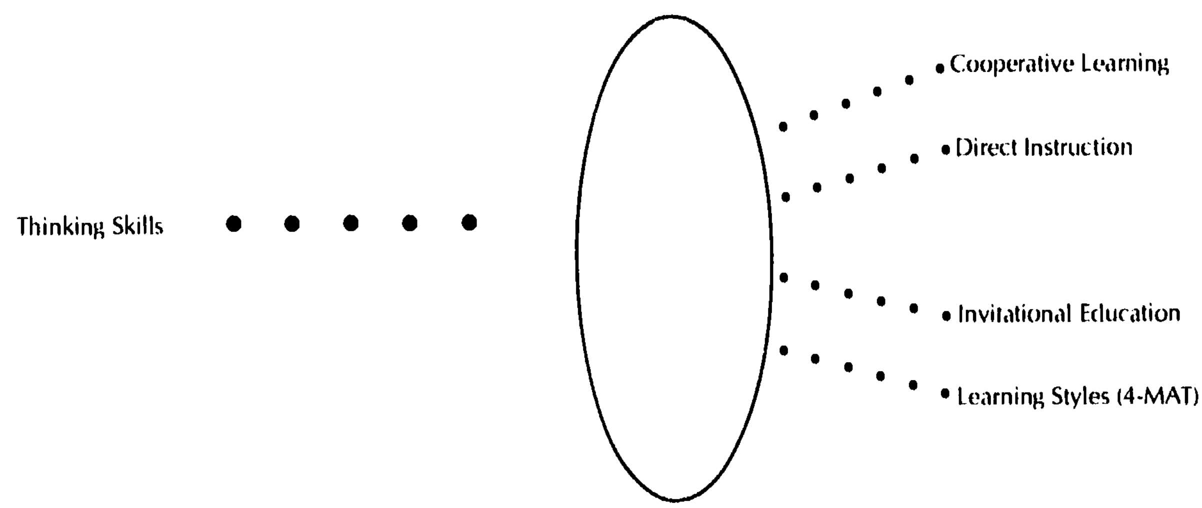
• "We're developing our district's long-range staff development plan. On which instructional models should we concentrate?"

It therefore appears timely to explore the connections among the various models for the purpose of achieving a deeper level of understanding and instructional integration. In this chapter, we seek to contribute to this goal by: (1) exploring the relationships and connections between cooperative learning, direct instruction, invitational education, learning styles, and the efforts to develop students' thinking skills (see Figure 1); (2) examining one organizing framework for assessing and synthesizing various instructional models; and (3) considering implications for staff development practices.

Thinking About Thinking

The goal of developing students' critical and creative thinking skills is certainly not new in education; however, renewed attention to this goal has been stimulated by a number of factors (see McTighe and Schollenberger 1990). For example, analyses of local, state, and national test results reveal that students have improved their performance on "basic skills" items but continue to experience difficulty in such areas as interpretive reading, persuasive writing, and multistep problem solving. In addition, changes in occupational patterns, increased global economic competition, and the "knowledge explosion" have prompted employers,

FIGURE 1



educators, and others to emphasize the importance of developing the skills of logical reasoning, critical thinking, and creative problem solving for the information age. Finally, contemporary models of learning emphasize the constructive nature of knowledge and point out that *meaningful learning* cannot occur without active intellectual engagement with new material. Nearly all of the educational reform reports produced in the 1980s cited reasons such as these in their recommendations that the "basics" include critical and creative thinking.

The current thinking skills movement is anchored by a number of fundamental assumptions regarding the nature of thinking and its development. These assumptions, as identified by McTighe and Schollenberger (1990), are summarized below:

- The thinking abilities of *all* students can be developed through instruction.
- The improvement of thinking should be addressed throughout the grades and should begin in primary classrooms.
- Thinking is fundamental to all subject areas and should be emphasized within each content area.
- Teaching for thinking promotes deeper understanding of content material.
- Cooperative learning exchanges enhance the quality of student thinking and comprehension.
- Current standardized tests do not adequately assess student thinking abilities.

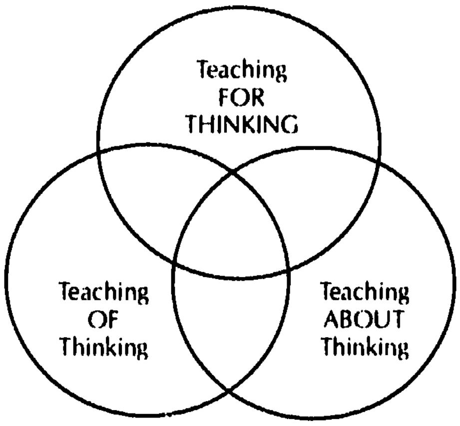
Despite general agreement regarding the importance of developing student thinking abilities, no such consensus has been reached regarding the best way of accomplishing this goal. Some experts maintain, for instance, that good thinking results from extended dialogue and discussion, stimulated by thought-provoking questions. Others argue for more direct instruction in specific thinking skills. Some believe that the most effective means of developing better thinking is through writing, while others advocate attention to "metacognitive" strategies. Philosophers urge us to cultivate the "dispositions" of good thinkers, such as the willingness to consider alternative points of view.

These diverse recommendations suggest that there is no single best method for developing student thinking. Rather, a number of complementary approaches should be used. Brandt (1984) offers a useful framework for considering the various instructional methods for promoting thinking: He proposes that we should be teaching FOR thinking, teaching OF thinking, and teaching ABOUT thinking (see Figure 2).

Teaching FOR thinking includes those teaching strategies that stimulate students to think, including a number of classroom activities that teachers have used for years, such as discussion, problem solving, debate, experimentation, simulations, interpretive reading, and writing. Strategies such as these provide opportunities for students to exercise their thinking abilities. They do not actually teach thinking, however.

The direct teaching OF thinking is based on the belief that effective thinking may not develop automatically as a by-product of other activities and, consequently, that a more explicit approach may be needed. The direct teaching OF thinking makes a selected thinking skill, such as predicting, or a thinking process, such as decision making, the focus of a lesson. The specific steps and strategies involved in applying the skill or process are overtly taught and modeled. Students are then involved through guided practice in using the skill in various contexts within the curriculum.

FIGURE 2



Teaching ABOUT thinking seeks to go further in making the invisible process of thinking visible through discussions with students about the thinking process itself. The goal in teaching ABOUT thinking is to help students become more "metacognitive," or conscious of their own thinking, and more aware of the strategies and dispositions of effective thinkers.

The "FOR, OF, and ABOUT" organizer is not an instructional model. Rather, it is intended to serve as an organizing framework for analyzing different instructional methods designed to improve the quality of student thinking.

Cooperative Learning

Cooperative learning may be broadly defined as any learning activity in which students of diverse backgrounds work together in groups toward a specific goal. Considerable research conducted in recent years substantiates the effectiveness of cooperative learning methods for promoting increased student achievement, improved attitudes toward school, and enhanced interpersonal relations (see Johnson, Maruyama, Johnson, Nelson, and Skon 1981; Slavin 1981). Reports of such cognitive and affective results have sparked a growing interest in cooperative learning methods. Although various cooperative learning designs have been developed, the most effective approaches are united by their adherence to the following principles: *positive interdependence*, whereby the group's success depends upon the performance of each of its members; *cooperative reward structures*, whereby the group is rewarded for effective performance; and *individual accountability*, whereby each individual is held accountable for his contributions to the group.

Cooperative learning promotes the interactive processing of ideas and thus naturally complements other instructional approaches for developing student thinking skills. This natural fit is recognized by the educational researchers Joyce, Showers, and Rolheiser-Bennett (1987), who note that "research into cooperative learning is overwhelmingly positive and the cooperative approaches are appropriate for all curriculum areas. The more complex the outcomes (higher-order processing of information, problem solving, social skills and attitudes) the greater are the effects."

A number of cooperative learning designs are especially well suited to stimulating "higher-order" thought. These designs include peer response groups for writing, group problem solving in mathematics, reciprocal teaching in reading, group investigations and experiments in science, discussions and debates using structured controversies in social studies and home economics, and collaborative projects in any content area.

In addition to the general benefits derived from student interactions, cooperative learning approaches contribute specifically to the development of student thinking in at least three ways. First, since group members are encouraged to share their knowledge, each individual has access to a larger pool of information about which to think. Second, collaborative group structures naturally provide opportunities for students to expand their own thinking by considering different points of view. Third, the articulation of strategies and reasoning within a group helps to render the invisible process of thinking visible for all participants.

Perhaps the connection between thinking and cooperation is best summed up by the adage "No one of us is as smart as all of us."

Thinking Skills and Direct Instruction

The direct instruction model emerged as an outgrowth of attempts to synthesize principles of effective teaching into a practical pedagogical model. Direct instruction emphasizes active teaching and student "time on task." Elements of the model include explicit instruction in identified skills and concepts, guided practice with immediate feedback, frequent reviews and "checks" for understanding, and independent practice. A synthesis of classroom research (Rosenshine 1976) confirms the effectiveness of these instructional elements in increasing student achievement.

How does the direct instruction model relate to efforts to improve the quality of student thinking? A cartoon by Sidney Harris (1978) provides a humorous insight into this relationship. In the cartoon, two professors are examining a blackboard filled with complex mathematical formulas. In the center of the board, amidst the calculations, is the phrase "then a miracle occurs." One professor turns to the other, points to this section of the board, and comments, "I think that you should be more explicit here in step two!" This cartoon may be used to make the point that the "miracle" of good critical and creative thinking may not occur on its own for all students. That is, just asking students "higher-order" questions does not ensure that they will have the thinking skills needed to answer them. Likewise, presenting students with a problem or a writing assignment does not teach the strategies employed by successful problem solvers or writers. And simply holding a classroom debate does not instruct students about how to effectively structure or rebut an argument. In each of these examples, a more explicit approach may be needed to develop specific thinking skills and strategies.

It is in this context that a direct instruction approach is valuable. Any identified thinking skill or process can be taught directly. To this end, Beyer (1987) has identified the following six-step lesson model for introducing any thinking skill:

- Step 1 — Introduce the skill.
- Step 2 — Explain the skill.
- Step 3 — Demonstrate the skill.
- Step 4 — Review what was done.
- Step 5 — Apply the skill.
- Step 6 — Reflect on the skill.

In addition to this directive procedure, Beyer has also developed an inductive and a developmental lesson model for explicitly teaching such fundamental thinking skills as classifying, comparing, evaluating, hypothesizing, sequencing, and summarizing. Direct instruction can also be applied to more complex mental processes, such as decision making and problem solving. Other examples of explicit instruction include the "process approach" to the teaching of writing, through which students are directly taught prewriting strategies such as brainstorming and the use of graphic organizers. Likewise, the contemporary view of reading encourages the direct teaching of comprehension monitoring strategies when necessary.

Although a direct instruction model can certainly be productively applied to the teaching of thinking, several caveats should be mentioned. First, we must be cautious not to fall into the reductionist trap, where dozens of microthinking skills are "drilled and practiced" in artificial contexts without any transfer into meaningful content. Unfortunately, a number of workbooks filled with such exercises are frequently used by well-intentioned teachers interested in "teaching" thinking skills. The research on "transfer" (Perkins and Salomon 1988) points out that, in general, students do not spontaneously apply thinking skills learned in one situation to new contexts. Thus, the direct teaching of thinking skills must include overt attention to the transfer of newly learned thinking skills into various content areas as well as into "real-world," out-of-school contexts.

Second, as Resnick (1987) reminds us, higher-order thinking is more heuristic than algorithmic. That is to say that although there may be certain identifiable elements involved in evaluation, argumentation, and problem solving, these thinking processes do not always follow a rigid, sequential series of steps. In addition, thinking is to some extent idiosyncratic in that individuals employ different strategies for organizing information and solving problems. Teachers interested in teaching thinking directly must remember not to require all students to memorize the *one correct* thinking procedure. Rather, they should take time to discuss the various ways in which students arrive at solutions, encourage students to reflect on their thinking, and serve as models by reflecting on their own thinking processes.

Invitational Education

The foundational principles of invitational education emerged from research that correlated school achievement with the self-concept of learners. This research suggests a reciprocal relationship; that is, students who display positive self-concepts are more successful in school while lower achieving-students tend to have less positive academic self-concepts.

Invitational education advocates contend that the school and classroom environments influence students' self-concepts in ways that are relevant to academic achievement and that educators can intentionally create a more "inviting" environment in order to promote these positive effects (Purkey 1970). As an educational model, invitational education is grounded in four fundamental assumptions regarding learners and the educative process:

> - People are capable, valuable, and responsible and should be treated accordingly.
> - Education should be a collaborative, cooperative activity.
> - People possess untapped potential in all areas of human endeavor.
> - Human potential can best be realized by places, policies, and processes that are specifically designed to invite development, and by people who are intentionally inviting with themselves and others, personally and professionally. (Purkey and Novak 1984)

An educationally inviting school would reflect each of these assumptions within its policies and activities.

A clear connection may be found between the principles of invitational education and the guiding assumptions and instructional practices of the thinking skills movement. Current efforts to improve thinking are grounded in the belief that *all* students can think and that the quality of their thinking can be improved through instruction. This fundamental assertion reflects evolving notions of human intelligence and its development (see Feuerstein and Jensen 1980; Gardner 1983; Sternberg 1984). These contemporary theorists maintain that intelligence is a complex, multifaceted phenomenon, which cannot be legitimately described by a single score from an "IQ test." In addition, they argue that the intelligence is, at least to some extent, educationally modifiable through explicit attention to cognitive and metacognitive processes.

The implications of these ideas have great significance for the nature of educational programming. For example, if one believes that cognitive abilities can be developed through instruction, then one must question whether thinking skills should be reserved primarily for the highly able. In fact, we are witnessing the results of such a reconceptualization on a national scale, as thinking skills programs, once the province of gifted education, are increasingly being advocated for all students. No longer is the notion of "thinking skills for the gifted and basic skills for the rest" a defensible proposition.

Other connections between invitational education and thinking skills are evident at the classroom level. Considerable research has been conducted on the influence of teachers' expectations of students on their instructional practices (Brophy 1983). These studies have shown, for instance, that teachers are less likely to call on "low-achieving" students to respond to thought-provoking questions. In addition, they provide these students with less "wait time" and fewer opportunities for elaboration, even though both of these techniques clearly influence the quality of a student's response. Such practices "disinvite" good thinking and reinforce conceptions of limitations.

Metacognition

A distinguishing characteristic of current programs to develop thinking skills is the attention given to metacognition. Metacognition may be generally defined as knowledge about, and control of, one's cognitive processes. Thinking skills instruction seeks to help students reflect on their own thinking and become more strategic in planning, monitoring, and evaluating their mental performance. Metacognition also includes awareness of attitudes and dispositions, such as a student's conception of himself as a thinker. Recent research (see attribution theory, Weiner 1983; and locus of control, Weinstein 1982) suggests that motivation to perform is strongly influenced by students' belief regarding the extent to which they are in control and have the capability to succeed. If a student's self-concept as a thinker is poor (e.g., "I'm not good at solving math problems," or "I'll never be a good writer"), then the student is unlikely to put forth maximum effort in such situations. Likewise, if a student believes that success depends primarily on luck, raw ability, or other people, then the student may give up easily when confronted with intellectually challenging tasks. The concern of invitational education for cultivating positive student self-concepts is crucial to the realization of the goal of improved thinking. One's self-concept is linked to the cultivation of important *dispositions* or characteristics of effective thinkers, such as persistence, concern for accuracy, and the willingness and flexibility to try new approaches.

Classroom Climate

Finally, the critical influence of classroom climate is strongly acknowledged by advocates of invitational education and thinking skills. In *Dimensions of Thinking* (Marzano, Brandt, Hughes, Jones, Presseissen, Rankin, and Suhor 1988), the authors suggest that "closely related to teachers' behavior is the development of a classroom climate conducive to good thinking. . . . Students cannot think well in a harsh, threatening situation or even in a subtly intimidating environment where group pressure makes independent thinking unlikely. Teachers can make their classrooms more thoughtful places . . . by demonstrating in their actions that they welcome originality and differences of opinion." By embracing and actualizing the principles of invitational education, educators can establish the conditions necessary for the cultivation of critical and creative thinking by students and staff.

Learning Styles

Learning styles, according to Joyce and Weil (1986), are important to consider because they are the "education-relevant expressions of the uniqueness of the individual." Just as it is true that different learning environments affect students in different ways, it is also true that students bring to the learning environment diverse learning preferences. These differences are described in terms of learning styles. Theories regarding learning styles build upon the theoretical work of Bruner (1960) and others who have attempted to explain a phenomenon that many teachers have understood intuitively: students do not perceive and process information

ERIC

in identical ways. For example, some students prefer to have information presented in visual form while others are more comfortable with verbal stimuli. And some learn best through concrete experiences while others enjoy abstract conceptualization. To accommodate these difference in the classroom, a number of educators have developed learning styles models. Currently, 4MAT (McCarthy 1981) is one of the most popular models.

Based on a synthesis of the theoretical and practical work on learning styles, McCarthy developed the 4MAT system, an eight-step cycle of instructional methods, which appeals to four major learning styles. The learning styles in 4MAT are *Type One* (innovative), *Type Two* (analytical), *Type Three* (common sense), and *Type Four* (dynamic). According to McCarthy, Type One learners ask "Why?"; they need to be given reasons. Type Two learners, on the other hand, ask "What?"; they seek facts that deepen their understanding. Type Three students ask "How?"; they need to be permitted to experiment and try things. Type Four learners' favorite questions are "If" questions; teachers are advised to allow Type Four learners to teach themselves and others.

In order to be effective with all students, teachers must employ a variety of instructional strategies to accommodate all learners. Type One learners, for example, learn best through brainstorming and interacting, while Type Two learners prefer observing, analyzing, and classifying. Type Three learners excel at manipulating materials and ideas. Type Four learners need activities that permit them to modify, adapt, and intuit. The optimal instructional program, McCarthy contends, provides opportunities for each type of student to be comfortable at least part of the time and "stretched to develop other abilities" the rest of the time.

The richness of the 4MAT model provides diverse opportunities for teachers to engage students in "higher-order" thinking. According to McCarthy, students must be encouraged to reflect and analyze in order to optimize learning. This approach is consistent with the views of experts such as Presseisen (1985) and Costa (1990), who stress the importance of metacognitive strategies as key to developing students' thinking abilities. McCarthy's belief that the legitimate goal of instruction is to "lead students to self-discovery, not the regurgitation of facts and figures" complements the orientation of thinking skills advocates. Her model accommodates the direct instruction of such thinking skills as classifying, hypothesizing, and drawing conclusions. Proponents of thinking skills instruction also emphasize the need to provide opportunities for students to interact and collaborate, analyze and reflect. The inclusion of cooperative learning strategies in the 4MAT model appeals to Type One "socializers," while providing *all* students with opportunities to work together in small groups and teams.

In sum, McCarthy's 4MAT system is structured to assist teachers in honoring the individuality of their students through the instructional methods and activities that they select. It provides a practical, student-centered model that naturally complements instructional approaches for developing thinking skills.

Putting It All Together: An Organizing Framework

Attempts to analyze and synthesize diverse teaching approaches are assisted by the use of a common instructional framework. One such framework has been proposed by a group of leading educators (Hanson, Marzano, Silver, Strong, and Wolfe 1989). Their framework consists of five components, which are acknowledged as important to the learning process, and serves as an organizing construct for examining any instructional model:

- *Motivation.* To what extent does this model use intrinsic and extrinsic approaches for motivating students?
- *Memory.* In what ways does this model assist learners in storing and retrieving information in long-term memory?
- *Meaning.* To what extent does this model involve students in the active construction of meaning? How is this accomplished?
- *Transfer.* In what ways does this model teach and encourage students to productively apply knowledge in new contexts?
- *Metacognition.* To what extent are students instructed in metacognitive strategies and dispositions?

Different instructional models may be compared using a matrix design (see Figure 3). In addition, the framework serves as a base from which a synthesis of models can be constructed.

Such a matrix could be developed using different learning variables on the vertical axis. Likewise, other instructional models, such as Writing Across the Curriculum, Mastery Learning, or TESA could be inserted along the horizontal.

Implications for Staff Development

Teachers, like students, are a diverse population. Their differing teaching experiences and training programs have led to the development of unique and personal models of teaching. According to Arends (1988), teachers expand their instructional repertoires by integrating newly learned techniques into their existing "teaching schemata." The struggle that many educators are experiencing in attempting to integrate the different instructional models is similar to the process that students go through in trying to understand new material they encounter in school. Schema theory tells us that

FIGURE 3

	Cooperative Learning	Direct Instruction	Invitational Education	Learning Styles	Thinking Skills
Motivation					
Memory					
Meaning					
Transfer					
Metacognition					

new information and concepts must be integrated into one's existing knowledge structures, or "schemata," for true comprehension to occur (see Rumelhart and Ortony 1977). This view characterizes learning as an active, constructive process by which the learner links the new input with prior knowledge. Meaningful learning, therefore, requires that students go beyond rote memorization and become intellectually engaged with new material. They should actively think about and puzzle over new concepts in order to develop a personal understanding. Teachers, administrators, and supervisors confronted with various models are immersed in a similar intellectual activity as they attempt to develop an expanded organizing schema to help make sense of the plethora of instructional options.

In order to facilitate a deeper level of understanding and integration, current staff development programs should include opportunities for experienced educators to actively explore the connections among various instructional models. Due to the idiosyncratic nature of an individual's teaching schemata, it is unlikely that a single, integrated instructional model will be effective for all educators. Rather, the process of exploring and discussing these connections with other educators will contribute to the construction of a personal synthesis that is meaningful and accessible to the individual.

Conclusion

The fact that there is now a rich marketplace of instructional theories, models, and techniques is cause for celebration. The classroom teacher has many options for designing and implementing an instructional program to meet the needs of the diverse student population in today's schools. Today's teachers, however, face the problem of "idea overload" as new teaching techniques are introduced, and sometimes mandated, by school districts. Likewise, it is not uncommon for educational planners to feel overwhelmed by the many instructional prescriptions that they encounter in educational journals and at conferences. In the language used in this chapter, many educators have not had sufficient time to incorporate the various approaches to instruction into their instructional schemata. In some instances, the problems of overload and fragmentation result in frustration and cynicism on the part of practitioners at all levels, often expressed through a "this-too-shall-pass" attitude of passive resistance to new ideas.

In this era of potentially competing approaches to instruction, it is important to take time to actively explore the connections among the various instructional models. Effective teachers do not adhere to a single, prescriptive teaching model. Instead, they make instructional decisions based on analyses of their objectives, the nature of the curriculum, students' age levels and learning characteristics, the available resources, and their preferred teaching styles (see Berliner 1988). By "making connections," they capitalize on the diverse strengths of the various instructional models.

REFERENCES

Arends, R. (1988). *Learning To Teach*. New York: Random House.

Berliner, D. (1988). *The Development of Expertise in Pedagogy*. Paper presented at meetings of the American Educational Research Association, New Orleans, La.

Beyer, B. (1987). *Practical Strategies for the Teaching of Thinking*. Boston, Mass.: Allyn and Bacon.

Brandt, R. (1984). "Teaching of Thinking, for Thinking, About Thinking." *Educational Leadership* 42, 1: 3.

Brophy, J. R. (1983). "Research on the Self-Fulfilling Prophecy and Teacher Expectations." *Journal of Educational Psychology* 75, 5: 631–661.

Bruner, J. (1960). *The Process of Education*. Cambridge, Mass.: Harvard University Press.

Costa, A., ed. (1990). *Developing Minds: A Resource Book for Teaching Thinking.* 2nd ed. Alexandria, Va.: Association for Supervision and Curriculum Development.

Feuerstein, R., and M. Jensen. (1980). "Instrumental Enrichment: Theoretical Basis, Goals, and Instruments." *Education Forum* 46: 401–423.

Gardner, H. (1983). *Frames of Mind: The Theory of Multiple Intelligence.* New York: Basic Books.

Hanson, R., B. Marzano, H. Silver, R Strong, and P. Wolfe. (1989). *School Is a Home for the Mind.* Workshop publication used at ASCD National Conference, Orlando, Fla.

Harris, S. (1978). *What's So Funny About Science?* Los Altos, Calif.: William Kaufmann.

Johnson, D., G. Maruyama, R. Johnson, D. Nelson, and L. Skon. (1981). "The Effects of Cooperative Learning, Competitive, and Individualistic Goal Structures on Achievement: A Meta-Analysis." *Psychological Bulletin* 89: 47–62.

Joyce, B., B. Showers, and C. Rolheiser-Bennett. (1987). "Staff Development and Student Learning: A Synthesis of Research on Models of Teaching." *Educational Leadership* 45, 11: 17.

Joyce, B., and M. Weil. (1986). *Models of Teaching.* 2nd ed. Englewood Cliffs, N.J.: Simon and Schuster.

Marzano, R., R. Brandt, C. Hughes, B. Jones, B. Presseisen, S. Rankin, and C. Suhor. (1988). *Dimensions of Thinking.* Alexandria, Va.: Association for Supervision and Curriculum Development.

McTighe, J., and J. Schollenberger. (1990). "Why Teach Thinking: A Statement of Rationale." In *Developing Minds: A Resource Book for Teaching Thinking,* 2nd ed., edited by A. Costa. Alexandria, Va.: Association for Supervision and Curriculum Development.

McCarthy, B. (1981). *The 4MAT System: Teaching to Learning Styles with Right/Left Mode Techniques.* Barrington, Ill.: Excel Inc.

Perkins, D. and G. Salomon. (1988). "Teaching for Transfer." *Educational Leadership* 46, 1: 22–32.

Presseisen, B. (1985). *Thinking Skills Throughout the K–12 Curriculum: A Conceptual Design.* Philadelphia, Pa.: Research for Better Schools.

Purkey, W. (1970). *Self Concept and School Achievement.* Englewood, Cliffs, N.J.: Prentice-Hall.

Purkey, W., and J. Novak. (1984). *Inviting School Success: A Self-Concept Approach to Teaching and Learning.* 2nd ed. Belmont, Calif.: Wadsworth.

Resnick, L. (1987). *Education and Learning to Think.* Washington, D.C.: National Research Council.

Rosenshine, B. (1976). "Classroom Instruction." In *Psychology of Teaching: The 77th Yearbook of the National Study of Education,* edited by N. Gage. Chicago, Ill.

Rumelhart, D., and A. Ortony. (1977). "Representation of Knowledge in Memory." In *Schooling and the Acquisition of Knowledge,* edit ' by R. C. Anderson, R. J. Spior, and W. E. Montague. Hillsdale. N.J.: Lawrence Erlbaum.

Slavin, R. (1981). "Synthesis of Research on Cooperative Learning." *Educational Leadership* 38, 8: 655–660.

Sternberg, R. (1984). *Beyond IQ: A Triarchic Theory of Human Intelligence.* New York: Cambridge University Press.

Weiner, B. (1983). "Attribution Theory, Achievement Motivation and the Educational Process." *Review of Educational Research* 42: 203–215.

Weinstein, R. (1982). "Student Perceptions of Schooling." Paper presented at the Conference on Research on Teaching: Implications for Practice, Warrenton, Va.

PART VIII

Assessing Growth in Thinking Abilities

After several years of intensive work on these matters, the improvements in students' higher mental process learning and achievement became very pronounced. These and other approaches made it clear that most students could learn the higher mental processes if they became more central in the teaching-learning process.

—Benjamin Bloom

The task of aligning curriculum is usually composed of three major decisions: (1) establishing the purposes, outcomes, goals or objectives of the educational enterprise, be it at the classroom, school, district, state, or national level; (2) designing the delivery system by which those goals will be achieved, including instructional design, materials selection, allocation of time and placement of learnings; and (3) developing procedures for monitoring, collecting evidence of, and evaluating the achievement of our goals as a result of employing our delivery system.

In the curriculum alignment process, sound educational practice dictates that the first group of decisions (the goals) needs to drive the system. Like it or not, what is inspected is what is expected; what you test is what you get. The traditional use of norm-referenced, standardized tests has dictated what should be learned (the goals) and has influenced how it should be taught (the delivery).

As evidenced in the preceding chapters, educators realize that new goals for the next century are becoming increasingly apparent as survival skills for our children's future, for the continuity of our democratic institutions, and even for our planetary existence. Such goals include:

- The capacity for continued learning
- Cooperativeness and team building
- Precise communication in a variety of modes
- The appreciation of disparate value systems
- Problem solving that requires creativity and ingenuity
- The enjoyment of resolving ambiguous, discrepant, and paradoxical situations
- The generation and organization of an overabundance of technologically produced information
- The craftsmanship of product
- High self-esteem
- Personal commitment to larger organizational and global values

These new goals need to drive the new curriculum alignment in thoughtful schools of the future. The delivery system—curriculum materials, instructional strategies, school organization, and the curriculum alignment decision-making processes employed—needs to embody these goals not only for students but for all of the school's inhabitants.

Likewise, our methods of assessment must be transformed to become more consistent with our new goals. We cannot employ product oriented assessment techniques to assess the achievement of process oriented goals. Norm-referenced, standardized test scores give us a static number that reflects the achievement and performance of isolated skills at a particular moment in a lifetime. Thinking, however, is dynamic: we learn from experience, react emotionally to situations, experience power in problem solving, and are energized by the art of discovery. Thus, testing thinking may indeed be an oxymoron.

We are witnessing a nationwide surge to go "beyond the bubble" of traditional testing (California State Department of Education Curriculum Assessment Alignment Conference 1989). State departments of education are providing leadership by experimenting with and advocating innovative assessment methods, such as writing samples, materials manipulation, open-ended multiple-answer questions, and portfolios. Teachers are learning how to more skillfully collect data about students' use of thinking skills through direct observation, group projects and discussions, anecdotal records, recording critical incidents, keeping checklists, journal writing, and engaging students in extended projects.

Such innovative methods are more useful than traditional testing for several reasons. First, they resemble the situations in which real problem solving and creativity are demanded; they are not contrived. Second, they allow teachers to more accurately diagnose students' abilities. Third, they take place during instruction rather than after instruction is completed. Furthermore, they provide more immediate results that assist teaching teams in evaluating the effectiveness of curriculum and instructional efforts. Finally, they provide "real-time" feedback to students themselves, who are (or who must become) the ultimate evaluators of their own performance.

To ensure the success of new assessment efforts, educators need to address several tasks:

1. *Reestablish the school-site team as the locus for accountability.* For too long the process of assessment has been external to teachers' goal setting, curriculum, and instructional decision making. School effectiveness, student achievement, and teachers' competence have often been determined by a narrow range of standardized student achievement test scores in reading, math, and language acquisition. Test results have been published in rank-order in newspapers. Awards of excellence have been given to schools that show the highest gains in scores. Teachers have been given merit pay based on their students' performance. In the process, teachers have been disenfranchised. Educators have had little say about what the tests measured. In fact, what tests do measure is usually irrelevant to the curriculum, and the results of the testing disclose little about the adequacy of teachers' curriculum and instructional decisions.

Accountability in the restructured school will be relevant to the staff because it will be used as a guide to informed and reflective practice. Of course, staff members will need training to learn how to use this feedback

2. *Expand the range, variety, and multiplicity of assessment techniques.* For too long we have relied on a limited range of acceptable measures, primarily paper-and-pencil tests. Enlightened, skillful teachers are the best collectors of data about students' growth in using process skills. They are able to observe students in problem-solving situations that demand cooperation, problem solving, and creativity. The data they collect over time in real-life classroom and school situations is probably "harder," more objective data than those collected on standardized achievement tests.

Our repertoire needs to be expanded to include assessments such as direct observation, portfolios of selected student work collected over time, performance in extended projects, logs or journals, student interviews, videotapes of student interactions, writing samples, and the like.

3. *Systematizing assessment procedures.* Actually, skillful teachers already assess their students in many of the above ways. What is lacking is a systematic way of doing so. Staff members need to refine their skills of observation and work for interrater reliability. They need to identify and define terms and adopt common goals. They need to continually scrutinize the curriculum to ensure that goals, instruction, and assessment are aligned. Teachers, parents, administrators, and students will all need to clearly see the school's objectives and purposes, and all will become more involved in collecting data, revising perceptions, and realigning practices.

4. *Reeducating legislators, parents, board members, and the community.* Educators have allowed people to use test scores to evaluate their schools, students, and teachers without helping them see that other, more significant, nonmeasurable objectives can also be documented using a variety of reliable sources and techniques. Political decisions about testing, schooling, curriculum, and teacher competencies will become the loser to educational principles.

5. *The process of evaluation will become internal for students.* We must constantly remember that the ultimate purpose of evaluation is to have students become self-evaluating. The highest level of Bloom's Taxonomy is generating, holding, and applying a set of internal and external criteria. For too long, adults alone have been practicing that skill. We need to gradually shift that responsibility to students. Our goal must be to help students develop the capacity to modify themselves.

REFERENCE

California State Department of Education Curriculum Assessment Alignment Conference. (October 16, 1989). Sacramento.

55

California: The State of Assessment

Robert L. Anderson

Children Are Active Meaning Makers.
The structure of the curriculum,
The forms of instruction,
The modes of assessment,
All follow from this simple sentence.
—epigraph by the author for the 1989
CAP "*Beyond the Bubble*" conferences

Assessment and Educational Reform

We are in the profession of education because we want to prepare our children to live their lives well. Our goal is for all of our children to develop the knowledge, skills, problem-solving capacities, and wisdom necessary to assure successful lives in the 21st century.

One of the primary goals in our struggle for educational reform in California has been to improve and strengthen educational assessment. Assessment serves many important purposes, but above all it gives educators the tools to evaluate the quality of students' learning. If we are to make effective educational reforms, we must discover what students know, what they can do with their knowledge and skills, and how well they are being prepared for the next level of education and for life beyond the school years. We need the right kinds of assessments to provide us with that information.

What you test is what you get. This once controversial axiom is fast becoming the conventional wisdom. Educational assessment and curriculum development are interactive, linked in a circle of cause and effect. We design a test to assess the curriculum, and then curriculum and instruction are redesigned to increase performance levels on the test. But if the test is not a full and complete measure of true achievement, the pressure for higher test scores will distort what is taught and how we teach it.

Multiple-choice tests have focused on the production and assessment of discrete, elementary skills developed and evaluated in a vacuum—skills that do not add up to effective performance capacities, the outcomes that really matter. This form of testing, so fundamental to our system of comparative evaluations, cannot tell us what we need to know: how well our students can apply what they learn to problems—problems that are patterned after the real-life situations they will encounter outside the school walls.

If the limitations of these multiple-choice tests merely revealed their irrelevance to the assessment of higher-order thinking, their results might still prove useful. After all, they do indicate the breadth of knowledge with which students are familiar and some rudimentary inferential and interpretative skills. But significant difficulties arise when standardized, multiple-choice tests are also used as a primary accountability tool, as if they were complete indicators of all of the essential dimensions of student learning. School districts and their instructional programs are evaluated comparatively using the results of these tests. District administrators, curriculum developers, principals, and teachers are under tremendous pressure to develop a curriculum and instructional program that will raise scores on these tests. The knowledge and skills that are assessed become the knowledge and skills that are valued. And effective teaching is teaching to this test. The assessments drive the curriculum,

This chapter was prepared by Robert Anderson based on materials developed by the staff of the California Assessment Program. All sample test items and quotations from CAP documents have been copyrighted by the California State Department of Education.
Copyright © 1990 by Robert Anderson.

and the assessment design de'igns instruction.

Administrators, teachers, and students alike raise one fundamental objection to standardized multiple-choice tests: as one teacher says, "They don't measure what matters! They don't show the ways in which I am truly an effective teacher nor what my students have really learned. They do not allow us to evaluate the quality of our students' preparation for life."

In our best classrooms, students show teachers their ability to analyze, organize, interpret, explain, evaluate, and communicate important experiences. They demonstrate that they can convey meaning, produce objects or results, and act in ways that matter to them and to the community.

These capacities, these qualities of teaching and learning that really matter, can be described, developed, encouraged, and expanded with the support of a system of authentic assessments. Such assessments would mirror the process of learning in the classroom, drawing higher-level responses from students. We can best draw inferences about student knowledge and skill by assessing performances that provide access to both the process and end-product of a complex task that involves higher-level thinking. Current assessments do this in only a very limited way. Ideally, the assessments should place students in situations that interest them, allowing them to express themselves fully and to generate a valued outcome.

The message of the past was clear: as far as the best in instruction and the higher levels of learning were concerned, not to evaluate them was not to value them. We have the opportunity now to create new, more authentic assessments that truly provide access to the finest curriculum and the best teaching. Such assessments can fuel enthusiasm and motivate students and teachers to higher levels of performance. They will be held accountable for nothing but the best that they can to.

The California State Department of Education, through its California Assessment Program (CAP), is in the process of developing assessments of the forms of learning that really matter—the culminating activities that fruitfully integrate knowledge and skill and reveal the capacity for productive, independent thinking that identifies our students as fully prepared to succeed in the world.

Assessing the Core of the Academic Curriculum

More powerful indicators of student learning are emerging on the horizon. The new California curriculum frameworks set the standard: curriculums must be literature based, value laden, culturally rich, and integrated across content areas. Students must develop the knowledge and skills necessary to analyze, organize, interpret, and evaluate their experience and to apply that learning fruitfully in their own lives.

The development and implementation of the new CAP tests have already affected curriculum and instruction. By adding science, history, and essay writing components to the grade 8 test, CAP signaled the essential importance of these content areas and skills, and schools have responded with reinvigorated programs in these areas. The grade 12 test has been thoroughly revised to incorporate open-ended mathematics items, a direct writing assessment, and items that demand sophisticated critical thinking. The tests at other grade levels are being developed and revised in comparable ways.

To support educational reform, CAP will test more content areas at more grade levels, and new testing formats will be introduced in all content areas at all grade levels tested (ultimately to include open-ended, short-answer, essay, performance, portfolio, oral, and integrated assessments). Evaluating student work in these testing formats is both labor-intensive and time-consuming, so systemwide assessment will probably combine local and regional scoring with a more limited sampling of student performances for program evaluation.

The California State Department of Education is committed to the process of developing a comprehensive set of performance standards to evaluate student achievement. Students will be challenged to show what they can do with a rich array of assessments, including complex, integrated performance tasks. The standards will not only embody California's educational goals in terms of performance capacities and outcomes, but will also establish a full spectrum of performance levels and indicate the percentage of students who are reaching them.

This vision is expressed in CAP's statement, prepared for the "Beyond the Bubble" 1989 Curriculum/Assessment Alignment Conferences and shown in Figure 1.

To make this vision a reality, CAP is enriching systemwide assessments. New forms of assessment are being added to evaluate fully what our students are learning in English–language arts, mathematics, science, and history–social science.

Performance Assessment in English–Language Arts

California already has one performance assessment in place at two grade levels. The CAP direct writing assessment was introduced at grade 8 in spring 1987 and at grade 12 in December 1988, and we are moving toward an integrated reading–writing language arts assessment for grades 3 and 6. This state-of-the-art, teacher-developed writing assessment

FIGURE 1

What if . . .
A Vision of Educational Assessment in California

- **What if** students found assessment to be a lively, active, exciting experience?
- **What if** they could see clearly what was expected of them and believed that the assessment provided a fair opportunity to show what they had learned?
- **What if** they were challenged to construct responses that conveyed the best of what they had learned—to decide what to present and how to present it—whether through speech, writing, or performance?
- **What if** they were educated to assess themselves, to become accurate evaluators of the strengths and weaknesses of their own work, and to prescribe for themselves the efforts they must make to improve it—ultimately, the most important form of assessment available to our students?
- **What if** the assessment allowed students to use their own backgrounds and indicated ways of building on their strengths for further learning?
- **What if** their learning were recognized by the school and the community when they had made outstanding progress—regardless of their initial level of achievement?
- **What if** teachers could look at the tests and say, "Now we're talking about a fair assessment of my teaching:
  - — one that focuses on the essence of the student outcomes that I am striving for—not one that focuses on the peripheral skills of the isolated facts which are easiest to measure;
  - — one that shows they can produce something of value to themselves and to others—an argument, a report, a plan, an answer or solution; a story, a poem, a drawing, a sculpture, or a performance; that they can conduct an experiment, deliver a persuasive oral presentation, participate cooperatively and productively in groups;
  - — one that is accessible to all my students, yet stretches the most capable students as well—not one that measures some mythical minimum competency level;
  - — one that matches the assessment that I use on a day-to-day basis to guide my teaching and that guides my students in their learning—not one that takes an artificial form and then naively expects students to give a natural response in an artificial situation;
  - — one that doesn't take valuable time from the teaching/learning process, but is an integral part of that process;
  - — one that doesn't treat me as a "Teller of Facts," providing and prescribing the concepts and the content that students are to study—but rather as a coach and a fellow learner, helping my students to become active learners who are prepared to discover what is important to them now and enthusiastic about learning in the future."
- **What if** the new assessment led parents, taxpayers, legislators, and the business community to exclaim:
  - — "I can see that the schools are focusing on the important things—that students are achieving levels of academic excellence which truly prepare them for the future."
  - — "I can see that students are learning what they need to fulfill themselves as individuals, to become concerned and involved citizens and workers who can adapt to the changing demands of our world—creative people who can think and take initiative, who care about what they do, and who can work with others to solve problems."
  - — "I can see the results in the newspapers which give me the information I need in terms I can understand, which show me the progress our schools are making on assessments that really matter, and where they need my help and support."

The California Assessment Program is committed to making this vision a reality:

- — a reality for students who are being challenged to achieve excellence in schooling that truly prepares them for life;
- — a reality for teachers who will find their best teaching assessed and rewarded;
- — a reality for the parents, taxpayers, legislators, and businesses so vitally interested in the success of the educational enterprise.

Please join us in accepting the challenge to create the new forms of assessment which will make this vision a reality.

is unique in the breadth of writing types assessed; in the sophistication of its testing, scoring, and reporting systems; and in the involvement of, and support services for, teachers. It is grounded in the principle that our assessments should include only those tasks that will stimulate high-quality instruction.

Teachers on the CAP Writing Development Team develop all the testing and instructional materials for the assessment. For every type of writing assessed, the team develops a special set of prompts (writing tasks) and a scoring guide that identifies the thinking and writing requirements for that type of writing—without being narrow, prescriptive, or formulaic.

Essays are scored in four to six days by several hundred teachers at four regional scoring centers. A special handbook for each grade level provides teachers with practical instructional materials for each type of writing, including sample prompts, illustrative essays, and related readings. And a three-part reporting system provides teachers, administrators, legislators, and the public with comprehensive information about student writing achievement in their local schools and throughout the state. The California Writing Project, California Literature Project, and others carry the critical information about the project to teachers.

The direct writing assessment has been an outstanding success. Educators throughout the state say that no program has ever had such a statewide influence on instruction. In an unpublished survey conducted in 1989 by the Center for the Study of Writing at U.C. Berkeley, 78 percent of the teachers surveyed said that they assign more writing than they did before the writing assessment was introduced, while 94 percent said that they assign a greater variety of writing tasks. Furthermore, the percentage of students in this survey who reported writing 11 or more papers in a six-week period jumped from 22 percent in 1987 to 33 percent in 1988. The writing assessment has also motivated a phenomenal amount of staff development—the California Writing Project alone has trained over 10,000 teachers.

Figure 2 shows an excerpt from *Writing Achievement of California Eighth Graders: A First Look*, the first statewide report of student performance on a direct writing assessment (California State Department of Education 1988b). The sample describes and gives an example of the performance of 8th grade students when they were asked to write an evaluative essay.

The rubric in Figure 3 establishes the standards for scoring the student essays on evaluative topics. Included are the percentages of students statewide who scored at each of the six achievement levels.

Integrated Language Arts Assessment. It is the charge of the California Assessment Program to develop and implement tests in English–language arts that reflect the meaning-centered, literature-based curriculum described in California's *English–Language Arts Framework* (California State Department of Education 1990b). The new, integrated reading and writing test aims to measure how well students are able to make meaning through the active processes of reading, talking, listening, and writing. Encouraged and as-

FIGURE 2

Evaluative Essay Sample

Evaluation. Students were asked to write an evaluative essay, make judgments about the worth of a book, television program, or type of music and then support their judgments with reasons and evidence. Students must consider possible criteria on which to base an evaluation, analyze their subject in light of the criteria, and select evidence that clearly supports their judgments. Each student was assigned one of the following evaluative tasks:

- To write a letter to a favorite author telling why they especially liked one of the author's books.
- To explain why they enjoyed one television program more than any others.
- To justify their preference for a particular type of music.

The tasks made clear that students must argue convincingly for their preferences and not just offer unsupported opinions.
This is a sample essay from a student who demonstrated exceptional achievement:

Rock Around the Clock

"Well, you're getting to the age when you have to learn to be responsible!" my mother yelled out.

"Yes, but I can't be available all the time to do my appointed chores! I'm only thirteen! I want to be with my friends, to have fun! I don't think that it is fair for me to baby-sit while you go run your little errands!" I snapped back. I sprinted upstairs to my room before my mother could start another sentence. I turned on my radio and "Shout" was playing. I noted how true the song was and I threw some punches at my pillow. The song ended and "Control", by Janet Jackson came on. I stopped beating my pillow. I suddenly felt at peace with myself. The song had slowed me down. I pondered briefly over all the songs that had helped me to control my feelings. The list was endless. So is my devotion to rock music and pop rock. These songs help me to express my feelings, they make me wind down, and above all they make me feel good. Without this music, I might have turned out to be a violent and grumpy person.

Some of my favorite songs are by Howard Jones, Pet Shop Boys, and Madonna. I especially like songs that have a message in them, such as "Stand by Me", by Ben E. King. This song tells me to stand by the people I love and to not question them in times of need. Basically this song is telling me to believe in my friends, because they are my friends.

My favorite type of music is rock and pop rock. Without them, there is no way that I could survive mentally. They are with me in times of trouble, and, best of all, they are only a step away.

California classroom teachers wrote comments like these after reading and scoring students' evaluative essays:

- "Evidence of clear thinking was heavily rewarded in our scoring."
- "I am struck by how much some students can accomplish in 45 minutes; how well they can sometimes marshall the ideas; and with how much flair and sparkle thev can express themselves."
- "More emphasis should be placed on critical thinking skills, supporting judgments, and tying thoughts and ideas together. Far too many papers digress, summarize, underdevelop, or state totally irrelevant facts."
- "Students generally need to develop skills in giving evidence to support their judgments. I plan to spend more time on these thinking skills next year."

Source: California State Department of Education 1988.

sisted by informed professional and governmental leadership, teachers are designing the new test to reflect their own classroom experiences as well as current theory and research. Recognizing the relationship between testing and teaching, CAP's test development team is designing a test to assess the work of students actively engaged in typical classroom activities—reading, talking, writing, and thinking about literature and human experience. The underlying goal of the integrated reading and writing assessment is to develop our students' capacities for flexible, insightful,

FIGURE 3

CAP Grade 8 Direct Writing Assessment
Achievement in Evaluation

Score Point	Percentage of California Grade 8 Students*	Cumulative Percentage	Description of Achievement
6 Exceptional Achievement	0.5		The student produces convincingly argued evaluation; identifies a subject, describes it appropriately, and asserts a judgment of it; gives reasons and specific evidence to support the argument; engages the reader immediately, moves along logically and coherently, and provides closure; reflects awareness of reader's questions or alternative evaluations.
5 Commendable Achievement	8.1	8.6	The student produces well-argued evaluation; identifies, describes, and judges its subject; gives reasons and evidence to support the argument; is engaging, logical, attentive to reader's concern; is more conventional or predictable than the writer of a 6.
4 Adequate Achievement	25.5	34.1	The student produces adequately argued evaluation; identifies and judges its subject; gives at least one moderately developed reason to support the argument; lacks the authority and polish of the writer of a 5 or 6; produces writing that, although focused and coherent, may be uneven; usually describes the subject more than necessary and argues a judgment less than necessary.
3 Some Evidence of Achievement	42.4	76.5	The student states a judgment and gives one or more reasons to support it; either lists reasons without providing evidence or fails to argue even one reason logically or coherently.
2 Limited Evidence of Achievement	19.2	95.7	The student states a judgment but may describe the subject without evaluating it or may list irrelevant reasons or develop a reason in a rambling, illogical way.
1 Minimal Evidence of Achievement	3.6	99.3	The student usually states a judgment but may describe the subject without stating a judgment; either gives no reasons or lists only one or two reasons without providing evidence; usually relies on weak and general personal evaluation.
No Response	0.3		
Off Topic	0.5		

*This column does not total to 100% because of rounding.

productive thinking by supporting curriculum and instructional programs that fully embody our highest aspirations.

The test is designed to ask students to make meaning rather than identify "correct" meanings that test-makers have posited. The assessment tasks will challenge students to discover for themselves what is important, meaningful, and valuable in a text and to create written responses to give evaluators a window on the process of student thinking—to articulate the ways they actually construct meaning from text.

There is no single model for this assessment, but here is a description of one prototype for the integrated reading and writing test.

I. FOCUS ON READING.

Reading Situation—forecasts all reading, talking, and writing activities; introduces the reading passage; and establishes a purpose for reading.

Anticipating the Reading—asks students to write briefly using their prior knowledge.

Reading Process—may ask students to reread and make marginal notes, underline, list, cluster, comment, or create a dialectical journal entry.

Initial Response—asks students to make an immediate, personal response.

Discussion—may ask students to talk about the text with a partner or small group. Teachers maybe asked to record their observations about the discussions.

Written Interpretation—will ask students to respond to open-ended questions that provide evidence of students' growing understandings of the text, encouraging them to incorporate their own experiences and prior knowledge.

Reflections on the Reading Experience—may ask students to reflect on their own reading processes—their patterns of thought, the strategies or procedures they employ.

II. FOCUS ON WRITING

As in the reading section of the test, directions to students establish a purpose for their writing and provide them with a scaffold for transforming their tentative, reading-based written responses into a more authoritative, elaborate, focused piece of writing for a given audience. The writing portion of this integrated assessment will use matrix sampling, and, as appropriate to the reading passage, ask students to create the full breadth of writing types now assessed in the Direct Writing Assessment. The writing prompts contain two parts:

The Writing Situation—orients students to the type of writing they will do and its purpose, focusing students' thinking and helping them anticipate problems they must solve. In this prototype for the integrated reading and writing test, the writing situations establish both the purpose and context for writing by linking the writing task to earlier reading activities.

The Directions for Writing—restate the purpose, mention the intended audience, and suggest requirements and features of the writing type—without being prescriptive or formulaic.

Variations in Test Format. There are a number of possible variations in test format. In contrast to the prototype just described, the writing test could precede the reading test, allowing an assessment of a students' prior knowledge or experience of the subject of the reading passage that will follow. Other model designs call for self-contained, separate reading and writing tests integrating the full spectrum of supporting student activities—extended group process, speaking and listening, prewriting and revision. While we are currently planning for the integrated test to be given over two class periods, we also plan to pilot test formats that call for other time frames.

Issues in Mathematics Assessment

CAP plans to develop several modes of assessment in mathematics, of which multiple-choice questions will be only one part. The assessment modes employed will reinforce good curriculum practices as emphasized in the forthcoming *California Mathematics Framework* (California Department of Education 1990a) and *Standards for School Mathematics* (National Council of Teachers of Mathematics 1989) and will try to reliably capture authentic student outcomes.

After much discussion, CAP's Mathematics Assessment Advisory Committee (composed of teachers, curriculum specialists, and researchers in coordination with the California Mathematics Project) decided to pilot three new assessment components: free response questions, mathematical investigations, and portfolios. The committee developed scoring guides and trained teachers and mathematics curriculum specialists so that they could train others in the process of scoring. If the pilots prove successful, the assessment modes will be introduced gradually into CAP's mathematics assessment.

Free Response Questions. CAP has achieved much success in trying out open-ended (free response) questions at the 12th grade level. Since winter 1988, all 12th grade students have been asked to respond to one of five open-ended questions; they are allowed 10 minutes for a response. The test questions themselves are complex, and a successful response involves more than a single correct answer. For most of the questions, students can make their own assumptions and respond correctly by giving appropriate reasons for their conclusions. Such items convey to students the idea that there are many ways to pursue a question, whereas multiple-choice items often convince students that there are predetermined thought processes that they must use.

In 1989 the California State Department of Education published *A Question of Thinking: A First Look at Student's Performance on Open-ended Questions in Mathematics*. This report analyzes the responses of 12th grade students to five open-ended questions from the mathematics section of the 1987–88 CAP test. Figure 4 shows a small excerpt from this report that presents the rationale underlying this innovative form of assessment, and Figure 5 shows a sample open-ended test question and one student's response.

In 1990, for the first time, the results of the free response questions were reported as part of the school, district, and statewide scores in mathematics.

Ninety-five high school teachers have been trained by the California Mathematics Project and the EQUALS staff from the Lawrence Hall of Science to develop scoring rubrics and to score student papers. One winter weekend in 1990, they scored nearly 24,000 papers!

Teachers involved in the scoring sessions were overwhelmingly positive about their experience. They said that reading the student responses gave them a unique insight into student thinking that would most certainly affect their teaching. Their perception of "good" mathematics changed, and they learned from discussions with one another. These trained teachers have also become a staff development resource throughout the state: so far, more than 50 districts have hired a teacher trained by the California Mathematics Project or EQUALS to train their own math teachers to score students' papers locally.

Mathematical Investigations. Mathematical investigations are 40- to 60-minute complex problem-solving projects given to students individually or in small groups. Students will be asked to plan and complete the investigations, and will periodically answer questions from their instructors to demonstrate their understanding of mathematical concepts and the thinking that underlies their choice of action. These assessments will be administered by the student's own classroom teacher, perhaps with the aid of another teacher.

Portfolios. Of special value in the classroom setting, student portfolios could be assessed on a sampling basis statewide. Portfolios assess student attainments over a period of time, and they will be designed to include components that are ordinarily difficult to assess using multiple-choice or open-ended questions. One plan is to apply the rule of thirds—that is, one-third of the materials for inclusion in the portfolio will be determined by the student, one-third by the teacher, and the remaining third by CAP. The California Mathematics Project is providing encouragement and sup-

FIGURE 4

Open-ended Questions in Mathematics

Open-ended questions in mathematics (those requiring a written response, as opposed to multiple-choice) have the potential to drive the curriculum in positive directions sought by leaders in education. The written responses required by open-ended mathematics questions stimulate students to think about mathematical problems and enable the students to communicate their mathematical thinking and solutions to others. When teachers can see students' thought processes sketched out in some detail, they can then target instruction appropriately to develop students' thinking further.

Open-ended questions were included in the grade 12 mathematics test of the California Assessment Program (CAP) for the first time in 1987-88. The inclusion of open-ended questions is part of CAP's long-standing emphasis on aligning assessment with principles from the California curriculum frameworks. Open-ended questions were intended to improve the grade twelve test's alignment with the concepts presented in the 1985 *Framework* in the following ways:

- Open-ended questions provide students an opportunity to think for themselves and to express their mathematical ideas that are consistent with their mathematical development.
- Open-ended questions call for students to construct their own responses instead of choosing a single answer.
- Open-ended questions allow students to demonstrate the depth of their understanding of a problem, almost an impossibility with multiple-choice items.
- Open-ended questions encourage students to solve problems in many ways, in turn reminding teachers to use a variety of methods to "get across" mathematical concepts.
- Open-ended questions model an important ingredient of good classroom instruction: openness to diverse responses to classroom questioning and discussion. Similarly, open-ended questions in assessment help educators move away from a curriculum of bits and pieces of information to a curriculum where students apply a set of mathematical tools as they are appropriate to situations.

By presenting open-ended questions that required written responses, the committee sought to gain evidence for the importance of writing in the mathematics curriculum. Good mathematics teachers have learned that writing is both a way of thinking and of communicating. By writing freely about problems, students often can discover solutions. By reporting their methods in writing, students can tell others how to solve problems. By reading what students have written, teachers can gain more informed insights into students' knowledge and possible misconceptions, compared with what teachers learn from seeing only students' mathematical computations or answers.

Source: California State Department of Education 1989a.

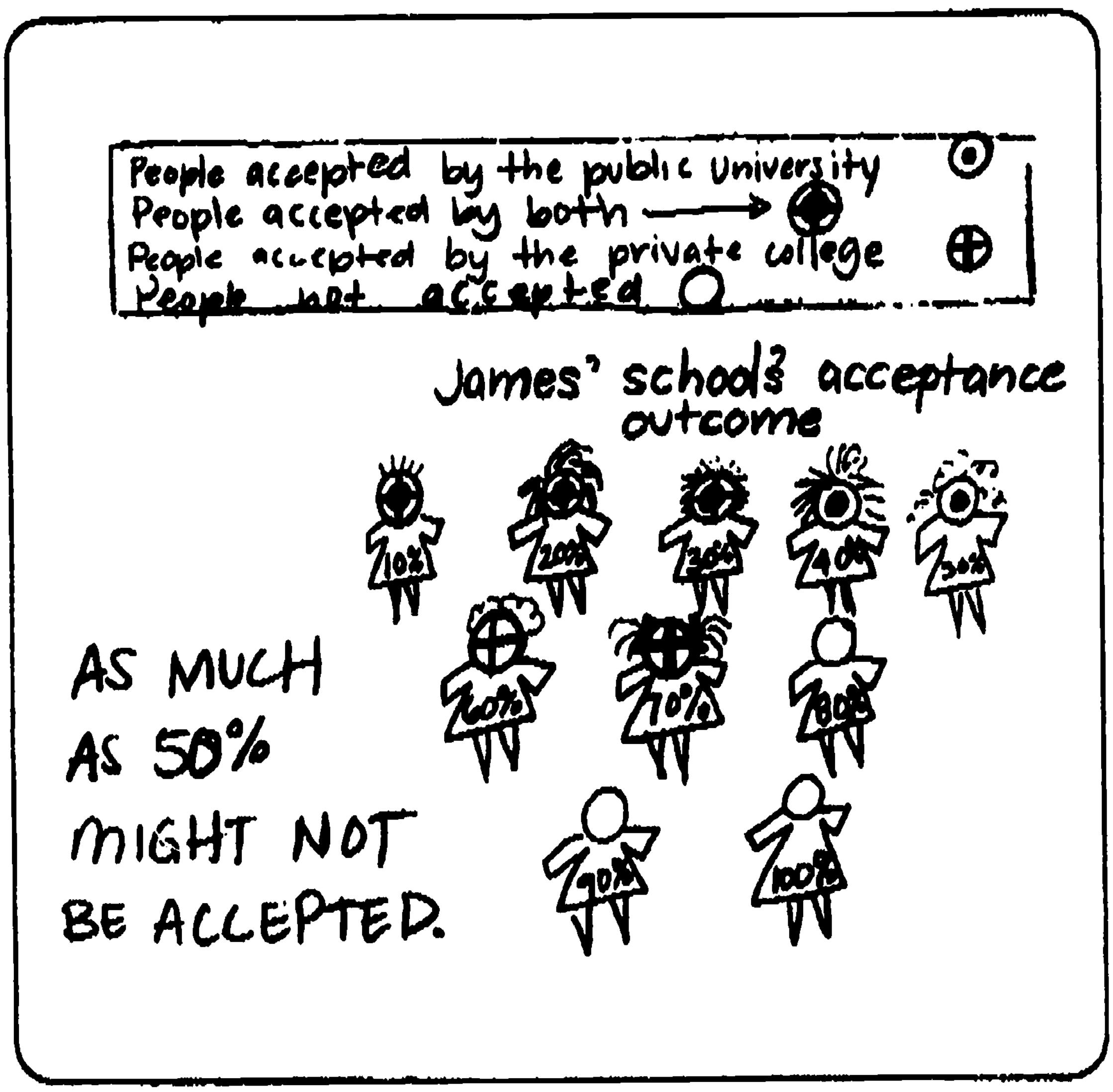
port for classroom portfolio projects and is preparing to train teachers in the scoring of portfolios. Portfolios will probably be evaluated using holistic criteria to rate them on a scale from 1 to 6. The evaluation will look for evidence of such student capacities as accomplishing a group or individual project; solving an interesting mathematical problem; organizing and displaying data; using other students, technology, and concrete materials as resources; using mathematics in novel ways; writing reflections on the process of mathematical problem solving and thought; and expressing feelings about mathematics.

A Link with Instruction. CAP's mathematics committee has proposed that staff development take the form of a video and written handbook that would illustrate an ideal 4- to 6-week instructional model. The training would link the content of these four modes of assessment—multiple-choice

FIGURE 5

Sample Question and Answer from the Mathematics Section of the 1987-88 CAP Test

James knows that half of the students from his school are accepted at the public university nearby. Also, half are accepted at the local private college. James thinks that this adds up to 100 percent, so he will surely be accepted at one or the other institution. Explain why James may be wrong. If possible, use a diagram in your explanation.



questions, free-response questions, performance tasks, and portfolios—with the instructional goals of the framework and curriculum guide.

Such a fully aligned, framework-based, integrated model of assessment and instruction would elicit the types of complex student responses that the CAP tests are being designed to assess. Students would be asked to use available resources, such as manipulatives, calculators, and computers; to work cooperatively with each other; and to persevere and explore available alternatives, taking responsibility for their decisions. Such important outcomes cannot be assessed by paper-and-pencil tests or even by observing students for an hour in a performance task. Such outcomes can be inferred to a large extent, however, from student work incorporated in a portfolio. The portfolio models would be general and flexible, not prescriptive, and we expect that schools would receive a new version each year—thus emphasizing the variety of instructional possibilities.

The matrix-sampled CAP test is well suited to distribute the four modes of assessment and to obtain the maximum efficiency and effect. All students will be given five to ten multiple-choice questions and one open-ended question; mathematical investigations and portfolios will be evaluated on a random sampling basis. This will assure a rich mix of information for the evaluation of students' mathematical ability—with tremendous potential for positive effects on the design of curriculum and instruction.

New Directions in Science Assessment

If we are to succeed in international economic competition, to advance technologically, and to learn more about ourselves and the world around us, education in science will play a central role. The American Association for the Advancement of Science addresses the critical need for the reform of education in science, mathematics, and technology in its report *Science for All Americans* (1989). This report includes recommendations to improve science literacy in the United States, and those recommendations are reflected in the new *Science Framework for California Public Schools, Grades K–12* (California Department of Education 1990c), and in the new directions for science assessment proposed by CAP. The new science assessment will match the curriculum and will model exemplary instruction. Students will be required to demonstrate their knowledge of the concepts and processes of science and their ability to solve problems, and to engage in hands-on performance tasks. They will have the opportunity to discover and construct the important ideas of science through inquiry and investigation.

Development of Performance Tasks. Since 1988, the science teachers, supervisors, and university faculty comprising the CAP Science Assessment Advisory Committee have developed and piloted performance tasks focusing on the scientific processes embedded in the life, physical, and earth sciences. Performance tasks were field-tested in spring 1990 for grade 6 and will be field-tested in fall 1990 for grade 12, moving toward implementation in 1991 and 1992.

CAP conducted the statewide field test of performance assessment at grade 6 in conjunction with the Science Unit of the California Department of Education, the California Science Implementation Network (CSIN), the California Science Project (CSP), Lawrence Livermore National Laboratory, and the Lawrence Hall of Science. By focusing on the essential outcomes of learning recommended in the new science framework, the performance assessment complements and enhances the 6th grade open-ended questions and conceptual/thematic multiple-choice items that were also administered in spring 1990.

Approximately 1,000 schools participated in this field test of performance assessment. Teachers participating in the administration of the performance tasks were trained by CSIN staff developers. Approximately 980 6th grade teachers throughout the state participated, and additional trainings were conducted at the district and site level.

Over 50,000 6th grade students had the opportunity to demonstrate their understanding of important scientific processes and concepts by "doing" science. The testing format consisted of five "stations" with one task per station. Each task took about ten minutes, and the students rotated through the stations, completing all five tasks in one testing session.

The students engaged in hands-on activities and recorded their observations and conclusions on five student response forms. They were asked to observe, classify, sort, detect patterns, infer, formulate hypotheses, and interpret results. The tasks challenged students to integrate their manipulative and thinking skills with their knowledge of the content of science.

The performance tasks field-tested in 1990 asked students the following:

1. To build a circuit out of the materials provided, to predict the conductivity of various materials, to test their conductivity, and to record the results.

2. To create a classification system for a collection of leaves and to explain the adjustments necessary when a "mystery leaf" is introduced into the group.

3. To perform a number of tests on a collection of rocks, to record the test results, and to classify them based on information provided.

4. To use the limited equipment provided to estimate and measure a particular volume of water.

5. To perform a chemical test on samples of lake water to determine why fish are dying.

In each of these tasks, the students were asked to move beyond the hands-on activity and to apply what they learned to the understanding of complex natural phenomena.

Open-ended Science Questions. In spring 1989, open-ended science questions were administered to 8,000 6th grade students. Open-ended questions actively engage students in creating hypotheses, designing scientific investigations, and writing about social and ethical issues in science. Students respond to the questions in one of three ways: by interpreting and entering data on a chart; by drawing a picture to explain an answer; or by writing a short, analytical paragraph. Students have 10 to 15 minutes to compose a written response to each open-ended question. Figure 6 shows a sample student response to one open-ended question field-tested in 1989 at grade 6.

The Future of CAP Science Assessment. When implemented in spring 1991, the CAP grade 6 science test is expected to include open-ended items, performance tasks, and multiple-choice questions. In 1990 CAP is also developing Golden State Examinations (GSE) in chemistry and biology in collaboration with the San Diego County Office of Education and with support from the Milkin Family Foundation. These exams will also include multiple-choice items, open-ended questions, and performance tasks. High schools throughout the state will field-test the GSEs in spring 1990, and both the GSE biology and chemistry examinations should be ready for statewide use in 1991.

New History–Social Science Assessments

CAP is adding assessments of student achievement in the area of history–social science to its tests for grades 6 and 12 and is revising the grade 8 test in this area as well. These tests mark the first major step toward assessments that are fully aligned to the curriculum envisioned in the *History–Social Science Framework* (California Department of Education 1988a). They will allow students to demonstrate breadth of learning and the ability to clarify issues, recognize relationships, determine causes and effects, interpret evidence, and argue for a position. The new CAP tests will not emphasize isolated facts, but will assess a deeper, more thorough study of eras, events, and original documents in their full social and cultural contexts.

All the new assessment activities will flow directly from the *History–Social Science Framework*. In an enriched history–social science curriculum, students steep themselves in a historical context, involving themselves with a period and the lives of its people, reading its literature and analyzing original historical documents. Assessment activities may include debating, dramatizing, and defending a point of view orally or in writing. Finding out how well students can think about history will be as important as finding out what they know.

In addition to the multiple-choice portion of the CAP tests, the following assessment modes are under consideration (some might involve audiotapes, videotapes, or computers): portfolios of student work; performance assessment (including oral presentations, drama, debate, group collaboration, student-assessor dialogue, etc.); writing tasks (both short-answer and essay); and integrated assessment (incorporating more than one assessment technique and interdisciplinary skills in a complex task that demands higher order cognition).

Group Performance Task in History–Social Science. The grade 12 history–social science assessment advisory committee has designed a model performance task in which students meet the challenge of combining their knowledge of history with critical thinking, group participation, and oral and written communication. They draw some useful lessons from history by imagining what course of action former presidents might suggest to President Bush for combating the Colombian drug cartel.

Students break into five groups, one representing President Bush and the others representing Teddy Roosevelt, Woodrow Wilson, Franklin Delano Roosevelt, and Jimmy Carter. Students analyze primary and secondary source materials that reflect different points of view and remind them of what they have previously learned and discussed in their history–social science classes. After reading and discussing the documents, each group determines what position would best represent its president and then presents that position orally to "President Bush." During each presentation, the Bush group is free to question the other groups about their position. Following this discussion, each student writes a summary of his or her own position in telegraph form and "sends it to President Bush." This activity can be completed in one class period.

On the second day, following the statement of President Bush's policy decision, students write an essay supporting or opposing that decision, backing up their viewpoint with facts and examples drawn from their knowledge of history–social science and what they have learned in the previous day's group activity.

The group as a whole will be evaluated for their success in group and cooperative learning, the quality of their thinking, their ability to communicate their ideas effectively, and their knowledge and use of history.

When the new tests are fully implemented statewide, students will be expected to be able to demonstrate not only

FIGURE 6

California Assessment Program

1988 1989 Open-ended Science Question(s): Grade 6

Survey of Academic Skills

P

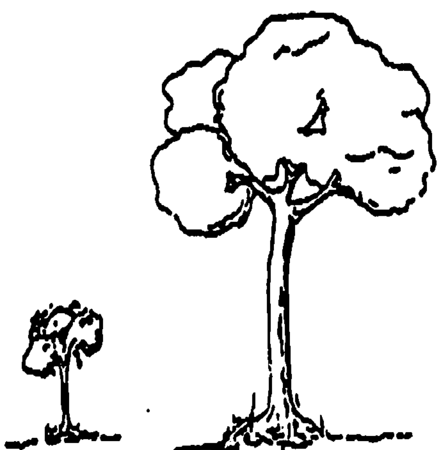
Name ______________________ Sex ______ Date of Birth ________

School ______________________ District ______________________

Instructions: Use this sheet to answer the question(s). Use the reverse side of this sheet if needed.

A small tree is planted in a meadow. After 20 years it has grown into a big tree, weighing 250 kg more than when it was planted.

Where do the extra 250 kg come from? Explain your answer as fully as you can.



The tree's weights was gained from the water, minerals and other things a tree needs to survive. As we all know living things that lives needs food. There for the tree gained weight while eating or drinking its food in the 20 years. And most of the time as a living organism grows it tends to eat more. The tree might have done this that they know historical content, but that they know how to analyze, interpret, and evaluate it for themselves.

A Statewide Network

California's system of assessments supports, and is supported by, a statewide network of dedicated and enthusiastic educators, working in all content areas across the curriculum, developing innovative curriculum, instruction, and assessment programs at all levels. Of special significance in the development of the CAP tests are the advisory committee members who create the tests; the state curriculum projects and professional organizations in the content areas that provide CAP with essential advice and communicate effectively with thousands of teachers, training them to incorporate the latest curriculum and instructional models in their classrooms and preparing them for CAP's new forms of assessment; and classroom teachers throughout the state, from whom new assessment ideas come, and who pilot, field-test, and review our assessments before they are implemented statewide.

CAP's new tests reinforce California's efforts to provide a public school education of the highest quality for every child—each student offered a truly rich, challenging, and exciting curriculum; each student receiving a real opportunity to reach as high as he or she can; each student developing the confidence, power, knowledge, and skill necessary to succeed in the 21st century.

BIBLIOGRAPHY

American Association for the Advancement of Science. (1989). *Science For All Americans: A Project 2061 Report on Literacy Goals in Science, Mathematics, and Technology.* Washington, D.C.

Archibald, D., and F. Newmann. (1988). *Beyond Standardized Testing: Authentic Academic Achievement in the Secondary School.* Reston, Va.: NASSP Publications.

California State Department of Education. (1988a). *History–Social Science Framework.* Sacramento, Calif.

California State Department of Education. (1988b). *Writing Achievement of California Eighth Graders: A First Look.* Sacramento, Calif.

California State Department of Education. (1989a). *A Question of Thinking: A First Look at Students' Performance on Open-Ended Questions in Mathematics.* Sacramento, Calif.

California State Department of Education. (1989b). *Writing Achievement of California Eighth Graders: Year Two.* Sacramento, Calif.

California State Department of Education. (1990a). *California Mathematics Framework.* Sacramento, Calif.

California State Department of Education. (1990b). *English–Language Arts Framework.* Sacramento, Calif.

California State Department of Education. (1990c). *Science Framework for California Public Schools, Grades K–12.* Sacramento, Calif.

National Council of Teachers of Mathematics. (1989). *Curriculum and Evaluation Standards for School Mathematics.* Reston, Va.

National Research Council. (1989). *Everybody Counts: A Report to the Nation on the Future of Mathematics Education.* Washington, D.C.: National Academy Press.

Resnick, L. (1987). *Education and Learning to Thinking.* Washington, D.C.: National Academy Press.

Resnick, L., and L. Klopfer, eds. (1989). *Toward the Thinking Curriculum: Current Cognitive Research.* Alexandria, Va.: Association for Supervision and Curriculum Development.

Resnick, L., and D. Resnick. (1990). "Assessing the Thinking Curriculum: New Tools for Educational Reform." In *Future Assessments: Changing Views of Aptitude, Achievement, and Instruction,* edited by B. R. Gifford and M. C. O'Connor. Boston: Kluwer Academic Publishers.

Wiggins, G. (May 1989). "A True Test: Toward More Authentic and Equitable Assessment." *Phi Delta Kappan* 70, 9: 703–713.

Wiggins, G. (April 1989). "Teaching to the Authentic Test," *Educational Leadership* 46, 7: 41–47.

56

Thinking: How Do We Know Students Are Getting Better at It?

Arthur L. Costa

When considering how evidence of students' achievement is collected, we most often think of testing: using some form of paper-and-pencil instrument to determine how many questions students answer correctly. Although there may be some types of thinking that can be assessed in this fashion, we must seek additional means of determining growth in intellectual abilities. In teaching students to think, the emphasis is not on how many answers students know, but on how students behave when they *don't* know. A critical characteristic of intellectual ability is knowing how to act on information, not just acquire it, thus we are interested in observing how students produce, rather than reproduce, knowledge.

Many teachers are unimpressed with standardized tests (Harootunian and Yarger 1981; Lazar-Morrison 1980). The results are often unavailable for several weeks or months after administering the test; thinking skills are contaminated by the degree to which students are acquainted with the subject matter; behavior is influenced by students' mental and emotional state at the time of testing; performance is subject to the vicissitudes of the situation; scores yield neither diagnostic clues as to how the student derived the answer (metacognition) nor information about how the student processed the data and emotions necessary to arrive at the best answer (Anderson 1981; Coffman 1980).

Teachers know that many students are deemed gifted simply because they are test-wise, while other talented students are often overlooked because they do poorly under testing conditions. Although *competency* may be demonstrated in a single test, *intellectual effectiveness* is demonstrated by sustained performance in a variety of situations that demand the selective and spontaneous use of clusters and linkages of problem-solving strategies rather than singular, isolated behaviors. Teachers, parents, and students themselves are best situated to observe the performance of these behaviors as they are applied in the day-to-day life of the home, school, and classroom. Skilled teams of teachers, knowing what to look for, can collect evidence of performance over time as students tackle problems, operate in groups and individually, and confront life situations requiring decision making, problem solving, and the resolution of discrepancies.

Data systematically collected over time through direct observation of performance are probably more reliable than data collected on a standardized achievement test composed by someone unfamiliar with the curriculum, the teacher's goals, the learning opportunities, or students' cultural/home backgrounds.

As students interact in real-life and day-to-day home and classroom problems, how might teachers systematically search for indicators that demonstrate the effects of their instructional efforts? If students are to become involved in self-evaluation, how might they collect evidence of their own and their group's increased performance of these intelligent behaviors? If we believe in the transference of these behaviors beyond the school and classroom setting, how might parents become involved in gathering supporting evidence of these behaviors at home and in other settings beyond the school?

I have three suggestions for collecting this kind of evidence of students' intellectual growth.

1. *The HOW ARE WE DOING checklists, developed by Bena Kallick, Westport, Connecticut.* The checklists, shown in figures 1–4 at the end of this chapter, have been developed to assist students, teachers, and parents in searching for and recording indicators of growth of the intelligent behaviors listed, chapter 20, "The Search for Intelligent Life. Several of the intelligent behaviors listed in that chapter have been operationally defined into statements of observable performance and entered on the checklist. Teams of teachers or school staff members may want to adapt these examples for their own students.

Although the lists are not intended to be used to observe all of the behaviors simultaneously, teachers can use the checklists to collect evidence of the growth of one particular intelligent behavior at a time. Teachers may also wish to have students develop a checklist of indicators of what they would see a person doing or hear a person saying if, for example, he or she is behaving with perseverance, restraining impulsivity, listening, and so on. (Change the form to read "How Am I Doing" for students to evaluate themselves.) The indicators should be stated *positively* and in *observable* terms, and they should be *feasible* for that particular group of students to perform (based on age, grade, cultural background, and population characteristics). The last rating on the forms, "NOT YET," is essential as a symbol of the positive potential of performance and the faith that all students can achieve these behaviors.

2. *A Reporting Form for Parents, developed by Charlotte Palmer, Pinellas Park Elementary School, Pinellas Park, Florida.* This form, shown in Figure 5, was developed as a means of gathering evidence from parents and initiating a home-school dialogue about a student's increased performance of the intelligent behaviors. It is accompanied by the suggestions for encouraging thinking shown in Figure 6.

3. *A sample letter for gathering feedback from parents.* This letter, shown in Figure 7, is intended to encourage parents to become more involved in gathering evidence of their child's performance at home of the thinking skills being taught at school. It can be adapted to fit any situation.

Keeping these and other anecdotal records of a student's acquisition of these types of behaviors can provide reliable and usable information about growth in intellectual behaviors.

REFERENCES

Anderson, S. (1981). "Testing and Coaching." Paper presented at the annual meeting of the American Association of School Administrators, Atlanta, Ga.

Coffman, W. E. (1980). "Those Achievement Tests—How Useful?" *Executive Review* 1, 1: 2–5.

Harootunian, B., and D. Yarger. (February 1981). *Teachers' Conceptions of Their Own Success.* Washington, D.C.: ERIC Clearinghouse on Teacher Education. No. SP 017 372.

Lazar-Morrison, C. (1980). *A Review of the Literature on Test Use.* Los Angeles: Center for the Study of Education. ERIC Document Reproduction No. ED 204 411.

FIGURE 1

HOW ARE WE DOING?

ATTRIBUTE: LISTENING TO OTHERS—With understanding and empathy

OBSERVABLE INDICATORS	OFTEN	SOMETIMES	NOT YET
Maintains eye contact			
Pays attention			
Paraphrases others' responses			
Demonstrates body language (e.g., nods approval, sits up, etc.)			
Asks questions related to the topic			
Responds by actions or words			
Gives accepting responses (the way in which the responses are given)			

Source: Bena Kallick, Westport, Conn.

FIGURE 2

HOW ARE WE DOING?

ATTRIBUTE: OVERCOMING IMPULSIVITY—Deliberativeness

OBSERVABLE INDICATORS	OFTEN	SOMETIMES	NOT YET
Listens to directions before starting			
Listens to responses of others and does not repeat what has been said or asked			
Asks questions to clarify the task or direction			
Decreases number of erasures			
Reduces the number of unnecessary, repetitious questions			
Analyzes the problem and develops a plan (uses visual strategies—e.g., mind map)			
Thinks before answering			
Takes time to use thoughtful, precise language			
Can paraphrase when called upon			

Source: Bena Kallick, Westport, Conn.

FIGURE 3

HOW ARE WE DOING?

ATTRIBUTE: PERSISTENCE—Persevering when the solution to a problem is not immediately apparent.

OBSERVABLE INDICATORS	OFTEN	SOMETIMES	NOT YET
Stays on task			
Seeks alternative sources of data			
May take a break, but returns to task			
May say, "Don't tell me, let me figure it out!"			
Shows intenseness of thought			
Says, "Wait a minute, I want to finish!"			
Completes task or project			

Source: Bena Kallick, Westport, Conn.

FIGURE 4

HOW ARE WE DOING?

ATTRIBUTE: FLEXIBILITY IN THINKING

OBSERVABLE INDICATORS	OFTEN	SOMETIMES	NOT YET
Is willing to change her/his mind			
Accepts another point of view ("I agree . . ." "I understand . . ." "I see and . . . .")			
Accepts or offers more than one alternative/idea to the problem			
Is able to change focus without panic or fretting			
Is able to compromise (gives up "ownership" or role)			
Is willing to consider more than one thing or source at a time			
Is willing to accept that there may not be an answer			

Source: Bena Kallick, Westport, Conn.

FIGURE 5

Twelve Ways Your Child/Student Shows Growth in Thinking Skills

This is a parent/teacher tool for rating a student's home/school thinking behaviors at the beginning and end of a school year. It should identify student strengths and weaknesses and promote some parent/teacher "team" goal setting to help the student develop more successful thinking strategies.

Mark each behavior using: N-Not Yet S-Sometimes F-Frequently

During the ________ school year I notice that Name: ____________________

____________ Age: ________ does the following:

Parent	Teacher	
		1. Keeps on trying; does not give up easily.
		2. Shows less impulsivity; thinks more before answering a question.
		3. Listens to others with understanding and empathy.
		4. States several ways to solve a problem. (shows flexibility in thinking)
		5. Puts into words how he/she solved a problem; is aware of his/her own thinking.
		6. Checks for accuracy and precision; checks completed work without being asked.
		7. Asks questions; wants to find out new information.
		8. Uses knowledge already learned in new situations; can solve problems in everyday living like using allowance, taking messages, going to the store, and practicing safety.
		9. Uses words more carefully to describe feelings, wants, other things.
		10. Uses touch, feel, taste, smell, sound, and sight to learn; enjoys art, music, experimenting, and active play.
		11. Enjoys making and doing original things; likes to show individuality in thought and dress.
		12. Enjoys problem solving; wonderment, inquisitiveness, and curiosity.

FIGURE 6

Some General Things Parents and Teachers Can Do to Encourage Thinking

1. Have faith that all children can think. They need to see thinking as a goal.
2. Share with children how you solve different kinds of everyday problems.
3. Provide opportunities for challenging problem solving.
4. Create a safe, risk-taking environment. It is OK to make mistakes; we can learn from them.
5. Give thinking time. We all develop at our own rate—physically, mentally, emotionally, and socially.
6. Model lifelong learning; be aware of your own growth and enjoyment of learning. (You don't lose the car keys anymore!) Get excited about life. Make each day count.

Some Suggestions for Strengthening Each of the 12 Thinking Skills

1. **Persistence:** "If at first you don't succeed, try, try again." Make it fun and OK to try again. Play "Clue" or read "Choose Your Own Adventure" or solve-it-yourself mystery books. Do experiments or plant a little garden for fun.

2. **Decreasing impulsivity:** Build models or work connect-the-dots puzzles, word searches, and crossword puzzles. Make your own mazes. Play video games, "Operation," "Perfection," or pickup sticks. Look for experiences that demonstrate "haste makes waste."

3. **Listening to others:** Play charades or telephone. Analyze characters' feelings in comic strips, television programs, and stories read and listened to. Hold a funeral for put-downs or zingers: Write them down, put them in a box, and bury them.

4. **Flexibility in thinking:** Try group problem solving and team tasks. Compare notes on how you do routine tasks like tying bows, mowing the lawn, drying dishes, or cleaning your room and how you do fun things like playing a video game, shooting a basket, or catching a pop fly. Try your child's way of doing a task and encourage him or her to try yours.

5. **Awareness of our own thinking:** Play checkers, chess, or some other strategy game and describe to an observer why you make each of your own moves. Have your opponent do the same. Challenge children to give a step-by-step explanation of how they make something, then guess what the outcome will be.

6. **Checking for accuracy and precision:** Play "I doubt it." Challenge children to show you how they can be sure something is true. Encourage them to challenge you in polite ways.

7. **Questioning and problem solving:** Ask children, "Have you asked any good questions today?" When questions are asked, help children locate the answers. Tell them why you chose a particular source of information to get an answer. Play "Question Me an Answer." Give a fact—your answer—then challenge students to ask different questions your fact would answer.

8. **Drawing on past knowledge and applying it to new situations:** Encourage involvement in scouting programs, church youth groups, boys' and girls' clubs, 4-H, and so on, where children take part in supervised group projects that raise money, help others, and take them on field trips. Play games like "Life," "The Allowance Game," "Monopoly," and so on. Give limited responsibility for running errands, taking messages, caring for animals, and the like.

9. **Precision of language and thought:** Play describing games; compare ads; explain why you use a particular cereal, soap, or toothpaste. Introduce *Consumer Reports* guides. Show how they compare products so you can decide what is the best value for your money.

10. **Using all the senses:** Play tasting, smelling, feeling, and sound location games. Draw pictures to music. Encourage field trips, "hands-on" experiments in class, cooking, model building, sewing, and carpentry at home. Do role-playing; put on plays. Play "Jr. Pictionary" or "Win, Lose, or Draw."

11. **Ingenuity, originality, insightfulness, creativity:** Try dressing up or lip-synching for fun. Do some scrap art or junk puppets. Watch "Pee Wee's Playhouse," the "California Raisins," or "Fraggle Rock" together. Create a diorama or make your own holiday decorations. Find a new use for familiar items.

12. **Wonderment, inquisitiveness, curiosity, and the enjoyment of problem solving:** Visit Great Explorations, MOSI, or EPCOT Center. Watch a 3-D movie. Learn a new skill together. Play "What would happen if . . ." (e.g., What would happen if . . . everybody were active all night and slept during the day? . . . we all lived underwater? . . . animals could talk?) Brainstorm together.

Don't limit yourself to these suggestions. Use them to stimulate your own thinking, and come up with your own ideas for using each of the 12 thinking skills. You know your child or student and know how best to motivate his or her interest and inspiration. Have fun together. Encourage a sense of humor.

Source: Charlotte Palmer, Pinellas Park Elementary School, Pinellas Park, Fla.

FIGURE 7

Thinking Skills Program Parent Feedback

Dear Parent,

As you are probably aware, your child is participating in a thinking skills program in school this year.

To better understand the effects of the program, it would help us if you could complete this brief feedback form. In the questions below and on the back of this sheet, please check the appropriate box and make any comments you can.

Thank you for your cooperation.

Name: ______________________________

____

Student's Name: ______________________________

1. My child talks to me about the thinking program:

   [ ] frequently [ ] occasionally [ ] never

   Comments: ______________________________

   ____

   ____

2. My child uses terms like Questions, Impulsivity, Metacognition, Persistence/Perseverance, Compare/Contrast, Inference/Assumption, Data/Opinion, at home:

   [ ] frequently [ ] occasionally [ ] never

   Comments: ______________________________

   ____

   ____

3. I work with my child at home on problems that require thinking:

   [ ] frequently [ ] occasionally [ ] never

   Examples: ______________________________

   ____

   ____

4. My child uses skills learned in the thinking program, to my knowledge:

☐ frequently ☐ occasionally ☐ never

Comments: ______________________________

____

____

5. Below please record any changes you have noticed in your child's thinking as a result of doing the thinking skills program at school.

____

____

____

____

____

____

____

____

This year I will help ______________________________ develop

skills in: ______________________________

by: ______________________________

____

____

Signed: ______________________________ (Parent)

This year I will help ______________________________ develop

skills in: ______________________________

by: ______________________________

____

____

Signed: ______________________________ (Teacher)

Date: ______________ Review Date: ______________

Source: Charlotte Palmer, Pinellas Park Elementary School, Pinellas Park, Fla.

57

Evaluation: A Challenge to Our Critical Thinking

Bena Kallick

Beware the man who knows the answer before he understands the question.

—C. M. Manasco

We often say that if we are to teach critical thinking to our students, we must model critical thinking in the classroom. We also discuss the need for students to develop the capacity to evaluate—to make good judgments based on developing criteria—describing it as one of the "highest orders" of thinking. And yet, we do not demonstrate the same drive and motivation for critical thinking that we ask of students when we examine the evaluation system on which the education enterprise rests.

Suppose we were challenged to place a district evaluation system on review to determine whether thinking was being properly evaluated. Using our best critical thinking abilities, what might an evaluation of thinking look like? We might begin by asking questions along two axes: Who are the audiences we are trying to inform from our evaluation? and What are the best methodologies to collect data in order to inform them?

Boards of Education

As many schools have moved toward site-based management, encouraging more choices and autonomy for individual schools, the school board takes on an even more significant role in evaluating the ultimate success of each school's fulfillment of its established goals. In the case of a system goal to develop student thinking, the board needs to consider curriculum: Is the course of study responsive to the requirements of the state, community, and student needs? Do the schools reflect equity and excellence as described in their district standards? These questions usually raise a whole set of other questions about the board's definition and description of equity and excellence in developing all students' thinking.

In simple terms, the question the board needs to ask is: If we are going to look for a method of evaluation for our goal for student thinking, what is it that we are looking for? This suggests that the work of the board might be more proactive than reactive. Most boards presently function by reacting to standardized test scores and state mastery test scores without raising a question about whether those scores are informative regarding the district's priorities. When focused on developing thinking for all students, the test data must be analyzed in light of that goal. Analysis might reveal that the tests do not sufficiently inform the board regarding that goal. Perhaps the test questions had cultural bias or contained a simulation outside of the context of students' experiences. The significant point is that the board analyzes the data in light of its standards, criteria, and goals, and understands the limitations of the data.

The next action might be to raise the questions: What more do we want to know about students' thinking than the test data provide, and how can we get this additional information? This might lead to dialogues with curriculum directors, teachers, and principals. A series of conversations might follow in which representatives from all aspects of the educational system come together to discuss how to expand the range and variety of assessments in order to evaluate student thinking.

Sounds like a lot of work? It certainly is! But it is worth it to a district that considers the development of students' critical thinking a major goal.

Classroom Teachers

Teachers are a significant audience for an evaluation system. They need to inform their teaching by what they learn from a good assessment tool. Unfortunately, the results of most standardized and statewide tests are reported to teachers too late. They administer tests either in the fall or in the spring. They usually receive testing feedback two or three months later. This means that either the school year is well under way and teachers have found other means to assess their students' skills or the school year is over and students will have a summer hiatus that might render the test data ineffective for instructional purposes.

Teachers need to have a more responsive relationship to student thinking in the classroom. If teachers are thinking critically about their classroom evaluation system, they need to decide what results they want their students to achieve in a given time frame. The kinds of questions teachers need to ask are: What is it that I am teaching (curriculum)? What is the best way to engage students with learning (instruction)? What are my expectations and priorities for student learning (assessment)? and What would be the most "authentic" (Wiggins 1989) assessment strategy to help me gain insight into student learning?

Students

Students are a critical audience for evaluation. Too often they are not informed about the meaning of the grade or number they receive. If we are teaching to encourage student thinking, then we must create assessment situations that require thinking. Such situations require students to *generate* knowledge rather than reproduce it. Once knowledge is produced, it is often more difficult to judge. For that reason, it is important for students to know the criteria against which judgments should be made.

The ultimate goal of a good evaluation system is to provide a model for self-evaluation, so that students become capable of generating criteria against which they are able to measure their own work. For example, if a writing teacher helps students generate criteria against which they measure a piece of writing, either their own or that of others, students will be able to evaluate writing based on a set of visible criteria. As the teacher and students continue to study writing, the criteria might expand or change. The work of developing a set of criteria can make the evaluation process visible to both the teacher and students, and leave students with a way to support judgments about writing even after the exercise is complete. Students, like other audiences, need to know what is being assessed and why.

Parents

Most parents ask three kinds of questions: How is my child doing in relationship to other students in her class? How is my child doing in relationship to the others her age in the country? How is my child doing in relationship to her own performance since she was last evaluated? And the latter is usually the most significant. Yet our evaluation information to parents usually is so greatly reduced by numbers and letters that parents do not get a clear portrait of their child as a learner. Parents need to be encouraged to ask more critical questions about their child's learning. We can encourage parents to do this through the way we describe student learning in parent conferences, student report cards, and when we are interviewed by the media.

Other audiences for evaluation within a school system might be curriculum directors, researchers, or administrators. Critical questions for each group might be developed by asking the same questions: What do we need to know, how can we describe it, and how can we best find out?

Alternative Strategies

Once we have fully explored the audiences for evaluation, fully describing what information each audience needs, then we are able to determine the best assessment strategies. We need to recognize that any assessment strategy, at best, is flawed. There is no one best strategy that will inform us about the complexities of human learning. So we must enter the question of *evaluation* by recognizing the need for more than one assessment strategy. Evaluation will bring together a composite picture, painted from different perspectives, hopefully illuminating the dimension and coloration of student learning.

Because we are generally familiar with the testing alternatives and limitations, this chapter will explore ways, other than tests, to measure the activities taking place in classrooms that are conducive to student thinking.

Portrait

A portrait of the environment in which learning is taking place provides important information about the possibilities for student thinking (Lightfoot 1983). A description of the room arrangement, for example, might tell us whether it is possible for students to have an interactive discussion in which they can make eye contact with one another. The walls usually carry a message; is it the message of student-generated material with an emphasis on originality? Are there books in the room, and if so, what kind? Does the environment invite participation or passivity? Where is the teacher located in the environment—in front of students or moving around the room?

In addition to the physical environment, the portrait includes a description of the teaching and learning that is taking place. A rich description of the classroom environment and the teaching that takes place can inform us about how well a teacher is encouraging her students' disposition for critical thinking.

Clearly, one of the limitations of portraiture is that it is only a slice of time in a classroom, and if not done well, can be more of a snapshot that a portrait. The person responsible for doing the portrait must learn how to describe a classroom with meaning and depth. In many school districts, teachers pair with one another to create the portrait and reflect upon its meaning.

Observations

Teachers keep a journal or log to record classroom activities and ask students to keep journals as well. Journals can be a rich source of data about what takes place during a particular lesson, and time should be set aside to allow students to reflect on their thinking. Systematic observations over time are necessary to provide a sufficient lens for understanding and evaluating thinking. The journal's strength is its ability to look at a student's thinking developmentally.

Journals can be analyzed for themes or patterns in thinking. For instance, teachers can analyze their own journals by asking such questions as:

- Is there a difference over time in the quality of students' responses to material?
- Are students showing evidence of their ability to deal with new situations by using thinking skills and strategies?
- Do class discussions take longer than they did a few weeks ago? Is this because there is more thoughtful analysis?
- What is significant about the questions I ask?
- Do my questions suppress thinking or force students to think as I do?
- What is the quality of the responses students offer based on my questions?
- How frequently do students ask questions of one another?

When examining students' journals, teachers may ask:

- Are my students more aware of their own thinking processes? Do they know how to approach a new problem or situation?
- Is there evidence that students are able to build a more persuasive argument for their points of view?
- Do they pay attention to other points of view?
- Are they clear? Logical?
- Do they use evidence to support their opinions?
- Do they raise questions about what they and others know?

One of the limitations of journals for assessment is that they are time consuming. It is difficult to read and respond to journals frequently. For that reason, many teachers rotate reading their students' journals so that they respond to each journal only once a month.

Tape Recordings

Video and audio recorders enable teachers to study students' verbal and nonverbal responses. Collected systematically over time, these can be analyzed to find out, for example:

- The quality of questions and discussion.
- The words and phrases used to encourage thinking, such as, "Some people say you need a special place in which to be creative; others say that is not important. What do you think?"
- If the teacher stresses thinking by asking students to clarify, check assumptions, use precise language.

Interviews or Conferences

Students who interview one another about their thinking strategies can record the results and analyze or compare the other students' strategies with their own.

As another strategy to test students' capability to ask analytic questions, the teacher might bring in community members to be interviewed. Data can be collected regarding the kinds of questions students generate for the interview.

Finally, teachers might interview students about their thinking strategies. It is critical that the teacher draw students' thinking out and resist evaluating student responses. After the conference, the teacher can analyze the interview data and evaluate the responses in order to gain insight into students' learning.

Many teachers make a commitment to interview each of their students at least once a month. They find that the interview strategy serves two important purposes. First, it provides time to establish a closer, personal relationship with each student. Second, it provides a window into the student's mind.

Portfolios of Student Work

A portfolio for each student might include writings, drawings, and other work that can be examined from different perspectives—such as papers that reflect work assigned by the teacher as well as student-initiated work. Many teachers ask students to choose some of their best work each week to include in the portfolio. They ask students to include the reasons why they have chosen this work as their best. This system provides students with an opportunity to generate criteria and evaluate themselves. The most important aspect of portfolios is that they be systematic. Because the strength of a portfolio is that it is a collection of work over time, the collection should not be random.

One of the limitations of portfolios is that teachers have sporadic evidence of student work.

Performance

It is often in the doing of an activity that we can best witness an individual's thinking. There are many opportunities to observe students as they work through problem solving. For example, students working in groups to solve problems lends itself to observation of thinking. A critical component for such observation is that there be explicitly defined criteria regarding what constitutes good thinking in a given situation.

In each example, strengths and limitations are noted. This serves to remind us of the need for more than one assessment strategy.

Implications for Staff Development

Reflecting on and evaluating student thinking requires continuous inquiry into teaching and learning, and teachers need support in doing so. Teachers need to be a part of study groups that focus on teachers as researchers in the classroom. Such study groups are based on a few common characteristics:

- Teachers are encouraged to raise questions about student learning.
- Teachers are required to collect data to answer their questions.
- The work of the researcher is to describe before attempting to analyze and evaluate.
- Teachers are encouraged to reflect on practice.
- Teachers are respected as credible sources and interpreters of classroom data.

Conclusion

Evaluation of thinking requires a re-vision: a new way of thinking about what it is we need to know, for whom, and how we can best obtain the information. We must think of evaluation as a prism of assessment strategies, not a single-faceted one. Our assessment strategies need to be complementary, so that each provides a different angle of the prism, which in its totality illuminates a larger understanding of thinking.

REFERENCES

Lightfoot, S. L. (1983). *The Good High School.* New York: Basic Books.

Wiggins, G. (April 1989). "Teaching to the (Authentic) Test." *Educational Leadership* 46, 7: 41–46.

58

Needed: Better Methods of Testing Higher-Order Thinking Skills

Edys S. Quellmalz

If you are specific in what you expect, then others will be specific in fulfilling your expectations.

—Rulon G. Craven

The task of designing a systematic program for testing and teaching higher-order thinking skills is formidable, yet recent advances in theory and research provide some basis for defining a core of fundamental skills and for designing exercises that require using such skills. Since testing programs at the national, state, and local levels are being used to assess students' reasoning skills, they may well become the vehicle for bringing focus to skill frameworks and areas of application. Consequently, testing programs must define skills and present tasks that are applicable to academic and life situations. Given the pervasive neglect of thinking skills, these tests will clearly serve a crucial policy role—perhaps the most critical shift in emphasis of the decade. They will define and test *what should be* accomplished in instruction rather than *what is* currently addressed.

Conceptions of Higher-Order Thinking Skills

Philosophers, psychologists, and curriculum theorists have all defined and analyzed reasoning skills. The perspectives of each discipline have resulted in somewhat different frameworks and terminologies, yet analysis of works that represent the major views of each field reveals substantial overlap.

Within the field of *philosophy*, Dewey (1933) defined reflective thought as the careful, persistent examination of an action, proposal, or belief and the analysis or use of knowledge in light of grounds that justify it and its probable consequences. Smith (1953) also emphasized the judgmental aspect of thinking. He defined critical thinking as "what a statement means and whether to accept or reject it." In his landmark paper, "A Concept of Critical Thinking," Ennis (1962) elaborated on Smith's definition of critical thinking by delineating skills that called for the application of formal and informal logic. Ennis has since considerably expanded his concept of critical thinking. His most recent, expanded skill clusters (1984) include clarifying issues and terms, identifying components of arguments, judging the credibility of evidence using inductive and deductive reasoning, handling argument fallacies, and making value judgments. To date, the Ennis compendium of critical thinking skills both encompasses those forwarded by other philosophers and represents skills appearing on such extant critical thinking tests as his own *Cornell Critical Thinking Test*, the *Watson-Glaser Critical Thinking Test*, and the *New Jersey Test of Reasoning*.

Within the field of *psychology*, definitions of higher-order skills tend to place the reasoning skills proposed by philosophers within broader frameworks. Psychologists studying general intelligence such as Piaget, Guilford, and Sternberg represent one research focus. Piaget's stages of

This chapter originally appeared in Edys S. Quellmalz, "Needed: Better Methods of Testing Higher-Order Thinking Skills," *Educational Leadership* 43, 2 (October 1985): 29–35.

development, particularly the distinction between formal and operational thought, are often used to differentiate among problems requiring logi 'al reasoning. However, Piaget's framework of discrete, hierarchical stages of mental development has been strongly criticized on definitional and empirical grounds by philosophers and psychologists (Ennis 1976; Linn 1982; Phillips 1975). Guilford's (1956) Structure of the Intellect model, based on correlational studies of performance on intelligence test items, has also been criticized on statistical and theoretical grounds. More recently, Sternberg placed the components of intelligence test items into a problem-solving framework. His triarchic model of intelligence includes skills involved in knowledge acquisition, performance, and metacognitive, self-monitoring skills. Sternberg's theory identifies analogical, inductive, and deductive reasoning skills required to perform both novel and familiar tasks (Sternberg 1983).

Studies of problem solving have identified strategies that generalize across many types of tasks and also sets of distinct steps and strategies for separate subject-matter disciplines and for problem types within them. Studies of how experts play chess and solve physics and mathematical problems have shown us that they call on the logical reasoning skills identified by philosophers. From the work of such psychologists as Bruner (1966), Gagne (1977), and Newell and Simon (1976), we find that people resort to generalized problem-solving strategies when faced with novel tasks, but that expertise depends heavily on extensive knowledge within a particular discipline. We also know that the metacognitive, self-monitoring activities of planning, monitoring, and revising are essential to skillful problem solving.

A final source of information for formulating the thinking skill domain is *curriculum*. In general, thinking skill clusters proposed in curriculum projects (e.g., Bruner 1966; Taba 1963; Suchman 1965; Covington 1968) are the reasoning skills identified by philosophers and psychologists. Bloom's Taxonomy (1956), for example, continues to be the most frequent guide for classifying types of higher-order skills. Curriculum experts also try to map the significant problem types and methods of inquiry within the subject matter.

Looking across these three disciplines, we see that:

• Philosophy provides definitions of reasoning skills and criteria for judging when reasoning is done well.

• Psychology also identifies reasoning skills and their underlying cognitive processes, and sketches a process for how reasoning is used to address purposeful tasks.

• Curriculum theory proposes significant classes of tasks and methods of inquiry.

To forge a framework for assessing higher-order reasoning, then, we need to (1) identify the salient, common reasoning skills proposed in psychology and philosophy, (2) track where skills seem to be required for addressing significant tasks, and (3) consider criteria for designing tasks.

Figure 1's definition of higher-order thinking attempts to merge the goal-directed problem-solving paradigm with the inferential, evaluative emphasis of the critical thinking paradigm.

FIGURE 1

Definition of Higher-Order Thinking

Students engage in purposeful, extended lines of thought during which they:
- Identify the task or problem type.
- Define and clarify essential elements and terms.
- Judge and connect relevant information.
- Evaluate the adequacy of information and procedures for drawing conclusions and/or solving problems.

In addition, students become self-conscious about their thinking and develop self-monitoring problem-solving strategies.
Commonly specified higher-order reasoning processes are:

1. **Cognitive**	2. **Metacognitive**
Analyze	Plan
Compare	Monitor
Infer/Interpret	Review/Revise
Evaluate	

One goal of higher-order thinking instruction proposes that students engage in purposeful, extended lines of thought in which they identify and analyze a problem, identify and relate information necessary to address the task, and evaluate the adequacy of conclusions or solutions. Further, students should be critical of the strategies they use. The cognitive processes of analysis, comparison, inference, and evaluation seem to be involved in various combinations in reasoning tasks, as do the three metacognitive components—planning, monitoring, and reviewing/revising.

Figure 2 illustrates the relationship among problem-solving, critical thinking, and cognitive strategies. Thus, the problem-solving skill of identifying and analyzing tasks involves the clarification skills Ennis identified. The more basic cognitive strategies primarily involve the analogical reasoning skills of analysis and comparison. The problem-solving skills of accessing appropriate content or procedural schemata and seeing how new information can be used

FIGURE 2

Relationship Among Reasoning Skills Proposed by Psychologists and Philosophers

Problem-Solving Strategies (Psychology)	**Critical Thinking Skills** (Philosophy)	**Probable Dominant Cognitive Processes** (Psychology)
1. Identify the problem (essential elements and terms)	1. Clarification • Identify or formulate a question • Analyze major components • Define important terms	1. Analogical • Analysis • Comparison
2. Identify appropriate information, content, and procedural schemata	2. Judge credibility of support, the source, and observations	2. Analogical • Analysis • Comparison Evaluate components
3. Connect and use information to solve the problem	3. Inference • Deduction • Induction • Value judgments • Fallacies	3. Inferential—infer/interpret relationships among components
4. Evaluate success of the solution	4. Use criteria to judge adequacy of solution	4. Evaluative—evaluate effectiveness of specific and general strategies

involve the critical thinking skills needed for recognizing the type of information or evidence (analogical reasoning) and judging the adequacy of the information (evaluation). Perhaps the closest correspondence among descriptions of reasoning occurs when learners employ inductive and deductive skills to connect and use information to solve problems and evaluate conclusions. Throughout problem solving, learners use metacognitive, self-monitoring strategies to evaluate and re-check progress. Analytical, comparative, inferential, and evaluative processes are significant, dominant task types or activities as well as processing components of complex tasks. Figure 3 proposes significant tasks that require these processes within three subject domains.

For example, *analyses* of a process or a literary piece are familiar activities in science, history, and literature. Similarly, *inferring* the consequences of an experiment or interpreting the motives of a character are significant tasks. Further, shoppers use analogical reasoning to *compare* products, much as inventors do when they create inventions. To *evaluate* how well problems have been solved and conclusions drawn, we rely on all the basic processes.

Recommendations for Designing Higher-Order Thinking Skills Tests

Higher-order thinking skills tend to be measured either on specialized tests or within subject-matter tests, most often in a multiple-choice format with a focus on specific, isolated skills. Although many significant interpretive and evaluative problems permit multiple-solution paths and require orchestration of a set of component judgments to arrive at a conclusion, the one-right-answer format and piecemeal testing of components dominate. Seldom are students asked to engage in sustained reasoning on significant tasks, nor are they asked to explain their reasoning. A major exception was the National Assessment exam, which asked students to interpret or evaluate literary selections in essay form. The appallingly few students who could offer even rudimentary support for their opinions highlighted the need for renewed emphasis on higher-order skills and constructed response test formats (NAEP 1981).

In addition to identifying a manageable set of skills fundamental to reasoning in academic subjects and in life and novel situations, we need to design tests that include a broader array of items and tasks. Clearly, assessments of higher-order thinking skills call for more task formats and contents than those that exist on available tests. We need to:

1. *Design problems that reflect important recurring issues in the domain.* Cognitive research has found that experts and skilled individuals store knowledge in problem-type structures. Examples of appropriate problems include classes of algebra problems or sets of reading or writing tasks with distinct narrative or persuasive discourse aims and structures. The reasoning skills required, of course, also

FIGURE 3

Examples of Higher-Order Reasoning Skills in Three Subject Domains

	Science	Social Science	Literature
1. Analyze	Identify the components of process and the features of animate and inaminate objects	Analyze components or elements of an event	Identify components of literary, expository, and persuasive discourse
2. Compare	Compare the properties of objects or events	Compare causes and effects of separate events; compare social, political, economic, cultural, and geographic features	Compare meanings, themes, plots, characters, settings, and reasons
3. Infer	Draw conclusions; make predictions; pose hypotheses, tests, and explanations	Predict, hypothesize, and conclude	Infer characters' movitation; infer cause and effect
4. Evaluate	Evaluate soundness and significance of findings	Evaluate credibility of arguments, decisions, and reports; evaluate significance	Evaluate form, believability, significance, completeness, and clarity

determine the content students must find and connect. The California Assessment Program's 1984 pilot of the direct assessment of writing gave students passages from science, social science, or literature and asked them to use information at various levels of interpretation, including cause-effect relationships; evaluating strengths and weaknesses of a position; and inferring character traits, atmosphere, and themes (Quellmalz 1985).

2. *Redress the imbalance between tests of component skills and their integration.* A set of comprehension questions, for instance, could contribute to inducing a theme or generalization rather than asking for unrelated details. Students would be required to sustain a line of reasoning to link multiple steps or sets of information in order to draw a conclusion.

3. *Design tasks that permit multiple interpretations or solutions.* For example, "Was Jack greedy or curious when he kept going back up the beanstalk?" Even in closed formats, students can check off sets of information and explanations that relate to one conclusion rather than another.

4. *Design open formats in which students explain their reasoning.* Single-sentence answers as well as complete essays can reveal plausible explanations or conclusions that a test writer might not have considered. The essay format is especially useful for assessing how students reach and explain their conclusions. Large-scale assessments have tended to avoid essays both because of their expense and questionable scoring reliability. Advances in writing assessment methodology, however, illustrate that high rater agreement levels can be achieved (Quellmalz 1984). The California Assessment Program's pilot of direct writing assessment found that readers required only 1.5 minutes to score one- to two-page essays in which they interpreted subject-matter passages (Quellmalz 1985). Further, the rater training discussions of such topics as quality of support serve as invaluable staff development experiences. Partially constructed response formats are also promising. Students tested on the Connecticut Assessment of Educational Progress were given the opening and closing statements of arguments and asked to provide strong support (Baron 1984).

5. *Build tasks that represent a range of generalization and transfer.* In a subject-matter test, problems calling for comparisons and analyses of salient components could ask students to compare two stories, characters, or settings. Tasks on a generalized thinking test could include comparisons of two accounts of an accident (life task), the Battle of Lexington (subject matter), and an incident on a space station (novel task). The rationale is both to test for generalization and transfer and to illustrate to teachers and students the relevant contexts for transfer.

6. *Develop tasks to assess metacognitive skills.* For example, given a problem, what are some ways to plan? Given a description of a problem-solving process, how might it have proceeded more efficiently? Again, such tasks both assess the process and serve as model activities for teachers and students.

The typical test development process involves producing items, field-testing them on large numbers of students, and then selecting and revising items with desirable psychometric properties. Given the complex nature of

FIGURE 4

Recommendations for Designing Instructionally Relevant Assessments of Higher-Order Reasoning Skills

Specification of Skills

- Identify skills common to several conceptualizations.
- Identify skills that can be applied in academic, life, and novel tasks.
- Select a manageable number of skills.
- Place skills in a coherent framework.

Design of Tasks

- Identify significant, recurring problem types.
- Assess integrated skills, *not* just components.
- Include tasks that permit alternative interpretations or solutions.
- Design open formats that ask for explanations of reasoning.
- Build sets of tasks that represent a desired range of generalization and transfer.

reasoning skills, the development of assessment tasks is likely to require significantly more time and pilot testing. Collecting protocols, interviewing, and observing will be essential to understanding the background knowledge and strategies students use on tasks. Constructed responses can also supply some of this information.

Development efforts would also benefit from companion staff development and instructional interventions. Many educators and citizens will question whether reasoning items are testing what *is* being taught, what *can* be taught, or what *should* be taught. Instructional interventions can address these concerns and provide additional input to the design process.

Conclusion

For assessments of higher-order thinking skills to be relevant to instruction, the rationales must be clear for the skills framework, the assessment task designs, and the plan for task coordination. The cognitive processes of analysis, comparison, inference, and evaluation seem to appear in the major conceptualizations of problem solving, critical thinking, and intellectual performance. These processes are, therefore, potential fundamental skills to include in an assessment framework that merges psychological and philosophical views of essential reasoning strategies.

Subject-matter achievement tests present few items that measure higher-order skills, and those items tend to require fractionated reasoning skills. Even specialized thinking tests limit reasoning to tasks that seek one right answer and allow no opportunity or requirement for explanation. We need to develop a broader range of tasks that present significant problems, require sustained reasoning, and require component information to be integrated to form a conclusion. Further, we should permit multiple interpretations, develop constructed response formats, and design tasks that illustrate desired ranges of generalization and transfer. Finally, test development should include protocol analyses of students' reasoning and be accompanied by staff development and instructional studies.

Assessments of higher-order skills must be clear, valid, and coordinated if teachers and students are to trust, understand, and use the information they yield. Clearly, the teaching and testing of reasoning must be reasonable.

REFERENCES

Baron, J. B. (1984). "A Holistic Eye Toward Analytic Assessment." *Educational Measurement: Issues and Practices* 3: 15–18.

Bloom, B. S., ed. (1971). *Taxonomy of Educational Objectives Handbook: Cognitive Domain.* New York: McGraw-Hill.

Bloom, B. S. (1968). "Learning for Mastery." *Evaluation Comment* 1, 2. Los Angeles: University of California, Center for the Study of Evaluation.

Bruner, J. S. (1966). *Toward a Theory of Instruction.* New York: W. W. Norton.

Covington, M. V. (1968). "Promoting Creative Thinking in the Classroom." *Journal of Experimental Education* 37, 1.

Dewey, J. (1933). *How We Think.* Boston: D. C. Heath.

Ennis, R. H. (1976). "An Alternative to Piaget's Conceptualization of Logical Competence." *Child Development* 47: 903–919.

Ennis, R. H. (1962). "A Concept of Critical Thinking." *Harvard Educational Review* 32: 81–111.

Ennis, R. H. (1985). "Large-Scale Assessment of Critical Thinking in the Fourth Grade." Paper presented at the annual meeting of the American Educational Research Association, Chicago.

Gagne, R. M. (1977). *The Conditions of Learning.* 3rd ed. New York: Holt, Rinehart and Winston.

Gagne, R. M., and L. J. Briggs. (1979). *Principles of Instructional Design.* 2nd ed. New York: Holt, Rinehart and Winston.

Guilford, J. P. (1956). "The Structure of Intellect." *Psychological Bulletin* 53: 267–293.

Linn, M. C. (1982). "Theoretical and Practical Significance of Formal Reasoning." *Journal of Research in Science Teaching* 21: 235–254.

National Assessment of Educational Progress. "Reading, Thinking, and Writing: Results from the 1970–80 National Assessment of Reading and Literature." Denver, Colo. 1981.

Newell, A., and H. A. Simon. (1976). "Computer Science as Empirical Inquiry." *Communications of the ACM* 19: 113–126.

Phillips, D. C., and M. E. Kelley. (1975). "Hierarchical Theories of Development in Education and Psychology." *Harvard Educational Review* 45: 351–375.

Quellmalz, E. S. (1985). "An Investigation of Scoring and Prompt Variations." Paper presented at the annual meeting of the American Educational Research Association, Chicago.

Quellmalz, E. S. (1984). "Successful Large-Scale Writing Assessment Programs: Where Are We Now and Where Do We Go from Here?" *Educational Measurement: Issues and Practices* 3: 29–32.

Smith, B. O. (1953). "The Improvement of Critical Thinking." *Progressive Education* 30: 129–134.

Sternberg, R. J. (1983). "What Should Intelligence Tests Test? Implications of a Triarchic Theory of Intelligence for Intelligence Testing." *Educational Researcher* 13: 5–15.

Suchman, J. R. (1965). "Inquiry and Education." In *Teaching Gifted Students: A Book of Readings*, edited by J. J. Gallagher. Boston: Allyn and Bacon.

Taba, H. (December 1963). "Teaching Strategy and Learning." *California Journal for Instructional Improvement*: 3–11.

59

Teaching to the (Authentic) Test

Grant Wiggins

Practical alternatives and sound arguments now exist to make testing once again serve teaching and learning. Ironically, we *should* "teach to the test." The catch is to design and then teach to *standard-setting* tests so that practicing for and taking the tests actually enhances rather than impedes education, and so that a criterion-referenced diploma makes externally mandated tests unobtrusive—even unnecessary.

Setting Standards

If tests determine what teachers actually teach and what students will study for—and they do—then the road to reform is a straight but steep one: test those capacities and habits we think are essential, and test them in context. Make them replicate, within reason, the challenges at the heart of each academic discipline. Let them be—authentic.

What are the actual performances that we want students to be good at, that represent model challenges? Design them by department, by school, and by district—and worry about a fair, efficient, and objective method of grading them as a *secondary* problem. Do we judge our students to be deficient in writing, speaking, listening, artistic creation, research, thoughtful analysis, problem posing, and problem solving? Let the tests ask them to write, speak, listen, create, do original research, analyze, pose and solve problems.

Rather than seeing tests as after-the-fact devices for checking up on what students have learned, we should see them as instructional: the central vehicle for clarifying and setting intellectual standards. The recital, debate, play, or game (and the criteria by which they are judged)—the "performance"—is not a checkup, it is the heart of the matter; all coaches *happily* teach to it. We should design academic tests to be similarly standard setting, not merely standardized.

Reform of testing depends, however, on teachers' recognizing that standardized testing evolved and proliferated because the school transcript became untrustworthy. An "A" in "English" means only that some adult thought the student's work was excellent. Compared to what or whom? As determined by what criteria? In reference to what specific subject matter? The high school diploma, by remaining tied to no standard other than credit accrual and seat time, provides no useful information about what students have studied or what they can actually do with what was studied.

To regain control over both testing and instruction, schools need to rethink their diploma requirements and grades. They need a clear set of appropriate and objective criteria, enabling both students *and outsiders* to know what counts, what is essential—what a school's standards really are. Until we specify what students must directly demonstrate to earn a diploma, they will continue to pass by meeting the de facto "standard" of being dutiful and persistent—irrespective of the quality of their work. And standardized testmakers will continue to succeed in hawking simplistic norm-referenced tests to districts and states resigned to using them for lack of a better accountability scheme.

Exhibitions of Mastery

The diploma should be awarded upon a successful final demonstration of mastery for graduation—an "Exhibition". . . . As the diploma is awarded when earned, the school's program proceeds with no strict age grading and with no system of "credits earned" by time

Except for the postscript and resource list, this chapter originally appeared in Grant Wiggins, "Teaching to the (Authentic) Test," *Educational Leadership* 46, 7 (April 1989): 121–127.

spent in class. The emphasis is on the students' demonstration that they can do important things.

—From the Prospectus of the Coalition of Essential Schools

The "exhibition of mastery," proposed by Ted Sizer in *Horace's Compromise* (1984) and a cornerstone of the "Essential School," is one attempt to grapple with these issues. The intent of the exhibitions project is to help schools and districts design more authentic, engaging, revealing, and trustworthy "tests" of a student's intellectual ability.

The reference to engagement is not incidental. The exhibition of mastery was initially proposed as an antidote to student passivity and boredom, not merely as a more valid form of assessment. The idea is to capture the interest value of an authentic test of one's ability, such as is often provided in schools by literary magazines, portfolios, recitals, games, or debates. Thus, "any exhibition of mastery should be the students' opportunity to show off what they know and are able to do rather than a trial by question . . ." (Sizer 1984, p. 68).

The exhibition of mastery, as the name implies, is meant to be more than a better test. Like the thesis and oral exam in graduate school, it indicates whether a student has *earned* a diploma, is ready to leave high school.[1] The school is designed "backwards" around these standard-setting tests to ensure that teachers and students alike understand their obligations and how their own efforts fit in a larger context. Teachers "teach to the test" because the test is essential—and teacher designed.

But why institute a radically new form of assessment? Why not just improve conventional teaching and course-related tests? As the "Study of High Schools" documented, a major cause of the high school's inadequacies is the absence of direct teaching of the essential skills of inquiry and expression. Even in "demanding" schools, students often fail to learn how to learn. The culprit is discipline-based curriculums that lead to content-based teaching and testing: the essential (cross-disciplinary) habits and skills of reading, writing, questioning, speaking, and listening fall through the cracks of typical content-focused syllabi and course credits; as indicated, for example, when teachers say "I teach English, not reading."

A required final public exhibition of know-how ensures that those essentials are taught and learned. The final exit-level exhibition reveals whether a would-be graduate can demonstrate control over the skills of inquiry and expression and control over an intellectual topic that approximates the expert's ability to use knowledge effectively and imaginatively. A final exhibition provides students with an occasion to make clear, if only perhaps symbolically, that they are ready to graduate.

An exhibition challenges students to show off not merely their knowledge but their initiative; not merely their problem solving but their problem posing; not just their learning on cue, but their ability to judge and learn how to learn on an open-ended problem, often of their own design. The experience thus typically focuses on the essential skills of "inquiry and expression"—a synthesis that requires questioning, problem posing, problem solving, independent research, the creation of a product or performance, and a *public* demonstration of mastery. Significantly, there is often a component calling for self-reflection and analysis of what one has undergone and learned.

Thus, a *final exhibition* is a misnomer in an important sense. Many Coalition schools provide a semester or yearlong course, an adult adviser, and a committee to ensure that a student has adequate guidance, evaluation, and incentive (see Figure 1 for an example of a final exhibition from a Coalition school). The exhibition of mastery is as much a process as a final product, if not more so. The process of choosing topics, advisers, and committees and refining one's ideas and skills is a yearlong exercise in understanding and internalizing standards.

A similar approach to a diploma at the college level has been used successfully at Alverno College, Milwaukee, Wisconsin, for over a decade.[2] Assessment is a central experience, with coursework a means to a set of known ends: students must achieve mastery in the following eight general areas, with their progress in each area being charted on a multistaged scale:

1. effective communication ability,
2. analytic capability,
3. problem-solving ability,
4. valuing in a decision-making context,
5. effective social interaction,
6. taking responsibility for the global environment,
7. effective citizenship,
8. aesthetic responsiveness.

Performances: Better Classroom Tests

Course-specific tests also have glaring weaknesses, not only because they are often too low level and content heavy. They are rarely designed to be authentic tests of intellectual ability; as with standardized tests, teacher-designed finals are usually intended to be quickly read and scored.

It seems wise, then, to talk about a move toward more intellectual performances in course-bound testing as a way of stressing the need to make tests more central, authentic, and engaging—as in the arts and athletics. (The term *exhibitions* would be reserved for those culminating graduation-level exercises designed to assess ability in the essentials underlying all coursework required for graduation.)

FIGURE 1

An Example of a Final Exhibition

The Rite of Passage Experience (R.O.P.E.) at Walden III, Racine, Wisconsin

All seniors must complete a portfolio, a study project on U.S. history, and 15 oral and written presentations before a R.O.P.E. committee composed of staff, students, and an outside adult. Nine of the presentations are based on the materials in the portfolio and the project: the remaining six are developed for presentation before the committee. All seniors must enroll in a yearlong course designed to help them meet these requirements.

The eight-part *portfolio*, developed in the first semester, is intended to be "a reflection and analysis of the senior's own life and times."

- The requirements include:
- a written autobiography,
- a reflection on work (including a resume),
- an essay on ethics,
- a written summary of coursework in science,
- an artistic product or a written report on art (including an essay on artistic standards used in judging artwork).

The *project* is a research paper on a topic of the student's choosing in American history. The student is orally questioned on the paper in the presentations before the committee during the second semester.

The *presentations* include oral tests on the previous work, as well as six additional presentations on the essential subject areas and "personal proficiency" (life skills, setting and realizing personal goals, etc.). The presentations before the committee usually last an hour, with most students averaging about 6 separate appearances to complete all 15.

A diploma is awarded to those students passing 12 of the 15 presentations and meeting district requirements in math, government, reading, and English.

Note: This summary is paraphrased from both the R.O.P.E. Student Handbook and an earlier draft of Archbald and Newmann's (1988) *Beyond Standardized Testing*.

Designing performances implies a very different approach to standard setting than is implied by typical criterion-referenced tests or outcome-based views of mastery, though the instincts behind the designs are similar. Performances would ideally *embody* and *evoke* desired outcomes in authentic contexts. Too often, specifying only outcomes leads to tests that atomize and decontextualize knowledge: the testmaker designs a set of isolated pat exercises designed to elicit each desired outcome. Genuine tests of ability rarely provide such blatant cues and simple recall; they require us to have a repertoire, the judgment and skill to "put it all together" in one central challenge, repeatedly tried. (Imagine the assessment of music ability in a series of little exercises tried once, rather than through practice and performance of a complete piece in recitals.)

In sum, the goals behind the exhibition of mastery and the performance are to design standard-setting tests that provide more direct evidence of a student's intellectual ability; design tests that are thus able to stand by themselves as objective results; design more authentic intellectual challenges at the heart of a discipline; and design tests that are more likely to engage students and motivate them to raise their own intellectual standards to do well on them. (See Figure 2 for an example of a performance that illustrates and illuminates these design standards.)

Toward More Authentic Tests

Exhibitions and performances sound fine on a schoolwide basis, you say, but districtwide or statewide? Isn't that too costly and cumbersome? I contend that the supposed impracticality and/or expense of designing such tests on a wide scale is a habit of thinking, not a fact. The United States is the only major country that relies so heavily on norm-referenced, short-answer tests instead of performance- and/or classroom-based assessment on a national level. In addition, a national committee on assessment in Great Britain has called for an exemplary system requiring flexible, criterion-referenced, and performance-based tests.[3] Many of the tests would be created by classroom teachers, who would be part of the standardizing process through "moderating" meetings to compare and balance results on their own and national tests.

In the U.S., more authentic skill assessment can now be found in various districts and states due, in part, to the work in writing assessment by the National Writing Project and its state offshoots (such as the California CAP writing test), and the American Council on the Teaching of Foreign Languages in the assessment of foreign language proficiency. Some states, such as Connecticut, have already designed and piloted performance-based assessment using ACTFL tests and criteria. In addition, they have piloted hands-on tests in graphics, small engines, and science. Vermont has proposed a statewide assessment system in writing and mathematics that would be portfolio based and teacher assessed.

We already have a national example in science: the 1987 NAEP pilot "Higher-Order Thinking Science Test," which includes some (though too few) hands-on experiments. One example:

Students are given a sample of three different materials and an open box. The samples differ in size, shape, and weight. The students are asked to determine whether the box would weigh the most (and least) if it were completely filled with material A, B, or C. There are a variety of possible approaches. . . . NAEP administrators used detailed checklists to record each student's procedures and strategies (Educational Testing Service 1987).

FIGURE 2

An Example of a Test of Performance

An Oral History Project for 9th Graders

To the student:

You must complete an oral history based on interviews and written sources and then present your findings orally in class. The choice of subject matter is up to you. Some examples of possible topics include: your family, running a small business, substance abuse, a labor union, teenage parents, and recent immigrants.

Create three workable hypotheses based on your preliminary investigations and four questions you will ask to test out each hypothesis.

Criteria for Evaluation of Oral History Project

To the teacher:

- Did student investigate three hypotheses?
- Did student describe at least one change over time?
- Did student demonstrate that he or she had done background research?
- Were the four people selected for the interview appropriate sources?
- Did student prepare at least four questions in advance, related to each hypothesis?
- Were those questions leading or biased?
- Were follow-up questions asked where possible, based on answers?
- Did student note important differences between "fact" and "opinion" in answers?
- Did student use evidence to prove the ultimate best hypothesis?
- Did student exhibit organization in writing and presentation to class?

Note: This example is courtesy of Albin Moser, Hope High School, Providence, Rhode Island. To obtain a thorough account of a performance-based history course, including the lessons used and pitfalls encountered, write to Dave Kobrin, Brown University, Education Department, Providence, RI 02912.

NAEP borrowed most of its experiments from the British Assessment of Performance Unit tasks, which have been used (and reliably scored) in Great Britain for a decade in reading, speaking, listening, math, and science.

Genuine tests *can* be widely implemented if we can overcome inertia and fatalism about current forms of standardized testing. Authentic, performance-based testing is a reality, not a romantic vision. There is also ample room for more intelligent design and use of conventional norm-referenced standardized tests.[4]

The state of Connecticut has developed a "Common Core of Learning," which lists objectives and criteria for all essential domains. Performance-based tests, built around criteria specified by experts in each field and involving tests administered by trained observers, are to be designed to honor those aims.

There are even standardized tests worth noting. ACT has developed a wide-ranging multimedia test of "general education knowledge and skills" called COMP, designed for colleges but easily adaptable to the high school level. The test uses art reproductions and audiotapes of news programs, for example, in testing writing and listening skills. On other items, students draft letters on different topics. There is even allowance for the student to respond orally on tape to a few test questions. The test takes six hours to administer, covers all the essential skills of inquiry and expression, and includes a 54-question self-assessment about one's patterns of activity related to each competency.

In sum, authentic tests have four basic characteristics in common. First, they are designed to be truly representative of performance in the field; only then are the problems of scoring reliability and logistics of testing considered. Second, far greater attention is paid to the teaching and learning of the *criteria* to be used in the assessment. Third, self-assessment plays a much greater role than in conventional testing.[5] And, fourth, the students are often expected to present their work and defend themselves publicly and orally to ensure that their apparent mastery is genuine. (See Figure 3 for a more thorough list of characteristics of authentic tests.)

Toward a Performance-Based Diploma

The diploma by exhibition implies radically different standards for graduation. Instead of seat time or the mere accrual of Carnegie units, the diploma is performance based and criterion referenced. We may not be ready for the demise of age grading and social promotion; but if the harm done by standardized testing is to be undone, we need to redesign schools "backwards" around graduation-level standards of performance.

The performances and exhibitions should be designed prior to instruction, thus setting the school's standards in functional, not merely abstract and idealized, terms. Seeing them as add-ons to the traditional curriculum is to miss the point. How must the school be redesigned to support exhibitions or any form of exit-level standards? This should be the question behind "restructuring" and the source of vigorous debate among faculties and school board members. Designing and institutionalizing exhibitions would better ensure, in other words, that the school had clear, coherent, and effective standards. Knowing the desired student abilities and work standards, as embodied in culminating performances and scoring criteria, would force key issues of policy: how will time, space, personnel, and other resources be best spent to ensure that diploma standards are met?

FIGURE 3

Characteristics of Authentic Tests

A. Structure and Logistics

1. Are more appropriately public; involve an audience, a panel, and so on.
2. Do not rely on unrealistic and arbitrary time constraints.
3. Offer known, not secret, questions or tasks.
4. Are more like portfolios or a *season* of games (not one-shot).
5. Require some collaboration with others.
6. Recur—and are *worth* practicing for, rehearsing, and retaking.
7. Make assessment and feedback to students so central that school schedules, structures, and policies are modified to support them.

B. Intellectual Design Features

1. Are "essential"—not needlessly intrusive, arbitrary, or contrived to "shake out" a grade.
2. Are "enabling"—constructed to point the student toward more sophisticated use of the skills or knowledge.
3. Are contextualized, complex intellectual challenges, not "atomized" tasks, corresponding to isolated "outcomes."
4. Involve the student's own research or use of knowledge, for which "content" is a means.
5. Assess student habits and repertoires, not mere recall or plug-in skills.
6. Are *representative* challenges—designed to emphasize *depth* more than breadth.
7. Are engaging and educational.
8. Involve somewhat ambiguous ("ill-structured") tasks or problems.

C. Grading and Scoring Standards

1. Involve criteria that assess essentials, not easily counted (but relatively unimportant) errors.
2. Are not graded on a "curve" but in reference to performance standards (criterion-referenced, not norm-referenced).
3. Involve demystified criteria of success that appear to *students* as inherent in successful activity.
4. Make self-assessments a part of the assessment.
5. Use a multifaceted scoring system instead of one aggregate grade.
6. Exhibit harmony with shared schoolwide aims—a *standard*.

D. Fairness and Equity

1. Ferret out and identify (perhaps hidden) strengths.
2. Strike a *constantly* examined balance between honoring achievement and native skill or fortunate prior training.
3. Minimize needless, unfair, and demoralizing comparisons.
4. Allow appropriate room for student learning styles, aptitudes, and interests.
5. Can be—should be—attempted by *all* students, with the test "scaffolded up," not "dumbed down," as necessary.
6. Reverse typical test-design procedures: they make "accountability" serve student learning (Attention is primarily paid to "face" and "ecological" validity of tests).[1]

[1]Thanks to Ted Sizer, Art Powell, Fred Newmann, and Doug Archbald; and the work of Peter Elbow and Robert Glaser for some of these criteria. A more thorough account of them will appear in an upcoming issue of *Phi Delta Kappan*.

To talk with disdain of "teaching to the test" is to misunderstand how we learn. The test is the point of leverage—for learning and for reform. The issue is the integrity of the test: the genuineness, effectiveness, and aptness of the challenge. The finals (and the criteria by which they are graded) set the standards of acceptable work in a course and a school—irrespective of noble language in school district reports or teacher intentions as reflected in syllabi. Legitimate and effective assessment is as simple(!) as ensuring that tests, grades, diploma requirements, and the structures and policies of the schools practice what we preach as essential. If we so honor our professed aims, the problems associated with standardized testing will take care of themselves.

NOTES

1. This (final) exhibition is patterned after the 18th century model of a public display of one's ability to engage in disputation: ". . . candidates for degrees expected to be academically tested at Commencement itself. Bachelor of Arts candidates prepared theses or topics on which they could be quizzed, and candidates for the Master of Arts submitted questions they were ready to defend. Titles of theses and questions were printed in advance and handed out at Commencement, and visitors often took the opportunity of challenging the candidates on their knowledge" (from the Harvard University Commencement program).

2. See Alverno College Faculty 1979/1985. For a history and an analysis of Alverno's program (as well as a general discussion of competency-based higher education), see Grant, Elbow et al. 1979.

3. See Department of Education and Science and the Welsh Office 1988. This is a landmark document, outlining in readable prose a plan for intelligent and humane assessment. A brief "Digest for Schools" is also available.

4. See Koretz 1988, which is an excellent summary of the controversy about norm-referenced state testing (the "Lake Wobegon effect" of each state being above average) and which provides a useful set of guidelines for assessing assessment.

5. At Alverno, self-assessment is often the first level of proficiency. Thus, in the speaking requirement, students must give a five-minute videotaped talk—with the first evaluations given on the student's self-assessment after watching the videotape.

REFERENCES

Alverno College Faculty. (1979/1985). *Assessment at Alverno College*. Rev. ed. Milwaukee, Wis.: Alverno College.

Archbald, D., and F. Newmann. (1988). *Beyond Standardized Testing: Authentic Academic Achievement in the Secondary School*. Reston, Va.: NASSP Publications.

Department of Education and Science and the Welsh Office. (1988). *National Curriculum: Task Group on Assessment and Testing: A Report*. London: Her Majesty's Stationery Office, Department of Education and Science, England and Wales.

Educational Testing Service. (1987). *Learning By Doing: A Manual for Teaching and Assessing Higher-Order Thinking in Science and Mathematics*. A report on the NAEP pilot of performance-based assessment. A summary of the NAEP pilot of performance-based assessment. Princeton, N.J.: ETS. The full report:

A Pilot Study of Higher-Order Thinking Skills Assessment Techniques in Science and Mathematics. ETS Report #17-HOS-80.

Grant, G., P. Elbow, et al. (1979). *On Competence: A Critical Analysis of Competence-Based Reforms in Higher Education.* San Francisco: Jossey-Bass.

Koretz, D. (Summer 1988). "Arriving in Lake Wobegon: Are Standardized Tests Exaggerating Achievement and Distorting Instruction?" *American Educator* 12, 2: 8–15, 46.

Sizer, T. (1984). *Horace's Compromise: The Dilemma of the American High School.* Updated ed. Boston: Houghton--Mifflin.

Wiggins, G. (May 1989). "A True Test: Toward More Authentic and Equitable Forms of Assessment." *Phi Delta Kappan* 70, 9: 703–713.

Postscript to "Teaching to the (Authentic) Test"

SINCE THE ARTICLE was written, we have been watching a revolution develop in how student assessment is conceived and undertaken. What was once a staid field, limited by and large to "measurement" people refining tried-and-true techniques, has become a battlefield in the debate over national standards. Instead of being viewed as a "technical" problem only, assessment design has once again become what it must always be in education: a debate about values—namely, what is *worth* measuring.

More important, what might have seemed naive or unrealistic in 1988 is now policy in many districts and states across the country. New York state has a hands-on science test for all 4th grade students; Maryland and Arizona have developed (and Kentucky has authorized) performance-based assessment in reading, writing and mathematics; Vermont has instituted a portfolio-based system in language arts and mathematics for grades 4 and 8; California has implemented open-ended assessments in mathematics for grade 12 and hands-on assessment in science for the middle grades, and it has expanded its successful writing assessments. There are now dozens of schools that have developed writing, project-based, oral, or portfolio requirements as part of exit-level assessments of students. At the federal level, NAEP has greatly increased the amount of performance-based assessment (principally through written responses required of students) and been encouraged to undertake more.

These moves are understandable in retrospect. As demands for the accountability of schools increase, the quality of the "measures" used to assess whether we are meeting "standards" becomes increasingly important—especially to those who would be judged. The reform of assessment is inseparable from the redesign of schools built around site-based management because teachers can only be held accountable for their new powers when tests have "face validity"—to *teachers, students, and the schools' "clients,"* not just psychometricians.

Authentic assessment has little to do with replacing one testing technology with another, therefore. It has to do with designing a testing *system* that practices what we preach pedagogically: able to embody and evoke (and not merely measure) high-quality performance on exemplary tasks, and capable of generating strong teacher and student ownership of the results.

AUTHENTIC ASSESSMENT: A LIST OF USEFUL RESOURCES

Alverno College Faculty. (1979/1985). *Assessment at Alverno College.* Rev. ed. Milwaukee, Wisc.: Alverno College.

American Council on the Teaching of Foreign Languages. (1982). *ACTFL Provisional Proficiency Guidelines.* Hastings-on-Hudson, N.Y.: ACTFL Materials Center.

Archbald, D., and F. Newmann. (1988). *Beyond Standardized Testing: Authentic Academic Achievement in the Secondary School.* Reston, Va.: NASSP Publications.

California Assessment Program. (1989). "Guidelines for the Mathematics Portfolio: Phase II Pilot Working Paper." (Available from the CAP Office, California State Department of Education, Sacramento).

California State Department of Education. (1989). *A Question of Thinking: A First Look at Students' Performance on Open-Ended Questions in Mathematics.* Sacramento, Calif.

California State Department of Education. (1989). *Writing Achievement of California Eighth Graders: Year Two.* Sacramento, Calif.

Connecticut Department of Education. (1990). "Toward a New Generation of Student Outcome Measures: Connecticut's Common Core of Learning Assessment." Hartford, Conn.: State Department of Education, Research and Evaluation Division.

Department of Education and Science and the Welsh Office. (1988). *National Curriculum: Task Group on Assessment and Testing: A Report.* London: Her Majesty's Stationery Office, Department of Education and Science, England and Wales. A brief "Digest for Schools" is also available.

Educational Testing Service. (1987). *Learning by Doing: A Manual for Teaching and Assessing Higher-Order Thinking in Science and Mathematics.* A report on the NAEP pilot of performance-based assessment. Princeton, N.J.: ETS. The full report: *A Pilot*

Study of Higher-Order Thinking Skills Assessment Techniques in Science and Mathematics, ETS Report #17-HOS-80.

Gardner, H. (1989). "Assessment in Context: The Alternative to Standardized Testing." In *Report to the Commission on Testing and Public Policy,* edited by B. Gifford. Boston: Kluwer Academic Press.

Mills, R. (December 1989). "Portfolios Capture Rich Array of Student Performance." *The School Administrator* 11, 46.

Ministry of Education, Victoria Australia. (1990). *Literacy Profiles Handbook: Assessing and Reporting Literacy Development.* Melbourne, Victoria: Education Shop.

National Commission on Testing and Public Policy. (1990). *From Gatekeeper to Gateway: Transforming Testing in America.* Chestnut Hill, Mass.: NCTPP, Boston College.

Northwest Regional Educational Laboratory. (1981). *Competency-Based Education: Beyond Minimum Competency Testing,* edited by R. Nickse. New York: Teachers College Press.

Spandel, V., and R. Stiggins. (1990). *Creative Writers: Linking Assessment and Writing Instruction.* New York: Longman.

University of California. (1989). "Assessment Alternatives in Mathematics." From EQUALS and the California Mathematics Council, Lawrence Hall of Science, Berkeley.

Vermont Department of Education. (1989). *Vermont Writing Assessment: The Portfolio.* (October draft).

Wiggins, G. (1990). "Secure Tests, Insecure Test Takers." In *The Prices of Secrecy: The Social, Intellectual, and Psychological Costs of Testing in America,* A Report to the Ford Foundation, edited by J. Schwarz. Cambridge, Mass.: Educational Technology Center, Harvard Graduate School of Education.

Wiggins, G. (May 1989). "A True Test: Toward More Authentic and Equitable Assessment." *Phi Delta Kappan* 70, 9: 703–713.

Wiggins, G. (Winter 1988). "Rational Numbers: Scoring and Grading That Helps Rather than Hurts Learning." *American Educator* 12, 4: 20–48.

Wolf, D. (December 1987/January 1988). "Opening Up Assessment." *Educational Leadership* 44, 4: 24–29.

Note: The April 1989 issue of *Educational Leadership* in which this article originally appeared was devoted to assessment and testing reform issues, as were the May 1989 issue of *Phi Delta Kappan* and the December 1989 issue of *Educational Researcher.*

60

Portfolio Assessment: Sampling Student Work

Dennie Palmer Wolf

Writing is not apart from living. Writing is a kind of double living.

—Catherine Drinker Bowen

For the last two years, a consortium of administrators, teachers, and researchers in the Pittsburgh schools has been searching for alternatives to standardized assessment. In that work we have found that the world brims over with examples of the differences between testing as we know it in schools and the reflective self-evaluation that is inseparable from pursuing virtually any kind of worthwhile work.

Some examples? A few summers ago when the Dodgers were heating up, I heard a radio announcer tease pitcher Orel Hershiser about keeping a journal. Hershiser wasn't fazed. He simply said human memory is too faulty and he cares too much about what makes him crackerjack one day and just average the next not to keep track. Several days later, I visited a small gallery where they show artists' books and working drawings. Inside, the walls and cases were crammed with sketches by Ree Morton, a sculptor who began studying art in her thirties, surrounded by young children, drafting and writing on top of the washing machine. There on the gallery walls was evidence of another kind of evaluation: Morton would stalk an idea from inception to final work, making version after version after version. Then, two days ago, I listened to Sonny Rollins reminiscing on a jazz show. He was remembering how, smack in the middle of gigs and tours, he decided to "step out to find a new sound." He left the world of clubs and concert halls to practice hours at a time where the acoustics would let him get inside the music—solo on the bridges of New York City.

Here is both promise and trouble. The promise lies in the demonstration of how demanding and thoughtful we can be about shaping work that matters to us. The trouble lies in recognizing how we ignore this capacity in schools. Never do we stop to ask how we could make our evaluative gatekeeping model the kind of self-observation and informed critique that separates ball tossers from fine pitchers, doodlers from artists, or instrumentalists from musicians. Yet virtually every student walks out of school into years of long-term projects: raising children, building a house, running a farm, writing a novel, or becoming a better lab technician. All of these projects require moment-to-moment monitoring, Monday morning quarterbacking, and countless judgments of errors and worth. Unfortunately, very little in the way we now structure assessment in schools names or encourages those lifelong skills.

Even in a time when increasing numbers of educators are working to diversify and humanize the way we evaluate student learning, much school-based assessment actually *prevents* students from becoming thoughtful respondents to, and judges of, their own work. The "surprise" nature of many test items, the emphasis on objective knowledge, the once-over and one-time nature of most exams—all offer students lessons that are destructive to their capacity to thoughtfully judge their own work: (1) assessment comes from without, it is not a personal responsibility; (2) what matters is not the full range of your intuitions and knowledge but your performance on the slice of skills that appear on tests; (3) first-draft

This article is adapted from Dennie Palmer Wolf, "Portfolio Assessment: Sampling Student Work," *Educational Leadership* 46, 7 (April 1989): 116–120.

work is good enough; and (4) achievement matters to the exclusion of development.

Alternatives from the Arts and Humanities

These issues about evaluating student learning have recently been aggravated by debates about what counts as knowledge and learning in the arts and humanities. On the one hand, critics like Bennett, Finn, Hirsch, and Ravitch argue that the first obligation of humanities education is to provide students with a considerable factual knowledge of Western history and culture. On the other hand, a coalition of projects and people argue that students cannot learn and retain facts unless they learn how to *think* about those facts. Therefore, from the earliest age, students must learn the processes characteristic of the humanities: how to question and form an opinion, understand the nature of knowing, or develop a sigr :ure as a thinker. Certainly another of these processes is self-knowledge and reflection, what the artist Ben Shahn once referred to as the ability to be "the spontaneous imaginer and the inexorable critic all at once." But these capacities may be squeezed out of schooling if current critiques of education lead to a relentless push for coverage of facts.

Among these contending voices are the designers of the new Civilizations of the Americas course at Stanford University, the College Board's EQuality project, and the Rockefeller-funded CHART (Collaborative for Humanities and Arts Teaching) programs designed to bring both critical and creative thinking to students normally disbarred from anything but functional education.

Included among the Rockefeller projects is PROPEL, the three-way consortium mentioned earlier. PROPEL brings together the Pittsburgh Public Schools, Educational Testing Service, and Project Zero at the Harvard Graduate School of Education in an effort to demonstrate that it is possible to assess the thinking processes characteristic of the arts and humanities in rigorous, but undistorted, ways. Central to this work are two aims: The first is to design ways of evaluating student learning that, while providing information to teachers and school systems, will also model personal responsibility in questioning and reflecting on one's own work. The second is to find ways of capturing growth over time so that students can become informed and thoughtful assessors of their own histories as learners.

To accomplish these aims, the teachers and researchers in PROPEL have asked experts—artists, musicians, and writers—how they sample and judge their own life work. Time and again, something like Orel Hershiser's diary, Ree Morton's stack of sketchbooks, or Rollins' sustained practicing surfaces. Whatever the medium, the message is the same: thinkers and inventors often keep longitudinal collections of their ideas, drafts, and questions. They use these as a kind of storehouse of possibilities for later work, valuing them as a record of where they have been and reading them for a sharp sense of their own signatures and uncertainties. Building on these examples, PROPEL teachers and researchers have developed systems of portfolio assessment in the visual arts, music, and writing.

Portfolios

PROPEL portfolios might better be called process-folios because they have developed some novel and distinguishing characteristics. To begin, students collect more than a diverse body of finished work. In fact, they gather what we have come to call *biographies of works*, a *range of works*, and *reflections*. A biography of work reveals the geology of different moments that underlies the production of any major project. Among young musicians preparing for a concert, such a biography includes regular tape recordings of a particularly telling section of a piece. For a young writer it might include the notes, diagrams, drafts, and final version of a poem.

The range of works is deliberately diverse. A student artist might include collages, prints, photos or portraits, landscapes, and still lifes. The young writer might bring together pieces as diverse as journal entries, letters, poems, or essays from social studies classes.

Reflections are documents (or even audiotapes) that come from moments when teachers ask students to return to their collections of work, taking up the stance of an informed critic or autobiographer, noticing what is characteristic, what has changed with time, or what still remains to be done. At the end of any given semester or year, teachers offer students a still longer period of time to study their collections, selecting several works that best exemplify what has changed for the student in that time. These works, along with student and teacher commentaries, become a final portfolio that can be passed along as a continuing document from year to year.

Why Bother?

Portfolios are messy. They demand intimate and often frighteningly subjective talk with students. Portfolios are work. Teachers who ask students to read their own progress in the "footprints" of their works have to coax and bicker with individuals who are used to being assessed. Halfway through the semester, at least a half dozen recalcitrants will lose every paper or sketch or tape they have ever owned. More important, teachers have to struggle to read and make sense of whole works and patterns of growth. Hence, hard questions arise: "Why bother? What comes out of portfolio-based assessment?" The immediate answer lies in the integrity and validity of the information we gain about how and what students learn. But that's far from all.

Student responsibility. In the fall of last year, Kathy Howard faced an ordinary class of 8th graders who had not written more than the answers to chapter questions and who had certainly never been asked to reflect on their progress as writers. In the ensuing months she began to insist that they write essays, journals, and poems. At intervals of several months, she asked her students to select two pieces: one that didn't satisfy them and another that they liked. Her students studied these pieces and wrote down what they noticed about themselves as writers. Sometimes she left students on their own; at other times she discussed the various dimensions of their writing that they might consider. As students continued to write, they revisited their earlier choices, seeing whether old favorites held up in the light of their own evolving standards. After eight months, the climate around writing had changed dramatically: part of writing was now the responsibility to know where you were and what you thought. By early June, the classroom dialogue had acquired a sound that was tough yet meditative:

"I want you to look at what you chose last time as your most satisfying piece and your least satisfying piece. You don't have to change them, but I want to give you the chance to re-evaluate them. Something that once looked good to you may look different now, or you might see something new in a piece you once thought wasn't much.

"Feel free to conference with each other. Go ahead and ask someone else's opinion. But be sure you really give them a chance to read what you have written. Don't just wave a paper in front of their face and ask them."

A student calls: "If we have two satisfying pieces, is that okay?"

"Yes, just be sure you know what you see in each of them."

Kathy pauses beside another student who is shuffling papers. "Rocky, show me what you are using."

"Is this the right one?"

"I don't care which one you choose. I'm just here to listen to your ideas."

He smiles and takes a paper out and holds it up. Kathy reads over his shoulder. "Nice choice. Now why?" Rocky begins to read the paper out loud to her. Kathy jokes: "No, you need to tell me. Think out loud about your writing."

Rocky looks quizzical.

"I want to know why you chose what you did. See, if I chose, I would probably choose different things for *my* reasons."

This slice of life in the classroom illustrates how portfolios promote a climate of reflection. Words like *think, choose,* and *risk* run throughout the conversation, which is punctuated by pauses for reflection. The answer to a question is not to be found in the text, but in thinking back to earlier times, comparing pieces, and struggling to put your intuitions into words. Kathy hasn't abdicated her role as teacher, but she uses that role to insist that her students go back to their own work, requiring that they construct their own autobiographies as learners. Time and again, she brings the conversation back to what they notice, value, or worry over. She makes her students responsible for taking the lead in evaluating their work.

Enlarging the view of what's learned. Because portfolios contain a range of work—fiction, poems, essays, journal entries—students come to see what is under development quite differently. While all of them still include neatness and good grammar among the dimensions of change they notice, students also come to see themselves as authors who write differently for different audiences or who make distinctive choices about how they convey information. By way of example, consider what Jeff, an 8th grader, has to say when he reflects on a piece of fiction writing based on Poe's poem "The Raven":

I had a hard time being the Raven. I knew it right away. So I tried to be really creative, well, sort of crazy. Now I would put some more basic story into it. I would take some of the abstractness out, put some real experiences into it. I wouldn't have left the story so blank.

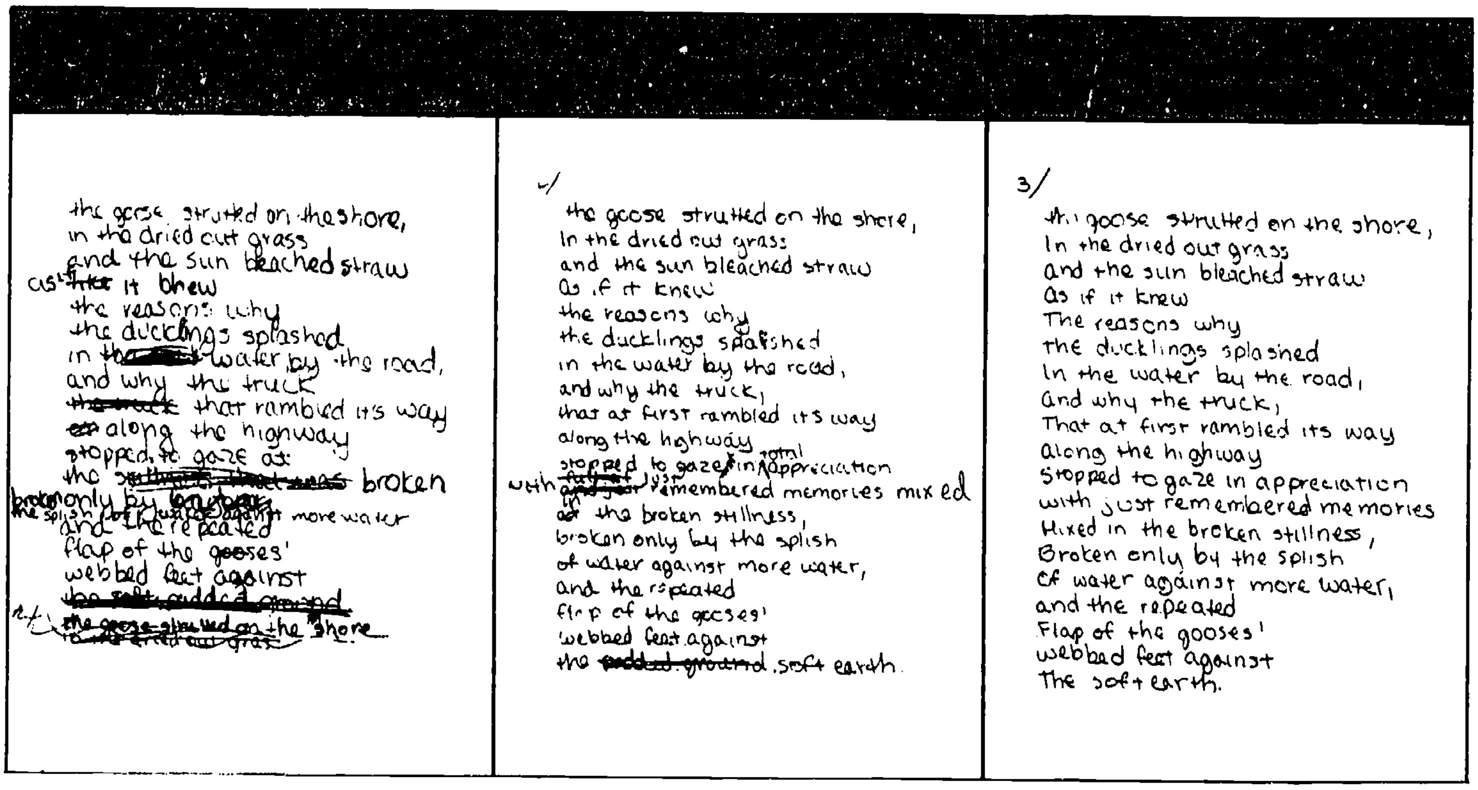
Later on, when he talks about his essays on books like *Animal Farm*, he relies on a different kind of criteria:

It's analyzing Napoleon's whole plan for how to get power. I showed each different step and how it came to a conclusion. I didn't use any creative writing. I liked being able to remember about all those things. I could really lay out such a giant story into a page and a half. [I like it when] you can really wrestle with ideas.

A place for process. Any writer's work unfolds over time, starting with incubation, changing into notes, undergoing revision, settling into its near-final form, and zigzagging between these different moments as well. In fact, knowing how to pursue the work of writing is as much a part of what is learned as is the sense for where a semicolon goes or how dialogue ought to sound.

At the very simplest level, many of the portfolio pieces are fat stacks of pages that tell the story of the piece's evolution. Such unusual data allow students as well as teachers to form new questions about writing development. Rather than just comparing final pieces, students investigate how their own revising or editing skills changed over time. Since their pieces don't disappear, students can afford to let ideas incubate and to take enormous trouble over the small changes that distinguish a third draft from a handsomely crafted final work. Student Pat Stone provides a wonderful instance of this sort of care in her series of drafts for a poem about a goose standing in a field (Figure 1).

FIGURE 1
Three Drafts of Student Poem



A developmental point of view. It is no accident that many of the anecdotes offered here take the form of narratives, full of words like *then*, *before*, and *later*. The use of portfolios engages students in constructing a story—a long-term account—of what and how they learn. As they page through their collections of writing in April or June, they are struck by what they have learned. But that in itself is a story. With time, experience, and conversation, students' ability to read their own portfolios with depth and understanding also develops. Early on, students appraise their own work using only standard and flat-footed criteria: neatness, length, or the grade written at the top. As little as six months later, they notice and care about a widened range of characteristics: how effective a story is, how unusual the words in a poem are, whether the ideas and arguments in an essay are sharp. Moreover, their judgment is variegated: they know a piece can open with fireworks and fizzle in closing. They can point out moments where their writing sails and where it "got away."

What emerges is not just insight about paragraphs or pieces. Talking to students at the end of the school year, one finds that they know their own histories as writers. As one young poet, Justin Brown, remarked:

> When I look back, I see my poems were very basic in the beginning; they were all rhymed haiku because that was all I knew about. Then I experimented with going with the feelings or ideas . . . don't kill yourself going over the rhymes, go with what you feel. I did that for two months. Then I started compacting them, shortening them to make deeper meaning. I could see that it would make more of a point if I washed out the *the's* and *and's* and *if's*. Now I am working on something different—the morals. If one day my mom's car broke down, I might write that night about how a fish got caught, or the feeling of not being able to swim. I am not trying to write how I feel only, but metaphors . . .

A Kind of Double Living

This study has two lives. One is a wholly different way of assessing writing. Within the framework of this project, teachers have begun to talk about using portfolios to widen the range of what they consider development. They don't ignore mechanics and usage, but the talk heats up as they move on to asking one another how they can judge what a student knows about the writing process; how well a student understands the demands of writing journals, poems, and essays; how many risks a young writer is taking.

At the same time, teachers are using these same portfolios to look at their *own* skills and development. At least once a year, a letter arrives from a wise supervisor, JoAnne Doran, asking teachers to select three to five processfolios that illustrate exceptional, moderate, or limited progress in writing. Her letter alerts teachers that she will be coming to talk with them about that writing. The conference is a time to describe how they are teaching a variety of types of writing, how they encourage students to engage in the several phases of the writing process, and how they comment on and critique student work. Several weeks later, Doran and the teacher grab a cup of coffee before school or in a "prep" period and then sit down to "do portfolios." These discussions may be a teacher's chance to talk about what portfolios contribute to student assessment, or the portfolios may serve to highlight places where a particular teacher struggles. But, in either case, during that half hour, teachers take active responsibility for portraying *their* work; they examine many facets of teaching; for instance, why they don't use tests or first-draft writing samples but evidence of the writing process and the back-and-forth between teacher and student. The result is not a score on a teachers' exam. Instead, it is a reflection on a sample of work. Like student portfolios, it offers a humane, useful, and generative portrait of development—one that a teacher, like a student, can learn from long after the isolated moment of assessment.

Author's note: I would like to acknowledge the close collaboration of students, teachers, and supervisors in the Pittsburgh Public Schools. This work was developed from a paper presented April 8, 1988, at the American Educational Research Association Meeting, New Orleans, Louisiana. The research reported here was supported by a grant from the Division of Arts and Humanities at the Rockefeller Foundation.

Portfolio is the quarterly newsletter of the PROPEL project. It prints writings by teachers and researchers and provides samples of student work and the different forms of assessment being developed. Available from Project Zero, 326 Longfellow Hall, Harvard Graduate School of Education, 13 Appian Way, Cambridge, MA 02138-3752.

Recommended Readings

Brandt, R. (December 1987/January 1988). "On Assessment in the Arts: A Conversation with Howard Gardner." *Educational Leadership* 45, 4: 30–34.

Wolf, D. P. (1986). "All the Pieces That Go into It: The Multiple Stances of Arts Education." In *Aesthetics in Education: The Missing Dimension*, edited by A. Hurwitz. Mattituck, Md.: Amercon Press.

Wolf, D. P. "Artistic Learning: What and Where Is It?" *Journal of Aesthetic Education* 22, 1: 144–155.

Wolf, D. P. (December 1987/January 1988). "Opening Up Assessment." *Educational Leadership* 45, 4: 24–29.

Zessoules, R. (1988). "A Better Balance." In *Beyond DBAE: The Case for Multiple Visions of Art Education*, edited by J. Burton, A. Lederman, and P. London. North Dartmouth, Mass.: Southeastern Massachusetts University.

Resources For Teaching Thinking

This section of *Developing Minds* will be out of date before the book comes off the presses. Addresses are changed, new books are published, more research is generated, and additional resources are developed and discovered. No resource list is ever complete. We have drawn from numerous sources to compile this one, but you should continue to add to it the books, articles, audio and video materials, and human resources that enrich your understanding of the nature of teaching for thinking.

The resources here are divided among four categories: a partial bibliography; a select bibliography by key leaders; critical thinking tests; and media, newsletters, and networks.

The extensive bibliography was coordinated by Nelson "Pete" Quinby. To assist in coping with such a vast array of material, it is presented in 13 categories developed by Inabeth Miller.

Because of the large size of this bibliography, we invited several key leaders in the field of cognitive education to recommend a few "classics" for those of you who might want a more select bibliography. They are Barry Beyer, Esther Fusco, Matthew Lipman, Jay McTighe, Robert Marzano, Fred Newton, Stephen P. Norris, Joe Onosko, Richard W. Paul, David Perkins, Lauren Resnick, and Selma Wasserman. We are grateful for their thoughtful contributions.

The media, newsletters, networks, and other agencies will assist teachers, curriculum decision makers, and other schools leaders as they continue to learn more about teaching thinking.

We extend our deep appreciation to all the contributors to this section.

A Partial Bibliography

Arthur L. Costa, Inabeth Miller, and Nelson "Pete" Quinby

The study of thinking covers topics such as problem solving, creativity, decision making, intelligence, neurobiology, research, and more. Although the categories employed here are somewhat vague and overlapping, they provide serviceable, if rough, partitions of a complex field. Annotations, where they are given, were written by Robert Sternberg and Arthur Costa.

General

Anderson, John. (1981). *Cognitive Skills and Their Acquisition*. Hillsdale, N.J.: Lawrence Erlbaum.

Bossone, Richard. (1983). *The Fourth R: Reasoning*. New York: City University of New York.

Cohen, Josef. (1971). *Thinking*. Chicago: Rand McNally.

de Bono, Edward. (1967). *New Think*. New York: Basic Books.

Dewey, John. (1933). *How We Think*. Boston: D. C. Heath.

Halpern, Diane F. (1984). *Thought and Knowledge: An Introduction to Critical Thinking*. Hillsdale, N.J.: Lawrence Erlbaum. Relates critical thinking to the current work by cognitive psychologists in problem solving, decision making, and intelligence.

Machado, Luis. (1980). *The Right to Be Intelligent*. New York: Pergamon.

Maxwell, William, ed. (1983). *Thinking: The Expanding Frontier*. Philadelphia: Franklin Institute Press.

Resnick, Lauren. (1987). *Education and Learning to Think*. Washington, D.C.: National Academy Press.

Segal, Judith W., S. Chipman, and R. Glaser, eds. (1985). *Thinking and Learning Skills*. Vol.I, *Relating Instruction to Research*. Vol. II, *Research and Open Questions*. Hillsdale, N.J.: Lawrence Erlbaum.

Upton, Albert. (1961). *Design for Thinking: A First Book in Semantics*. Palo Alto, Calif.: Pacific Press.

Teaching for Thinking

Installing intelligent behavior in young people is the major challenge of educators and parents. There is not unanimity in the field of education to prescribe the best methods of instruction and what school and home conditions need to exist to produce thoughtful children and youth. This section includes several points of view on this subject.

Adams, M. J., and others. (1982). *Teachers Manual. Prepared for Project Intelligence: The Development of Procedures to Enhance Thinking Skills*. Cambridge: Harvard University Press.

Aylesworth, Thomas, and Gerald Reagan. (1965). *Teaching for Thinking*. New York: Doubleday.

Baron, Joan, and Robert Sternberg, eds. (1987). *Teaching Thinking: Theory and Practice*. New York: W. H. Freeman and Company.

Bellanca, James, and Robin Fogarty. (1990). *Bluprints for Cooperative Learning in the Thinking Classroom*. Palatine, Ill.: Skylight Publishing.

Bellanca, James, and Robin Fogarty. *Catch Them Thinking: A Handbook of Classroom Strategies*. Palatine, Ill.: Skylight Publishing.

Beyer, Barry K. (1987). *Practical Strategies for the Teaching of Thinking*. Boston: Allyn and Bacon

Beyer, Barry K. (1987). *Developing a Thinking Skills Program*. Boston: Allyn and Bacon.

Beyer, Barry K. *Practical Strategies for the Teaching of Thinking*. (1987). Boston: Allyn and Bacon.

Bills, Robert. (1982). *Education: For Intelligence? Or Failure?* Washington, D.C.: Acropolis Books. Basing his analysis on a survey of 124,000 students in public, private, and parochial schools, Bills offers answers to the question "Why are schools failing to educate our children?" and proposes a five-part plan for change.

Black, Howard, and Sandra Black. (1990). *Organizing Thinking, Graphic Organizers*. Book II. Pacific Grove, Calif.: Midwest Publications, Critical Thinking Press & Software.

Bloom, Benjamin. (1981). *All Our Children Learning*. New York: McGraw-Hill.

Bloom, Benjamin, and D. R. Krathwohl. (1956). *Taxonomy of Educational Objectives, Handbook I: Cognitive Domain*. New York: David McKay.

Brandt, Ronald S., ed. (1989). *Readings from Educational Leadership: Teaching Thinking*. Alexandria, Va.: Association for Supervision and Curriculum Development.

Bransford, J. D., N. Vye, C. Kinzer, and V. Risko. (in press). "Teaching Thinking and Content Knowledge: Toward an Integrated Approach." In *Teaching Thinking*, edited by B. Jones. Hillsdale, N.J.: Lawrence Erlbaum.

Bruner, Jerome. (1960). *The Process of Education*. Cambridge, Mass.: Harvard University Press.

Chall, Jeanne, and Allan Mirsky, eds. (1978). *Education and the Brain*. 77th Yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press.

Clarke, John. (1990). *Patterns of Thinking: Integrating Learning Skills in Content Teaching*. Boston: Allyn and Bacon.

Collins, Cathy, and John N. Mangieri. *Building the Quality of Thinking In and Out of Schools in the Twenty-First Century*. (in press). Hillsdale, N.J.: Lawrence Erlbaum. Describes innovative projects to advance the thinking abilities of youth and adults. In addition to discussing ongoing research, the authors point to aspects of thinking development that have only recently been discovered and the impact these hold for education in the next century. Contains the work of anthropologists, cognitive psychologists, curriculum specialists, and business leaders to expand our population's ability to succeed in our changing world.

Copple, C., I. Siegel, and R. Saunders. (1984). *Educating the Young Thinker: Classroom Strategies for Cognitive Growth*. Hillsdale, N.J.: Lawrence Erlbaum.

Costa, Arthur. (1985). *Teaching for Intelligent Behavior: A Course Syllabus*. Orangevale, Calif.: Search Models Unlimited. Describes the teacher behaviors and strategies that support thinking. Presents and suggests ways of practicing the behaviors.

Costa, Arthur, and Lawrence Lowery. (1989). *Techniques for Teaching Thinking*. Pacific Grove, Calif: Midwest Publications.

Covington, Martin, R. Crutchfield, L. Davies, and R. M. Olton. (1974). *The Productive Thinking Program: A Course in Learning to Think*. Columbus, Ohio: Charles Merrill.

Cronbach, L. J., and R. E. Snow. (1977). *Aptitudes and Instructional Methods*. New York: Irvington. The best and most comprehensive single account of the relations between patterns of aptitude and optimal instructional methods.

Dantonio, Marylou. (1990). *How Can We Create Thinkers? Questioning Strategies That Work for Teachers*. Bloomington, Ind.: National Education Service.

de Bono, Edward. (1980). *Teaching Thinking*. New York: Penguin.

de Bono, Edward. (1976). *Teaching Thinking*. London: Temple Smith.

Feuerstein, Reuven, Y. Rand, M. Hoffman, and R. Miller. (1980). *Instrumental Enrichment: An Intervention Program for Cognitive Modifiability*. Baltimore: University Park Press. A thorough description of Feuerstein's Instrumental Enrichment program for training intellectual skills.

Fogarty, Robin, and James Bellanca. (1989). *Patterns for Thinking, Patterns for Transfer*. 4th ed. Palatine, Ill.: Illinois Renewal Institute.

Fogarty, Robin, and Kay Opeka. (1988). *Start Them Thinking: A Handbook of Classroom Strategies for the Early Years*. Palatine, Ill.: Skylight Publishing.

Fogarty, Robin. (1990). *Keep Them Thinking: A Handbook of Model Lessons*. Palatine, Ill.: Skylight Publishing.

Fogarty, Robin, and James Bellanca. (1986). *Teach Them Thinking: Mental Menus for 24 Thinking Skills*. Palatine, Ill.: Skylight Publishing.

Frankenstein, C. (1979). *They Think Again*. New York: Van Nostrand.

Furth, Hans, and Harry Wachs. (1974). *Thinking Goes to School*. New York: Oxford University Press.

Glaser, Robert. (1978). *Advances in Instrumental Psychology*. Vol. 1. Hillsdale, N.J.: Lawrence Erlbaum.

Hart, Leslie. (1983). *Human Brain and Human Learning*. New York: Longman. Suggests that schools and normal brain functioning are incompatible. Presents Hart's Proster Theory of intellectual processing.

Heiman, Marsha, and Joshua Slomianko, eds. (1987). *Thinking Skills Instruction: Concepts and Techniques*. Building Students' Thinking Skills Series. Washington, D.C. National Education Association.

Hunkins, Francis P. (1989). *Teaching Thinking Through Effective Questioning*. Boston: Christopher-Gordon Publishers.

Hyde, Arthur, and Marilyn Bizar. (1988). *Thinking in Context: Teaching Cognitive Processes Across the Elementary School Curriculum*. Santa Barbara, Calif.: Longman.

Jones, B. F., A. S Palincsar, D. S. Ogle, and E. G. Carr, eds. (1987). *Strategic Teaching and Learning: Cognitive Instruction in the Content Areas*. Alexandria, Va.: Association for Supervision and Curriculum Development.

Kruse, Janice. (1989). *Resources for Teaching Thinking: A Catalog*. Philadelphia: Research for Better Schools.

Kruse, Janice, comp. (1987). *Classroom Activities in Thinking Skills*. Philadelphia: Research for Better Schools.

Langrehr, John. (1990). *Sharing Thinking Strategies*. Bloomington, Ind.: National Educational Service.

Langrehr, John. (1988). *Teaching Students to Think*. Bloomington, Ind.: National Educational Service.

Levine, J. M., and M. C. Wang. (1983). *Teacher and Student Perceptions: Implications for Learning*. Hillsdale, N.J.: Lawrence Erlbaum.

Lipman, M., A. Sharp, and F. Oscanyan. (1980). *Philosophy in the Classroom*. 2nd ed. Philadelphia: Temple University Press. An introduction to the principles behind Lipman's Philosophy for Children program for training thinking skills.

Lochhead, Jack, and John Clement, eds. (1979). *Cognitive Process Instruction*. Philadelphia: Franklin Institute Press. A collection of papers presented at the first conference on Thinking held at the University of Massachusetts in 1978.

Lochhead, Jack, and Arthur Whimbey. (1982). *Instructor's Guide for Problem Solving and Comprehension: A Short Course in Analytical Reasoning*. Philadelphia: Franklin Institute Press.

McPeck, John. (1981). *Critical Thinking and Education*. New York: St. Martin's Press.

Meichenbaum, D. (1977). *Cognitive Behavior Modification*. New York: Plenum.

Meyers, Chet. (1986). *Teaching Students to Think Critically: A Guide for Faculty in All Disciplines*. Jossey-Bass Higher Education Series. San Francisco, Calif: Jossey-Bass.

Nickerson, Raymond. David Perkins, and Edward Smith. (1985). *Teaching Thinking*. Hillsdale, N.J.: Lawrence Erlbaum. A review of available programs for training thinking skills. Addresses the question of how one might go about trying to enhance thinking skills. Discusses concepts, courses, and experiences that are likely to enhance intellectual development and teaching strategies that can ease the transition from concrete to formal thinking.

Norris, Stephen, and Robert Ennis. (1989). *Evaluating Critical Thinking*. Pacific Grove, Calif.: Midwest Publications.

Olds, H. F., and others. (1974). *Motivating Today's Students*. Palo Alto, Calif.: Learning Handbooks.

Perkins, D N. (1986). *Knowledge as Design*. Hillsdale, N.J.: Lawrence Erlbaum.

Raths, Louis, Selma Wassermann, Arthur Jonas, and Arnold Rothstein. (1967). *Teaching for Thinking: Theory and Application*. Columbus, Ohio: Charles E. Merrill. An early seminal work on developing thinking skills.

Resnick, Lauren B., and Leopold E. Klopfer, eds. (1989). *Toward the Thinking Curriculum: Current Cognitive Research*. 1989 ASCD Yearbook. Alexandria, Va.: Association for Supervision and Curriculum Development.

Ruggiero, Vincent R. (1984). *The Moral Imperative: An Introduction to Ethical Judgment*. Mountain View, Calif.: Mayfield Publishing.

Ruggiero, Vincent R. (1987). *Teaching Thinking Across the Curriculum*. New York: Harper & Row.

Sanders, Norris. (1966). *Classroom Questions: What Kinds*. New York: Harper and Row. Describes teacher questioning related to Bloom's taxonomical levels.

Schoenfeld, Alan H. (1987). *Cognitive Science and Mathematics Education*. Hillsdale, N.J.: Lawrence Erlbaum. This volume is a result of mathematicians, cognitive scientists, mathematics educators, and classroom teachers combining their efforts to help address issues of importance to classroom instruction in mathematics.

Schwebel, M., and Jane Raph, eds. (1973). *Piaget in the Classroom*. New York: Basic Books.

Segal, Judith W., S. Chipman, and R. Glaser, eds. (1985). *Thinking and Learning Skills*. Vol.I, *Relating Instruction to Research*. Vol. II, *Research and Open Questions*. Hillsdale, N.J.: Lawrence Erlbaum. A large collection of papers describing current programs for training intelligence and evaluating their strengths and weaknesses.

Segal, Judith W., S. Chipman, and R. Glaser. (1983). *Relating Instruction to Basic Research*. Hillsdale, N.J.: Lawrence Erlbaum.

Siegel, Harvey. (1988). *Educating Reason: Rationality, Critical Thinking and Education*. New York: Routledge and Chapman Hall.

Silver, Harvey. (1983). *Teaching Strategies*. Moorestown, N.J.: Hanson Silver Strong Associates.

Swartz, Robert, and David N. Perkins. (1989). *Teaching Thinking: Issues and Approaches*. Pacific Grove, Calif.: Midwest Publications.

Voss, James F., David Perkins, and Judith W. Segal. (in press). *Informal Reasoning and Instruction*. Hillsdale, N.J.: Lawrence Erlbaum. After summarizing theoretical and empirical considerations regarding the question of how individuals reason in everyday personal and professional activities, this volume focuses specifically on the question of how logic occurs in school activities and how students acquire such reasoning skills.

Wasserman, Selma. (1978). *Put Some Thinking in Your Classroom*. Chicago: Benefic.

Wilen, William W. (1990). *Teaching and Learning Through Discussion: The Theory, Research and Practice of the Discussion Method*. Springfield, Ill.: Charles C. Thomas.

Assessing Thinking Skills

Aiken, Lewis. (1987). *Assessment of Intellectual Functioning*. Needham Heights, Mass.: Allyn and Bacon.

Aiken, Lewis. (1987). *Psychological Testing and Assessment*. 6th ed. Needham Heights, Mass.: Allyn and Bacon.

Alverno College Faculty. (1985). *Assessment at Alverno College*. Milwaukee, Wisc.: Alverno Productions.

Anastasi, Anne. (1988). *Psychological Testing*. 6th ed. New York: Macmillan.

Anderson, Scarvia B., and John S. Helmick, eds. (1983). *On Educational Testing: Intelligence, Performance Standards, Test Anxiety, and Latent Traits*. Social and Behaviorial Science Series. San Francisco: Jossey-Bass.

Archbald, Douglas A., Fred M. Newmann. (1988). *Beyond Standardized Testing: Assessing Authentic Academic Achievement in the Secondary School*. Reston, Va.: National Association of Secondary School Principals.

Bejar, Isaac I. (1983). *Achievement Testing*. Newbury Park, Calif.: Sage Publications.

Berthoff, Ann E. (1981). "The Teacher as Researcher." In *The Making of Meaning: Metaphors, Models, and Maxims for Writing Teachers*. Montclair, N.J.: Boynton/Cook.

Bissex, Glenda, and Richard Bullock. (1987). *Seeing for Ourselves: Case Study Research by Teaching of Writing*. Portsmouth, N.H.: Heinemann.

Bogdan, Robert C., and Sari K. Miklen. (1982). *Qualitative Research for Education: An Introduction to Theory and Methods*. Boston: Allyn and Bacon.

Buros, Oscar K., ed. (1975). *Foreign Language Tests and Reviews*. Lincoln: University of Nebraska Press.

Carey, Lou. (1987). *Measuring and Evaluating School Learning*. Rockleigh, N.J.: Allyn and Bacon, Longwood Division.

Creativity and Divergent Thinking. (1986). Princeton, N.J.: Educational Testing Service. Approximately 75 tests of creative thinking or divergent thinking are described in this bibliography. Test scores are listed and availability information is included.

Ennis, Robert H. (1987). "A Taxonomy of Critical Thinking Dispositions and Abilities." In *Teaching Thinking Skills: Theory and Practice*, edited by J. Baron and R. Sternberg. New York: W. H. Freeman. This chapter is a good review of current issues in assessing critical thinking.

Ennis, Robert H. (1986). *Critical Thinking Tests*. Champaign: Illinois Critical Thinking Project, University of Illinois. Brief reviews of major reasoning tests currently available. Includes seven general and four aspect-scientific critical thinkings tests.

Goswami, Dixie, and Peter Stillman, eds. (1987). *Reclaiming the Classroom: Teacher Research as an Agency for Change*. Upper Montclair, N.J.: Boynton/Cook.

Gough, H. G. (1985). "Free Response Measures and Their Relationship to Scientific Creativity." *Journal of Creative Behavior* 19: 229-240. This paper describes 10 creativity measures used with adults in a study of scientific creativity.

Gronlund, Norman E., and Robert L. Linn. (1990). *Measurement and Evaluation in Teaching*. 6th ed. New York: Macmillan. Includes student manual.

McArthur, David L., ed. (1987). *Alternative Approaches to the Assessment of Achievement*. Hingham, Mass.: Kluwer Academic.

Macrorie, Ken. (1980). *Searching Writing*. Upper Montclair, N.J.: Boynton/Cook.

Mitchell, James V., Jr. (1985). *The Ninth Mental Measurements Yearbook*. Lincoln, Neb.: Buros Institute of Mental Measurements. The classification scheme in the grandparent of test reviewing sources does not include "critical thinking," but it is possible to look under a know title for an in-depth review of a test or to use the "score index" to look for tests producing scores with various labels. The following scores have been indexed: critical comprehension, critical thinking, creative thinking, divergent thinking, logical ability, logical/analytical, and problem solving.

Mitchell, James V., ed. (1983). *Tests in Print III*. Lincoln: University of Nebraska Press. A companion volume to the *Mental Measurements Yearbook* (MMY). Lists availability and price information for 2,672 tests, including most of the test in MMY. The same classification scheme as that in MMY is used, and the subtests are not indexed.

Newark, Charles S., ed. (1985). *Major Psychological Assessment Instruments*. Boston: Allyn and Bacon.

Nohr, M., and M. Maclean. (1987). *Working Together: A Guide for Teacher-Researchers*. Urbana, Ill.: National Council of Teachers of English.

Norris, S. P., and R. King. (1984). "The Design of a Critical Thinking Test on Appraising Observations." Institute for Educational Research and Development, Memorial University of Newfoundland. This report details how the authors developed and validated the Test of Appraising Observations. Included is their procedure for interviewing students in order to come up with an independent measure of quality of reasoning.

Norris, Stephen, and Robert Ennis. (1989). *Evaluating Critical Thinking*. Pacific Grove, Calif.: Midwest Publications.

A Question of Thinking: A First Look at Students' Performance on Open-ended Questions in Mathematics. (1989). Sacramento: California Assessment Program, California State Department of Education.

Reasoning, Logical Thinking and Problem Solving. (1986). Princeton, N.J.: Educational Testing Service. Abstracts and availability information for 133 tests are included in this bibliography. The majority of tests are aptitude measures, thought three are critical thinking tests.

Rudner, Lawrence J., et al., eds. (1989). *Understanding Achievement Tests: A Guide for School Administrators*. Washington, D.C.: ERIC Clearinghouse on Tests, Measurement, and Evaluation; American Institutes for Research.

Sachse, Thomas P. (1981). *Role of Performance Assessment in Tests of Problem Solving*. Portland, Oreg.: Clearinghouse for Applied Performance Testing, Northwest Regional Educational Laboratory. Reviews of 13 school ability, life-skills, problem-solving, and critical thinking tests are included in this bibliography. Six features of each test are examined: definitions of problem solving, measurement strategy, performance assessment, reliability, uses of the test, and validity.

Stewart, Bruce L. (1979). *Testing for Critical Thinking: A Review of the Resources*. Champaign: Illinois Rational Thinking Project, University of Illinois-Urbana. Rational Thinking Reports No. 2, ERIC No. ED 183588. Twenty-five critical thinking tests are reviewed. Information on reliability and validity as well as item analysis is included Most of the test have a pre-1970 copyright, yet a few are still available in updated editions.

Stiggins, R. J., E. Rubel, and E. Quellmalz. (1986). *Measuring Thinking Skills in the Classroom: A Teacher's Guide*. Portland, Oreg.: Northwest Regional Educational Laboratory. This publication addresses how to asse.s HOTS in the classroom and how to embed HOTS skills into everday lesson plans.

Sweetland, Richard C., and Daniel J. Keyser, eds. (1984). *Tests: A Comprehensive Reference for Assessments in Psychology, Education and Business* and *Tests Supplement* (1984). Kansas City, Mo.: Test Corporation of America. This bibliography lists ordering and sub-test information without evaluating instruments. Critical thinking tests may be found under the headings for English, Achievement and Aptitude, and Gifted. There is no cross-reference to sub-test scores.

Worthen, Blaine R., and James R. Sanders. (1987). *Educational Evaluation: Alternative Approaches and Practical Guidelines. White Plains, N.Y.: Longman.*

Problem Solving

Nearly any task we face, from the most mundane to the most creative, can be called a problem. In the fields of psychology and education, however, problem solving tends toward a narrower meaning. It ranges from solving academic problems in mathematics, physics, and other disciplines, to solving puzzle-like problems and riddles, and to solving everyday "how to" problems, such as how to foster better employer-employee relations.

Ackoff, R. L. (1978). *The Art of Problem Solving*. New York: John Wiley and Sons.

Anderson, Valerie, and C. Bereiter. (1980). *Thinking Games 2*. Belmont, Calif.: Pitman Learning.

Ballin, Sharon, ed. (1988). *Achieving Extraordinary Ends: An Essay of Creativity*. Norwell, Mass.: Kluwer Academic.

Burns, Marilyn. (n.d.). *The Book of Think: Or How to Solve Problems Twice Your Size*. New York: Little Brown.

Charles, R., and E. Silver, eds. (1988). *The Teaching and Assessing of Mathematical Problem Solving*. Reston, Va.: National Council of Teachers of Mathematics.

Fisher, Richard. (1987). *Brain Games: 134 Original Scientific Games That Reveal How Your Mind Works*. New York: Schocken Books.

Hayes, John R. (1981). *The Complete Problem Solver*. Hillsdale, N.J.: Lawrence Erlbaum. A useful course covering a wide range of problem-solving skills.

Hudgins, Bryce B. (1977). *Learning and Thinking: A Primer for Teachers*. Itaska, Ill: F. E. Peacock.

Jacobs, Paul. (1977). *Up the I.Q.* New York: Wyden.

Jacobs, Paul, and M. Meirovitz. (1983). *Brain Muscle Builders: Games to Increase Your Natural Intelligence*. Englewood Cliffs, N.J.: Prentice-Hall.

Mayer, Richard. (1983). *Thinking, Problem Solving, Cognition*. San Francisco: Freeman and Co.

Newell, A., and H. Simon. (1972). *Human Problem Solving*. Englewood Cliffs, N.J.: Prentice-Hall.

Polya, Gyorgy. (1957). *How to Solve It*. Princeton, N.J.: Doubleday.

Rubenstein, M. F. (1975). *Patterns of Problem Solving*. Englewood Cliffs, N.J.: Prentice-Hall.

Schmuck, Richard, M. Chesler, and Robert Lippit. (1966). *Problem Solving to Improve Classroom Learning*. Chicago: SRA.

Schoenfeld, A. (1985). *Mathematical Problem Solving*. New York: Academic Press.

Smith, Mike U. (n.d.). *Toward a Unified Theory of Problem Solving: Views from the Content Domains*. Hillsdale, N.J.: Lawrence Erlbaum. This book tries to foster the productive exchange of information by drawing together preliminary theoretical understandings, sparking debate and disagreement, raising new questions and directions, and perhaps developing new world views.

Snow, R., P. Federico, and W. Montague, eds. (1980). *Aptitudes, Learning and Instruction*. Vol 1. Hillsdale, N.J.: Lawrence Erlbaum.

Tuma, D. T. and F. Reif, eds. (1980). *Problem Solving and Education: Issues in Teaching and Research*. Hillsdale, N.J.: Lawrence Erlbaum.

Walberg, Franette. (1980). *Puzzle Thinking*. Philadelphia: Franklin Institute Press.

Whimbey, Arthur, and Jack Lochhead. (1982). *Problem Solving and Comprehension: A Short Course in Analytical Reasoning*. 3rd ed. Philadelphia: Franklin Institute Press. Pair problem solving is explained in depth. Problems and step-by-step solutions follow each chapter. Also available are problem cards, which are taken from the text (40 different problems).

Whimbey, Arthur, and Jack Lochhead. (1984). *Beyond Problem Solving and Comprehension*. Philadelphia: Franklin Institute Press. A sequel to, and advanced version of, the previous entry. Suitable for high school students and adults.

Wickelgren, W. E. (1974). *How to Solve Problems: Elements of a Theory of Problems and Problem Solving*. San Francisco, Calif.: Freeman and Co.

Creativity

Creativity refers to the individual train of producing appropriate and original ideas or other products in any field. Appropriateness without originality is mundane, and originality without appropriateness is simply bizarre. The word creativity does not imply a single ability; it may be as much a matter of personality as ability and may involve a mix of diverse abilities, perhaps a different mix in different cases. The literature on creativity includes a variety of theoretical positions and numerous books oriented toward self-help and instruction. Some of each are represented in our list.

Adams, James. (1980). *Conceptual Blockbusting: A Guide to Better Ideas*. 2nd ed. New York: W. W. Norton.

Amabile, Theresa. (1983). *The Social Psychology of Creativity*. New York: Springer-Verlag.

Barron, Frank. (1969). *Creative Person and Creative Process*. New York: Holt, Rinehart and Winston.

Buzan, Tony. (1983). *Use Both Sides of Your Brain.* New York: E. P. Dutton.

de Bono, Edward. (1970). *Lateral Thinking: Creativity Step by Step* New York: Harper and Row.

Eberle, Bob, and Bob Stanish. (n.d.). *CPS for Kids: A Resource Book for Teaching Creative Problem Solving to Children.*

Edwards, Betty. (1989). *Drawing on the Right Side of the Brain: A Course in Enhancing Creativity and Artistic Confidence.* Los Angeles, Calif.: J. P. Tarcher.

Finke, Ronald A. (1990). *Creative Imagery Discoveries and Inventions in Visualization.* Hillsdale, N.J.: Lawrence Erlbaum. Bringing together the results of experiments on discovery and invention in visualization conducted by the author over three years, this book reports new findings on the generation of creative inventions and concepts using mental imagery, and it proposes a reconceptualization of the creative process.

Getzels, Jacob, and M. Csikszentmihalyi. (1976). *The Creative Vision: A Longitudinal Study of Problem Finding in Art.* New York: Wiley.

Howard, V. A. (1982). *Artistry: The Work of Artists. Indianapolis: Hackett.*

Kobert, Don. (1976). *The All New Universal Traveler: A Soft-Systems Guide to Creativity, Problem Solving, and the Process of Reaching Goals.* Los Altos, Calif.: W. Kaufmann.

Koestler, Arthur. (1964). *The Act of Creation.* New York: Macmillan.

Le Boeuf, Michael. (1982). *Imagineering: How to Profit from Your Creative Powers.* New York: McGraw-Hill.

MacKinnon, Donald W. (1978). *In Search of Human Effectiveness: Identifying and Developing Creativity.* Buffalo, N.Y.: The Creative Educational Foundation, Inc., in association with Creative Synergetic Associates, Ltd.

Mansfield, R.S., and T. V. Busse. (1981). *The Psychology of Creativity and Discovery.* Chicago: Nelson-Hall.

Moore, Edgar, H. McCann, and J. McCann. (1985). *Creative and Critical Thinking.* New York: Houghton Mifflin.

Osborn, A. (1963). *Applied Imagination: Principles and Procedures of Creative Problem Solving.* New York: Charles Scribner's.

Parnes, Sidney, J., R. B. Noller, and A. M. Biondi. (1977). *Guide to Creative Action.* New York: Charles Scribner's.

Perkins, David. (1983). *The Mind's Best Work: A New Psychology of Creative Thinking.* Cambridge, Mass.: Harvard University Press. A fascinating description of research on creativity, insightfulness, and giftedness.

Rothenberg, A., and C. R. Hausman, eds. (1976). *The Creativity Question. Durham, N.C.: Duke University Press.*

Rothenberg, A. (1982). *The Emerging Goddess: The Creative Process in Art, Science, and Other Fields.* Chicago: University of Chicago Press.

Simonton, Dean K. (1984). *Genius, Creativity and Leadership: Historiometric Inquiries.* Cambridge: Harvard University Press.

Vitale, Barbara Meister. (1986). *Free Flight: Celebrating Your Right Brain.* Rolling Hills Estates, Calif.: Jalmar Press

Von Oech, Rober. (1983). *A Whack on the Side of the Head: How to Unlock Your Mind for Innovation.* New York: Warner.

Philosophy of Mind and Thinking

Besides founding the critical thinking movement, philosophers have addressed the nature of mind, of knowledge, and of thinking directly, sometimes with an eye toward how students can be introduced to a philosophical perspective and style of inquiry.

Bechtel, William. (1988). *Philosophy of Mind: An Overview for Cognitive Science.* Specifically designed to make the philosophy of mind intelligible to those not trained in philosophy, this book provides a concise overview for students and researchers in the cognitive sciences.

Block, Ned. (1980). *Readings in Philosophy of Psychology,* Vol 1. Language and Thought series. Cambridge: Harvard University Press.

Cederbolm, J., and D. Paulsen. (1982). *Critical Thinking.* Belmont, Calif.: Wadsworth. Emphasizes understanding and criticizing arguments and theories. Deals with the problems of the amateur in a world of specialization.

Damer, Edward T. (1987). *Attacking Faulty Reason.* Belmont, Calif.: Wadsworth.

Engel, S. (1986). *Analyzing Informal Fallacies.* New York: Prentice-Hall.

Engel, S. M. (1986). *With Good Reason: An Introduction to Informal Fallacies.* New York: St. Martin's Press.

Fahnestock, Jeanne, and Marie Secor. (1985). *A Rhetoric for Argument.* New York: McGraw-Hill.

Gardner, Howard. (1985). *The Mind's New Science: A History of the Cognitive Revolution.* New York: Basic Books.

Gardner, Howard. (1982). *Art, Mind and Brain: A Cognitive Approach to Creativity.* New York: Basic Books.

Galyean, Beverly. (1983). *Mind Sight: Learning Through Imaging.* Santa Barbara, Calif.: Center for Integrative Learning.

Govier, Trudy. (1988). *A Practical Study of Argument.* Belmont, Calif.: Wadsworth.

Hitchcock, David. (1983). *Critical Thinking: A Guide to Evaluating Information.* Ontario, Canada: Methuen. Uses informal logic and focuses on real-life rather than artificial examples.

Kahane, Howard. (1980). *Logic and Contemporary Rhetoric.* Belmont, Calif.: Wadsworth. The best-selling college text; excellent chapters on how the "news" and "basic belief systems" are "managed."

Matthews, Gareth. (1980). *Philosophy and the Young Child. Cambridge: Harvard University Press.*

Miller, Robert K. (1988). *Informed Argument.* New York: Harcourt Brace Jovanovich.

Missimer, Connie A. (1986). *Good Arguments: An Introduction to Critical Thinking.* New York: Prentice-Hall.

Radner, Daisie, and Michael Radner. (1982). *Science and Unreason.* Belmont, Calif.: Wadsworth. Focuses on recognizing the difference between science and pseudo-science.

Ruggerio, Vincent. (1984). *The Art of Thinking.* New York: Harper and Row. Excellent general overview without technical detail.

Scheffler, Israel. (1965). *Conditions of Knowledge.* Glenview, Ill.: Scott, Foresman.

Scriven, Michael. (1977). *Reasoning.* New York: McGraw-Hill. An excellent college-level introduction to the problem of thinking critically. Closely reasoned and precise.

Weddle, Perry. (1978). *Argument: A Guide to Critical Thinking.* New York: McGraw-Hill.

Seech, Zachary. (1988). *Logic in Everyday Life: Practical Reasoning Skills.* Belmont, Calif.: Wadsworth.

Siegel, Harvey. (1987). *Relativism Refuted.* Norwell, Mass.: Kluwer Academic.

Voss, J. F., D. N. Perkins, and J. Segal. (in press). *Informal Reasoning and Instruction.* Hillsdale, N.J.: Lawrence Erlbaum.

Learning to Learn

Learning to learn may sound odd at first, but it is a commonplace part of human development. For instance, most high school students have acquired strategies for memorizing that are unfamiliar to the 2nd grader, such as the value of repetition, visualization, or organized time. Although some learning to learn happens spontaneously, much more might occur if education broadened its focus to include not only content, but the learning process.

Baddely, A. (1982). *Your Memory: A User's Guide*. New York: Macmillan.

Bransford, J. D. (in press). *Enhancing Thinking and Learning*. San Francisco, Calif.: Freeman and Co.

Brown, S., and M. Walter. (1983). *The Art of Problem Posing*. Philadelphia: Franklin Institute Press. Offers practical methods that affect our view of learning and teaching. Includes many problems and specific strategies, such as the "what-if-not" approach to problem posing. Although set within the context of mathematical problems, the discussion is readily accessible to other problems as well.

Gall, M. D., Joyce P. Gall, Dennis R. Jacobsen, and Terry L. Bullock. (1990). *Tools for Learning: A Guide to Teaching Study Skills*. Alexandria, Va.: Association for Supervision and Curriculum Development.

Higbee, Kenneth L. (1977). *Your Memory: How It Works and How to Improve It*. Englewood Cliffs, N.J.: Prentice-Hall.

Meiland, Jack W. *College Thinking: How to Get the Best Out of College*. New York: New American Library.

Novak, J. D., and R. D. Gowin. (1984). *Learning How to Learn*. New York: Cambridge University Press.

O'Neil, H. F., and C. D. Spielberger, eds. (1979). *Cognitive and Affective Learning Strategies*. New York: Academic Press.

O'Neil, H. F., ed. (1978). *Learning Strategies*. New York: Academic Press.

Segal, Judith W., S. Chipman, and R. Glaser, eds. (1985) *Thinking and Learning Skills*. Vol. I, *Relating Instruction to Research*. Vol. II, *Research and Open Questions*. Hillsdale, N.J.: Lawrence Erlbaum.

Visual, Oral, and Symbolic Communication

Thinking is not just a matter of how we think, but what tools we think with. The written or spoken word, pictures, and other symbol systems are instruments that often help us to form, edit, and preserve lines of thought. The way that various symbol systems aid and foster thinking has been explored by many contemporary thinkers.

Arnheim, Rudolf. (1976). *Visual Thinking*. Berkeley: University of California Press.

Barry, V. (1982). *Good Reason for Writing: A Text with Readings*. Belmont, Calif.: Wadsworth.

Bowen, Eleanor. (1964). *Return to Laughter*. Garden City, N.Y.: Natural History Press.

Chihak, Mary, and Barbara J. Heron. (1980). *Games Children Should Play: Sequential Lessons for Teaching Communication Skills*. Glenview, Ill.: Scott Foresman.

Chukovsky, Kornei. (1963). *From Two to Five*. Berkeley: University of California Press.

Gardner, Howard, and Hope Kelly, eds. (1981). *Viewing Children Through Television*. San Francisco: Jossey-Bass.

Greenfield, Patricia. (1984). *Mind and Media: The Effects of Television, Video Games and Computers*. Cambridge: Harvard University Press.

Horton, Susan R. (1982). *Thinking Through Writing*. Baltimore, Md: Johns Hopkins University Press.

Johnson-Laird, P. N. (1983). *Mental Models: Toward a Cognitive Science of Language, Inference and Consciousness*.

Kytle, Ray, Jr. (1986). *Clear Thinking for Composition*. New York: McGraw-Hill.

Lazere, Donald. (1982). *Composition for Critical Thinking: A Course Description*. Washington, D.C.: National Endowment for the Humanities.

Luria, A. R. (1976). *Cognitive Development: Its Cultural and Social Foundations*. Cambridge, Mass.: Harvard University Press.

Moffett, James. (1983). *Teaching the University of Discourse*. Boston: Houghton-Mifflin.

Morris, P., and P. Hampson. (1983). *Imagery and Consciousness*. Orlando, Fla.: Academic Press.

Olson, David R., ed. (1976). *Media and Symbols: The Forms of Expression, Communication and Education*. Chicago: University of Chicago Press.

Paley, William. (1981). *Wally's Stories*. Cambridge: Harvard University Press.

Perkins, David, and Barbara Leondar, eds. (1977). *The Arts and Cognition*. Baltimore: Johns Hopkins University Press.

Rose, Mike. (1984). *Writer's Block: The Cognitive Dimension*. Carbondale: Southern Illinois University Press.

Rosenberg, Vivian. (1989). *Reading, Writing, and Thinking: Critical Connections*. New York: McGraw-Hill.

Salomon, Gavriel. (1981). *Communication and Education: Social and Psychological Interactions*. Beverly Hills, Calif.: Sage Publications.

Salomon, Gavriel. (1977). *The Language of Media and the Cultivation of Mental Skills: A Report on Three Years of Research Submitted to the Spencer Foundation*. Jerusalem: Hebrew University.

Scull, Sharon. (1987). *Critical Reading and Writing for Advanced English as a Second Language*. New York: Prentice-Hall.

Vygotsky, L. S. (1962). *Thought and Language*. Cambridge, Mass.: MIT Press.

Artificial Intelligence and Computers

Artificial intelligence means the use of computers to perform tasks that, in a human being, would be considered intelligent. Among the tasks that have received special attention are playing chess, identifying objects in a scene from a visual input, and conducting a conversation in ordinary language via keyboard and monitor. Much of the work in artificial intelligence informs our understanding of how people think. More generally, artificial intelligence and related disciplines have led to research on how computers can help people learn to think better.

Boden, Margaret. (1977). *Artificial Intelligence and Natural Man*. New York: Basic Books.

Boden, Margaret. (1981). *Minds and Mechanisms: Philosophical Psychology and Computational Models*. Brighton, Sussex, England: Harvester Press.

Dreyfus, H. L. (1979). *What Computers Can't Do*. New York: Harper and Row.

Goldenberg, E. P. (1979). *Social Technology for Special Children*. Baltimore: University Park Press.
McCorduck, P. (1979). *Machines Who Think*. Van Nuys, Calif.: Freeman.
Newell, A., and Estes, W. K. (1983). "Cognitive Science and Artificial Intelligence." In *Research Briefings 1983*, edited by Committee on Science, Engineering, and Public Policy. Washington, D.C.: National Academy Press.
Papert, S. (1982). *Mindstorms: Children, Computers and Powerful Ideas*. New York: Basic Books.
Turkle, S. (1984). *The Second Self: Computers and the Human Spirit*. New York: Simon and Schuster.
VanLehn, Kurt. (n.d.). *Architectures for Intelligence*. Hillsdale, N.J.: Lawrence Erlbaum Associates. Focuses on computing systems that exhibit intelligent behavior. As such, it discusses research aimed at building a computer that has the same cognitive architecture as the mind, permitting evaluations of it as a model of the mind and allowing for comparisons between computer performance and experimental data on human performance.
Weizenbaum, J. (1976). *Computer Power and Human Reason. From Judgment to Calculation*. Van Nuys, Calif.: Freeman.
Winston, P. (1984). *Artificial Intelligence*. 2nd ed. Reading, Mass.: Addison-Wesley.

Brain Functioning and Neurobiology

As conscious beings, we cannot help but find it odd that our thinking and learning occur through the actions of a biochemical machine. This information provokes many questions: What parts of the brain do which jobs, or is the work distributed throughout? Is there any substance to the popular left-right brain them? Can mental capacities and incapacities be attributed to anatomical or chemical differences in the brain? Does the development of the brain tell us anything about what can or should be taught when?

Annett, Marian. (1985). *Left, Right, Hand and Brain: The Right Shift Theory*. Hillsdale, N.J.: Lawrence Erlbaum.
Bloom, F. E., L. Hofstadter, and L. Arlyne. (1984). *Brain, Mind, and Behavior*. New York: W. H. Freeman. Study guide available.
Caine, Renate, and Geoffrey Caine. (1991). *Making Connections: Teaching and the Human Brain*. Alexandria, Va.: Association for Supervision and Curriculum Development.
Diamond, Marian. (1988). *Enhancing Heredity*. New York: Macmillan.
Eysenck, Michael W., and Mark Keane. (n.d.). *A Student's Handbook of Cognitive Psychology*. Hillsdale, N.J.: Lawrence Erlbaum. Treats the dynamic impact of different views on the main areas of cognitive psychology: perception, attention, memory, categorization, language, problem solving, and reasoning. A comprehensive account of the current state of cognitive psychology.
Gardner, Howard. (1976). *The Shattered Mind: The Person After Brain Damage*. New York: Vintage.
Hampden-Turner, Charles. (1982). *Maps of the Mind*. New York: Collier (Macmillan).
Healy, Jane M. (1990) *Endangered Minds: Why Our Children Don't Think*. New York: Simon and Schuster.
Heilman, K., and E. Valenstein, eds. (1979). *Clinical Neuropsychology*. New York: Oxford University Press.
Hampden-Turner, Charles. (1981). *Maps of the Mind: Charts and Concepts of the Mind and Its Labyrinths*. New York: Collier (Macmillan).
Hart, Leslie. (1975). *How the Brain Works*. New York: Basic Books.
Lazear, David. (in press). *Step Beyond Your Limits: Applications of Contemporary Brain Research*. Palatine, Ill.: Skylight Publishing.
Ornstein, Robert., and Richard F. Thompson. (1986). *The Amazing Brain*. New York: Houghton-Mifflin. Visual and intellectual exploration of the construction, evolution, and chemical and electrical operations of the brain. Illustrated by David Macaulay.
Penfield, Wilder. (1975). *The Mystery of the Mind. Princeton, N.J.: Princeton University Press.*
Restak, R. (1984). *The Brain*. New York: Bantam.
Restak, R. (1979). *The Brain: The Last Frontier*. New York: Warner.
Samples, Bob, and M. McClaren. (1987). *OpenMind/WholeMind: Parenting and Teaching Tomorrow's Children Today*. Rolling Hills Estates, Calif: Jalmar Press.
Wittrock, M. C., ed. (1980). *The Brain and Psychology. New York: Academic Press.*

Reasoning and Critical Thinking

While the core discipline for most of the other categories in this bibliography is psychology, the core discipline for this category is philosophy. That is, the majority of the ideas and writings come from philosophy and philosopher-educators. Reasoning and critical thinking focus on the assessment of beliefs and products of thought. Is it clear? Is it sound? Has it been proven? The "critical" of critical thinking does not imply a negative posture but an objective, analytical, and evaluative one, a posture that most would agree education should foster.

Anderson, J. R., ed. (1981). *Cognitive Skills and Their Acquisition*. Hillsdale, N.J.: Lawrence Erlbaum.
Brookfield, Stephen D. (1987). *Developing Critical Thinkers: Challenging Adults to Explore Alternative Ways of Thinking and Acting*. San Francisco, Calif.: Jossey-Bass.
Chaffee, John. (1988). *Thinking Critically*. Boston, Mass.: Houghton Mifflin.
Giere, Ronald. (1979). *Understanding Scientific Reasoning*. New York: Holt, Rinehart and Winston.
Halpern, Diane F. (1984). *Thought and Knowledge: An Introduction to Critical Thinking*. Hillsdale, N.J.: Lawrence Erlbaum.
Hoaglund, John. (1984). *Critical Thinking: An Introduction to Informal Logic*. Newport News, Va.: Vale Press.
Kahneman, D., P. Slovic, and A. Tversky, eds. (1982). *Judgment Under Uncertainty: Heuristics and Biases*. New York: Cambridge University Press.
Mayfield, Martys. (1990). *Thinking for Yourself: Developing Critical Thinking Skills Through Writing*. Belmont, Calif.: Wadsworth.
Michalos, Alex C. (1986). *Improving Your Reasoning*. New York: Prentice-Hall.
Moore, Brooke N., and Richard Parker. *Critical Thinking: Evaluating Claims and Arguments in Everyday Life*. Mountain View, Calif.: Mayfield Publishing.
Nickerson, Raymond S. (1986). *Reflections on Reasoning*. Hillsdale, N.J.: Lawrence Erlbaum.
Nisbett, R., and L. Ross. (1980). *Human Inferences: Strategies and Shortcomings of Social Judgment*. Englewood Cliffs, N.J.: Prentice-Hall.
Samson, Richard. (1965). *Thinking Skills: A Guide to Logic and Comprehension*. Stamford, Conn.: Innovative Sciences, Inc.
Segal, Judith W., S. Chipman, and R. Glaser, eds. (1985). *Thinking and Learning Skills*. Vol.1, *Relating Instruction to Research*.

Vol. II, *Research and Open Questions.* Hillsdale, N.J.: Lawrence Erlbaum.
Shor, Ira. (1987). *Critical Thinking and Everyday Life.* Chicago: University of Chicago Press.
Toulmin, S. E., R. Reike, and A. Janik. (1979). *An Introduction to Reasoning.* New York: Macmillan.
Whimbey, A., and J. Lochhead. (1982). *Problem Solving and Comprehension.* 3rd ed. Philadelphia, Pa.: Franklin Institute Press.
Wilson, John. (1970). *Thinking with Concepts.* New York: Cambridge University Press.

Cognitive Development

Cognitive development concerns long-term human intellectual growth and learning. A number of themes characterize the field, among them the question of whether development is stage-like or continuous, whether certain concepts can't be learned until learners have attained some general level of intellectual readiness, whether intellectual development depends on a few core operations or a multitude, whether direct instruction or a nourishing environment best fosters development across a broad front.

Bjorklund, David F. (1990). *Children's Strategies: Contemporary Views of Child Development.* Hillsdale, N.J.: Lawrence Erlbaum. Describes current research and theory concerning the development of children's strategies for handling a variety of cognitive tasks.
Boden, Margaret A. (1980). *Jean Piaget.* New York: Viking.
Flavell, J. (1977). *Cognitive Development.* Englewood Cliffs, N.J.: Prentice-Hall.
Friedman, S. L., E. K. Scholnick, and R. R. Cocking, eds. *Blueprints for Thinking: The Role of Planning in Cognitive Development.* New York: Cambridge University Press.
Frye, Douglas, and Chris Moore. (n.d.). *Children's Theories of Mind: Mental States and Social Understandings.* Hillsdale, N.J.: Lawrence Erlbaum. The contributors examine several aspects of the child's theory of mind and present significant research findings on the theory itself and how it changes and develops for each child. Discussions of the utility of a theory of mind to the child and to developmental psychologists trying to understand children are provided.
Gelman, R., and C. R. Gallistel. (1978). *The Child's Understanding of Number.* Cambridge, Mass.: Harvard University Press.
Gardner, Howard. (1982). *Developmental Psychology: An Introduction.* Boston: Little, Brown.
Kohlberg, Lawrence. (1981). *The Meaning and Measurement of Moral Development.* Worcester, Mass.: Clark University Press.
Kohlberg, Lawrence, and others. (1978). *Assessing Moral Stages: A Manual.* Cambridge, Mass.: Harvard University Press.
Kohlberg, Lawrence, and others. (1983). *Moral Stages: A Current Formulation and a Response to Critics.* New York: Karger.
Levin, Joel R., and Vernon Allen. (1976). *Cognitive Learning in Children.* New York: Academic Press.
Loevinger, J. (1976). *Ego Development: Conceptions and Theories.* San Francisco: Jossey-Bass.
Meadows, S., ed. (1983). *Developing Thinking: Approaches to Children's Cognitive Development.* London: Methuen.
Perry, W. G. (1976). *Formal Intellectual and Ethical Development in the College Years.* New York: Holt, Rinehart and Winston.
Siegler, Robert S., and Eric A. Jenkins, ed. (n.d.). *How Children Discover New Strategies.* MacEachran Lecture series. Hillsdale, N.J.: Lawrence Erlbaum. Divides the process of constructing new problem-solving strategies into two parts: discovery of the new strategy and its generalization to new contexts.
Sternberg, R., ed. (1984). *Mechanisms of Cognitive Development.* San Francisco: Freeman.
Sugarman, S. (1983). *Children's Early Thought: Developments in Classification.* Cambridge, England: Cambridge University Press.
Yussen, S. R., ed. (1985). *The Growth of Insight in Children.* New York: Academic Press.

Intelligence

In everyday terms, intelligence refers to a person's ability to solve problems, plan well, learn well, and deal flexibly and appropriately with situations. In other words, intelligence means general mental competence. Psychologists have long sought a simple model of what is most essential to intelligence and how it is measured. Is it really one trait or a product of several, influenced primarily by inheritance or learning, subject to change by instruction or not? Interpretations are so diverse that while some would say we can improve thinking without improving intelligence, others would say that to improve thinking is to improve intelligence.

Baron, Jonathan. (1985). *Rationality and Intelligence.* New York: Cambridge University Press.
Benzwie, Teresa. (1987). *A Moving Experience: Dance for Lovers of Children and the Child Within.* Tuscon, Ariz.: Zephyr Press.
Block, N. J., and Gerald Dworkin, eds. (1976). *The IQ Controversy.* New York: Pantheon.
Cattell, R. B. (1971). *Abilities: Their Structure, Growth, and Action.* Boston: Houghton-Mifflin. The most comprehensive single presentation of Cattell's psychometric theory of intelligence, according to which there are two major subfactors of general intelligence: fluid and crystallized abilities.
Eysenck, H. J., ed. (1982). *A Model for Intelligence.* Heidelberg: Springer-Verlag. A collection of papers on the nature of intelligence, most of which emphasize the importance of mental speed in intelligence.
Feuerstein, Reuven. (1979). *The Dynamic Assessment of Retarded Performers.* Baltimore: University Park Press.
Feuerstein, Reuven, Y. Rand, and J. E. Rynders. (1988). *Don't Accept Me As I Am: Helping "Retarded" People to Excel.* New York: Plenum.
Gardner, Howard. (1983). *Frames of Mind: The Theory of Multiple Intelligences.* New York: Basic Books. Gardner acknowledges that some capacities, like memory, common sense, and even wisdom, can cut across the lines between intelligences. He argues that human intelligence is actually a host of different intelligences that reside in various parts of the brain, develop more or less independently, and can bloom separately, skill by skill. Gardner sharply challenges the notion that any single measure of intelligence is sufficient to label someone smart or stupid.
Gould, Stephan Jay. (1967) *The Mismeasure of Man.* New York: McGraw-Hill.
Guilford, J. P., and R. Hoeptner. (1971). *The Analysis of Intelligence.* New York: McGraw-Hill. A presentation of Guilford's Structure of Intellect model, a widely cited psychometric theory of intelligence.
Herrnstein, R. J. (1973). *I.Q. in the Meritocracy.* London: Allen Lane.

Jacobs, P. I., and J. Knapp. (1981). *Setting Standards for Assessing Experiential Learning*. Columbia, Md.: Council for the Advancement of Experiential Learning.

Jensen, Arthur. (1983). *Bias in Mental Testing*. Riverside, N.J.: Free Press. Jensen's well-known treatment of test bias; he claims that, in general, intelligence tests are not biased against subgroups and presents his information-processing theory of intelligence.

Jensen, Arthur. (1975). *Genetics in Education*. New York: Harper and Row.

Jensen, Arthur. (1982). *Straight Talk About Mental Tests*. Riverside, N.J.: Free Press.

Lazear, David. (in press). *Seven Ways of Knowing: Teaching for Multiple Intelligences*. Palatine, Ill.: Skylight Publishing.

Matarazzo, J. D. (1972). *Wechsler's Measurement and Appraisal of Adult Intelligence*. 5th ed. Baltimore: Williams and Wilkins. An exposition of David Wechsler's theory of intelligence and also of the basic nature of the Wechsler Adult Intelligence Scale.

Meeker, Mary N. (1969). *The Structure of Intellect: Its Interpretation and Uses*. Columbus, Ohio: Charles E. Merrill.

Piaget, Jean. (1972). *The Psychology of Intelligence*. Totowa, N.J.: Littlefield, Adams.

Resnick, Lauren. B., ed. (1976). *The Nature of Intelligence*. Hillsdale, N.J.: Lawrence Erlbaum. The first major collection of papers on the information-processing approach to intelligence.

Spearman, Charles C. (reprint of 1932 ed.). *The Abilities of Man*. New York: Macmillan. A classic book on Spearman's "two-factor" psychometric theory of intelligence.

Stenhouse, D. (1972). *The Evolution of Intelligence: A General Theory and Some of Its Implications*. New York: Harper and Row.

Sternberg, Robert J. (1986). *Intelligence Applied: Understanding and Increasing Your Intellectual Skills*. New York: Harcourt Brace Jovanovich.

Sternberg, Robert J. (1986). *What Is Intelligence?* Norwood, N.J.: Ablex.Sternberg, Robert J. (1984). *Beyond I.Q.: A Triarchic Theory of Human Intelligence*. New York: Cambridge University Press.

Sternberg, Robert J. (1982, 1984). *Advances in the Psychology of Human Intelligence*. Vols. 1 and 2. Hillsdale, N.J.: Lawrence Erlbaum.

Sternberg, Robert J. (1977). *Intelligence, Information Processing, and Analogical Reasoning: The Componential Analysis of Human Abilities*. Hillsdale, N.J.: Lawrence Erlbaum.

Sternberg, Robert J., ed. (1984). *Human Abilities: An Information Processing Approach*. New York: W. H. Freeman

Sternberg, Robert J., ed. (1982). *Handbook of Human Intelligence*. New York: Cambridge University Press.

Sternberg, Robert J., and Douglas. K. Detterman, eds. (1979). *Human Intelligence: Perspectives on Its Theory and Measurement*. Norwood, N.J.: Ablex.

Vernon, P. E. (1971). *The Structure of Human Abilities*. London: Methuen.

Whimbey, A., and L. Whimbey. (1975). *Intelligence Can Be Taught*. New York: E. P. Dutton.

A Select Bibliography by Key Leaders

Barry Beyer

Baron, Joan, and Robert Sternberg, eds. (1986). *Teaching Thinking Skills: Theory and Practice*. New York: W. H. Freeman. Seven provocative papers addressing various topics related to thinking by Robert Ennis, Richard Paul, David Perkins, and Robert Sternberg, Joan Baron, and others.

Beyer, Barry K. (1987). *Developing a Thinking Skills Program*. Boston: Allyn and Bacon. A detailed plan for how to create a thinking skills program in any subject or school, with procedures, examples, and sample materials for identifying skills to teach, defining them, sequencing them for instruction, structuring a program, selecting appropriate teaching strategies, providing staff development, and assessing instruction and learning.

Beyer, Barry K. (1987). *Practical Strategies for the Teaching of Thinking*. Boston: Allyn and Bacon. Includes a rationale for teaching thinking, an analysis of different kinds of thinking (including metacognition), a framework for providing direct instruction in any thinking operation in any subject, and detailed explanations and examples of strategies for introducing, guiding practice in, and transferring any thinking skills. Plus directions for teacher-made skills tests and suggestions for supporting the teaching of thinking.

Heiman, Marsha, and Joshua Slomianko, eds. (1987). *Thinking Skills Instruction: Concepts and Techniques*. Building Students' Thinking Skills series. Washington, D.C.: National Education Association. More than 30 essays by theorists and practitioners on the teaching of thinking, critical thinking, classroom strategies, and developing student thinking in various subjects.

Swartz, Robert, and David N. Perkins. (1989). *Teaching Thinking: Issues and Approaches*. Pacific Grove, Calif.: Midwest Publications. A brief survey of different kinds thinking, ways to structure thinking skills programs, approaches to teaching thinking and to designing lessons, support systems, and various approaches to assessing and testing of thinking skills, with attention to problems commonly encountered in developing thinking programs.

Esther Fusco

Frank, Mary. (1984). *A Child's Brain: The Impact of Advanced Research on Cognitive and Social Behaviors*. New York: Haworth Press.

Fusco, Esther. (1987). *Cognitive Matched Instruction*. Columbus, Ohio: National Middle School Association.

Guild, Pat Burke, and Stephen Garger. (1986). *Marching to Different Drummers*. Alexandria, Va.: Association for Supervision and Curriculum Development.

Labinowicz, Ed (1980). *The Piaget Primer: Thinking, Learning, Teaching*. Menlo Park, Calif.: Addison-Wesley.

Piaget, Jean, and Barbel Inhelder. (1969). *The Psychology of the Child*, translated by Helen Weaver. New York: Basic Books.

Matthew Lipman

Aristotle. *Nicomachean Ethics*, Book VI. Any edition.

Descartes. *Meditations on First Philosophy*. Any edition.

Dewey, John. *Logic: The Theory of Inquiry*. Any edition.

Hegel, G. W. F. *The Phenomenology of Spirit*. Any edition.
Kant, Immanuel. *Critique of Pure Reason*. Any edition.
Locke, John. *Essay Concerning Human Understanding*. Any edition.

Jay McTighe

Baron, Jonathan. (1989). *Thinking and Deciding*. New York: Cambridge University Press. A scholarly and comprehensive treatment of a variety of "cognitive" topics, including intelligence and thinking, problem solving, and decision making.

Brandt, Ronald, ed. (1989). *Teaching Thinking: Readings from Educational Leadership*. Alexandria, Va: Association for Supervision and Curriculum Development. This superb collection of articles reflects the various philosophies, theories, and approaches of many of the leaders within the thinking "movement."

Marzano, Robert, Ronald S. Brandt, Carolyn S. Hughes, Beau Fly Jones, Barbara Z. Preisseisen, Stuart C. Rankin, Charles Suhor. (1988). *Dimensions of Thinking: A Framework for Curriculum and Instruction*. Alexandria, Va.: Association for Supervision and Curriculum Development. This book provides an excellent overview of thinking and its components, organized within a practical framework.

Resnick, Lauren B. (1987). *Education and Learning to Think*. Washington, D.C.: National Academy Press. This succinct and highly readable book examines the major issues related to teaching thinking in the light of current research.

Segal, Judith W., S. Chipman, and R. Glaser, eds. (1985). *Thinking and Learning Skills*. Vol. I, *Relating Instruction to Research*. Vol. II, *Research and Open Questions*. Hillsdale, N.J.: Lawrence Erlbaum. This two-part collection features a scholarly look at cognitive research and includes a descriptive review of major thinking skills programs.

Robert Marzano

Chance, P. (1986). *Thinking in the Classroom: A Survey of Programs*. New York: Teachers College Press. This text provides a comprehensive description of major programs that enhance thinking. Programs reviewed include CoRT, Philosophy for Children, Odyssey, and Instrumental Enrichment. Also included is a discussion of the essential components of thoughtful teaching.

Halpern, Diane F. (1984). *Thought and Knowledge: An Introduction to Critical Thinking*. Hillsdale, N.J.: Lawrence Erlbaum. Halpern begins with a thoughtful and comprehensive discussion of the nature of reasoning and its relationship to thinking in general. She then describes specific strategies for enhancing such reasoning skills as problem solving, decision making, and creative thinking.

Jones, B. F., A. S. Palincsar, D. S. Ogle, and E. G. Carr, eds. (1987). *Strategic Teaching and Learning: Cognitive Instruction in the Content Areas*. Alexandria, Va.: Association for Supervision and Curriculum Development. Jones and her colleagues first outline a model of learning that includes such principles as the following: learning is goal directed, learning is organizing information, and learning is acquiring a repertoire of cognitive and metacognitive strategies. Focusing on this last principle about learning, they present strategies and tactics for rendering teaching strategic in various content areas. Strategic teaching involves the thoughtful selection by teachers of instructional practices of new knowledge and appropriate cognitive strategies.

Maxwell, William., ed. (1983). *Thinking: The Expanding Frontier*. Philadelphia, Pa.: The Franklin Institute Press. This work provides an excellent discussion of some of the theoretical issues surrounding the teaching of thinking. Topics include the relationship of thinking to culture; the relationship of thought and language; the role of artificial intelligence in enhancing knowledge about cognition. Contributors include such noted theorists as Bruner, Lochhead, de Bono, Perkins, and McPeck.

Nickerson, Raymond, David Perkins, and Edward Smith. (1985). *Teaching Thinking*. Hillsdale, N.J.: Lawrence Erlbaum. This text reviews the theory and research behind the major thinking skills programs and the thinking skills movement in general. It is perhaps the most comprehensive and readable of all such reviews. Topics covered include problem solving, creativity, metacognition, componential approaches, and heuristic approaches.

Fred Newton

Alexander, Christopher. (1979). *The Timeless Way of Building*. New York: Oxford University Press. Alexander is an architect, but in this book he shows as good an understanding of the relationship between physician and metaphysist as anyone, including Bateson, that I can find.

Arendt, Hanna. (1977). *The Life of the Mind*. Vol. 1, *Thinking*. Vol. 2, *Willing*. New York: Harcourt Brace Jovanovich. Arendt's books are astonishingly deep and inclusive philosophical presentations on these separate actions.

Bateson, Gregory. (1979). *Mind and Nature: A Necessary Unity*. New York: Bantam. Bateson provides the only definition of the mind that makes any sense to me.

Bowen, Murray. (1978). *Family Therapy in Clinical Practice*. Northvale, N.J.: Aronson. Bowen has the best grasp of the healthy and unhealthy growth and thought processes. He beats out any of the thinking psychology that I've come across because he's pounded out a theory of the differential self from his own experiences as a therapist and teacher.

Campbell, Joseph. (1986). *The Inner Researcher of Outer Space: Metaphor as Myth and as Religion*. New York: Van der Marck. Campbell, I think, is the best user of Jung's "archetypes" to show the workings of mind, thought, and action.

Stephen P. Norris

Giere, Ronald N. (1984). *Understanding Scientific Reasoning*. 2nd ed. New York: Holt.

Govier, T. (1987). *A Practical Study of Argument*. 2nd ed., edited by Ben King. Belmont, Calif.: Wadsworth.

Hitchcock, David. (1983). *Critical Thinking: A Guide to Evaluating Information*. Toronto: Methuen.

Norris, S. P., and R. H. Ennis. (1989). *Evaluating Critical Thinking*. Pacific Grove, Calif.: Midwest Publications.

Siegel, Harvey. (1988). *Educating Reason: Rationality, Critical Thinking and Education*. New York: Routledge and Chapman Hall. This two-part collection features a scholarly look at cognitive research and includes a descriptive review of major "thinking" programs.

Joe Onosko

Kahane, Howard. (1984). *Logic and Contemporary Rhetoric: The Use of Reason in Everyday Life*. 4th ed. Belmont, Calif.: Wadsworth.

Siegel, Harvey. (1988). *Educating Reason: Rationality, Critical Thinking and Education*. New York: Routledge and Chapman Hall.

Swartz, Robert, and David N. Perkins. (1989). *Teaching Thinking: Issues and Approaches*. Pacific Grove, Calif.: Midwest Publications.

Richard W. Paul

Paul, Richard W., A. J. A. Binker, and D. Weil. (1990). *Critical Thinking Handbook: K-3. A Guide for Remodelling Lesson Plans in Language Arts, Social Studies & Science*. Rohnert Park, Calif.: Foundation for Critical Thinking, Sonoma State University.

Paul, Richard W., A. J. A. Binker, Karen Jensen, and Heidi Kreklau. (1990). *Critical Thinking Handbook: 4th-6th Grades. A Guide for Remodelling Lesson Plans in Language Arts, Social Studies & Science*. Rohnert Park, Calif.: Foundation for Critical Thinking, Sonoma State University.

Paul, Richard W., A. J. A. Binker, Douglas Martin, Chris Vetrano, and Heidi Kreklau. (1989). *Critical Thinking Handbook: 6th-9th Grades. A Guide for Remodelling Lesson Plans in Language Arts, Social Studies & Science*. Rohnert Park, Calif.: Foundation for Critical Thinking, Sonoma State University.

Paul, Richard W., A. J. A. Binker, Douglas Martin, and Ken Adamson. (1989). *Critical Thinking Handbook: High School. A Guide for Redesigning Instruction*. Rohnert Park, Calif.: Foundation for Critical Thinking, Sonoma State University.

Siegel, Harvey. (1988). *Educating Reason: Rationality, Critical Thinking and Education*. New York: Routledge and Chapman Hall.

David N. Perkins

Costa, Arthur, and Lawrence Lowery. (1989). *Techniques for Teaching Thinking*. Pacific Grove, Calif: Midwest Publications.

Hayes, John R. (1981). *The Complete Problem Solver*. Hillsdale, N.J.: Lawrence Erlbaum.

Perkins, D. N. (1986). *Knowledge as Design*. Hillsdale, N.J.: Lawrence Erlbaum.

Perkins, D. N. (1981). *The Mind's Best Work: A New Psychology of Creative Thinking* Cambridge, Mass.: Harvard University Press.

Norris, Stephen, and Robert Ennis, eds. (1989). *Evaluating Critical Thinking*. Pacific Grove, Calif.: Midwest Publications.

Segal, Judith W., S. Chipman, and R. Glaser, eds. (1985). *Thinking and Learning Skills*. Vol.I, *Relating Instruction to Research*. Vol. II, *Research and Open Questions*. Hillsdale, N.J.: Lawrence Erlbaum.

Swartz, Robert, and D. N. Perkins. (1989). *Teaching Thinking: Issues and Approaches*. Pacific Grove, Calif.: Midwest Publications.

Lauren Resnick

Resnick, Lauren B., and Leopold E. Klopfer, eds. (1989). *Toward the Thinking Curriculum: Current Cognitive Research*. Alexandria, Va.: Association for Supervision and Curriculum Development.

Resnick, Lauren B. (1987). *Education and Learning to Think*. Washington, D.C.: National Academy Press.

Segal, Judith W., S. Chipman, and R. Glaser, eds. (1985). *Thinking and Learning Skills*. Vol.I, *Relating Instruction to Research*. Vol. II, *Research and Open Questions*. Hillsdale, N.J.: Lawrence Erlbaum.

Voss, J. F., D. N. Perkins, and J. Segal, J. (in press). *Informal Reasoning and Instruction*. Hillsdale, N.J.: Lawrence Erlbaum.

Selma Wassermann

Fisher, Robert. (1987). *Problem Solving in Primary Schools*. London: Basil Blackwell. This text examines current developments in the teaching of problem solving and thinking across many areas of the curriculum. It presents starting points for investigation and works from a theoretical framework of curriculum and instruction. It is rich in ideas and examples and is delightfully written.

Glasser, William. (1986). *Control Theory in the Classroom*. New York: Harper and Row. Although not, on the surface, related to thinking per se, this text is important for those who want to implement a thinking program. The issue of control has not been explored in relation to thinking; yet it is obvious that when teachers need to exercise authoritarian controls, thinking cannot be encouraged. Glasser presents his theoretical framework, called the "control theory," and describes how important relinquishing control is in a teaching for thinking classroom. The book is easy to read and makes a great deal of sense.

Raths, Louis E., Selma Wasserman, Arthur Jonas, and Arnold Rothstein. (1986). *Teaching for Thinking: Theory, Strategies and Activities for the Classroom*. 2nd ed. New York: Teachers College Press. Originally published in 1967, this revised edition contains the original theory of Louis Raths that links certain maladaptive behaviors to lack of experience with thinking. It also includes extensive ideas for applications in elementary and secondary schools, as well as an examination of how teachers' interactions discourage and encourage thinking. Materials for teachers' self-training in interaction skills are included.

Wassermann, Selma. (1990). *Serious Players: Empowering Children in the Primary Years*. New York: Teachers College Press. Takes the Play-Debrief-Replay instructional process several steps further in its application to all curriculum areas in the primary grades. Once again, theory in the primary grades. Once again, theory is presented, and conditions for children to grow as "can-do" adults are described in a teaching for thinking context. Much emphasis is given to classroom conditions that empower children, and specifically to how teachers may learn to do this. The text contains numerous examples of how Play-Debrief-Replay processes are carried out in math, science, social studies, and language arts.

Wassermann, Selma, and George Ivany. (1988). *Teaching Elementary Science: Who's Afraid of Spiders?* New York: Harper and Row. Although the text is specifically aimed at those who would teach science with an emphasis on higher-order skills, it also presents a curriculum approach, Play-Debrief-Replay, which helps teachers understand a particular teaching for thinking process in classroom application. Moving from a theoretical base, the text includes 60 fully fleshed-out higher-

order science "plays," as well as materials for self-training in interactions skills. The relationship between thinking and decision making in science is particularly emphasized. As indicated in the title, teachers' fears about teaching science, and teaching for thinking, ares also examined.

Critical Thinking Tests*

Robert H. Ennis

This listing is divided into general critical thinking tests, which attempt to assess three or more aspects of critical thinking, and aspect-specific critical thinking tests, which attempt to assess only one aspect of critical thinking. Regrettably, none attempts to assess critical thinking dispositions, such as the disposition to be open-minded or the disposition to try to be well-informed. So none of these tests is truly a general critical thinking test.

All but one are multiple-choice tests. To my knowledge, the listed critical thinking essay test is the only published essay test with critical thinking as its primary focus, although there are published essay tests (especially the College Board A.P. tests) that have critical thinking as a significant, though not primary, focus.[1]

There also are a number of published multiple-choice tests that have critical thinking assessment as a significant, though not primary, focus. These include the ACT (*American College Test*) and its sister, the P-ACT, the ITED (*Iowa Tests of Educational Development*), the GRE (*Graduate Record Examination*) general test, the LSAT (*Law School Aptitude Test*), and the new MCAT (*Medical College Admissions Test*).[2]

Critical thinking is here defined as "reasonable and reflective thinking focused on deciding what to believe or do." This definition seems to capture the basic intent that is in most educators' minds when they speak about critical thinking. However, the same test listings would probably appear under most current definitions.

Appearance of a test on this listing does not constitute endorsement. Anyone considering any of these tests should actually take the test and think critically about the scoring key or the manual's procedures for scoring. For multiple-choice critical thinking tests, background beliefs different from those assumed by the test author can possibly result in an answer that is keyed incorrect, even though the test taker was thinking critically. So it is important not only to make sure that the test assesses what you want it to assess, but to make sure that the background beliefs of the test takers are as similar as possible to those assumed by the test author. This is a difficult task, and you cannot be certain that you are correct.

Wide grade ranges are listed for many of these tests. These wide ranges accommodate the fact that there are wide ranges of critical thinking among students at the same grade level, resulting from different backgrounds and different learning experiences.

General Critical Thinking Tests

The California Critical Thinking Skills Test—College Level (1990) by Peter Facione. Aimed at college students. Items dealing with deduction, meaning, relevance, argument analysis, assumption identification, analytic puzzles, induction, and argument appraisal. (California Academic Press, 217 LaCruz Ave., Millbrae, CA 94030.)

Cornell Critical thinking Test, Level X (1985) by Robert H. Ennis and Jason Millman. Aimed at grades 4–14. Sections on induction, credibility, observation, deduction, and assumption identification. (Midwest Publications, P.O. Box 448, Pacific Grove, CA 93950.)

Cornell Critical Thinking Test, Level Z (1985) by Robert H. Ennis and Jason Millman. Aimed at advanced or gifted high school students, college students, and other adults. Sections on induction, credibility, prediction and experimental planning, fallacies (especially equivocation), deduction, definition, and assumption identification. (Midwest Publications, P.O. Box 448, Pacific Grove, CA 93950.)

The Ennis-Weir Critical Thinking Essay Test (1985) by Robert H. Ennis and Eric Weir. Aimed at grade 7 through college; also intended to be used as a teaching material. Incorporates getting the point, seeing the reasons and assumptions, stating one's point, offering good reasons, seeing other possibilities (including other possible explanations), and responding appropriately to equivocation, irrelevance, circularity, reversal of an if-then (or other conditional) relationship, overgeneralization, credibility questions, and the use of emotive language to persuade. (Midwest Publications, P.O. Box 448, Pacific Grove, CA 93950.)

Judgment: Deductive Logic and Assumption Recognition (1971) by Edith Shaffer and Joann Steiger. Includes sections on deduction, assumption identification, and credibility, and distinguishes between emotionally loaded content and other content. (Instructional Objectives Exchange, PO Box 24095, Los Angeles, CA 90024.)

New Jersey Test of Reasoning Skills (1983), developed by Virginia Shipman. Aimed at grade 4 through college. Syllogism (including A.E.I.O. statements) heavily represented. Several items apiece on assumption identification, induction, good reasons, and kind and degree. (IAPC Tests Division, Montclair State College, Upper Montclair, NJ 98043.)

Ross Test of Higher Cognitive Processes (1976) by John D. Ross and Catherine M. Ross. Aimed at grade 4 through college. Sections on verbal analogies, deduction, assumption identification, word relationships, sentence sequencing, interpreting answers to questions, information sufficiency and relevance in mathematics problems, and analysis of attributes of complex stick figures. (Academic Therapy Publications, 20 Commercial Blvd., Novato, CA 94947.)

Test of Enquiry Skills (1979) by Barry J. Fraser. Sections on using reference materials (library usage, index, and table of contents), interpreting and processing information (scales, averages, percentages, proportions, charts, tables, and graphs), critical thinking in science (reading comprehension, experimental design, conclusions, and generalizations). (Australian Council for Educational Research Limited, Frederick Street, Hawthorn, Victoria 3122, Australia.)

Test of Inference Ability in Reading Comprehension (1987) by Linda M. Phillips and Cynthia Patterson. Aimed at grades 6 through 8. Items call for test takers to infer information and interpretations from short passages. Multiple-choice (by both authors) and constructed response (by Phillips only) versions. (Institute for Educational Research and Development, G.A. Hickman Building, Memorial University of Newfoundland, St. John's, Newfoundland, Canada A1B 3X8).

Watson-Glaser Critical Thinking Appraisal (1980, 2 forms) by Goodwin Watson and Edward Maynard Glaser. Aimed at

*Copyright © 1991 by Robert H. Ennis.

grade 9 through adulthood. Sections on induction, assumption identification, deduction, beyond-a-reasonable-doubt reasoning, and argument evaluation. (The Psychological Corporation, 555 Academic Court, San Antonio TX 78204.)

Aspect-specific Critical Thinking Tests

ASPECT: DEDUCTION

Cornell Class-Reasoning Test, Form X (1964) by Robert H. Ennis, William L. Gardiner, Richard Morrow, Dieter Paulus, and Lucille Ringel. Aimed at grades 4–12. Seventy-two items, each of which contains a premise asserting a class relationship, such as "no A are B's." Each of 12 logical forms is represented by 6 items of varying types of content. (Illinois Critical Thinking Project, University of Illinois, 1310 S. 6th St. Champaign, IL 61820.)

Cornell Conditional-Reasoning Test, Form X (1964) by Robert H. Ennis, William L. Gardiner, John Guzzetta, Richard Morrow, Dieter Paulus, and Lucille Ringel. Aimed at grades 4–12. Seventy-two items, each of which contains as a premise a conditional statement, such as "If A, then B." Each of the 12 logical forms is represented by 6 items of varying types of content. (Illinois Critical Thinking Project, University of Illinois, 1310 S. 6th St., Champaign, IL 61820.)

Logical Reasoning (1955) by Alfred F. Hertzka and J. P. Guilford. Aimed at high school and college students and other adults. Tests for facility with syllogisms, the premises of which include a statement asserting a class relationship, such as "No A's are B's." (Sheridan Psychological Services, Inc., P.O. Box 6101, Orange, CA 92667.)

ASPECT: OBSERVATION

Tests on Appraising Observations (1983) by Stephen P. Norris and Ruth King. Aimed at grades 7–14. Pairs of statements are compared for their believability. The manual provides principles for judging observation statements, which the items serve to test. Two story lines are used. Multiple-choice and constructed response versions. (Institute for Educational Research and Development, Memorial University of Newfoundland, St. John's, Newfoundland A1B 3X8, Canada.)

NOTES

[1] I would appreciate hearing from any readers who know of currently available critical thinking tests that do not appear on this list. Please contact Robert H. Ennis, Director, Illinois Critical Thinking Project, University of Illinois, Urbana-Champaign, 1310 S. 6th St., Champaign, IL 61820.

[2] See also these two general references:

- *A Consumer's Guide: Assessing Higher Order Thinking Skills* (1987) by Judith A. Arter and Jennifer R. Salmon (Northwest Regional Educational Laboratory, 101 S.W. Main St., Suite 500, Portland, OR 97204). Telephone: 503-275-9500. An annotated list of higher order thinking tests—with commentary.
- *Evaluating Critical Thinking* (1989) by Stephen P. Norris and Robert H. Ennis (Midwest Publications, PO Box 448, Pacific Grove, CA 93950). Telephone: 408-375-2455. A general discussion of critical thinking assessment, including comments on existing tests and suggestions for making one's own tests and other assessment procedures. Since Norris and I are co-authors of some of the listed tests, we have an obvious conflict of interest in making test lists and suggestions for assessment. Hence the Arter and Salmon consumer's guide should certainly be consulted.

Media, Newsletters, and Networks

NEWSLETTERS

Subscription rates vary from free, a one time donation, or an annual charge. Since prices change frequently, they are not listed; you can find out the subscription price by contacting the publisher directly.

American Creativity Association. Joyce E. Juntune, Executive Director. P.O. Box 26068, St. Paul, MN 55126.

Applied Research in the Cognitive and Behavioral Sciences. A quarterly publication of Hanson Silver Strong and Associates Inc., 10 West Main, Moorestown, NJ 08057.

Center for Guided Design. Charles E. Wales, Editor. Center for Guided Design, Engineering Sciences Building, West Virginia University, Morgantown, WV 26506-6101.

The Clearinghouse Bulletin. Mary Ellen Freeley and Janet Perrin, editors. Oklahoma State Dept. of Education, 2500 N. Lincoln, Oklahoma City, OK 73105-4599.

Cogitare. Robin Fogarty, Editor. ASCD Network on Teaching Thinking, 200 E. Wood St., Suite 250, Palatine, IL 60067.

Cognition and Instruction. Lawrence Erlbaum Associates, 365 Broadway, Suite 102, Hillsdale, NJ 07642.

Critical Thinking News. Center for the Reasoning Arts, California State University, 1600 J St., Sacramento, CA 95819

Doubts & Certainties. Dorothy Massie, National Editor. 8380 Greensboro, Apt. 324, McLean, VA 22102.

Hotstuff. Stanley Pogrow, University of Arizona, College of Education, Tuscon, AZ 85721.

Human Intelligence Newsletter. Published quarterly. Oakland University, School of Human and Ed. Services, Rochester, MI 48309-4401.

Informal Logic. University of Windsor, Department of Philosophy, Windsor, Ontario, Canada N9B 3P4.

Inquiry: Critical Thinking Across the Disciplines. Robert Michael Esformes, Editor. Newsletter of the Institute for Critical Thinking, Montclair State College, Upper Montclair, NJ 07043

International Journal of Cognitive Education and Mediated Learning. Dr. Martha L. Coulter, Department of Community and Family Health, College of Public Health, University of South Florida, 13301 Bruce B. Downs Blvd., Tampa, FL 33612-3899.

The Implementor. Bob Stolte, Editor. Attn: Center for the Teaching of Thinking, Huntington Beach Union High School District, 10251 Yorktown Ave., Huntington Beach, CA 92646.

Learning Styles Network. St. John's University, Jamaica, NY 11439.

Mind-Brain Bulletin. Interface Press, P.O. Box 4221, 4717 N. Figueroa St., Los Angeles, CA 90042.

National Thinking Skills Network. Dr. Cathy Petrosky, NTSN Treasurer, 6890 Shawnee Run, Cincinnati, OH 45243.

Networker. Wayne B. Bennings, Editor. Institute for Learning and Teaching, 449 Desnoyer, St. Paul, MN 55104-4915

NITA--National Inventive Thinking Association (A Network for Inventive Thinkers). National Inventive Thinking Association, 400 South Greenville Ave., Richardson, TX 95081.

Noetic Sciences Bulletin. Carol Guion, Editor. 475 Gate Five Rd., Suite 300, P.O. Box 909, Sausalito, CA 94966-0909.

On The Beam. New Horizons for Learning, P.O. Box 51140, Seattle, WA 98115

Problem Solving. Franklin Institute Press, 20th and Race Streets, Box 2266, Philadelphia, PA 19103.

Professional Journal of Record: Informal Logic. Informal Logic, University of Windsor, Ontario, Camada N9B 3P4.

Reflections. National Thinking Skills Network, c/o Jan Meronone, Beech Grove Middle School, 1248 Buffalo, Beech Grove, IN 46107.

Structure of Intellect News (SOI News). Mary Meeker, Editor. SOI Systems, 45755 Goodpasture Rd., Vida, OR 97488.

Teaching Thinking and Problem Solving. Fran Beyer, Editor. Research for Better Schools, 444 N. 3rd St., Philadelphia, PA 19123.

Thinking Allowed. A newsletter of Maryland Center for Thinking Studies, K-12. Leah Curlee and Barbara Griffis, Editors-in-Chief. Toni Worsham, Director. MCTS, K-12, Coppin State College, 2500 W. North Ave., Baltimore, MD 21206.

Thinking Skills Newsletter. Pennsylvania Department of Education, c/o Stephanie Bowen or John Beehan, 333 Market Street, Harrisburg, PA 17126-0333

Wisconsin Center for Education Research Highlights (WCER Highlights). Andrew Porter. Director. Wisconsin Center for Education Research, S hool of Education. University of Wisconsin, 1025 W. Johnson St., Madison, WI 53706.

MEDIA

Beyond the Three R's—Reasoning and Responsibility. Audiocassette. Jane Stallings accounts for how we teach children to ask key questions and what concepts—not merely facts and figures—we want them to learn (612-20414) Alexandria, Va.: ASCD, 1984.

Direct Instruction and Teaching for Thinking. Theme issue of *Educational Leadership*. Articles by Bruce Joyce, John Barell. Richard W. Paul, and Stephen Norris explaining the relationship between effective teaching and critical thinking. Alexandria, Va.: ASCD, May 1985.

Frameworks for Teaching Thinking. Theme issue of *Educational Leadership*. Articles by D. N. Perkins, Robert Marzano, Renate M. Nummela, and others. Alexandria, Va.: ASCD, May 1986.

Improving the Quality of Student Thinking. Videotape. Ron Brandt encourages teachers to analyze their own teaching to improve students' thinking skills. Features actual classroom episodes, statements by researchers, psychologists, and other authorities. Alexandria, Va.: ASCD, 1984.

The New Research on Learning. Theme issue of *Educational Leadership*. Includes articles by Lauren Resnick, Beau Fly Jones, and Donna M. Ogle. Alexandria, Va.: ASCD, December 1988/January 1989.

Problem Solving. Theme issue of *Educational Leadership*. Arthur Whimbey on paired problem solving; two articles on Instrumental Enrichment. Alexandria, Va.: ASCD, April 1980.

Put Some Thinking in Your Classroom. Sound filmstrip series by Selma Wasserman. Westchester, Ill.: Benefic Press, 1978.

Tactics for Thinking. Video-supported training program. A 22-unit program for training K–12 teachers in all subject areas in the teaching of mental tactics to help students take control of their own learning throughout their lives. The 22 skills, or tactics, fall into three categories: learning-to-learn skills, content thinking skills, and reasoning skills. Developed by Robert J. Marzano and Daisy E. Arredondo. Alexandria, Va.: ASCD, 1986.

Talks on Teaching Thinking. Audiocassettes. A set of seven tapes covering strategies that have emerged from research. Features Barry Beyer, "Practice Is Not Enough"; Sandra Black, "Survey of the Thinking Skills Movement"; Ron Bra. ., "Approaches to Teaching Thinking"; Arthur Costa, "Classroom Conditions That Encourage Student Thinking"; Edward de Bono, "Thinking as a Skill"; Da /id Perkins, "Knowledge as Design"; and Robert Sternberg, "Teaching for Problem Solving in the Real World." (612-20472) Alexandria, Va.: ASCD, 1985.

Teaching Reading as Thinking. Videotape. Explains how research on teaching thinking can help teachers improve student reading abilities in all content areas, K–12. Features Annemarie Palincsar, Donna Ogle, Beau Fly Jones. Alexandria, Va.: ASCD, 1986.

Teaching Skillful Thinking. Videotape. A four-part program to help teachers plan ways to emphasize thinking throughout the curriculum. Features Ernest Boyer, David Perkins, Matthew Lipman, and others. Alexandria, Va.: ASCD, 1986

Teaching Thinking in Elementary Schools. Audiocassettes. A set of five tapes that presents a framework for teaching thinking in elementary schools. Features Ron Brandt and David Perkins, "Analyzing Approaches to Teaching Thinking"; Richard W. Paul, "Critical Thinking in Elementary School"; Barry Beyer, "Planning a Thinking Skills Program"; Esther Fusco and John Barell, "The Development of Children's Thinking and Teaching Thinking in River Edge, New Jersey, Schools"; and Arthur Costa, "What Human Beings Do When They Behave Intelligently." (612-87623) Alexandria, Va.: ASCD, 1987.

Teaching Thinking Skills. Theme issue of Educational Leadership. Includes symposium on brain research, articles by Robert Sternberg, Ray Nickerson, Arthur Costa, Sydelle Seiger-Ehrenberg, and others. Alexandria, Va.: ASCD, October 1981.

Teaching Thinking Throughout the Curriculum. Theme issue of *Educational Leadership*. Articles by Barbara Presseisen, John Chambers, John Barell, Debra Pickering, Stanley Pogrow, and others. Alexandria, Va.: ASCD. April 1988.

Thinkabout. Television series for school use. Designed to help students experience and become aware of their thinking and problem-solving processes. Bloomington, Ind.: Agency for Instructional Television.

Thinking Skills in the Curriculum. Theme issue of *Educational Leadership*. Articles by Richard W. Paul on critical thinking, Matthew Lipman on reasoning, Robert Sternberg on intelligence, Edward de Bono on thinking as a skill, and David Perkins on creativity. Alexandria, Va.: ASCD, September 1984.

When Teachers Tackle Thinking Skills. Theme issue of *Educational Leadership*. Arthur Costa, Irving Sigel, Carol Booth Olson, Meredith Gall, and others discuss ways to help teachers prepare to teach thinking. Alexandria, Va.: ASCD, November 1984.

Why in the World? Television series by Elinor Richardson and Carlos E. Cortes. Uses national and international current events to stimulate critical analyses in high school students. Los Angels: KCET Agency for Public Broadcasting.

NETWORKS AND PROFESSIONAL ASSOCIATIONS

Association for Supervision and Curriculum Development: Teaching Thinking Network. Facilitators: Robin Fogarty, Skylight Publishing, Inc. 200 East Wood St., Suite 250, Palatine, IL 60067. Telephone: 800-922-4474. FAX: 708-991-6420. Esther Fusco, 24 Hopewell Dr., Stony Brook, NY 11790. Telephone: 516-661-5820. FAX: 516-661-5886.

Research for Better Schools. 444 N. 3rd St., Philadelphia, PA 19123.

National Council for Excellence in Critical Thinking. c/o Richard W. Paul, Center for Critical thinking, Sonoma State University, Rohnert Park, CA 94928.

International Center for the Development of Thinking Skills. 5 Canal Rd., Pelham Manor, NY 10803.

New Horizons for Learning. P.O. Box 51140, Seattle, WA 98115.

ERIC

Appendices

Almost every classification system has a "miscellaneous" category and what follows is ours. Included in this section are a collection of checklists and a glossary of terms. We hope they will help you in your implementation of a "teaching for thinking" curriculum.

Appendix A
A Glossary of Thinking Skills

Arthur L. Costa and Barbara Presseisen

Although there is no one glossary of thinking terms that serves the many nuances of meaning associated with cognitive operations, a working definition is a useful base to further understanding. While some may take issue with these definitions, the following terms may be helpful to practitioners who are seeking to integrate thinking skills into their curricular and instructional tasks.

"Aha" experience: An instantaneous generation of ideas or rules.

Algorithm: A problem-solving procedure that, if followed exactly, will always yield the solution to a particular problem. Compare with heuristic.

Ambiguity: The result of more than one meaning or underlying representation in a communication or utterance.

Analogy: A problem-solving strategy in which linguistic or figural similarities are noted between two or more situations while simultaneously discerning that there are also differences in the relationship.

Analyze: To separate or break up a whole into its parts according to some plan or reason. Opposite of *synthesis*. *Structural analysis* is performed in random order. *Operational analysis* is performed in sequential steps.

Anticipate probabilities: To assess all of the factors in a situation in order to determine the likely effects or outcomes of that situation.

Assumption: A fact or condition taken for granted; a supposition that something is true without proof of evidence.

Brainstorming: A group or individual method for generating solution paths for problems. The goal is to produce multiple possible solutions.

Build hypotheses: To construct tentative assumptions that appear to account for an observed effect, which may be used more fully to examine a specified situation or to provide possible conclusions or proofs.

Categorical reasoning: Also known as syllogistic reasoning. Use of such quantifiers as "some," "all," "no," and "none" to indicate category membership.

Categorize: To arrange items in such a way that each possesses the particular properties, based on predetermined criteria, required to belong to a specific group.

Causation: The act or process that occasions or effects a result.

Cause/effect: A condition or event (cause) that makes something happen; the result (effect) or outcome created by the previous condition or event.

Change forms of concepts: To translate information into a different form or present information through a different medium.

Classify: To sort into clusters, objects, events, or people according to their common elements, factors, or characteristics. Includes giving that cluster a label that communicates those essential characteristics.

Cognition: Related to the various thinking processes characteristic of human intelligence.

Compare and contrast: To examine objects in order to note attributes that make them similar and different. To contrast is to set objects in opposition to each other or to compare them by emphasizing their differences.

Compare word meanings: To analyze the various uses of a word and the relationship of that word to other words.

Comprehension: The arrival at the speaker's or writer's intended meaning by a listener or reader.

Conceive: To organize information in order to form an idea or generalized rule; to conceptualize; to understand.

Conclusion: An inferential belief that is derived from premises.

Conditional logic: Also known as proportional logic. Logistical statements that are expressed in "if, then" format.

Conduct projects: To describe the important elements of a task and explain the ways in which the task can be completed successfully.

Consequent: In "if, then" statements, the information given in the "then" clause.

Contingency relationships: Relationships that are expressed with "if, then" statements. The consequent is contingent or dependent upon the antecedent.

Contradiction: A problem-solving strategy in which the problem solver shows that a goal cannot be obtained from the givens because of inconsistencies.

Contrasting: To set objects or ideas in opposition or to compare them by emphasizing their differences.

Convergent thinking: Thinking that requires a single correct answer to a question or problem. (Compare with divergent thinking.)

Creative thinking: The act of being able to produce along new and original lines. See also *flexibility, originality, elaboration, aha.*

Critical thinking: Using basic thinking processes to analyze arguments and generate insight into particular meanings and interpretations; also known as directed thinking.

Decision making: The process leading to the selection of one of several options after consideration of facts or ideas, possible alternatives, probable consequences, and personal values.

Deduce (deductive reasoning): To infer from what precedes; to lead or draw to a conclusion; to derive the unknown from the known. The opposite of *induce* (inductive reasoning).

Detect ambiguity: To recognize the existence of two possible interpretations of a sentence or phrase because (1) of the manner in which the words are arranged, or (2) a word may be interpreted in two or more ways within the same context.

Detect assumptions: To recognize that a supposition is being made or that a supposition underlies a statement.

Determine alternative actions: To explore and develop different approaches to the solution of problems.

Develop criteria: To create standards, rules, or tests for judging ways in which one event, item, or person may be differentiated from another one.

Discriminate between definition and example: To identify a word, phrase, or term by stating its precise meaning or significance (definition) as contrasted with identifying it by giving instances of its occurrence (examples).

Discriminate between fact and opinion: To differentiate between statements generally accepted as true and those based on personal or unsubstantiated assumptions.

Discriminate between real and fanciful: To distinguish between that which is true or actual and that which is illusory, fictitious, or imaginative.

Divergent thinking: The kind of thinking required to generate many different responses to the same question or problem. (Compare with convergent thinking.)

Elaborate: To expand on concepts or ideas; to give an idea or object greater detail.

Epistemic thinking: Related to the collective knowledge produced by various forms of thinking: scientific, aesthetic, political, etc., and the ways these bodies of knowledge are developed and extended.

Error: The result of a mistake.

Estimate: To form a judgment about the worth, quantity, or significance of something—the implication being that the judgment formed is based on rough calculations.

Evaluate value conflicts: To assess the coherence of specific actions and ideals and determine the compatibility of personal desires and social sanctions.

Evaluation: To make an examination or judgment based upon a set of internal or external criteria.

Fact: A statement that can be proven or verified; information presented as having objective reality.

Fallacy: An error or mistake in the thinking process.

Flexibility: The ability to take alternate points of view; present a different perspective with each response; try several different approaches; apply concepts, ideas, or rules to a variety of situations.

Fluency: (See ideational fluency)

Generalization: A rule, principle, or formula that governs or explains any number of related situations.

Group: To assemble objects according to a unifying relationship or critical attribute.

Heuristic: A general strategy or "rule of thumb" that is used to solve problems and make decisions. While it doesn't always produce a correct answer, it is usually a helpful aid. ("Look before you leap" as an example.) (Compare with algorithm.)

Hypothesis: A tentative proposition or relationship assumed in order to draw out its logical or empirical consequences. An "if, then" statement that serves as a basis for testing through experimentation or gathering facts.

Hypothesize: To construct a hypothesis.

Ideational fluency: The ability to list many possible ideas—the more ideas, the more fluent. The ability to produce a variety of responses.

Identical: Sharing all attributes.

Identity: A sameness of essential or generic characteristics.

Identify relationships among events: To determine the particular ways that occurrences can be analogous.

Identify relevant principles: To assess the usefulness of specific theories in clarifying or solving a problem.

Identify steps in a process: To recognize and point out discrete yet ordered elements within a larger activity.

Identify structure: To describe patterns and relationships among the elements or parts of a work.

Illogical: Reaching conclusions that are not in accord with the rules of logic.

Induce (inductive reasoning): To combine one or more assumptions or hypotheses with available information to reach a tentative conclusion. Reaching a rule, conclusion, or principle by inference from particular facts. Opposite of *deduce* (deductive reasoning).

Infer: To arrive at a conclusion that evidence, facts, or admissions point toward but do not absolutely establish; to draw tentative conclusions from incomplete data. Inferring is the result of making an evaluation or judgment in the absence of one or more relevant facts. Inference requires supposition and leads to prediction.

Inquiry: Seeking information about a problem or condition.

Insight: Sudden knowledge of a solution to a problem. Finding a new relationship between seemingly unrelated events, conditions, or objects.

Interpret changes in word meanings: To detect and analyze alterations or extensions of word meanings.

Interpret the mood of a story: To assess or appraise the temper—the range of sensitive impressions—of a literary work.

Interpretation: Explanations of the meaning of a situation or condition.

Intuition: The power or faculty of attaining direct knowledge or cognition without rational thought and inference.

Irrelevant information: Data that are not useful in solving a problem or answering a question. May be a distraction.

Judge abstract or concrete: To determine whether words describe general or specific items or ideas. The distance from reality: real, pictorial representation of the real, symbolic representation of the real, verbal or auditory sound that stands for the real.

Judge completeness: To assess data to determine whether or not they are sufficient for thorough coverage of the subject or issue under consideration.

Judge elements of a selection: To analyze a work to determine the function and effectiveness of each major component.

Judge logic of actions: To assess the feasibility, utility, and applicability of a procedure or method.

Judge relevance of information: To decide whether or not data are connected logically with and are useful in the solution of a problem.

Judge story logic. To assess materials, actions, and events to determine whether or not episodes within them are related in a consistent manner and follow a logical pattern of development.

Judgment: The process of forming an opinion or evaluation based upon a value.

Knowledge: The condition of having information or of being learned.

Label: To assign a category name or phrase to a set of objects or ideas in which the name selected identifies the major attributes shared by the members of the set.

Lateral thinking: Thinking "around" a problem. Used to generate new ideas. (Compare with vertical thinking.)

Logical: Reaching conclusions that are in accord with the rules of logic; derived from valid (correct) conclusions.

Logical reasoning: To think in a systematic fashion in order to determine the truth or validity of an argument.

Memory: The power or process of reproducing or recalling what has been learned and retained. That portion of the brain or mind where information and knowledge is stored and from which it is retrieved.

Metacognition: Consciousness of one's own thinking processes.

Metaphor: Linguistic comparisons formed when similarities between things that are basically dissimilar are noted. Often used in creative thinking.

Mnemonics: Memory aids or techniques that are utilized to improve memory.

Observe: To use the senses to gather information; to notice qualities, quantities, texture, color, form, number, position, direction, and so on.

Opinion: A personal belief, judgment, or appraisal regarding a particular matter.

Order: To arrange objects, conditions, events, or ideas according to an established scheme or criterion or to identify the scheme by which they have been arranged.

Originality: The ability to generate novel, nontraditional, or unexpected responses.

Part to whole relationships: The elements of an object, condition, event, or idea and how they combine to form a complete unit.

Pattern: An artistic or mechanical design revealing constant traits or replicable characteristics.

Patterning: Arranging objects, conditions, events, or ideas according to an established, repeated scheme or recognized, repeated schemata.

Perceive: To become aware through the senses; to discern.

Point of view: A perception of the world based on a variety of physical, environmental, intellectual, cultural, and emotional factors.

Predict: To formulate possible consequences of a particular event or series of experiences.

Premise: A statement that allows the inference of logical conclusions.

Prioritize: To rank objects, ideas, persons, conditions, or events by importance or personal preference.

Problem solve: To define or describe a problem, determine the desired outcome, select possible solutions, choose strategies, test trial solutions, evaluate the outcome, and revise these steps where necessary.

Qualification: Finding unique characteristics of particular identity or description.

Question: To formulate relevant inquiries so as to evaluate a situation, guide hypotheses, verify information, seek logical evidence, clarify, and so on.

Reasoning: In two forms, deductive and inductive. *Deductive:* use knowledge of two or more premises to infer if a conclusion is valid. *Inductive:* collect observations and formulate hypotheses based upon them.

Recall: To bring from memory storage ideas, facts, terminology, formulas, or propositions.

Recognize "either-or" fallacies: To detect situations in which only two choices are offered as alternatives, although other possible courses of action may actually be available.

Recognize false analogies: To determine when two situations or sets of evidence have been falsely compared.

Recognize guilt by association: To detect situations in which individuals or groups are falsely assumed to possess all or most of the characteristics of people with whom they associate; to determine cases in which individuals or groups have been falsely assumed to have taken part in an action because of proximity.

Recognize slanted arguments: To determine when language has been purposely misused in order to create false impressions or to convert others to a certain point of view that may be biased.

Relate cause and effect: To find a relationship between two events—one, the source, producing the other; to distinguish between simultaneity, coincidence, and causality of events.

Relate hierarchically: To arrange objects, items, or events by rank, grade, or class according to some value.

Relationships: Detecting regularity between two or more operations: temporal, causal, syllogistic, transitive, spatial, mathematical, and so on.

Relevant information: Data useful in solving a problem or answering a question.

Rules: The principles or formulae that underlie or govern some problems or relationships.

Sequence/seriate: To arrange events, items, or objects in some order according to an ascending or descending relationship of size or value; to order according to a temporal relationship in which the events occurred.

Strategy: The art of devising or employing plans toward achievement of a goal.

Summarize: To present the substance of a complex idea in a more condensed or concise form.

Syllogistic reasoning: Drawing a logical conclusion from two statements or premises; using deductive logic to reason from the general to the particular.

Synthesize: To unite parts into a whole; to conclude; to move from principle to application; to reason deductively from simple elements into a complex whole.

Test generalizations: To determine whether or not declarations, conclusions, or systematically organized bodies of knowledge (prepared by others) are justified and acceptable on the basis of accuracy and relationship to relevant data.

Thinking: The mental manipulation of sensory input to formulate thoughts, reason about, or judge.

Transformations: Relating known to unknown characteristics, creating meanings.

Understand figural relationships: To compare representations of objects or ideas with concrete forms or objects in order to discern ways in which they are related.

Vertical thinking: Thinking that is logical and straightforward. Used in the refinement and development of ideas and solutions. (Compare with lateral thinking.)

---

*These definitions are taken from a variety of sources. Readers who are interested in more detailed explanations of these terms should refer to: Donald Barnes and others, *SEASCAPE Manual* (1978); Barry K. Beyer, "What's In A Skill? Defining the Thinking Skills We Teach," *Social Studies Review* 24 (1): 19-23; Commission on Science Education, *Science—A Process Approach* (Washington, D.C.: American

Association for the Advancement of Science, 1963); Diane F. Halpern, *Thought and Knowledge: An Introduction to Critical Thinking* (Hillsdale, N.J.: Lawrence Erlbaum Associates, 1984, pp. 357-372); Dana G. Kurfman, ed., *Developing Decision-Making Skills* (Arlington, Va.: National Council for the Social Studies, 1977); and George A. Miller and others, *Plans and the Structure of Behavior* (New York: Holt, Rinehart & Winston, 1960).

Appendix B

Classroom Observation Form

John Barell

This form has been developed using the most recent research on teacher effectiveness as it relates to improving students' complex thinking processes in the classroom.

Generic Teaching Methods

1. Sets high standards:
   - Expects students to think with complexity and creativity.
   - Models desired thinking skills in day-to-day conduct.
2. Structures the classroom for thinking:
   - Organizes the classroom with clearly delineated rules for managerial and academic tasks.
   - Informs students that thinking is the objective.
   - Organizes the class for individual, paired, small-group, or total-group interaction.
   - Communicates desired attitudes and behaviors to students, including specific objectives for thinking processes.
   - Models thinking processes for students verbally.
3. Presents complex problems for students to think about:
   - Provides rationale for new skill/concept being introduced.
   - Provides meaningful examples, models, and comparisons.
   - Relates new information to previously learned material and students' own experiences.
   - Poses questions at various cognitive levels.
4. Establishes a warm, supportive environment for risk-taking:
   - Encourages autonomy of thought and action.
   - Encourages peer listening and responsive interaction.
   - Accepts students' contributions nonjudgmentally.
   - Uses silence (wait time) effectively.
   - Probes for clarification, extension, or expansion of meaning.
   - Probes for clarification of process (metacognition)—"How did you arrive at your conclusion?"
   - Builds on and extends students' responses.
   - Encourages trust and cooperative behavior.
   - Provides an environment rich in data sources.
   - Responds with information when the student needs or requests it.
   - Identifies students' cognitive functions.

Appendix C

Self-Reflection on Your Teaching: A Checklist

John Barell

Using a scale of 1 to 5, rate your classroom and school according to the following items.

5 = Very Often 4 = Often 3 = Sometimes 2 = Seldom 1 = Hardly Ever

CLASSROOM

1. When students pose unusual or divergent questions, I ask, "What made you think of that?"	5	4	3	2	1
2. Whatever the text says is accepted as the right answer.	5	4	3	2	1
3. When a decision has to be made between involving the class in a discussion of an intriguing student idea (topic related) or moving on to "cover" content, I choose the latter.	5	4	3	2	1
4. I encourage students to seek alternative answers.	5	4	3	2	1
5. Students give reasons for making statements.	5	4	3	2	1
6. I use subject matter as a means for students to generate their own questions (or problems), which we then seriously consider.	5	4	3	2	1
7. When teaching, I sit or stand behind my desk.	5	4	3	2	1
8. Most questions posed during class can be answered with short or one-word answers.	5	4	3	2	1
9. Students spontaneously engage in critiquing each other's thinking.	5	4	3	2	1
10. Students relate subject matter to experiences in other subjects or in their personal lives.	5	4	3	2	1

11. I stress *what* to think, not *how*.	5	4	3	2	1
12. Students often set objectives for their own learning.	5	4	3	2	1
13. Students spend time working collaboratively to solve subject matter questions.	5	4	3	2	1
14. One focus in my classroom is trying to understand how and why people (mentioned in texts) created ideas, solutions, experiments, rules, principles, and so on.	5	4	3	2	1
15. My classroom mirrors the patterns of involvement practices in most faculty meetings.	5	4	3	2	1
16. Students actively listen to each other.	5	4	3	2	1
SCHOOL					
17. We talk about the nature of thinking.	5	4	3	2	1
18. My school stresses collaborative instructional problem solving.	5	4	3	2	1
19. I learn from my colleagues by observing their teaching.	5	4	3	2	1
20. My supervisor and I discuss how to challenge students to think in more complex fashions.	5	4	3	2	1

Appendix D
How Thoughtful Are Your Classrooms?

Arthur L. Costa

Using the following 14 questions as your criteria, rate your school's effectiveness in developing thinking skills.

	Degree of Effectiveness (*5 = high*				*1 = low*)
1. Do your community and staff value thinking as a primary goal of education?	5	4	3	2	1
2. Does the staff believe that with appropriate intervention human intelligence can continue to grow throughout life?	5	4	3	2	1
3. Have you reached consensus on or adopted a model of intellectual functioning?	5	4	3	2	1
4. Are students aware that intelligent behavior is an instructional objective?	5	4	3	2	1
5. Does the teachers' language (questioning and structuring) invite students to think?	5	4	3	2	1
6. Do the teachers' response behaviors extend and maintain higher levels of thinking?	5	4	3	2	1
7. Are learning activities arranged in order of increasing complexity and abstraction?	5	4	3	2	1
8. Do instructional materials support higher cognitive functioning?	5	4	3	2	1
9. Is adequate instructional time devoted to thinking?	5	4	3	2	1
10. Does instruction provide for differences in modality strengths?	5	4	3	2	1

	Degree of Effectiveness (*5 = high*				*1 = low*)
11. Are concepts and problem-solving strategies encountered repeatedly throughout, across, and outside the curriculum?	5	4	3	2	1
12. Do students and teachers discuss their thinking (metacognition)?	5	4	3	2	1
13. Do evaluation measures assess intelligent behavior?	5	4	3	2	1
14. Do significant adults model intelligent behaviors?	5	4	3	2	1

Appendix E
A Thinking Skills Checklist

Barry K. Beyer

	Yes	*In Progress*	*No*
1. Does your school system have:			
a. A list of major thinking skills to be taught throughout the system?	______	______	______
b. Agreement among all subject areas that these skills should be taught throughout the system?	______	______	______
c. A K-12 curriculum document that clearly delimits which thinking skills are to be taught at each grade level in each subject area?	______	______	______
d. A K-12 curriculum document that presents thinking skills to be taught in a developmental sequence based on the cognitive development of learners, nature of the target skills, and subject-matter needs?	______	______	______
e. A thinking skills curriculum that provides for continuing instruction in these thinking skills across many grade levels and subjects?	______	______	______
f. Detailed descriptions of the operating procedures, rules, and distinguishing criteria of each major thinking skill or process to be taught?	______	______	______
g. Appropriate thinking skill descriptions in the immediate possession of every teacher and administrator?	______	______	______
h. Provisions for instruction in each skill with a variety of media, in a variety of settings, and for a variety of goals?	______	______	______

Copyright 1985 by Barry K. Beyer. Reprinted with permission.

ERIC

	Yes	In Progress	No
2. *Do your teachers:*			
a. Use a common terminology and instructional language to describe the thinking skills they are required to teach?	______	______	______
b. Provide instruction in thinking skills when these skills are needed to accomplish subject-matter learning goals?	______	______	______
c. Understand the major components of the thinking skills they are teaching?	______	______	______
d. Provide continuing instruction in each thinking skill through the stages of readiness, introduction, guided practice, extension, practice, and application?	______	______	______
e. Introduce thinking skills as explicitly as possible by explaining and modeling each skill and having students apply the skill with their guidance?	______	______	______
f. Provide frequent, guided practice in each skill with appropriate instructive feedback?	______	______	______
g. Require students to reflect on and discuss how they make each skill operational?	______	______	______
h. Use instructional materials appropriate to learning thinking skills?	______	______	______
i. Test on their own unit tests the thinking skills they are responsible for teaching?	______	______	______
3. *Do your provisions for evaluating the learning of thinking skills include the:*			
a. Selection or development of instruments that measure student performance on skills taught in the school system?	______	______	______
b. Use of instruments that are valid measures of thinking skill competency?	______	______	______
c. Use of instruments that provide the maximum data for diagnostic or monitoring purposes?			
4. *Do your supervisors and instructional leaders:*			
a. Understand the nature of the thinking skills and how to teach and measure them?	______	______	______
b. Provide inservice instruction in the nature of the thinking skills to be taught and in different ways to teach these skills?	______	______	______
c. Help teachers in different subject areas and grade levels share methods for teaching thinking skills?	______	______	______

	Yes	*In Progress*	*No*
d. Ensure that teachers follow the thinking skills curriculum?	________	________	________
e. Ensure the revision of the thinking skills curriculum, instructional strategies, and instructional materials as appropriate?	________	________	________

Appendix F

Classroom Observation Checklist

S. Lee Winocur

Teacher ______________________ School ______________ District ____________

Observer ______________________ Subject ______________ Date ____________

Directions:

Mark an "x" in the appropriate column for each classroom behavior. If the statement is generally true of this classroom, mark *yes*. If the statement is generally not true of this classroom, mark *no*. If you are unsure, mark the third column.

	Yes	*No*	*Unsure*
Affective Disorders			
1. FOSTERS A CLIMATE OF OPENNESS			
• Eye contact is frequent between teacher and students, and students and students.	____	____	____
• Teacher moves around the room.	____	____	____
• Students listen attentively to others.	____	____	____
• Teacher calls on students by name.	____	____	____
2. ENCOURAGES STUDENT INTERACTION/COOPERATION			
• Students work in pairs or small groups.	____	____	____
• Students respond to other students.	____	____	____
• Students help others analyze and solve problems.	____	____	____
3. DEMONSTRATES ATTITUDE OF ACCEPTANCE			
• Teacher accepts all valid student responses.	____	____	____

ERIC Full Text Provided by ERIC

	Yes	No	Unsure
• Incorrect student responses elicit encouraging, supportive comments.	______	______	______
• Teacher acknowledges student comments with a nod or other signal.	______	______	______
Cognitive Indicators			
4. ENCOURAGES STUDENTS TO GATHER INFORMATION			
• Reference materials are readily available.	______	______	______
• Students use reference materials.	______	______	______
• Student mobility is allowed to obtain information.	______	______	______
• Teacher acts as facilitator.	______	______	______
• Students record data in notebooks or journals.	______	______	______
5. ENOURAGES STUDENTS TO ORGANIZE INFORMATION			
• Teacher works from organized lesson plans.	______	______	______
• Students classify and categorize data.	______	______	______
• Students take notes systematically.	______	______	______
• Teacher's presentation is logical, organized.	______	______	______
• Ideas are graphically symbolized during instruction.	______	______	______
6. ENCOURAGES STUDENTS TO JUSTIFY IDEAS			
• Teacher probes for correct responses.	______	______	______
• Teacher seeks evidence for stated claims.	______	______	______
• Students analyze sources of information for reliability, relevance.	______	______	______
• Teacher frequently asks, "Why do you think so?"	______	______	______
• Students relate learning to past experience or similar situations.	______	______	______
7. ENCOURAGES STUDENTS TO EXPLORE ALTERNATIVES AND OTHERS' POINTS OF VIEW			
• Teacher establishes expectations for divergent solutions.	______	______	______
• Teacher allows time to consider alternatives/points of view.	______	______	______
• More than one student is queried for point of view/solution.	______	______	______
• Teacher asks students to justify and explain their thoughts.	______	______	______
8. ASKS OPEN-ENDED QUESTIONS			
• Teacher asks open-ended questions with multiple answers *as frequently as* single-answer questions.	______	______	______
9. PROVIDES VISUAL CUES FOR DEVELOPING COGNITIVE STRATEGIES			
• Teacher appropriately uses a variety of visual media (charts, chalkboard, maps, pictures, gestures).	______	______	______

	Yes	*No*	*Unsure*
• Teacher uses symbolic language to illustrate a point (simile, metaphor).	____	____	____
• Teacher uses outlining.	____	____	____
10. Models Reasoning Strategies			
• Teacher uses "if/then" language.	____	____	____
• Teacher poses "what if" or "suppose that" questions.	____	____	____
• Teacher uses clear examples to facilitate logical thought.	____	____	____
11. Encourages Transfer of Cognitive Skills to Everyday Life			
• Teacher encourages transfer at end of lesson with comments like, "This will help you in your everyday life in this way. . . ."	____	____	____
12. Elicits Verbalization of Student Reasoning			
• Teacher poses questions at different levels of Bloom's Taxonomy.	____	____	____
• Teacher allows at least ten seconds wait time for student answer before restating or redirecting the question.	____	____	____
• Teacher asks students to clarify and justify their responses.	____	____	____
• Teacher probes "I don't know" responses.	____	____	____
• Teacher reinforces students for responding to open-ended questions.	____	____	____
13. Probes Student Reasoning for Clarification			
• Teacher asks questions to elicit reasoning by students.	____	____	____
• Teacher requires students to expand on answers.	____	____	____
• Teacher cues students for most logical answers.	____	____	____
14. Encourages Students to Ask Questions			
• Teacher poses problematic situations.	____	____	____
• Teacher withholds "correct" responses; encourages students to explore possibilities.	____	____	____
• Teacher encourages students to answer other students' questions.	____	____	____
15. Promotes Silent Reflection of Ideas			
• Teacher allows time for reflection.	____	____	____

Copyright 1983 by Project IMPACT, Orange County Department of Education, Costa Mesa, California.

ERIC

Appendix G

Questionnaire: Are You Ready to Teach Thinking?

Arthur L. Costa

DIRECTIONS

1. *Answer the first eight questions individually.*
2. *Share your answers with other staff members.*
3. *As a total staff, grade-level team, or department, compile one copy that reflects the consensus of the total group.*
4. *Sign the group's composite copy. Your signature indicates that:*
   a. *You understand it—not necessarily that you agree with it.*
   b. *You will support it—even though you may not agree with it.*
   c. *You feel comfortable enough to explain it and respond to questions about it from parents or visitors to your school.*
5. *Now answer question nine and repeat the above process.*
6. *Describe and evaluate the process and the time it took to complete this procedure.*

THE QUESTIONNAIRE

1. **Why do you want to teach thinking?**

2. **What is it about your students that makes you think they need to learn to think?**

3. **What conditions are present in your school that make this a good time to begin teaching for thinking? What indicators of readiness, desire, and motivation exist?**

4. **What is the degree of your commitment? How much time, energy, and resources are you willing to give?**

5. What do you think human beings do when they are acting/behaving intelligently? Describe the vision of human intelligent behavior for which you are striving.

6. How do you think human beings learn to become more like this vision? What are the conditions in which intelligent behavior is learned?

7. What conditions must be created in your school to promote these intelligent behaviors?

8. What can classroom teachers do to promote these intelligent behaviors?

9. What changes do you think it would take to install a thinking skills curriculum?

a. Time allocations: How much time in the school day, week, or year should be given to thinking skills?

b. Instructional materials?

c. Curriculum materials, organization, and development procedures?

d. Staffing?

e. School organization?

f. Assessment tools, techniques, and procedures?

g. Teaching skills?

h. Staff development?

i. Other?

Appendix H
Suggestions for Getting Started

Sandra Black

1. Review the objectives and methods of existing cognitive skills and logical reasoning programs.
2. Establish a hierarchy of thinking skills for identifying and sequencing instructional objectives.
3. Select a few skills identified by district objectives and identify how they are being taught in content areas.
4. Determine the form of regular student practice in thinking skills and methods to monitor such practice.
5. Identify or develop materials for classroom instruction and assume that their application is to be intradisciplinary rather than extradisciplinary.
6. Develop an inservice plan for administrators and teachers.
7. Organize a parent education plan and a community awareness program.
8. Identify techniques and materials that should be included in staff development programs.
9. Determine which teaching skills to observe when coaching and supervising.
10. Develop teacher and administrator assessment plans.
11. Develop and adopt methods to assess students' growth in cognitive abilities.

Appendix I

Questions System Planners Need to Ask

Carolee S. Matsumoto

The following are questions that system planners need to consider when incorporating higher-level thinking into teaching and learning.

INPUT

Development of a rationale:

1. Why should we be concerned with higher-level thinking?
2. Do we have a commitment to intelligent behavior?
3. Do school administrators and committees (boards) support, model, and promote higher-level thinking and intelligent behavior?

Input of outside data and information from research and practice:

1. What do the experts say about this (Costa, Paul, Perkins, Sternberg, and others)?
2. What are the various approaches that have been taken?
   a. Formal programs (Project Intelligence, Instrumental Enrichment, Philosophy for Children, and others)
   b. What outstanding school systems, state programs, and other plans exist?

ACTION

Definition, setting goals, and internal reflection:

1. What do we mean by higher-level thinking, cognitive development, and intelligence?
2. What elements/areas of thinking are we going to include as goals for the K-12 learning experience?
3. What are we already doing to promote thinking?
   a. What institutional structures and practices promote thinking?
   b. Does/will/how can the school culture support change to incorporate a priority to promote higher-level thinking?
   c. What teacher behaviors encourage thinking?
   d. What curriculums/programs expect, stimulate, or provide opportunities or contexts for higher-level thinking?
4. What do we do that inhibits or restricts thinking?
   a. What institutional structures and practices inhibit thinking?
   b. What teacher behaviors inhibit thinking?
   c. What curriculums/programs inhibit or restrict thinking?
5. How can and will we use computers/technologies to help us develop thinking?
6. What are our immediate goals and priorities?

PROCEDURES

Action:

1. How can we create expectations that demand higher-level thinking and cognitive development?

2. What are the training/development implications for:
   a. Administrators?
   b. Teachers?
   c. Schools and systems?
   d. Teacher training in universities?

3. How can we develop K-12 curriculums that expect, stimulate, or provide opportunities or contexts for higher-level thinking and cognitive development?

4. How can we infuse higher-level thinking and cognitive development across all disciplines and programs?

5. Who will support these expectations, training, and curriculum development efforts, and how will they do so?

6. Can our supervisors (principals, department chairs, or other administrators) cognitively coach, supervise, and evaluate?

7. How will the answers to all of these questions be conceptualized and realized in our schools and systems?
   a. What steps will we take?
   b. What additional support (human and financial) is necessary?
   c. How will we maintain a long-term commitment?

8. How can we continually inform, educate, and train parents and community members to understand and support their children's and our efforts?

PRACTICE

Evaluation:

1. How will we know if students have developed their thinking skills, strategies, and self-confidence?

2. What evidence/indicators will reflect staff (administrators and teachers) skills in thinking?

3. How will we access supervisors' (principals, department heads, and others) ability to coach cognitively?

4. What processes will continually develop and revise curriculums for the infusion of thinking and cognitive development?

INSTITUTE

School culture:

1. How will we know that thinking and cognitive development are a part of the school culture?

2. How can we be sure that everyone in the school system is committed, participating, and prioritizing this endeavor?

Contributing Authors

Robert L. Anderson, Consultant, California Assessment Program, 721 Capitol Mall, P.O. Box 944272, Sacramento, CA 94244-2720.

Arthur N. Appleebee, Professor, Department of Educational Theory and Practice and Codirector, Center for the Learning and Teaching of Literature University of Albany, State University of New York.

John Barell, Professor of Curriculum, Montclair State College, 214 Chapin Hall, Upper Montclair, NJ 07043.

Jonathan Baron, Professor of Psychology, Graduate School of Education University of Pennsylvania, 3815 Walnut St., Philadelphia, PA 19104-6196.

James A. Bellanca, Executive Director, Illinois Renewal Institute, 200 E. Wood Street, Suite 250, Palatine, IL 60067.

Shelley Berman, President, Educators for Social Responsibility, 23 Garden St., Cambridge, MA 02138.

Barry K. Beyer, Professor of Education, George Mason University, 4400 University Dr., Fairfax, VA 22030.

Sandra Black, Educational Consultant, University of North Florida at Jacksonville, P.O. Box 468, St. Augustine, FL 32085.

Ronald S. Brandt, Executive Editor, Association for Supervision and Curriculum Development, 1250 N. Pitt St., Alexandria, VA 22314.

John H. Clarke, The University of Vermont, College of Education and Social Services, 244 Commons Living/Learning Center, Burlington, VT 05405.

Rochelle Clemson, Specialist, Teacher Education and Teacher Recruitment, Maryland State Department of Education, 200 W. Baltimore St., Baltimore, MD 21201-2595.

Patricia M. Copa, Division Manager, Human Development Studies, St. Paul Technical College, 235 Marshall Ave., St. Paul, MN 55102.

Arthur L. Costa, Professor, California State University, Sacramento, and Co-Director, the Institute for Intelligent Behavior. Send correspondence to: 950 Fulton Ave., Suite 245, Sacramento, CA 95825.

Elliot W. Eisner, Professor of Education and Art, School of Education 221, Stanford University, Stanford, CA 94305-2384.

Robert H. Ennis, Professor, Department of Educational Policy Studies, University of Illinois at Urbana-Champaign, 360 Education Building, 1310 S. Sixth St., Champaign, IL 61820.

Robin Fogarty, Director of Training and Development, Illinois Renewal Institute, Inc., and Editor-in-Chief, IRI Skylight Publishing, Inc., 200 East Wood St., Suite 250, Palatine, IL 60067.

Gwen Fountain, Assistant Professor of Management and Curriculum Coordinator, College of Business, Butler University, Indianapolis, IN 46208.

Esther Fusco, Principal, Babylon Elementary School, 171 Ralph Ave., Babylon, NY 11702.

Allan A. Glatthorn, Professor of Education, School of Education, East Carolina University, Speight 102B, Greenville, NC 27858.

Carolyn Sue Hughes, Assistant Superintendent, Oklahoma City Public Schools, 900 N. Klein, Oklahoma City, OK 73106.

Francine H. Hultgren, Associate Professor, Home Economics Education, University of Maryland, College Park Campus, 3216 J. M. Patterson Building, College Park, MD 20742.

David W. Johnson, Professor of Educational Psychology, University of Minnesota, Cooperative Learning Center, 202 Pattee Hall, 150 Pillsbury Dr., S.E., Minneapolis, MN 55455.

Roger T. Johnson, Professor of Curriculum and Instruction, University of Minnesota, Cooperative Learning Center, 202 Pattee Hall, 150 Pillsbury Dr., S.E., Minneapolis, MN 55455.

Beau Fly Jones, Program Director, North Central Regional Educational Laboratory, 1900 Spring Rd., Suite 300, Oak Brook, IL 60521.

Bena Kallick, Consultant, 12 Crooked Mile Rd., Westport, CT 06880.

Judith A. Langer, Professor, Reading Department, and Codirector, Center for the Learning and Teaching of Literature, University of Albany, State University of New York. Send correspondence c/o Ina V.S. Mullis, Center for the Assessment of Educational Progress, P.O. Box 6710, Princeton, NJ 08541-6710.

Lawrence F. Lowery, Professor, University of California, School of Education, Tolman Hall, Room 4533, Berkeley, CA 94720.

Frank T. Lyman, Jr., Coordinator, Southern Teacher Education Center, University of Maryland-Howard County, 6000 Tamar Dr., Columbia, MD 21045.

Jay McTighe, Education Coordinator, Maryland School Performance Program, Maryland State Department of Education, 200 W. Baltimore St., Baltimore, MD 21201-2595.

David S. Martin, Dean, School of Education and Human Services, Gallaudet University, 214 Fowler Hall, 800 Florida Ave., NE, Washington, DC 20002.

Robert J. Marzano, Senior Program Director, Mid-continent Regional Educational Laboratory, 2550 S. Parker Rd., Suite 500, Aurora, CO 80014.

Carolee Matsumoto, Senior Research Associate, Education Development Center, 55 Chapel St., Newton, MA 02160.

Ina V. S. Mullis, Deputy Executive Director, National Assessment of Educational Progress, Educational Testing Service, P.O. Box 6710, Princeton, NJ 08541-6710.

Carol Booth Olson, Project Director, UCI Writing Project, University of California, Irvine, CA 92717.

Joseph Onosko, Assistant Professor, Department of Education, 2106 Morrill Hall, University of New Hampshire, Durham, NH 03824-3595.

Kevin O'Reilly, Critical Thinking in American History, Hamilton-Wenham Regional High School, 775 Bay Rd., South Hamilton, MA 01982.

Richard W. Paul, Director, Center for Critical Thinking and Moral Critique, Sonoma State University, 1801 East Cotati Ave., Rohnert Park, CA 94928.

David N. Perkins, Co-Director, Harvard Project Zero, and Associate of the Educational Technology Center, Harvard University, Graduate School of Education, 315 Longfellow Hall, Appian Way, Cambridge, MA 02138.

Debra J. Pickering, Staff Development Specialist, Cherry Creek Schools, Willow Creek, 7855 South Willow Way, Englewood, CO 80112.

Stanley Pogrow, Associate Professor of Educational Foundations and Administration, College of Education, University of Arizona, Tucson, AZ 85721.

Richard S. Prawat, Michigan State University, College of Education, 259 Erickson Hall, East Lansing, MI 48824-1034.

Barbara Z. Presseisen, Director, National Networking, Research for Better Schools, The Mid-Atlantic Regional Educational Laboratory, 444 N. Third St., Philadelphia, PA 19123-4107.

Edys S. Quellmalz, Senior Research Associate, RMC Research, 2570 West El Camino Real, Suite 610, Mountain View, CA 94040.

Stuart C. Rankin, Visiting Professor, University of Michigan, Department of Education, 610 E. University, Ann Arbor, MI 48109.

Gavriel Salomon, Professor, College of Education, University of Arizona, Tucson, AZ 85721.

Alan H. Schoenfeld, Dean, Department of Mathematics, University of California, Berkeley, CA 94720.

Jan Schollenberger, Consultant/Educator, 4782 Hobnail Circle, West Bloomfield, MI 48033.

Sydelle Seiger-Ehrenberg (deceased), was Director, Institute for Curriculum and Instruction, P.O. Box 747, Coshocton, OH 43812.

Irving E. Sigel, Distinguished Research Scientist Emeritus, Educational Testing Service, Princeton, NJ 08541.

Robert B. Stevenson, Assistant Professor, Department of Educational Organization, Administration, and Policy, 468 Baldy Hall, State University of New York, Buffalo, NY 14260.

Charles Suhor, Deputy Executive Director, National Council of Teachers of English, 1111 Kenyon Rd., Urbana, IL 61801.

Robert J. Swartz, Professor, University of Massachusetts at Boston, and Codirector, Center for Teaching Thinking, Regional Laboratory for Educational Improvement of the Northeast and Islands, 300 Brickstone Sq., Suite 900, Andover, MA 01810.

Robert Sylwester, Professor of Education, University of Oregon, Eugene, OR 97403.

Bruce Wellman, Director, Science Resources, 167 Bedford Rd., Lincoln, MA 01773.

Grant Wiggins, Director of Educational Research and Development, CLASS, 56 Vassar St., Rochester, NY 14607.

Joan Wilkosz, Curriculum Coordinator, Minneapolis Public Schools, 807 N.E. Broadway, Minneapolis, MN 55413.

S. Lee Winocur, National Director, Center for the Teaching of Thinking, 21412 Magnolia St., Huntington Beach, CA 92646.

Dennie Palmer Wolf, Senior Research Associate, Project Zero, Harvard Graduate School of Education, 13 Appian Way, Cambridge, MA 02138.

Antoinette Worsham, Director, Maryland Center for Thinking Studies, Coppin State College, 2500 W. North Ave., Baltimore, MD 21216.

Index

Index to Authors

Association for Supervision and Curriculum Development

ERIC