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ABSTRACT

Cognitive theory and research are relevant to vocational education. Three theoretical perspectives underlie cognitive theory-based curriculum and instruction: information processing, knowledge structure, and social history. A review of these perspectives in vocational curriculum and instruction suggests that instruction supporting higher-level thinking is a possibility and a reality in vocational education. Instruction and assessment based on cognitive theory tend not to use traditional methods. Although development of assessment approaches lags behind instructional approaches, a more fundamental problem exists in the purposes and meanings of assessment. For example, emphasis in cognitive theory on self-monitoring and self-assessment raises issues of control of assessment. Other difficulties arise in comparing vocational and academic education and interpreting the outcomes. The new understanding of thinking and learning generated by cognitive theory suggests a need for major changes in educational methods, perspectives, and institutions. Barriers to change include the following: (1) vocational education research does not focus on teaching/learning; (2) teachers are not prepared in cognitive methods; (3) school structures hinder cognitive development; and (4) society does not demonstrate that thinking is valued. Vocational education can fulfill its role in cognitive development by providing real-world experiences, changing mind sets about assessment, and systematically researching cognition and vocational education. (200 references) (SK)

Information Series No. 349

COGNITIVE THEORY-BASED TEACHING AND LEARNING IN VOCATIONAL EDUCATION

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TABLE OF CONTENTS

TABLE OF CONTENTS--*Continued*

FOREWORD

The Educational Resources Information Center Clearinghouse on Adult, Career, and Vocational Education (ERIC/ACVE) is 1 of 16 clearinghouses in a national information system that is funded by the Office of Educational Research and Improvement (OERI), U.S. Department of Education. This publication was developed to fulfill one of the functions of the clearinghouse--interpreting the literature in the ERIC database.

ERIC/ACVE would like to thank Ruth G. Thomas for her work in preparing this paper. Dr. Thomas is Associate Professor in the Department of Vocational and Technical Education at the University of Minnesota. She is director of the Higher Order Thinking Research Program at the Minnesota Research and Development Center in Vocational Education as well as principal investigator of the Cognitive Theory and Research-Based Instructional Design Project for the National Center for Research in Vocational Education. She served as a member of the writing team for Higher Order Thinking Skills in Minnesota Schools, sponsored by the Minnesota Department of Education. Among her numerous publications are ***Cognitive Research and Instructional Design: Implications for Vocational Education*** and ***Instructional Design for Developing Higher Order Thinking.***

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Ruth G. Thomas

EXECUTIVE SUMMARY

This review of literature concerning cognition related to teaching and learning explores why cognitive theory and research are relevant to vocational education: (1) the need for education to be responsive to a changing environment, student needs and characteristics, and democratic values; and (2) the potential to guide educational practice.

Definitions of cognition suggest that knowledge, thinking, and learning are all components of it. Three theoretical perspectives are explored:

- Information processing--how the human mind takes in information and processes and structures it
- Knowledge structures--how knowledge is represented and organized in the mind
- Social history--social context as a central factor in the development of higher mental functions

These three theories underlie cognitive theory-based curriculum and instruction in terms of purpose and goals, assumptions about teachers and learners, choice of instructional processes, and assessment of outcomes. Examples of the three perspectives in vocational curriculum and instruction are examined, as well as research in the following areas: (1) understanding, describing, and documenting instruction; (2) instructional development and design; and (3) the effectiveness of instructional approaches and methods. The review suggests that instruction supporting higher-level cognitive processes is a possibility and a reality in vocational education. The paper offers a synthesis of the following dimensions of instruction based on cognitive theory: aims of instruction, learning environments, learning, learners, and teaching.

Instruction based on cognitive theory leads away from traditional methods. Similarly, assessment of the resulting learning tends not to be based on traditional evaluative approaches. Although development of cognitive theory-based approaches to assessment has lagged behind instructional development, a more fundamental problem is the purposes and meanings of assessment. For example, emphasis in cognitive theory on self-monitoring and self-assessment raises the issue of shared control of assessment. Other difficulties arise in comparing vocational and academic education and in interpreting the outcomes.

As cognitive theory generates new understanding of thinking, learning, knowledge, teaching, and assessment, some suggest the need for major changes in educational methods, perspectives, and institutions as well as in cultural patterns and structures. Barriers to these changes are apparent:

- For the most part, vocational education research does not focus on teaching-learning processes.
- Teachers are not prepared in methods that support knowledge construction by learners.
- School structures isolate students from experience that leads to cognitive development and raise barriers for teachers attempting cognitive theory-based instruction.
- Educational leaders and policy makers need to examine basic beliefs about the teaching-learning environment.
- The broader culture does not demonstrate that thinking is truly valued.

Many arguments for the value of higher-level cognitive capacities support the role of vocational education in their development. The following recommendations can help vocational education fulfill its role:

- Support for development of cognition in early childhood
- Real-world experiences that support cognitive development
- Changed mind sets about assessment and its materials and procedures
- Systematic programs of research linking cognitive theory to vocational education

This literature review includes a 200-item bibliography. Information on cognitive theory and vocational education may be found in the ERIC system using the following descriptors: *Cognitive Development, *Cognitive Measurement, *Cognitive Processes, Cognitive Psychology, Cognitive Structures, Educational Change, Educational Research, *Learning Theories, Problem Solving, Social History, *Thinking Skills, *Vocational Education. Asterisks indicate descriptors that are particularly relevant.

INTRODUCTION

The purpose of this document is to review the vocational education literature concerning cognition as it relates to teaching and learning, especially literature since 1980 that reflects the influence of cognitive theory. Because a comprehensive review of the broader cognitive literature is beyond the scope of this document, and because the intended audience for this publication is vocational education researchers, teachers, and policy makers, the document is structured around the vocational education literature. Connections to the broader cognitive literature are made in relation to the vocational education literature rather than the other way around. Exceptions to this pattern occur twice, in the second and third chapters, in which alternative cognitive theory perspectives and their implications for research and education are briefly outlined. Other, already available documents have as their primary goal a review of the broader base of cognitive literature and its implications for vocational education (Laster 1985; Raizen 1989; Thomas and Litowitz 1986).

Interest among educational researchers in cognitive theory has burgeoned since 1970. Despite intense efforts in some areas of education to apply what has been learned from cognitive theory to curriculum and instruction, few such efforts have been evident in vocational education. Because the work in vocational education has been limited, synthesizing and bringing coherence to the current state of knowledge regarding applications of cognitive theory to vocational education is a less reasonable goal for this review than is stimulating interest in and illustrating and outlining possibilities for cognitive theory-based research and practice in vocational education. Consequently, this review reflects an attempt to bring together cognition-focused conceptual and research literature regarding teaching and learning in vocational education in a way that will encourage further exploration of cognitive theory by teachers, researchers, and policy makers concerned with vocational education.

The emphasis in this review is on cognition-related vocational education literature of the 1980s and 1990s that exists in the ERIC database and in vocational education-related journals. Vocational education theses and dissertations are included to the extent that the author could obtain access to them. The large volume of research that relates cognitive theory to technical education is not reviewed here, although references to that literature are made. Reviewed in some detail is research identified within these parameters that reflects explicit use of cognitive theory and that involves in-depth probing into the nature of cognition and cognition-focused instruction. Documents that are not reports of research and research that is tangential to the cognitive theory perspectives described in chapters two and three are given more limited attention.

The literature for the review was selected in the following manner. A search of the ERIC database was made to select documents with the key words vocational education and cognition. In addition to the documents identified through this search, issues since 1980 of two major vocational

education research journals, the *Journal of Vocational Education Research* (JVER), and the *Journal of Vocational and Technical Education* (JVTE) were searched for cognition-related articles. In addition, all JVTE-published lists of completed vocational education research were searched and relevant items obtained. Three vocational education researchers known to be conducting cognitive theory-related research and advising student research in this area were also contacted and asked to provide relevant theses and dissertations and to identify literature that may have been missed by the procedures described. Selection of items from the broader cognitive literature was based on the author's judgment and on recommendations from four peer reviewers of the manuscript.

Why Are Cognitive Theory and Research Relevant to Vocational Education?

Arguments that cognitive theory and research are relevant to vocational education focus on educational problems and solutions. Problem-focused arguments concern the need for education to be responsive to a changing environment, to student needs and characteristics, and to democratic values. Solution-focused arguments concern the potential of cognitive theory and research to guide educational practice.

Problem-Focused Arguments

During the past decade, education in general has come under attack from critics. Criticisms have been expressed in numerous reports, position statements, and policy papers. These documents, which focus largely on K-12 education, argue that schools are falling short in fostering capacities needed by students for the kind of environment in which they will live, in meeting the needs of all students, and in reflecting democratic values. Many who argue that cognitive theory and research have relevance for vocational education (Champagne 1986; Laster 1985; Mauter 1988; Pucel 1984; Raizen 1989; Schmidt 1985) justify their claims on the basis of these documents:

- *The Information Society: Are High School Graduates Ready?* (Gisi and Forbes 1982)
- *Skills in the U.S. Work Force* (Center for Public Resources 1982)
- *The Paideia Proposal: An Educational Manifesto* (Adler 1982)
- *A Nation at Risk: The Imperative for Educational Reform* (National Commission on Excellence in Education 1983)
- *High School: A Report on Secondary Education in America* (Boyer 1983)
- *Action for Excellence: A Comprehensive Plan to Improve Our Schools* (Education Commission of the States 1983)
- *A Place Called School* (Goodlad 1984)
- *Horace's Compromise: The Dilemma of the American High School* (Sizer 1984)
- *High School and the Changing Workplace: The Employer's View* (National Academy of Sciences 1984)
- *The Unfinished Agenda: The Role of Vocational Education in the High School* (National Commission on Secondary Vocational Education 1984)
- *Investing in Our Children: Business and the Public Schools* (Committee for Economic Development 1985)
- *Teaching Thinking and Reasoning Skills: Problems and Solutions* (Pauker 1987)

Themes similar to those pervading these documents are also evident in arguments appearing in the vocational education literature that imply or directly state that cognitive theory is relevant to vocational education. These arguments are outlined here in relation to the themes.

Need for more highly developed cognitive capacities in a changing environment. Problem-focused arguments concerning why cognitive theory is relevant to vocational education point to a changing environment, especially to changes in social, economic, political, and technical contexts. These arguments emphasize three environmental trends and their implications for cognitive functioning at work and in other aspects of everyday life. These three trends are increased complexity, increasingly rapid change, and increasing economic competition. They have been described as pervasive within as well as beyond Western societies (Bailey 1990; Fam and Luan 1984).

Thomas and Litowitz (1986) make a complexity-focused argument asserting that the information age has increased the cognitive demands for dealing with greater amounts of more complex information. As a result, people need to be able to (1) select from a large array of information that which is relevant, (2) process information in systematic ways, (3) recognize where gaps and problems exist with respect to available knowledge and one's own processing of it, and (4) take action that addresses those gaps and problems. The need for these capacities is not limited to exotic and unusual functions, but extends to ordinary, everyday life activities of people at home, at work, and in their communities.

Others have focused their arguments more specifically on work. Stasz et al. (1990) report that technologies that allow automation and computerization of some job functions have contributed to increased complexity of work by broadening the scope of skills and functions covered within a single job. Bailey (1990) reports increasingly complex structure and organization of firms and markets. One implication of increasingly complex work tasks and contexts is that, in many cases, an array, extent, and complexity of knowledge are required by workers that only a group (as opposed to an individual) can possibly possess (Resnick 1987).

In addition to becoming more complex, the environment is changing rapidly. Consequently, the future is less predictable and more uncertain. Evidence of this increasingly rapid change is apparent in the emergence of new forms and varieties of social institutions and organization. For example, in the United States and many other countries, especially highly industrialized societies, family and community composition and structures have changed dramatically since 1950. Similarly, rapid change is creating a need for different organizational structures at work, and flatter structures that allow information to be shared quickly are emerging (Bailey 1990; Raizen 1989). These flatter structures, along with work groups, are broadening the scope of interaction and collaboration among workers having diverse functions and backgrounds (Bailey 1990; Berryman 1991; Resnick 1987; Secretary's Commission on Achieving Necessary Skills 1991). This, in turn, is a factor in the increasing complexity of work. Rapid change is also evident in the need experienced by people of all ages to make several major career changes throughout their lives. In the face of such frequent and dramatic work and life changes, people need to be able to detect, understand, and resolve unfamiliar problems. Doing so requires continued learning throughout life and using skills and knowledge flexibly (Bailey 1990; Champagne 1986; Franz 1983; Kerka 1986; Laster 1985; Miller 1990; Raizen 1989).

In addition to increased complexity and rapid change, an increasingly competitive economic context is creating a need for careful, well-informed decisions about what should be produced and for fast, efficient production that results in high

quality goods and services. At the same time, increasing concern about the environmental consequences of production processes is placing new constraints on such decisions and production processes. These challenges are heightening the importance of well-developed cognitive capacities at all organizational levels (Chantrill 1990; Kerka 1986; Stasz et al. 1990).

Need for education to be responsive to all students. Problem-focused arguments concerning student needs reflect the view that schools need to serve all students, that different students have different learning needs, that cognitive factors are central in these needs, and that schools have not sufficiently attended to what helps all students learn. One argument points out that vocational education serves a large portion of students who experience learning difficulties because their background or experience may not have prepared them well for learning in terms of basic cognitive development (Garner 1986). Such students may or may not be classified as special students (Hartman-Haas 1981; Miles 1981). Difficulties with thinking and learning are believed to result from lack of grounding in essential cognitive prerequisites (Feuerstein et al. 1991). Many cognitive capacities, or the prerequisites for their later emergence, have their roots in the early years of life and depend for their development on early experiences in supportive home and school environments (Browning and Greenwald 1990; Champagne 1986; Garner 1986; Sellwood 1989). Although most young children's cognitive capacities develop through everyday experiences with objects, people, and concepts, children who grow up in starkly impoverished home environments are likely to have fewer opportunities for development-enhancing experiences. Cognitive prerequisites are believed to be at least partially remediable through education that supplies missed opportunities for cognitive development (Feuerstein et al. 1991). However, Allington (1991) contends that the kind of education many students receive in school does not provide such opportunities.

Other student need-focused arguments contend that students differ in the way they learn and, consequently, different students need different learning environments to learn best. Drawing on three major national reports that support the importance of thinking and learning in the current and future workplace, Champagne (1986) suggests that, even though many policy makers believe that science and mathematics are the best places to develop learning and thinking processes, vocational education might be as good a place or better for some students to develop these capacities. For groups who do not enroll in science and mathematics, and for learners who do better with thinking in the context of real life situations, emphasis in vocational education on thinking and learning processes may be especially important.

> Instruction that produces understanding explicitly links physical operations to mental ones and makes students aware of how procedures learned in one context can be applied to other contexts. Procedures and concepts are the foundation for problem-solving and reasoning skills. These are embedded in practical, everyday situations and operations such as measuring, cutting, and mixing materials--contexts and operations that are integral to the curriculum of vocational education. For many students who have experienced failure in traditional science and math courses, the vocational education context might well be the context in which

thinking skills can best be learned. (Champagne 1986, p. 14)

In a similar vein, Pucel (1984) also argues that vocational education is a place where better learning can occur for some students. He suggests that teaching approaches used in academic classrooms fit with the way some students learn best and that other students learn best through methods emphasized in vocational education. Pucel contends that these differences among students are due less to variations in intelligence than to variations in learning preference.

Need for education to reflect democratic values. Some problem-focused arguments reflect the belief that schools should more adequately reflect democratic values and that cognitive capacities are relevant to those values. For example, some suggest that national interests supersede those of the individual in schools (Fam and Luan 1984), even though better thinking capacities should make for a better life for both the individual and the society (Hartman-Haas 1981; Osborne 1988). Nickerson (1987) reflects this tension when he questions whether, beneath all the rhetoric advocating the importance of thinking, critical thinkers are truly desired by educators, industry, and the society. This ambivalence regarding support of thinking as an aim of education is reflected in arguments frequently offered against such an aim (Miles 1981):

- The stages of cognitive development cannot be hurried.
- We do not know how to teach thinking skills.
- Reading, writing, and arithmetic (the "real" basic skills) should take priority over thinking skills.
- It takes too much time.
- It asks too much of already overburdened teachers.
- We or you are not the right group to teach thinking skills.

The latter argument is one that vocational teachers may themselves believe and one that they may have heard from others.

Solution-Focused Arguments

In contrast to problem-focused arguments that concern relationships between cognitive capacities and challenges faced by individuals, the society at large, and education, solution-focused arguments concern contributions that cognitive theory and research can make in helping education and, more specifically, vocational education, address the challenges. For example, some have argued that rapid change necessitates teaching general cognitive skills in vocational education on the grounds that they will be more transferable than more specific knowledge and skills (Raizen 1989; Stasz et al. 1990). Others assert that, because complex kinds of work requiring well-developed cognitive capacities are becoming more pervasive and unskilled jobs are disappearing, cognitive theory-based models of instruction are becoming increasingly appropriate for an increasing proportion of occupations (Moss 1981; Raizen 1989; Secretary's Commission on Achieving Necessary Skills 1991; Stasz et al. 1990). Raizen (1989) argues that the shift in the nature of work toward greater reliance on cognitive capacities makes the critical features of many jobs less accessible to direct observation than in the past. Because of this, there is a need for cognitive theory-based models of instruction that make cognitive features of occupations more explicit.

What is different about cognitive theory-guided educational practice? Resnick (1989) contends that "current cognitive theory emphasizes . . . aspects of learning that . . . call for forms of instructional theory very different from those that grew

out of earlier associationist and behaviorist psychologies" (p. 1). Cognitive theory is viewed as providing deeper and more adequate understanding of intelligence and learning. For example, as a result of cognitive theory, intelligence is coming to be viewed as having multiple facets and dimensions (Gardner 1983; Perkins 1987) and as more subject to modification than previously thought (Kerka 1986). Gardner (1983) identifies seven domain-related intelligences. Sternberg and Wagner (1986) emphasize three components of intelligence: contextual intelligence, thinking, and dealing with novelty. These multidimensional perspectives suggest that one can have more of one kind of intelligence than another. Similarly, learning is no longer viewed as absorbing someone else's (usually, the teacher's) intact knowledge. Instead, learning is a process of actively constructing one's own knowledge (Laster 1985; Resnick 1989; Thomas and Englund 1990). Context is coming to be seen as an important factor influencing both how knowledge is constructed (learned) and used (Rehm 1987; Schön 1983; Scribner 1984; Sternberg and Frensch 1991). It is also becoming apparent that capacities to think deeply and well and to transfer learning from one problem or context to another are not necessarily a natural byproduct of learning content, as educators have sometimes assumed (Larkin 1989; Nickerson 1987; Osborne 1988; Resnick 1989; Ruggiero 1988; Swartz 1987; Thomas 1986). Relationships between thought and action are becoming better understood and learning of actions is perceived as aided by careful attention to their cognitive origins (Moss 1981; Thomas 1986, 1988b).

Others have questioned whether enough is known about thinking to be able to facilitate it and have cautioned that understanding may not be deep enough to prevent actions that might have more negative than positive consequences (Wasserman 1989). Wasserman states that thinking is complex, highly varied in its forms, and eludes control, and that experts do not agree on what constitutes thinking. She cautions educators to be wary of single perspectives on what thinking is on the grounds that by limiting their view of thinking too much, they may require that learners' thinking conform too much to their view. As a consequence, they may risk limiting rather than enhancing learners' thinking, especially their creative thinking.

Summary and Conclusions

A number of arguments have been put forth supporting the relevance of cognitive theory to vocational education. Grounds for these arguments include the following:

- A changing environment in which cognitive capacities are critical to survival and flourishing of both people and organizations
- An obligation to understand and serve the needs all students have for learning
- The importance to the individual and collective quality of life in a democracy of cognitive capacities well distributed across the citizenry
- The potential of cognitive theory to guide educational practice toward meeting these challenges

These grounds are relevant to vocational education at all levels.

The view that some students are better served by vocational education and others by academic subjects implies that the same students are not well served by both. The wisdom of separating students by academic and vocational curricula has been questioned by Oakes (1985, 1987), who interprets such tracking of students as limiting opportunities and, consequently,

as contrary to democratic values. Oakes' argument assumes that exposure of students to areas and demands for which they have not yet developed capacities or orientations allows them to develop new dimensions and expand their potential opportunities. The different treatments for different students argument assumes that student attributes affecting learning are stable and unlikely to change, so providing an environment consistent with those attributes is best.

Economic, political, human, and social values are reflected in the arguments, suggesting that the implications of cognitive theory for education touches all of these arenas. The potential for conflict among these values appears in the ambivalence reflected in the expressed importance of thinking on the one hand and a sense that, at a deeper level, it may also be feared.

There are some notable gaps in the arguments. The implications of a changing environment are more elaborately described for organizations and the workers within them than for other sectors of society that vocational education also serves, such as agriculture, consumers, and families. For example, a global economy and changing markets are likely no less relevant for agriculture, consumers, and families than they are for industrial and service corporations and their workers. The point of view of producers predominates in the arguments concerning the implications of changes in the nature and structure of markets and work, even though the changes in market structures, product differentiation, and technology have implications for consumers' cognitive capacities as well for those of workers. Arguments that reflect the importance to children's cognitive development of early environments provided in the home focus implications on how developmental gaps can be remediated later by educators. These arguments ignore the possibility that educators may also be able to assist parents and families in developing their capacities to provide environments that are more supportive of children's cognitive development and that doing so may do far more for children's long-term cognitive development than later remediation can ever accomplish.

WHAT IS COGNITION?

Wasserman's (1989) question posed near the end of the first chapter (Do we know enough about thinking to teach it?) leads to other questions such as What do we know about thinking and other aspects of cognition? and What is cognition? This chapter focuses on such questions, particularly in relation to vocational practice and in the context of vocational education.

Dictionary definitions of cognition include the act or process of knowing, perception, and the products (for example, knowledge) of such acts or processes. These definitions suggest that knowledge, thinking, and learning are all part of cognition. Cognitive theory is the body of knowledge focused on describing, explaining, and understanding cognition.

Conceptualizations of Higher Levels of Cognition

One place to begin to explore conceptualizations of higher levels of cognition is with documents that compile definitions from various sources (Champagne 1986; Laster 1985; Lee 1989; Mauter 1988; Mielke 1989; Thomas and Litowitz 1986). Closer examination of these compilations reveals that conceptualizations and definitions of complex intellectual functioning differ in many, often confusing ways. Some conceptualizations focus on cognitive processes (for example, information gathering, remembering, organizing, analyzing) that are believed to function together in orchestrated harmony in macroprocesses (for example, concept formation, problem solving, decision making) (Beyer 1987; Marzano 1991; Marzano et al. 1988; Mielke 1989; Stasz et al. 1990). Often, such macroprocesses and their enabling component processes are referred to as generic in nature, because they are believed to be generalizable across many contexts, situations, and domains (Greenan 1983; Miles 1981; Stasz et al. 1990). Other conceptualizations emphasize a single macroprocess: problem solving (Laster 1986b), practical reasoning (Laster 1986a; Scribner 1984, 1986), critical thinking (Eyre and Peterat 1990; Hultgren 1986), or reflective thinking (Bobbitt 1986). Both more specific and macrolevel cognitive processes are typically viewed as learnable and as subject to improvement through education.

In contrast to process-focused views of cognition, which are often referred to as cognitive skills, other conceptualizations reflect a view of higher levels of cognition as characteristics, dispositions, qualities, and capacities. Examples include dispositions or motivational aspects of thinking (Stasz et al. 1990; Thomas and Litowitz 1986), competence (Laster 1985; Thomas 1985; Thomas and Litowitz 1986), expertise (Glaser 1985), intelligence (Laster 1985; Thomas and Litowitz 1986), and creativity (Chantrill 1990; Rehm 1989b; Thomas and Litowitz 1986). Critical thinking and reflective thinking are also sometimes viewed as a characteristic, disposition, quality, or capacity (Bobbitt 1986; Ennis 1987; Eyre and Peterat 1990; Hultgren 1986; Paul 1990). Like views of cognitive processes, these characteristics, dispositions, qualities, and capacities are

viewed as multidimensional and modifiable.

Metacognition is cognition about cognition. It refers to cognitive self-awareness and cognitive self-control (Borkowski et al. 1990; Paris and Winograd 1990). Metacognition reflects the capacities to think about one's own thinking and to control one's own cognitive processes, knowledge, and dispositional orientations in ways that are appropriate to the activity in which one is involved.

More recent cognitive literature has reflected a shift away from an earlier dualistic, either-or view that, among cognitive resources, either knowledge or thinking processes is the most important. More recent views emphasize the importance of both as well as their interaction. Perkins' (1987) conceptualization of intelligence as having three dimensions reflects this synthesis as well as the view that intelligence is multidimensional and modifiable. Power, the bestowed part of intelligence, is the hardware, the computing power, capacity, and speed of the brain. The second dimension is what is known through learning and experience. The third is how people think, the strategies they have for using the mind. Perkins suggests that the latter two aspects, as modifiable ones, have the greatest implications for education.

Theories of Cognition

Theoretical foundations that help in understanding cognition have developed along three major avenues. Each avenue reflects different underlying assumptions that guide where the theory focuses attention. These three avenues of theory--information processing, knowledge structures, and social history theory--are briefly described here in relation to research. In the next chapter, they are revisited in relation to curriculum and instruction.

Information Processing Theory

In information processing theory, the human mind is viewed as a system that takes in information and processes it in ways that give it meaning, determine its memory storage, and incorporate it in the formation of actions. Various models of the mind as an information processing system have been proposed that have, in general, the following parts or subsystems and functions. An attentional focusing system enables phenomena in the environment perceived through the senses to be processed so that they can be represented in the mind and interpreted. Processing, which occurs in short-term memory, involves a search through long-term memory for possible meanings. These meanings are also potential storage places for the new input. Processing involves interpreting the input based on what was found in long-term memory. The interpretation determines where in long-term memory the input will be stored. The networks within memory formed during processing determine how easy later retrieval of the information will be. Processing control mechanisms (such as self-monitoring), and the formation and organization of memory units (such as condition-action units) are of central interest, especially in relation to task- and goal-focused cognitive strategies (such as approaches to problem solving). A more detailed summary of this theory can be explored in Laster (1985) and investigated in more technical detail in Lachman, Lachman, and Butterfield (1979).

Think-aloud protocol analysis (Ericsson and Simon 1984) is a major research method through which information processing theorists and researchers attempt to discover what goes on in short-term

memory, the nature of long-term memory, and how short-term memory interacts with sensory inputs and long-term memory. This method typically confronts individuals with a problem and then asks them to "think aloud" (verbalize their thoughts) as they solve the problem. This method, which assumes that what is in the short-term memory is available to consciousness and can therefore be verbalized, will not detect cognitive activity that has become automatized (that is, it is so familiar that it no longer requires conscious processing). This method also assumes that, because information stored in long-term memory is continually entering and leaving the short-term memory, the thinking-aloud process can reveal some sense of the nature of what is in a person's long-term memory. Thinking-aloud protocols are often obtained from people who have been categorized as novices or experts and who are asked to work on the same problem. Comparison of the protocols reveals differences in cognitive structures and strategies. One aspect of the field of artificial intelligence is studying the thinking of experts through the think-aloud method as well as other methods and then programming computers to process information as researchers think the human experts do. This process has been used as a way of verifying hypotheses about mental functioning. Its potential in industry for allowing computers to assume some work tasks that previously required humans has also been explored. Artificial intelligence work has contributed to the understanding of cognition and has created an appreciation for what the human mind can do that eludes both computerization and understanding.

Knowledge Structure Theories

Knowledge structure theories focus on how knowledge is represented in the mind, how knowledge representations are organized, and how these representations interact with cognitive processes. Several bodies of knowledge structure theory exist, including propositional networks, schema theory, and mental models. Each of these bodies of theory posits a type of data structure for representing knowledge. Propositional networks, which represent small units of meaning, contain propositions (an idea and its relationship to another idea) (Anderson 1985).

Schema theory focuses on mental structures that store large sets of organized information about concepts. Schemata (plural for schema) have been described as knowledge units, mental data structures that represent conceptual knowledge, and as active mental processes (Rumelhart 1980). Schema theory suggests that individuals place mental filters, or schemata, on the world that organize it perceptually and conceptually. In this way, schemata are thought to influence what one perceives, what one selects to pay attention to, and how one interprets what is perceived. Schemata also direct expectations and actions, including exploratory activities that make new information available, which may modify the schemata (Neisser 1976). Modifications in schemata reflect learning. For example, a car schema for people whose experience with cars is limited to seeing and driving them likely includes some attributes such as four wheels, a body, a steering wheel, a trunk, a motor, gas tank, and so forth. Such a car schema might also include functions such as going forward, backward, turning, and transporting people and things. The schema might also include makes of cars and optional and standard features such as radios, tape decks, compact disc players, heaters, air conditioners, power windows, power steering, and so forth. If one were to see a vehicle that matched the car schema in all ways except that it had three wheels, attention would be drawn to it because it would not fully fit the individual's

schema. The person may feel a desire to explore why this vehicle has only three wheels, what unique functions it might have, and question if it can be considered a car. In this way, a schema guides perceptions, interpretations, and exploratory actions.

The interpretive function of schemata that enables a person to comprehend sensory input also influences memory. Both schema and propositional network theories hold that one remembers interpretations of events rather than the sensory input. One "remembers" by reconstructing the original interpretation from the fragments of it stored in memory. Schemata are used in this reconstruction process.

There are many forms of schemata. People are thought to have schemata for concepts underlying objects, situations, events, sequences of events, actions, and sequences of actions (Rumelhart 1980). For example, plans are considered to be a type of schema that can direct a complex series of actions. In addition, motivations or themes (for example, getting ahead, fairness) are believed to be schemata that generate goals and intentions (Schank and Abelson 1977). Schemata are believed to be linked together in elaborate networks that facilitate cognitive flexibility and speed of processing. For example, the car schema discussed earlier is likely to be embedded within a larger vehicle schemata and may have embedded within it smaller-scale schemata such as classic cars, sports cars, family cars, and so forth. The wide range of abstraction over which schemata are believed to exist is illustrated by the examples of a car schema and a schema for fairness.

Mental models, a third type of knowledge structure, are mental data structures constructed to represent a particular object, situation, problem, or event. Unlike schemata, which are thought to be precompiled structures, mental models are constructed anew at the time of input, upon encountering something that is unfamiliar (Brewer 1987). Also in contrast to schemata, mental models are specific, not generic knowledge representations.

Experimental and qualitative research methods are used in knowledge structure theory-based research. Schema theorists do experiments in which they confront people with real or simulated environments, events, and problems and then examine the knowledge people use in these situations. Schema theorists look especially for what a person adds when recalling an experience beyond what was actually present in the experience. Added elements are interpreted as indicating elements of the person's schemata that were active during the experience. In artificial intelligence research based on schema theory, computers are used to verify hypotheses about the nature of schemata. A program is written to reflect hypothesized schemata and then is run on data input to see if it handles the data as anticipated. In-depth interviews that use open-ended questions and probing to elicit the dimensions of a person's schemata have also been used.

Social History Theory

Social history theory (Luria 1976; Vygotsky 1978, 1981, 1986) probes the social origins of knowledge structures and cognitive processes. This theory, more than the other two, emphasizes context, especially social context, as a central factor in the development of higher mental functions. Central tenets in this theory are that context introduces constraints into intellectual activities that significantly influence the nature of those activities (Scribner 1984) and that the social environment profoundly affects the way cogni-

tion develops and is structured (Vygotsky 1978).

According to Vygotsky (1978), all the higher mental functions originate as actual relations between human individuals. People significant in one's life (for example, peers and cultural authorities such as parents, teachers, and supervisors) mediate one's interpretations of experience in ways that reflect sociocultural patterns and, in so doing, structure one's cognition in terms of cultural codes and social organization. Through these mediation processes, objects that have instrumental value in physical activity take on symbolic meanings that become incorporated in mental operations (Scribner 1984). This is seen when people learn principles underlying socially rooted and historically developed activities through imitating the ways others use tools and objects. Thus, an operation that is initially an external activity is reconstructed and begins to occur internally; interpersonal processes are transformed into intrapersonal ones. Vygotsky views tools and language as particularly important in this internalization process. Through their use as media of interpersonal exchange, they become mentally internalized. Once internalization of their meanings has occurred, they are used by learners to direct their own actions. It is through these means that cognitive structures and processes are shaped in the course of participation in socially organized practices (Scribner 1984).

Field observations and experimental-developmental research methods are used in research based on social history theory. These methods focus on an analysis of mental processes with the aim of identifying their social origins. Ideally, research is done over time in the developmental context. The emphasis on context gives field observation research methods a central place in the social history theory perspective. People's thinking and knowledge are studied in relation to their cultural milieu. A cultural milieu has been interpreted as an ethnic group, a work or life setting, a family, a community, a classroom, and a society. Field observations made during the introduction of a cultural change are viewed as especially rich sources for gaining an understanding of how culture influences cognition (Luria 1976). Processes of psychological development are also set in motion by researchers in experiments. Social history researchers may combine interviews, focused questions, and simulated problems incorporating think-aloud protocols with field observations to obtain data regarding people's thinking and knowledge. Some of these research methods are the same as those used by theorists working within the other cognitive theory perspectives. The difference is that the social history researcher gathers data regarding context and relates it to the data regarding people's thinking and knowledge.

Research on the Nature of Cognition

Research that has sought to understand cognition has emphasized the methods identified with the theoretical perspectives outlined earlier. A common characteristic of most of these methods is that they study thinking when people are engaged in doing it. Studies reviewed in this section on the vocational practice and training setting reflect this characteristic. More than one of the theoretical perspectives may be incorporated in a given study, and methods central to different perspectives are sometimes combined in research studies. Some of the research reported in this section is generated from an interest in understanding what a person needs to know in order to perform successfully in some specific domain of knowledge or practice, whereas other studies seek a deeper understanding of

influences on cognition. Several studies include expert-novice comparisons. One of the challenges of doing novice-expert comparisons is the problem of identifying novices and experts. Approaches often used combine nominations from colleagues, years of experience in a field, and performance on tests. This problem was addressed in different ways in the following studies. Studies that reflect the three cognitive theory perspectives and examine cognition in process within vocation-related activities are reviewed. Other studies concerning cognition and vocational education are mentioned.

Studies of How Knowledge and Thinking Function in Domains of Vocational Practice

The studies reported in some detail here focus on cognitive differences between individuals who have developed expertise in a domain of vocational practice and those who have not. These studies, like those reported elsewhere in the cognitive literature, reveal that expert thinking leads to efficient and effective performance. These qualities of performance are made possible by awareness of and flexible adaptation to the specific features and demands of a situation and by conservation of both cognitive and physical effort. This awareness, flexible adaptation, and conservation of effort are, in turn, made possible by a vast array of accumulated knowledge stored in memory over many experiences and organized to facilitate adaptation and economy of effort, and by cognitive strategies that are closely linked to that knowledge and that also facilitate adaptation and economy of effort (Thomas 1988 a,b).

Product assembly and pricing delivery tickets in a dairy. Scribner (1984) used social history theory as a conceptual framework for studying intellectual activities in a work setting. Work settings were viewed in this study as cultures that provide significant contexts for the development of cognitive resources in adulthood. According to Scribner, "occupational activities are socially organized for socially defined objectives and make use of 'culture-specific' knowledge domains and technologies" (p. 15). In addition, the functional requirements of the work setting shape work activities in both their technical and social aspects and, useful for research purposes, required tasks and norms of performance are made explicit in job descriptions. Thus, targeted cognitive activities to study should be those occurring in the course of work-related tasks.

At first glance, Scribner's research looks very much like that underlying development of technical curriculum in vocational education. Her research begins by describing skilled performance on each task within a particular job in a dairy and identifying its systematic characteristics. However, the analysis of the descriptions was not focused on behavior sequences as is typical in vocational education task analysis. Rather, it was focused on the cognitive strategies people used. Scribner also incorporated a job simulation technique in which she modified occupational tasks to reveal more clearly the nature of cognitive processes and structures underlying their performance.

Scribner used expert-novice comparison methods through which she found that the people who worked in the dairy used markedly different cognitive strategies from those used by nondairy employees, although the accuracy of performance for both groups was similar. In addition, dairy workers made subtle adaptations in their strategies that tailored the more general strategy being used to the unique demands of a situation, and they used

approaches that minimized their cognitive and physical effort.

Based on her findings, Scribner concluded that practical thinking has two major distinguishing characteristics: variability and conservation of mental or physical effort. Regarding the first characteristic, practical reasoning and practical intelligence were adaptive in nature, tailored to the changing properties of problems and changing conditions in the task environment. This adaptive thinking in turn produced highly skilled, adapted performance in practical, real-world tasks. The fine-grained tailoring of thinking and action to the situation was made possible by a large repertoire of solution strategies stored in memory. Skilled practical thinking also organized the operational components of tasks so as to make them more economical, which, according to Scribner, contrasts with the type of academic thinking in which a single algorithm is used to solve all problems of a given type. For product assembly workers, this economy of cognitive effort was made possible by what appeared to be direct perceptual mapping of configurations of dairy products in case lots. Experts were able to "see" product unit counts visually (that is, they knew what a case of 10 with 2 missing looked like; they could obtain quantitative information visually) and avoid slower, more effortful counting operations. Scribner credited this direct perceptual mapping to memory storage of a vast array of product unit configurations in case lots. The delivery ticket pricing strategies of milk truck drivers revealed a similar "case lot" organization.

The field observations aspect of Scribner's study (observations were made in the dairy during working hours) is characteristic of social history-based research. According to Scribner, "if cognitive skills systems are closely tied to the intellectual requirements of the practices in which they are embedded, one way to determine their characteristics is to study them as they function in these practices" (pp. 14-15). In other words, the practices themselves need to become objects of cognitive analysis. Research needs to pursue such questions as "What intellectual tasks do these practices pose? What knowledge do the various tasks require, and what intellectual operations are involved in their accomplishment?" (p. 14).

Three studies (L. K. Anderson 1989; Cooke 1988, 1989; Johnson 1988) conducted within vocational education take up the questions Scribner poses. These studies are based on information processing and knowledge structure theories rather than social history theory. They use simulated problems and in-depth interviews rather than field-based observations. The simulated problems closely resemble real life problems in each of the domains. The studies have as a primary goal gaining a better understanding of the knowledge and thinking processes underlying domain-specific practice. All three studies involve expert-novice comparisons.

Technical troubleshooting. Johnson's (1988) study identified differences in knowledge and thinking between novice and expert troubleshooters while they were engaged in working on electric generators in which two types of faults had been embedded by the researcher. This study used a cognitive task analysis approach (Champagne 1986; Laster 1985; Lesgold et al. 1986 a,b) and think-aloud verbal protocol methodology in identifying knowledge, thinking, and performance differences between novices and experts. Findings indicated that the expert troubleshooters understood the functions of the generator parts and the principles governing generator operation. They possessed a mental model of the generator as a system composed of several subsystems that they used in targeting their search for the

faults. Because they had a deeper understanding of the generator's subsystems, the principles underlying their functioning, and their interrelationships, the experts were able to make informative interpretations of what they noticed. These interpretations allowed the experts to represent the problem accurately and proceed to find the faults in a systematic, planful manner. In contrast, novices used a random, trial-and-error approach, made limited interpretations, and were often unsuccessful in identifying the faults.

Compared to the novices, experts sought more specific information in their diagnostic evaluation of the generator and relied on gauges and other technical tools to help them find it. In contrast, novices sought more general, global information and limited their search for information to a sensory scanning of the generator. Compared to the experts, novices also sought more information that was irrelevant to the faults. Novices generated a greater number of hypotheses than experts (lacking a mental model of the generator, they were unable to target their thinking to high probability areas indicated by the symptoms), and a larger proportion of their hypotheses were irrelevant to the faults.

Parent-child interaction. Cooke (1988, 1989) compared the knowledge, thinking processes, and performance of parents identified as experts and novices by their parent education instructors who had worked with them and their children over several weeks. Cooke's methodology combined in-depth interviews, verbal think-aloud protocols recorded during a 15-minute play segment in which the mothers were asked to engage their infants' interest in a basket of toys, and stimulated recall. Stimulated recall is a procedure in which a person is videotaped while engaged in the activity of interest. Immediately following the activity, the videotape is played back to the person in short segments and the person is asked to indicate what his or her thoughts were during each segment. In contrast to a thinking-aloud protocol, which is viewed as representing stream of consciousness thought as thinking is occurring in the short-term memory, the stimulated recall technique involves a retrospective account of thinking. Although the think-aloud method is preferred, stimulated recall is used when the task or situation does not lend itself to thinking aloud. For example, teacher thinking while engaged in interacting with students has been studied using stimulated recall (Calderhead 1981). The videotape is believed to be a sufficient stimulus for reconstituting the contents of short-term memory as they were during the actual interaction, thus allowing them to be reported.

Compared to novices, expert parents had more relevant education (for example, at least a baccalaureate degree in a field related to children and families) and more experience with children, and they reported in the interviews a higher number of sources of knowledge available to them. This translated into more extensive knowledge expressed by experts concerning both their own child and children in general. Expert parents demonstrated more than twice as much attentional focus on the behavioral cues given by their child during the play task compared with novice parents who focused more on the toys or the task. When the novice parents did notice a behavioral cue from their child, they frequently misinterpreted it and acted in ways that appeared to be directed toward meeting their own needs and goals rather than those of their child. Attentional focus on and accurate interpretation of cues from their child was critical to parental responsiveness to the child's states and needs. The experts' superior cue recognition and interpretation was facilitated

by their more extensive and integrated knowledge.

Also related to parental responsiveness were parental goals and expectations. Goals that experts expressed for their children in the interviews and their goals for the play task were child centered (strongly oriented to their child's desires and needs, such as letting their child choose toys that interested the child), and reflected their knowledge of children and their recognition and accurate interpretation of their child's cues. In contrast, novices' goals and expectations were more parent focused (reflected what the parent wanted to have happen, focused on the parent's rather than the child's needs and interests), reflected a limited understanding of children and their development as well as the parent's hopes for meeting his or her own desires and needs through the child's accomplishments, and showed a need to control the situation. Also related to the responsiveness of the expert parents to their children were the experts' child-focused plans for action that reflected their child's cues and a pattern of providing their child with opportunities for self-direction by allowing the child to have a major share of the control in the situation. An example of an action plan sequence frequently reflected by expert parents was as follows: (1) observe and reflect on child's actions, (2) model alternative use of toy, and (3) verbalize child's actions. In contrast, novices indicated no plans, proceeding in a more trial-and-error fashion.

Finally, expert parents characterized their parental role in less intrusive, less directive terms (observer, guide, and verbalizer) that allowed the child to take more initiative than did novice parents whose parental role characterizations focused on shower (shows the child things), fellow player, observer, and model. Although the observer role was reflected by both groups, it was more strongly reflected by the expert group. Expert parents mentioned guide as characterizing their parental role two times more frequently than did novice parents who more frequently characterized their parental role as reinforcer/limit setter. Experts revealed an ability to reflect on their own perspectives and development as a parent and on their behavior, analyze it, and select roles and actions most appropriate for meeting the needs of their child. Novices gave no indication of doing this.

Making housing decisions. L. K. Anderson (1989) examined the thinking processes and problem-solving actions of individuals at different levels of learning in making decisions about appropriate housing for specific family situations. This study incorporated in-depth interviews, simulation of housing selection problems through the use of family case profiles, the think-aloud protocol method, and a tab item technique that tracked each person's path through the problems and the information resources. The study also incorporated three proficiency levels (novices, intermediates, and experts) rather than two. This study revealed that the thinking of novices was descriptive in nature, focusing largely on general features of housing, especially physical aspects. The thinking of intermediates focused on functions of housing. Experts focused on housing as an expression of the interactions between families and broad, social systems (social, economic, political, cultural). Experts started with the specific and fit the general to it. Intermediates started with the general and fit the specific to it. Novices started and remained with the specific, linking it only to specific personal experience. More general understandings of housing were not a part of their thinking.

Differences in the patterns of reasoning among the groups were reflected in the

patterns of statements detected in the verbal protocols. Structure statements indicated where attention was focused and the schema that was activated. These statements came early in the reasoning sequence for all groups. Component statements focused on descriptive attributes or features. These were expressed more frequently by novices and intermediates than by experts. Reasoning statements were arguments that took the form of principles, cause-effect relationships, and theories. These statements were found more frequently and earlier in the experts' protocols compared with the other two groups. Outcome statements focused on conclusions that expressed consequences or results of actions. Expert protocols contained these with notable regularity whereas they were notably absent in most novices' protocols and less prominent in intermediates' protocols.

Anderson's study indicated that experts use more powerful forms of reasoning (meaning-focused and predictive/anticipatory reasoning) than do intermediates and novices, and that intermediates use more powerful, functional forms of reasoning than do novices who reason at a descriptive level. Anderson interpreted these differences as reflecting a developmental progression in practice-focused reasoning that is influenced by the extent and organization of a person's knowledge.

Implications for vocational education. The four studies reported in this section all have in common the in-depth study of thinking while it is in process within the context of domain-specific activity. A primary contribution to vocational education of such studies is a deeper understanding of cognitive capacities underlying some aspect of practice in a specific domain. Such understanding is useful to educators in establishing learning environments that will support learners' construction of domain-relevant knowledge and cognitive processes. For example, the troubleshooting study (Johnson 1988) revealed the importance of mental models to troubleshooters' practice. This finding implies that instruction in this domain would do well to provide experiences that enable students to construct mental models of devices. The parent-infant interaction study (Cooke 1988, 1989) suggests that noticing and interpreting children's cues in terms of the child are critical aspects of interaction that is supportive of children. This finding implies the importance of providing experiences in instruction within this domain that enable students to develop their sensitivity to children's cues and to what the cues may reveal about a particular child. The housing study (L. K. Anderson 1989) implies that instruction that creates opportunities to consider consequences and meanings of housing decisions is likely to help students develop cognitive capacities central in this domain. In summary, these studies are useful in pointing to cognitive capacities that are critical to complex areas of domain-specific practice. They do not identify what kind of instruction will support the development of those capacities. Research reviewed in the next chapter takes up that question.

Studies of Cognition during Learning in a Training Setting

Two studies by Federico focused on cognition during the learning process in a military training context. The first study (Federico 1983a) grew out of an interest in adapting instruction to a range of student abilities and cognitive styles. Brain electrical activity was recorded at eight brain sites for good and poor concept learners while they were engaged in learning pulsed radar concepts. Results indicated that right temporal and parietal areas of the brain were significantly related to concept acquisition. Differ-

ences between the two learning groups were found in the amplitude and variability of brain activity in the right frontal, temporal, parietal, and occipital, and the left parietal regions. Poorer concept learners reflected higher brain activity amplitudes and larger amplitude variance than did better learners. Based on these findings, Federico proposed that, contrary to popular right brain-left brain models that attribute concept learning to the left brain hemisphere, the right frontal, temporal, and parietal areas are significantly associated with concept learning.

The second study (Federico 1983b) determined changes in cognitive correlates of learning for naval recruits during their enrollment in a computer-managed, 11-module mastery course in basic electricity and electronics in a military training context. Enrollees' scores on psychometric measures of 6 cognitive styles and 12 cognitive abilities and aptitudes were correlated with their achievement scores obtained on each module in the course. Federico found that cognitive components shifted in importance during the course, which emphasized verbal learning and memorization initially and application of knowledge in later phases. He suggested that this was due to a difference in the cognitive processing involved in initial phases of learning compared with that involved in later phases and that content, task demanded of learners, and method of instruction are all likely factors influencing which cognitive components will be important. Federico concluded that these findings support the importance of studying the process of change from ignorance to competence through protocol analyses of the cognitive processing involved in early, intermediate, and later phases of learning.

Studies of Other Factors and Cognition

In general, the studies identified in this section differ from those described earlier in that they do not reflect studying thinking while it is in process within the context of a domain-related activity. Rather, the studies discussed here use standardized measures of cognitive variables to establish cognitive characteristics of people and, in some cases, establish relationships between those characteristics and some other variable(s). This difference is pointed out because, although cognition is not a new focus for vocational education research, research methods based on cognitive theory differ from methods used in other cognition-related research and lead to findings of a different nature.

A review by Franz (1983) outlines several bodies of research that relate general cognitive development to the ways in which people think. These studies expand Piagetian-based ideas regarding a developmental progression in thinking to older adults. Individual styles are also believed to influence thinking as it relates to learning and performance. Cognitive variables such as field dependence/independence, locus of control, self-concept, conceptualizing style, reflectiveness-impulsiveness, tolerance of ambiguity, and cognitive complexity have been related to learning (Cole 1984; Federico 1983b; Garner 1986; Kowal 1984) and to performance in drafting (Guster 1986). Learning style differences among and within different groups of students have been identified by some investigators (Cox, Sproles, and Sproles 1988; Jackman 1987; Kendall 1986; Kendall and Sproles 1986; Kendall-Sproles, Cox, and Sproles 1987) and refuted by others (Rojewski and Holder 1990). Similarly, cognitive style differences among vocational students have also been identified (Fisher and Cole 1981).

Purdin's (1989) study of adults enrolled in Ohio Vocational Home Economics programs indicated that age was related to critical thinking ability as measured by Level X of the Cornell Critical Thinking Test, a standardized test of general critical thinking ability. Others have focused on gender as a variable influencing cognition (Anderson 1986; Dweck et al. 1978; Gilligan 1982). Rehm (1989b) used in-depth interviews to uncover factors that home economics teachers and student teachers believed affected their creativity. Factors identified as supporting creativity included opportunities to share ideas and cooperate with others in creative work, support from co-workers and supervisors, and challenges introduced by others. Lack of time was a factor identified as inhibiting creativity.

Summary and Conclusions

A history of ideas is reflected in the evolution of the three cognitive theory perspectives and in changing views of intelligence. The cognitive processes versus knowledge debate that raged earlier in the life of cognitive theory has subsided as more has been learned about the contribution of each to higher levels of cognitive functioning and about their interaction and mutual interdependence. Information processing theory, in which the mind is viewed as an information processing system, reflects an emphasis on cognitive processes. Knowledge structure theories reflect an emphasis on knowledge. Despite these emphases, research stemming from both streams of theory reflects the mutual interdependence of cognitive processes and knowledge. Social history theory extends this mutual influence to the level of culture and to the role that social processes and social organization play in the development of both cognitive processes and knowledge. Studying thinking while it is occurring is a central feature of research related to all three theories. Evolving views of intelligence also reflect the mutual contribution of knowledge and thought processes as well as the ideas that there are multiple types of intelligence and that some aspects of intelligence are modifiable.

The studies reviewed investigate cognition in action, as it operates within domain-specific activities and in learning. The methods used to record evidence of cognition in action in several of the studies (think-aloud protocols, stimulated recall, or the tab item technique) obtain records of what is presumed to be conscious processing. This focus on conscious processing leaves untouched a potentially large arena of subconscious cognitive activity. To the extent that there is interchange between conscious and subconscious cognitive activity, these methods may reveal that part of subconscious activity which, momentarily at least, enters consciousness. Nevertheless, it is important to remember that the understandings of cognition that are gleaned through such methods likely reflect only a portion of human cognitive activity and resources.

The studies that involved experts and novices reinforce the perspective that both knowledge and cognitive processes, as well as their interaction, are important dimensions underlying expertise. The studies suggest that the cognitive organization of people at different levels of competence is fundamentally different and that these differences are responsible for differences in focus of attention, amount and kind of knowledge brought to bear on a problem or situation, interpretations made, plans formulated, and strategies used. Experts and novices see phenomena in fundamentally different ways. The results suggest that expertise involves facile cognitive movement between specific details and general principles. Experts have the capacity to tailor their thinking and their actions to the unique aspects of each sit-

uation in ways that reflect both the context and more general principles, and they can do so with minimal physical and cognitive effort. They can do these things because of two factors: a vast store of knowledge that includes many details organized in ways that allow rapid, targeted access and the ability to process information efficiently and in ways that capitalize on their knowledge store. Experts' knowledge allows them to perceive, and their cognitive strategies target their attention to, critical cues in the environment. Through their strategic detection of cues, they are able to learn quickly what is unique and important about a situation. Once the situation is well understood, they have at their disposal efficient, appropriate, and effective responses that they tailor to address the cues they detected. These capacities allow experts to anticipate and to be deliberate, both in understanding a situation or problem as well as in determining ways of dealing with it.

The studies also suggest that, although expertise is more efficient, it often, but not always, leads to higher quality results. If a problem does not require extensive knowledge to understand or resolve, then both experts and novices appear to be able to achieve a resolution of similar quality, although novices use more cumbersome approaches in doing so and take longer to achieve the same result. When extensive knowledge is required, however, the solutions of experts are more effective than those of novices, who may never resolve the problem even if given unlimited time. The studies also reveal the importance of context-linked experience to the development of both knowledge and cognitive processes associated with expertise.

COGNITIVE PERSPECTIVES ON VOCATIONAL CURRICULUM AND INSTRUCTION

The three theoretical perspectives described as influencing research on cognition are also reflected in cognitive perspectives of curriculum and instruction. Differences in assumptions and interests underlying the three theoretical perspectives (briefly reviewed in the preceding chapter) are reflected in differences in purposes and goals for instruction, assumptions about learners and teachers and their respective roles in the learning process, in the kinds of instructional processes emphasized, and in what are viewed as important instructional outcomes and how they are assessed. These differences have sometimes led to confusion and difficulty in developing a coherent sense of what the cognitive research on instruction means when taken as a whole.

Despite the differences in the three perspectives, there are also commonalities. These commonalities include a view that independent learning is possible and can be facilitated through instruction, that understanding rather than memorization and recall is a goal of instruction, and that thinking transforms information in ways that make it usable (Idol, Jones, and Mayer 1991; Jones 1992). Additional commonalities include the following (Jones 1992):

- Departure from traditional instructional approaches in which the learner is a passive recipient of learning that is controlled by someone else, emphasizing instead a collaborative learning context in which human interaction both stimulates and supports learning.

- Departure from a focus on low-level basic skills and isolated facts to a concern with learning meaning through opportunities to link new information to prior knowledge, connect school learning to significant real-world tasks and issues, and to engage actively with content, questioning its premises and applying it to new examples and situations.

- The assumption that learning involves multiple sources of knowledge and that the role of teachers is to help students become aware of those sources and take responsibility for managing their own learning activities and thinking.

Many of the features of current cognitive theory-based perspectives on teaching and learning are reflected in earlier models of teaching, such as Bruner's concept attainment model, Taba's inductive model, Suchman's inquiry training model, Ausubel's advance organizer model, and various group-based and student-centered teaching models (Joyce and Weil 1972).

Differences among the theoretical perspectives are reflected in the characterizations of curriculum and instruction that follow. Other conceptualizations of cognitive theory-based instructional perspectives can be explored in Jones (1992), McKeough (1991), and Prawat (1991).

Information Processing Perspectives

The information processing perspective on curriculum and instruction emphasizes cognitive processes. Among the three perspectives, content is least important in this view. When it is considered, its primary interest is in how it affects cognitive processes. Cognitive processes are seen as operating on knowledge, as largely generic, and therefore as relevant across subjects, disciplines, and problems. The educational problem is to transform individual cognitive strategies and to facilitate their transfer to many different contexts and problems (McKeough 1991). Thinking processes are seen as skills that entail knowing, executing, and controlling procedures and steps. Purposes and goals for instruction focus on the acquisition of thinking skills deemed relevant in a technological society, their transfer across content domains to new problems and from the classroom to the real world, and on awareness of one's own cognitive patterns and processes (Jones 1992; McKeough 1991).

Learning is defined as movement from novice-like toward expert-like problem-solving strategies. Learners are viewed as information processors whose current level of functioning within a novice-expert continuum limits what they are able to learn. Learners must observe and experience the cognitive processes of interest in order to learn them and know how, where, and when to use them. Teachers take a directive role in instruction by selecting the strategies and skills students will learn; by labeling, explaining, illustrating, and modeling them and their appropriate application; and by assessing how well students have learned them (Jones 1992). Teachers also take a supportive role by activating students' prior knowledge about skills and strategies and guiding students as they practice the skills.

Stand-alone courses on generic thinking skills and portions of subject-area courses that explicitly focus on thinking skills are emphasized. When context is of concern, it is viewed as a task environment in which the particular kind of expertise of interest is relevant. The learning context is of most value when it is as similar as possible to that task environment. Simulations are often used to accomplish this similarity. The task environment constrains problem representations and solution possibilities.

Engaging learners in verbalizing their thinking is believed to facilitate learners' metacognition (Lochhead 1985; Lochhead and Clement 1979; Lochhead and Whimbey 1987). Collaboration among learners, particularly within specifically structured roles determined by the teacher, is often an aspect of simulations and instructional methods that engage learners in verbalizing their thinking.

Instructional development and design involves developing models of both novice and expert knowledge states, cognitive processes, and performance, as well as an understanding of the steps in between and of where the learner falls on this continuum. Problem-solving strategies used by novices and by experts must be determined so that novice learners' errors can be identified and expert-like strategies explicitly taught. Cognitive task analysis is used to obtain information on cognitive tasks that is needed for model development (Johnson 1988; Laster 1985; Lesgold et al. 1986a,b). Cognitive task analysis entails determining representations of the problem space used by learners at different levels of expertise, their solution paths through the space, and the cognitive strategies they use (Ohlsson and Langley 1988). Such analyses require empirical observation (through think-aloud methodology) of learners' thinking while they are engaged in solving problems. This

understanding is then used to design learning environments and instructional procedures that facilitate the desired cognitive patterns.

Assessment of instructional outcomes involves ascertaining whether students have developed, mastered, and integrated a repertoire of cognitive processes and strategies, whether they can transfer those processes and strategies, and whether their self-awareness of their cognitive processes has increased. Models of expert thinking provide a criterion against which learners can be assessed. Information processing theory approaches have been used especially successfully with learners who have missed the opportunities to develop cognitive skills that children acquire in the course of normal development. The information processing approach has been criticized for being too tied to an external model of what constitutes learning (the expert) and for giving too little attention to the influence of knowledge on thinking, the contributions that the unique aspects of learners' cognition make to learning, and to learner-generated strategies that have sometimes rivaled and superseded the efficiency and effectiveness of the ones being taught. In addition, it has been notably difficult to document that transfer of learning outcomes has occurred as a result of information processing instructional approaches.

Knowledge Structure Perspectives

In contrast to the cognitive processes focus of curriculum and instruction based on information processing, curriculum and instruction based on knowledge structure theories emphasize knowledge and its integration with cognitive processes. Instructional goals and purposes emphasize constructing meaning in the context of course content and developing a capacity for reflective reasoning within a subject area or knowledge domain. Although cognitive skills and strategies are relevant, they are not of interest as ends in themselves, but as integral to broad, encompassing endeavors such as dealing with ill-structured problems relevant to a subject or area of practice.

Learning is viewed as constructing meaning through differentiation and integration, processes through which meanings constructed by the learner become more specific and, at the same time, are organized according to increasingly general abstractions. Learning involves interaction between the learner's thinking processes and knowledge, and between the learner and the environment. The learner is viewed as an active constructor of knowledge through experience with the environment. Although learning is viewed as involving the learner's unique mental frameworks and experiences, the learner is also believed to construct knowledge in a systematic fashion. Because of this, learners' progression through a knowledge domain has certain universal qualities and dimensions (McKeough 1991). Developing the capacity to learn on one's own entails developing schemata that strengthen abilities to direct one's own experiences in ways that foster learning. Learning materials and environments that enable learners' self-directed exploration contribute most to learning. Learning situations that introduce multiple perspectives, such as collaborating with peers is likely to do, stimulate students to construct higher-level syntheses and refinements in their knowledge. A major role of the teacher is structuring a learning environment rich in cognitive stimulation and opportunities for exploration and social interaction. A second teacher role is to support and promote learners' interest, exploration, and interaction through encouragement and nonintrusive guidance.

Existing subject areas provide the context for schema-based instruction. Curriculum offers experience that is adapted to the developmental level of the learner and through which learners can independently construct their own knowledge. Learners engage in broad, encompassing cognitive processes (such as problem finding) in the context of their use within specific subject matter and, as a result, develop schemata for them. In contrast to information processing approaches, this kind of instruction does not provide the learner with a social model to emulate or a detailed map of problem-solving strategies.

Learning activities are designed to encourage learners to explore and direct their own questioning and problem solving. The teacher encourages learners to discover the limits of their current views and to construct more adequate ones through questions that activate learners' prior knowledge, probe their reasoning, and help them to connect and integrate new knowledge with prior knowledge, and through the introduction of diverse perspectives. As learners confront perspectives and ways of doing things that differ from each other and from their own, they are challenged to adjust or transform more dramatically their existing schemata to accommodate the new cognitions. The teacher also provides a supportive, low-risk environment that allows failure and views it as an opportunity and motivation for learning.

This approach incorporates large-scale, learner-directed inquiry, sustained over time, and that integrates exploring, planning, creating, problem solving, dialogue, calculating, reading, and writing. Schema theory-based instruction may begin with an ill-structured problem, a question, or a puzzling concept as a way of stimulating learners' higher-level thinking processes. Explicit attention may be given to looking back and looking ahead in order to foster cognitive linkages throughout the learning process. Over time, problems introduced become more diverse and complex to encourage greater cognitive differentiation and higher levels of integration.

Assessment is ongoing and informal. Learners may be asked to apply what they have learned to an unfamiliar problem and be observed in doing so to ascertain their capacity to direct their own exploration and interpretation and to formulate their own resolution. Learners may also be asked to draw on paper their cognitive or conceptual map of a problem or a flowchart of a process as a way for themselves and the teacher to gain access to the content and organization of their knowledge (Novak and Gowin 1984). All of these approaches seek evidence that the learner has developed more complex, interrelated, and integrated knowledge structures that are supportive of more complex thinking processes.

Social History Perspectives

Social history theory focuses on how cognitive structures and processes come about through culturally embedded human interaction and activity. Learning is viewed as socially situated. The learner is taught that which the culture considers important to the learner's functioning in the cultural context. The kind of transfer of concern is from the learning situation to the real world, rather than generic learning across a broad range of different applications. Because of this, the learning context and the ultimate context of application are as similar as possible, very often the same. Consequently, the learning context is often the real world rather than the classroom. Apprenticeship is a concept reflected in some of the terms associated with a social history perspective of instruction as a way of conveying this real-world situatedness.

Such terms include enculturation, cognitive apprenticeship, and situated cognition.

Learning results from dialogue between the learner and members of his or her social world. This dialogue is viewed as a dialectic exchange of more mature and less mature views and capabilities that fosters development of the less mature toward the more mature. Language, as the vehicle of social interaction, plays a central role in cognitive change. Language is the vehicle by which teacher and learner make their thoughts known to one another and by which the learner internalizes the concepts of the culture. Language used to label operations in the environment eventually becomes internalized, integrated into the cognitive makeup of learners in ways that internally direct the learners' actions. Once this happens, external direction from the teacher is not needed.

In contrast to schema theory, which obscures distinction between learning and development, social history theory places learning and development in a temporal relationship that is reflected in Vygotsky's (1978) concept of the zone of proximal development. This zone is represented by the difference between what the learner can do when assisted by a more competent other (which represents learning) and what the learner can do by himself or herself (which represents development). Learning precedes and enables development. Thus, people "know" things before they can independently incorporate them in their actions. Movement by the learner through this zone, which contains knowledge that lies just beyond the learner's current performance capacities, is possible with external supports that have been likened to a scaffold. The teacher's role is to provide the scaffolds learners need to engage in activities that are just beyond their current capacities. The teacher does this by serving as a more knowledgeable partner in jointly carried out activities, providing tools or materials that are adapted to make their use and a task easier or safer, and pairing learners of different learning levels. Teachers also mediate learners' interpretations of their experience and support learners' experience through encouragement and guidance. The student-teacher relationship is likened to that of apprentice-master.

Of the three perspectives, context is the most central in instruction based on social history theory. Learning is situated in authentic cognitive tasks (as opposed to contrived exercises) in both in- and out-of-school learning environments. More knowledgeable members of the culture (teachers, master craftspeople, more advanced learners) provide the learner with frameworks for interpreting experience through modeling, explaining, guiding, and discussing experiences. Learners use these frameworks initially in communicating socially with the teacher and other learners, but eventually internalize them psychologically where they are incorporated in learners' formulations of their own interpretations. These organizing frameworks are not copied directly from the teacher; rather, learner and teacher negotiate a mutual understanding (McKeough 1991). As learners develop their capacities to interpret their own experience, the teacher removes the scaffolds so that, increasingly, the learner assumes more and more responsibility (especially cognitive responsibility) for an activity. This is sometimes referred to as fading.

Classrooms are structured for cooperation. Collaboration between learner and teacher and among learners provides a context for the joint activity and the partner roles and relationships that characterize instruction. Although some explicit instruction is integrated into the guidance process, much learning is left to internalization of

what is left implicit. The context, the activity, and social interaction are vehicles of instruction that lend meaning to what is being learned. Learners are involved in setting learning goals and in self-monitoring and self-assessment: they are believed to contribute to their own learning through these processes.

Culturally valued capacities are the outcomes of interest in this perspective. Such outcomes, in their most basic form, relate to the survival of a culture. Assessment occurs in the context of learning activities. Skilled independent performance indicates development. The capacity to perform in partnership with a more skilled person reveals learning. Both learning and development are of interest and are assessed through informal observation. The same approaches are used in assessment as are used to support learning. Self-evaluation is viewed as integral to performing independently and interdependently.

Vocational Curriculum and Instruction

Cognitive theory-based curriculum, instruction, and assessment in the real world of schools and other educational agencies and institutions often reflects mixed rather than pure models. That is, the three theoretical perspectives are often combined because each has something to offer that is perceived as valuable by educators. When the three perspectives are mixed, aims of instruction sometimes suggest more emphasis on one model than another. Consequently, mixed models may have a dominant model with one or both of the others embedded within it.

The vocational education literature suggests that vocational educators are, indeed, thinking about instruction relevant to higher levels of cognition and that this interest is not a new phenomenon but has been reflected historically (Herren 1987; Lass and Moss 1988; Moore and Moore 1984). Much of the vocational education literature concerning higher levels of cognition includes conceptualizations, literature reviews, arguments, reports of activities, and so forth. This character of the literature is reflected in the following items:

- Reports of experiences related to curricular change within institutional contexts (Fam and Luan 1984; Fitzpatrick 1991; Hartman-Haas 1981)
- Arguments, recommendations, and suggestions for what and how to teach (L. D. Anderson 1989; Champagne 1986; Claus 1989; Crowell 1989; Crunkilton 1984, 1988; Fedje 1986; Garner 1986; Henderson 1983; Hunter 1992; James 1990; Johnson and Thomas 1992; Kerka 1986; Laster 1982, 1985, 1986a; Lee 1989; Miles 1981; Miller 1990; Montague 1986; Mosser 1989; Ormerod 1983; Osborne 1988; Rehm 1989a; Sellwood 1989; Thode 1989; Thomas 1985; Underwood 1986; Way 1986)

Some cognition-related, instruction-focused research has been done in vocational education in the form of self-report mail surveys focused on describing teachers' attitudes regarding higher levels of cognition and identifying the ways teachers attempt to facilitate their students' cognitive development (Nwagbara 1990; Osborne and Hamzah 1989).

The vocational education literature identified here varies widely in the degree to which it explicitly or deeply reflects the broader cognitive theory and research literature. The primary interest in the sections that follow is to review vocational education research focused on cognitive theory-based curriculum and instruction. As mentioned in the first chapter, during the 1980s research relating new understandings about cognition to instruction

burgeoned in several educational areas, including technical training. In contrast, such research in vocational education has been more limited. Studies reviewed in this chapter reflect instruction-focused, cognitive theory-related research efforts that have been carried out in vocational education. Studies concerned with general education aspects of the curriculum vocational students experience are included. One way of categorizing studies focused on vocational curriculum and instruction is in terms of the purpose or goals of the research. Three broad categories of instruction-focused research can be identified: (1) understanding, describing, and documenting instruction; (2) developing and designing instruction; and (3) determining the effectiveness of instructional approaches and methods. At a more general level, the first category might be thought of as problem-finding studies. Such studies take the form of in-depth observations of instruction as it is occurring and interviews to aid understanding of the nature of teachers' and learners' perspectives and concepts. This research often produces case studies that reflect instruction in process, as it occurs over an extended period of time. Instructional development and design studies might be thought of as problem analysis studies. Such studies take the form of developing principles, models, or materials and field testing them. Studies that focus on the effectiveness of instructional approaches and methods might be thought of as testing problem solutions. Typically, such research takes the form of experimental or quasi-experimental studies that compare two or more instructional approaches or methods.

Research on Understanding, Describing, and Documenting Instruction

Four studies, the findings of which are remarkably similar with respect to the ways in which vocational education instruction was observed to be supportive of student engagement in higher levels of cognition, focused on understanding, describing, and documenting the nature of vocational instruction (Dinham 1989; Rehm 1987; Stasz et al. 1990; Weber and Puleo 1988). One of these studies (Stasz et al. 1990), which drew on both information processing and social history theory, investigated what types of generic (non-domain-specific) skills are taught in vocational education programs, what methods vocational teachers employ in teaching such skills, and how the instructional context affects the teaching of such skills. Reflective of the Scribner studies reported in the second chapter, this study was an intensive case history of one course, a high school interior design course.

Generic skills taught in the course included repair skills (learning from errors), analyzing parts of the problem, generating solution paths and evaluating them (monitor as you go), and reflecting on the solution and its generation after it is achieved in order to improve performance next time. The teacher encouraged students to cooperate, to take responsibility for accountability and for decision making, and to take the risk of making bold decisions. The project-focused curriculum and organization gave students many opportunities to make choices and to reflect actual working environments. The teacher-student relationship was described as reflecting a master-apprentice relationship. The teacher saw students as mature, having some knowledge, and motivated to learn. The teacher encouraged risk-taking and self-assessment by crediting effort at creative solutions rather than results, structuring to allow students to detect and correct their own errors, provided constructive criticism with caring and respect, and encouraged students' persistence in the face of failure. The teacher helped students focus their efforts on the project

tasks by holding high expectations, helping them internalize responsibility for their own work, monitoring student activity and intervention when warranted, and assigning grades. The need to repeat information several times was accepted as normal and that role was delegated to students who already knew it.

In another intensive case study, Dinham (1989) explored teaching in an apprenticeship setting within the context of a higher education program in a technical design field. Based on data from in-depth interviews with two design studio teachers, and in-depth observations of their teaching practices related to an extended design project assigned to students, a model of the influences upon teachers' thinking and instructional planning was developed. This model included five interrelated dimensions.

The first of these dimensions was the teacher's conceptual frame. This was a set of views brought to teaching, a complex of experiences, beliefs, and expectations regarding life commitments and orientations, the subject matter, and the learning process. The second dimension was appropriate teaching in this subject. This was the teacher's belief system that guided teaching practice and that was based on the teacher's broad philosophical views, understanding of the subject, and views of how students best learn the subject. This dimension balanced competing principles and perceptions in a way that satisfied all the elements of the teacher's conceptual frame. The third dimension was the personal experience of teaching. This included the teacher's explanations of the rewards of teaching, of its risks, and of the teaching context.

The fourth dimension was the teacher's views of students. This dimension included the teachers' view of students' characteristics. It also was the dimension within which teachers balanced the students' feelings of risk and ambiguity in doing something new and unfamiliar, but through which learning and discovery could occur, with the students' need for confidence and success. It was here that the teachers balanced teacher-imposed direction with student initiative by either resisting or giving in to students' press for more detailed and specific instructions. This dimension also included encouragement of students to express their own thoughts and acknowledgment that students shape the project and the instruction.

The fifth dimension was that of the central jobs, tasks, or processes in teaching. There were two of these in teachers' conceptions of design project-focused studio teaching: designing a good problem and helping students through a solution. A good problem had multiple goals and a theoretical base, extended previous learning, meshed with the larger school curriculum, was representative and prototypic of a broad class of problems, and was relevant to practice in the work setting. Helping students through a solution involved teachers' instructional strategies, the techniques they use in dealing with students. These strategies and techniques included making arrangements so students can engage in and pursue the task set out in the assignment, balancing opening up possibilities for students with narrowing the problem for them, and improvising and modifying the assignment in response to individual student needs.

Dinham's study represents an attempt to understand the knowledge system underlying teachers' instructional practices. The report of this study provides a very detailed picture of the qualitative research methodology that was used in collecting and analyzing the data obtained in the interviews and classroom observations.

In a larger-scale study encompassing 893 classrooms, 2,251 teachers, 120 high schools, and 24 states, Weber and Puleo (1988) documented and compared instructional approaches used in secondary vocational classrooms with those used in nonvocational classrooms. Using both classroom observations and questionnaires completed by teachers, these investigators found that, compared with nonvocational teachers, vocational teachers did the following:

- Used slightly more class time for instructional activities
- Spent less time lecturing and explaining or presenting material
- Worked more with students in small groups and individually
- Emphasized student reading, writing, and extended speaking less and other observable opportunities to practice and use higher-order skills more
- Used textbooks and worksheets less
- Used a wider variety of machines and tools more
- Engaged students more in tasks or activities in which students exercise a degree of control such as physical demonstrations, practice, and performance, simulations, and role playing
- Used paper and pencil tests less and performance appraisals more

Students in vocational classes worked more on tasks that differed from each other and interacted more with peers than did students in nonvocational classrooms where students worked more on the same or similar tasks and interacted more with the teacher than with other students.

Weber and Puleo's findings reflect, on a larger scale, several findings similar in pattern to those reflected in the Stasz et al. and Dinham case studies of vocationally oriented classrooms and, in addition, provide a comparison with nonvocational classrooms that reveals a number of differences. These differences are summarized by the investigators as follows: (1) teacher-led instruction, information presentation by the teacher, total class or large group activity, lectures, discussions, written work, reading, use of textbooks and worksheets, and teacher-to-student interactions were less prevalent in vocational than nonvocational classrooms; and (2) student-led instruction, student practice directed toward development of specific verbal or psychomotor skills, individual and small group work by students, use of machines and tools, and student-to-student interactions were more prevalent in vocational than nonvocational classrooms. Weber and Puleo also pointed out evidence that there is considerable variability in these patterns within vocational education, especially on the basis of service area.

Rehm (1987) used metaphor in interpreting observational and interview data obtained in case studies of vocational education classrooms over time. Rehm's cases were not focused on design project classes as were the Stasz et al. and Dinham studies, and they spanned a broader set of teachers and classrooms. Applying an artist metaphor to interpreting data regarding student activities during vocational education instruction, Rehm identified the following categories of creative artistic endeavor in which vocational students were engaged: creating a style and forms of action, appreciation, and critique, and expressing personal and social purposes. According to Rehm, these kinds of activities represent paths students trod "from perception to critique, from intention to production, and from production to function. In a sense, students are artists who must appreciate and confront a complex world in order to tap its potential, and vocational education offers a most active 'gallery' in which to develop this skill. However, it is researchers and educators who must provide the direction and learn-

ing experiences for students" (Rehm 1987, p. 31). Rehm's study reveals how vocational education helps students link their internal mental activity with their physical and expressive activity in the external world. In another study, Rehm (1989b) explored through in-depth interviews the meanings home economics students and teachers held for creativity, how it is expressed and encouraged in vocational education instruction, and what are seen as influences on it. Freedom within limits and supportive colleagues and environments were important factors reflected by both groups.

The findings of the studies summarized in this section closely reflect features of programs that facilitate students' learning and thinking capacities (Resnick 1987):

- Socially shared intellectual work is organized around joint accomplishment of tasks so that elements of the skill take on meaning in the context of the whole.

- Skill is allowed to build up bit by bit in apprenticeship-like fashion through making usually hidden processes overt, encouraging student observation and commentary, and making participation possible, even for the relatively unskilled, through the social sharing of tasks and other means.

- Organization of curriculum is around particular bodies of knowledge (subject matter rather than general abilities) that are tailored to engage students in processes of interpretation and constructing meaning.

- Students are actively engaged in using their powers of reflection and analysis to create sensible responses to new situations.

Research on Instructional Development and Design

Thomas and Englund (1989, 1990, 1991) emphasized schema theory, but incorporated aspects of all three theoretical perspectives in the development and field testing of principles and a model for designing domain-specific cognitive theory-based instruction. Design processes contained in the model include developing an understanding of the knowledge domain, describing levels of development within it, and creating learning environments that enable learners to construct knowledge relevant to the domain and that permit strategic mediation of learners' experiences. The model contains four principles related to creating learning environments: fidelity, visualization, wide-ranging and in-depth experience, and mediation. Fidelity involves (1) a learning environment that contains deep, principle-level features characterizing the real-world practice setting and that confronts learners with problems and puzzlements in the ways they arise in the practice setting; (2) opportunities for learners to notice, on their own, relevant cues signaling those features from among irrelevant cues embedded in real-world practice settings; and (3) opportunities for learners to detect and use feedback from the environment as a way of developing their self-monitoring capacities required for continued learning in the practice setting.

Visualization capitalizes on the capacity of the human perceptual system to represent large amounts of highly complex information at a glance, store that information in memory with great accuracy and durability, and aid retrieval of knowledge from memory (Spiro, Coulson, Feltovich, and Anderson 1988; Spiro, Vispoel, Schmitz, Samarapungavan, and Boerger 1987). The principle of wide-ranging and in-depth experiences reflects the need to include both types of experience. Wide-ranging

experiences are selected to differ in surface features but be similar in deep principles. Such experiences enable learners to extract highly abstract generalizations. Deep experiencing is extended in time, involving detailed and repeated examination and analysis of the same problem or situation from different perspectives. Deep experiencing is also personally and emotionally involving. Mediation entails helping students interpret their experience and providing alternative interpretations for them to consider. Thomas and Englund's instructional design model was tested for usability by using it to guide the development of an instructional prototype within a specific knowledge domain. The prototype created was an interactive, videodisc-based learning environment that employed case-based learning as a central strategy and incorporated three levels of learning.

The interactive videodisc learning environment confronted small groups of learners with unstaged, videotaped situations from the real world practice context and engaged learners in observing, analyzing, comparing, and evaluating each case. In addition, each case was explored a number of times, each time from a different perspective or in relation to a different concept. The computer mediated students' experiences with the cases. The computer also posed questions to help learners connect new learning to their prior experience and knowledge and to the real world and to stimulate individual and group reflection. The prototype was field tested and changes were identified in learner's knowledge structures and thinking during their 10- to 30-hour experience with the prototype. Changes in students' knowledge toward greater complexity and integration were reported. Knowledge complexity was defined as the number of levels and types of knowledge reflected in student responses. Knowledge integration was defined as the number of linkages between knowledge types and levels. Increases in expert-like thinking and in deep feature detection on the part of students were also reported.

In another instructional design-focused study, Bentley (1984) sought an alternative to the study of existing trade practices and requirements as an approach to the derivation and organization of subject matter in graphic communications. An alternative was sought because of the increasing degree to which graphic communications have become subject to radical technological change. Using cognitive theory as a basis, Bentley developed a conceptual system for graphic communications subject matter organized to accommodate the changing structure of this body of knowledge and its increasing complexity, reveal the interrelatedness of its elements, enhance its potential meaningfulness, and suggest a learning hierarchy. The conceptual system resulting from this study has two dimensions: communication process and general to specific levels of subject matter.

In a study designed to provide a basis for both instructional design and assessment of learning, Greenan (1983) identified generic basic skills relevant to vocational education. Basic skills were seen as those critical to employability and occupational competence. Generic basic skills were defined as those basic skills that are transferable because of their broad applicability to a broad range of occupations and jobs. Relevance to vocational education was determined in terms of generalizability across secondary vocational programs and direct relationship to vocational education programs, services, and expected outcomes. Research literature was reviewed to identify such skills, which were then categorized in four areas: mathematics, communications, interpersonal relations, and reasoning. The identified skills were reviewed by several groups and finally rated by secondary vocational

teachers as to their importance to student performance in their vocational education programs. Further research efforts concerning these skills have focused on assessment and are reviewed in the next chapter.

Systematic, cognitive theory-based studies of instructional development and design are not numerous. Only one of the three reviewed investigated the application of new instructional development and design principles and models to actual instruction and monitored the results. This step seems a necessary one in order to determine if and how instructional practice is affected by the new instructional principles and models and, if affected, whether or not the changed instructional practice makes any difference in learning.

Research on the Effectiveness of Instructional Approaches and Methods

The studies reviewed in this section compared cognitive theory-based instructional approaches with other instructional approaches, usually more traditional ones, to determine whether cognitive theory-based instruction is more effective in producing instructional outcomes of interest.

Siebold (1989) compared the impact of schema theory-based instruction on industrial arts students' acquisition and retention of concepts, processes, facts, and manipulative processes skills with that of an instructional approach already in use that focused on the same content. This study was carried out in the context of learning and performing a sequence of steps in an activity. In the schema approach, diagrams representing schemata were presented to students. In the traditional approach, a sequence of procedural steps was emphasized. Findings were mixed in that there was no difference between instructional approaches on any but the retention of manipulative processes skills. The schema theory-based approach resulted in a higher retention rate than the traditional approach. There are several questions that make this study's results difficult to interpret. First, what was identified as a schema theory-based approach employed directive teaching methods. (Ausubel's advance organizer approach was a primary model for the schema-based instruction.) This meant that both the traditional and the schema approach were didactic. In addition, although presenting a graphic organizer (identified as the schema in this study) to students is sometimes part of schema-based approaches, this, by itself, is insufficient to constitute a schema-based approach. Assessment measures included general tests of intelligence and a paper and pencil test of scaling. Assessments consistent with schema theory-based instruction emphasize domain-specific knowledge and thinking rather than general intelligence.

Westerdahl (1991) compared instruction for troubleshooters based on prior troubleshooting research by Johnson (1988) with a company's usual approach to troubleshooting instruction. In a quasi-experimental study based on Johnson's prior research within the same company, two components were added to the experimental group's training. These components included exposing trainees to five major troubleshooting approaches relevant to problems typically encountered with the equipment of interest and to a map of the problem space that visually and conceptually depicted the subsystems of the equipment and their relationships. The map was developed by Johnson based on his observations of expert troubleshooters working on the same equipment. Compared with trainees receiving the usual instruction, experimental trainees scored higher following instruction on a knowl-

edge test of electricity, mechanics, the equipment item, and troubleshooting approaches and took less time to identify the failed part in a troubleshooting performance test. This study, like Siebold's study, used a graphic organizer. However, the graphic organizer used in this study was based on mental models empirically derived from study of experts in Johnson's prior research on troubleshooting the same device. Siebold reported no empirical grounding for the graphic organizer incorporated in his study.

Glass (1992) investigated an information processing-based instructional approach designed to elicit verbalization of technology education students' thought. Pair problem solving was compared with unstructured groups for effects on students' understanding of problems, transfer of relevant previously learned concepts and principles, use of metacognitive strategies, and solutions to problems. Pair problem solving involves pairs of students in working on problems. One student, the thinker-problem solver, thinks aloud while attempting to understand and solve a problem. The second student listens and tries to understand the first student's thinking, asks for reasons for the first student's actions and thoughts, and reminds the first student to keep talking. The unstructured dyads worked on the same problems but were told to solve the problems in whatever way they felt worked best. Results indicated that, compared to students who experienced the unstructured dyads, students who experienced the pair problem-solving approach expressed more metacognitive thought and transferred previously learned concepts and principles to a larger extent. The quality of pair problem-solving students' solutions to problems was higher for some problems but not for others. Students' understanding of the problems did not differ between the groups.

Three quasi-experimental pretest-posttest studies (Edersheim 1988; Jenkins-Vulgamore 1991; Martin 1988) were conducted to determine the contribution of practical reasoning instruction and other factors (reading level, gender, prior home economics education experience) to levels of decision making used by home economics students. Edersheim compared change in decision-making levels used by 10th-grade students exposed in a home economics course to a 2-week, 11-hour unit on practical reasoning and to practical problem solving integrated into subsequent instructional units with decision-making levels used by 10th-grade students enrolled in a health class who had some prior experience in home economics but no experience with practical reasoning. Experimental students used practical reasoning to solve hypothetical and personal, home, and family problems. Practical reasoning was defined as a complex critical thinking process whereby one gathers adequate, reliable information regarding values, contextual factors, alternatives, and consequences to help make decisions; considers carefully what is best or ought to be done; justifies decisions on courses of action with adequate and reliable reasons; and collaborates with others to decide what is morally best to do. Results indicated significant differences between experimental and control groups in decision-making level posttest scores. Further analyses indicated that reading level and gender-reading level also made significant contributions to decision-making level scores.

In a study that replicated the major features of Edersheim's work, Martin (1988) involved a teacher who had four semesters of experience in teaching practical reasoning. (The teacher in Edersheim's study who taught practical reasoning to the experimental group had not taught it previously.) A 19-hour unit on practical reasoning was taught at the

beginning of the semester followed by integrating practice in this kind of reasoning throughout 83 hours of instruction in subsequent units during the remaining 15 weeks of the semester. Like Edersheim, Martin found differences between experimental and control groups based on the practical reasoning instruction and reading levels of the students. A similar pattern of findings regarding instructional group was found by Jenkins-Vulgamore (1991), who also replicated the major features of the Edersheim study but with seventh-grade students. Gender-related differences were not found in this study, but students with the lowest reading levels made the most significant gains in decision-making levels.

These three studies reveal consistent results suggesting that vocational education instruction focused on cognitive capacities (in this case practical reasoning and decision making) does make a difference. These studies, like the Westerdahl study, reflect conceptual alignment of the dependent variable measure with the treatment and a systematic approach to research that builds on and extends prior efforts.

Two studies (Curtis 1980; Samuels et al. 1984) involved testing cognitive theory-based instruction with students whose school records revealed low levels of achievement. Samuels et al. (1984) assessed the effectiveness of Feuerstein's Instrumental Enrichment program with low achieving adolescents in a Canadian vocational school. The Instrumental Enrichment (Feuerstein et al. 1991) program is a content-free, supplemental program for adolescents and adults comprised of paper and pencil exercises focused on correcting deficient cognitive functions (related to perception, reasoning, and language) and class discussion focused on helping students understand and integrate the functions with life experiences. Cognitive functions emphasized are data-gathering capacities (such as precision, accuracy, discrimination, spatial orientation), data-using capacities (such as hypothesis testing, detection of relevance, planning), and expressive capacities (for example, precision, accuracy, and adequacy of communication of ideas). Teachers mediate the learning process in ways that help learners develop metacognitive capacities (capacities to direct and control their own cognitive activity). Because it gives explicit attention to developing generic cognitive skills, the Instrumental Enrichment program reflects an information processing perspective.

In the Samuels et al. study, 15 students who participated in an Instrumental Enrichment class for one 45-minute period 5 days per week over a 2-year period were compared in a pre-posttest and time series design to a group of similar students who did not receive the Instrumental Enrichment program. Few differences between the groups were found on the dependent variables, which included reasoning and intelligence, achievement, attitudes, and behavior. Some differences that were found were in favor of the control group. This was attributed to a high rate of attrition from the experimental group among students who had high reading and mathematics scores and who left the program to enter academic programs. Teachers' views of causes for failure of students of normal intelligence shifted during the study to include poor thinking skills. Because of the attrition factor, it is difficult to draw any firm conclusions about effectiveness of the Instrumental Enrichment program for vocational students. Although this study may reflect limitations of decontextualized learning of cognitive skills, it also reflects one of the difficulties when field-based tests of effectiveness of educational interventions are extended over long periods of time.

Curtis (1980) tested an inquiry-oriented, problem-solving teaching model in a social studies course for students enrolled in special classes for slow learners and non-achievers and in vocationally oriented programs. By focusing directly on thinking processes, by embedding the instruction in the context of content regarding housing issues, and by incorporating teacher mediation of student experience, the teaching model experienced by the experimental group reflected all three theoretical perspectives described earlier. Control groups experienced more traditional approaches focused on teaching facts and concepts. Comparison of experimental and control group means on a general test of critical thinking ability revealed significant differences in favor of the experimental group.

The contribution of cognitive variables to psychomotor performance and the interrelationships among cognitive, affective, and psychomotor functions is becoming better understood (Osborne and Matulis 1988). A study by Mevarech (1983) drew upon a mastery perspective of instruction rather than a cognitive theory perspective. The study was, however, concerned with variables of interest in cognitive theory, including cognitive and perceptual dimensions of psychomotor performance and the impact of mediation. Mevarech compared a feedback correctives, mastery learning approach to individualized instruction with conventional individualized instruction lacking the feedback corrective aspect. Feedback correctives involved the teacher's monitoring of student learning in order to provide guidance and encouragement when learning related to instructional objectives slowed, stopped, or failed to occur. The dependent variable--behavioral sequences of learned responses used by students in the solution of new psychomotor problems--was indicated by use of basic skills in manipulating workshop equipment, analysis of diagrams and application of the analysis to mechanics problems, application of understanding to determine an order of operations, application of theoretical knowledge to the practical solution of mechanics problems, and complex overt responses.

Students exposed to feedback correctives were better able to operate workshop equipment, read and interpret diagrams, and apply theoretical knowledge to mechanics problem solving. Low achievers benefited more from the feedback correctives approach than high achievers. This finding was attributed to patterns of findings in other research that indicate that high achievers do their own mediation (that is, spontaneously diagnose their learning, give themselves feedback, and correct their mistakes before proceeding to a new task). Mevarech concluded that the flexible time mode in individualized instruction is insufficient to affect practice and that mediation in the form of feedback correctives is a necessary aspect of individualized instruction in order for many students to attain high standards of performance. One reason Mevarech offered for this conclusion is that many conventional individualized instruction students did not use all their available time and were less persistent than the students who received the mediation treatment. Cognitive theory suggests that the mediation helped students focus their attention and efforts on the learning tasks and on critical features of those tasks, and it sustained attention and effort when they experienced discouragement and failure. Whiting and Render's (1984) study reflected similar results for individualized mastery learning, which included but was not designed to examine specifically feedback correctives mediation.

Summary and Conclusions

The studies reviewed in this chapter suggest that instruction supportive of higher levels of cognitive functioning is both a possibility and a reality in vocational education. The studies also suggest that such instruction has been investigated within several vocational education subject areas. Although most of the studies did not address the question of whether this kind of instruction is an exception or the rule throughout vocational education, the large-scale study by Weber and Puleo (1988) gives some indication that at least some of the dimensions of instruction identified in the Stasz et al. (1990) case study are present in several vocational education program areas.

All three theoretical perspectives are represented, either singly or in combination, in the studies reviewed in this chapter. A greater number of the studies concerned determining the effectiveness of instructional approaches than understanding, describing, and documenting instruction or instructional development and design. This suggests that researchers may be investigating potential solutions before they have understood the problems. However, it should also be emphasized that several of the effectiveness studies did build on prior work. In total, the research reflects the potential contribution that each kind of research--that focused on understanding instruction, on instructional design, and on determining the effectiveness of instructional approaches--can make to understanding and educational practice.

The group of studies categorized as understanding, documenting, and describing instruction revealed remarkably similar characteristics of vocational instruction. These studies offer an in-depth picture of vocational instruction that suggests that teacher, students, and learning environment (or context) are mutually influential and interdependent dimensions of the instructional situation. These studies reveal characteristics of vocational instruction that are consistent with cognitive theory perspectives and that contrast with more traditional instructional modes. For example, in traditional instruction, critical elements (knowledge, responsibility for learning and assessment of learning) are perceived as residing with the teacher. Some of these, such as knowledge, are viewed as flowing from the teacher to the students through the teacher's actions. The others, however, remain with the teacher. In contrast, these elements are perceived in a cognitive theory-based perspective as shared by the teacher, students, and learning environment. Some elements are vested in the learning environment (for example, materials and the social and physical structure are organized so that collaborative and independent learning by students can occur). Several critical elements are vested in the student (responsibility for learning, self-assessment, self-monitoring, decision making related to problems to be solved), who is assisted by the teacher only if and to the extent needed.

Research by Stasz et al. (1990), Dinham (1989), Weber and Puleo (1988), and Rehm (1987) reveals particularly similar findings in the following areas:

- Structuring of instruction for collaboration and cooperation among learners
- Assumption of responsibility for learning by learners
- Role of learners as choice makers
- Encouragement of students to express their own thoughts
- Respect and caring for students and acknowledgement of student capabilities on the part of the teacher
- The teacher's acceptance of students' needs and responsiveness to them in ways uniquely tailored to each individ-

ual student and that also support other students' learning
- Reflection of the real world in the classroom environment and in students' learning experiences

Dinham's concept of balancing the opening and narrowing of problems for students seems roughly similar to Rehm's concept of freedom within limits. Dinham's concept of students shaping projects and instruction reflects both her own finding that students were encouraged to express their own thoughts and the Stasz et al. findings that students were encouraged to make bold decisions and take responsibility for their own learning and were viewed as people who knew something. Stasz et al.'s findings that the project assignment and the learning environment reflected actual working environments and that the teacher-student relationship resembled that of a master-apprentice relationship reflected relevance to a practice setting, one of the attributes in Dinham's good problem framework. This and Dinham's other good problem attributes (multiple goals, theoretical base, connects previous and future learning, represents a broad class of problems) were reflected in the features of Thomas and Englund's prototype learning environment.

What follows is a summary and synthesis of dimensions of cognitive theory-based instruction that reflects the features highlighted here, characteristics drawn from all three theoretical perspectives on instruction, and the full range of studies reviewed in this chapter:

EXHIBIT 1

DIMENSIONS OF COGNITIVE THEORY-BASED INSTRUCTION

Aims of Instruction Focus on Fostering and Supporting Such Capacities as--

--Being able to handle multiple inputs and deal simultaneously with multiple factors and considerations
--Social skills of communication, cooperation, collaboration
--Ability to learn and to use prior learning to aid new learning
--Ability to transfer previous learning to new situations
--Ability to interpret, judge, plan, modify, create
--Ability to understand points of view different from one's own
--Ability to criticize one's own and other perspectives

Learning Environments Display Such Characteristics as--

--Reflective of, high fidelity with, or synonymous with real-life situations, problems, and contexts
--Emphasis on ill-structured problems characteristic of real life (do not have one right answer, all the information needed to solve them is not available, are not "given"--need to be "found") versus school-type problems (have one right answer, provide all the information needed to solve them, are defined--"given")
--Collaboration among teachers, departments, disciplines, students, school, and community

--Richly stimulating, encouraging curiosity, exploration, and investigation on the part of students
--Exploration of multiple perspectives and sources of knowledge encouraged
--Few rules; ones that exist are collaboratively developed by students and teacher
--Responsibility for learning vested in the learner
--Effort, not just performance, acknowledged
--Failure viewed as a learning opportunity
--Provide opportunities for self-monitoring and self-assessment by learners
--Atmosphere of respect and caring among students and between students and teacher
--Allow time for thinking

Learning Characterized as--

--Personally involving
--An active rather than passive process
--A constructive process, one in which the learner constructs knowledge as a result of interaction with the physical and social environment
--An internalization process that occurs through social interaction and the use of language

Learners Characterized as--

--Having knowledge and experience that they bring to the learning situation
--Capable people
--Able to direct their own learning, learn on their own
--Able to support each other's efforts to learn

Teaching Viewed as--

--Scaffolding
--Guide on the side
--Following the learner's lead
--Teacher-learner partnership
--Collaboration with students in the learning process
--Supporting, encouraging learning
--Providing a cognitive apprenticeship
--Mediating students' experiences (helping learners interpret their experience)
--Confronting students with alternative perspectives and thought-provoking questions
--Bringing learners to their own understanding.

Some of the studies focused on determining effectiveness of instruction reflect several problems that surround this kind of study. First, there is the problem of being sure that the cognitive theory-based instruction being compared with another instructional approach is truly a cognitive theory-based approach. Second, there is the problem of being sure that the intended instructional approaches are actually the ones implemented. Third, there is the problem of being sure that the ways that outcomes are assessed capture the outcomes of interest. Fourth, there is the problem of having some reason to think that the cognitive theory-based instruc-

tional approach being tested is relevant to the outcomes of interest. Fifth, because significant cognitive change does not happen quickly, there is the problem of needing to sustain the approaches being tested over a reasonable length of time. The longer this time is, the more open the study is to risks of attrition and confounding contributions to learning outcomes. Those effectiveness studies in which these problems were more adequately addressed revealed that cognitive theory-based instruction was related to changes in learners' thinking toward higher cognitive levels. Products of thinking (solutions) of learners exposed to cognitive theory-based instructional approaches were not always different in quality from those of learners in control groups, but were, in some cases, achieved more quickly. The studies that addressed the problems more adequately were those lodged within a program of research (a series of studies that build on each other). Perhaps this is because there is the opportunity in programs of research to address each of these problems in a cumulative fashion and hone, over time and experience, conceptual foundations and procedural aspects of the research.

ASSESSMENT OF COGNITIVE DEVELOPMENT AND LEARNING IN VOCATIONAL EDUCATION

The previous chapter suggested that instruction based on cognitive theory leads away from traditional, didactic instructional modes. Assessment of learning based on cognitive theory also leads away from traditional assessment approaches that are focused on information recall and rely on objective paper and pencil tests. Assessment approaches that have their roots in cognitive theory are less distinguishable from instructional approaches than are traditional approaches to assessment. Cognitive theory-based assessment is focused on determining characteristics of learners' thinking and knowledge organization, on determining learners' capacities to use and transfer their knowledge and thought processes to new situations and problems, and on detecting changes in these characteristics and capacities. Formative purposes of assessment aimed at understanding student cognition in order to determine how learning can be supported are as central as summative purposes. Consequently, assessment occurs as an integral part of instruction rather than only as a separate, add-on piece at the end.

The challenge presented by assessment of cognitive development and learning is that thinking processes and the qualities of learners' thinking and knowledge must be observed, not just their results or products. For example, it is not enough to know that learners have stored and can recall information. How their knowledge is organized and the degree to which it is integrated must also be determined. Performance assessments may indirectly indicate that certain cognitive attainments have or have not occurred, but are often not focused directly enough on underlying cognitive aspects to reveal where problems lie. Because development of self-monitoring capacities is an important goal of cognitive theory-based instruction, students are involved in self-assessment and in assessing each other.

The three theoretical perspectives outlined in the second and third chapters influence how assessment is viewed and conducted. For example, a view of thinking processes as generic and separable from knowledge is likely to lead to the use of generic or general tests of thinking abilities that minimize dependence on knowledge. General tests of critical thinking, intelligence, reasoning, decision making, and so forth are likely to be incorporated as assessments of learning and instruction. In contrast, a view that thinking and knowledge are closely related is likely to lead to the development of content-linked assessments of cognition. A view that thinking is contextually embedded suggests that assessment would take place in the contexts of interest.

Development of cognitive theory-based assessment has lagged behind that of cognitive theory-based instruction. This lag has limited the means available for verifying that new instructional designs purported to affect cognition in certain ways actually do so. The need for alternative approaches to assessment that depart from paper and pencil tests of factual knowledge is recognized (Linn 1991), and a recent

publication in which a range of work on cognitive theory-based assessment is compiled responds to this need (Frederiksen et al. 1990). Suggestions have also been made for ways of determining the degree to which more traditional assessment approaches validly reflect reasoning (Norris 1991). The following sections contain a review of assessment-focused research in vocational education and point to research already reviewed that has implications for assessment.

Research on Assessment in Vocational Education

Although few in number, the assessment-focused studies reviewed here represent a range of conceptualizations of and approaches to assessment. Some reflect an interest in assessment of generic thinking processes whereas others reflect interest in domain-based thinking.

Greenan and McCabe (1989) developed, field tested, and validated assessments of 40 generalizable reasoning skills that had been identified in previous research (Greenan 1983). Assessment instruments included student self-ratings, teacher ratings of students, and a student performance assessment. The validation study involved 10 students and 1 teacher from each of 10 vocational programs including agriculture, business, health, home economics, and trade and industry. Students rated themselves and teachers rated the students using three scales: verbal reasoning, problem solving, and planning. The students also completed the reasoning performance test. Internal consistency reliability coefficients for student self-ratings and teacher ratings ranged from .81 to .99 and for the performance test from .60 to .92. Stability reliability test-retest coefficients for student self-ratings and teacher ratings were reported to vary widely. Low correlations between student self-ratings and performance scores and between student self-ratings and teacher ratings were also reported. Although these findings suggest that student perceptions of their own reasoning capacities are unrealistic in relation to their performance of those capacities and in relation to teachers' perceptions of their capacities, several assumptions must be made to come to that conclusion. For example, it must be assumed that students had an understanding of the reasoning skills on which they were rating themselves, that the performance test actually involved the same reasoning skills as reflected on the rating scales, and that teachers also understood the reasoning skills they were rating and observing. One avenue of further research on these assessments would be to learn whether these assumptions are warranted.

Also focusing on generic thinking skills, Purdin (1989) used a general test of critical thinking to evaluate the critical thinking skills of adults entering Ohio vocational home economics specialized programs; the results were intended as a basis for curriculum development for these programs. Target audiences of these specialized programs included unemployed persons, displaced homemakers, and single parents. Based on a review of several general tests of critical thinking, Purdin selected the Cornell Critical Thinking Test Level X to measure critical thinking skills of a sample of participants from the identified programs. Features of the Cornell test important in its selection included its low required reading level and its story format, which was anticipated to create interest and motivation. Completed tests were obtained from 169 respondents. Scores fell considerably below those obtained in previous studies of high school and college groups. Test scores also revealed significant differences in the critical thinking skills of participants entering the three different programs, sug-

gesting that each program may need to provide different curricular approaches with respect to facilitating critical thinking.

In another assessment study that represents a transition between assessing generic thought processes and content-embedded thought processes, Manifold (1984) modified a previously developed decision-making assessment instrument to fit the requirements of assessing practical reasoning within formative and summative evaluations of consumer and homemaking courses. More specifically, Manifold's purpose was to make available to home economics programs a valid, reliable, and usable decision-making skill evaluation instrument for the purpose of assessing level and stability of decision-making skills involved in practical reasoning. Decision making involved in practical reasoning was described as composed of six skills that represent essential aspects of choosing a course of action: identifying a good set of alternatives from which to select, identifying good criteria for making decisions, assessing alternatives, summarizing information to make a choice, conducting self-evaluation, and having the propensity to act. The instrument, adapted from work by Ross and Maynes, includes four written scenarios of practical problems. Students are asked to describe for each scenario how they would go about deciding what to do, what their decision would be, and why. Students' open-ended responses were scored using a Scorecard for Evaluating the Decision-Making Framework, which assigned points according to seven levels of decision-making skill. These levels included choice with no justification, justified choice, more than one alternative considered, alternatives compared, alternatives evaluated in terms of criteria, criterion weightings used multiplicatively, and use of a classification scheme to invent new alternatives and/or categories of comparison.

The adapted instrument was administered to 80 consumer and homemaking students. All students' responses were scored by 2 experienced raters, and a subset of responses were scored by 12 home economics teachers trained specifically in the scoring procedure. Results were judged to indicate that the instrument measured decision-making skills and levels at an appropriate range for home economics students and curriculum. Interrater reliability coefficients for the experienced raters varied between $r=.79$ and $r=.85$. Interrater reliability coefficients for the teachers, who scored fewer items than did the experienced raters, were lower. Significantly higher mean scores were found for students who had been taught practical reasoning compared with those who had not, a finding that supported the validity of the adapted instrument. Differences in the decision-making levels and skills of the same students across the four problems were interpreted as due to the influence of variations in a student's knowledge. Teacher raters suggested that usability would be strengthened with training for and practice in scoring. Later studies using this instrument report similar findings and some higher interrater reliabilities (Edersheim 1988; Jenkins-Vulgamore 1991; Martin 1988).

Thomas (1988c) sought to address a lack of adequate assessment tools for documenting learning of work role-related higher cognitive processes and their interaction with knowledge. Such learning was identified as the ability to make interpretations and judgments in situations representative of those learners encounter in real life. The Tailored Response Test was explored as an approach to (1) assessing content-embedded perceptual processes, interpretive thinking processes, and complex judgment processes, and the interaction of these processes with knowledge relevant to a specific knowledge domain or area of practice; (2) reducing the threat

to test score validity from test-wiseness on the part of the test-taker; and (3) providing an approach to assessment that is usable by both researchers and teachers in terms of time, effort, and knowledge required for scoring and that is sufficiently reliable and valid for use in research and program evaluation. The Tailored Response Test confronts the individual with a problem, puzzle, dilemma, or other situation, drawn from the practice domain, that requires the learner to acquire and interpret information, form conclusions, and plan strategies. The person is then asked to edit a paragraph discussing the situation by crossing out words, phrases, symbols, or sentences so that the final edited version represents the person's perceptions, interpretations, judgments, and plans regarding the situation. Because there are no response choices indicated, nor any indication of where editing should or should not occur, cues on which test-wise students often rely are minimized.

An extended procedure, described in detail in the study, was used to develop a prototype Tailored Response Test in the knowledge domain of working with children, an area believed to involve a high degree of judgment and in which considerable substantive knowledge relevant to judgments is available. The prototype test was evaluated in a study involving 123 students and 4 instructors enrolled in child development and child care courses in high schools, technical colleges, a community college, a 4-year college, and a university. Internal consistency reliability of the 12 paragraphs that were evaluated ranged from .66 to .91. Internal and external validity data supported the validity of the test. Administration required a 2-hour block of time. Scoring of the final form of the test (the nine paragraphs achieving the highest internal consistency coefficients) required an average of 9 minutes per student. This final form of the test was used in a later study to assess domain-related learning, where its performance with other assessments further supported its validity (Thomas and Englund 1990, 1991).

Assessment of Cognition in Other Studies

The studies just reviewed had as their main focus assessment of cognition for purposes related to the development of vocational instruction and determining its effectiveness. A number of studies reviewed in earlier chapters as having other focuses also involved assessment of cognition. Some of these studies incorporated tests of general abilities and orientations (Cole 1984; Cox, Sproles, and Sproles 1988; Curtis 1980; Federico 1983a,b; Jackman 1987; Kendall 1986; Kendall and Sproles 1986; Kendall-Sproles, Cox, and Sproles, 1987; Kowal 1984; Rojewski and Holder 1990; Siebold 1989). Others incorporated ways of observing both thinking processes and performance. These studies are highlighted in the following paragraphs.

Various forms of simulation were used in several studies to provide opportunities to observe both thinking processes and actions of individuals during their engagement in the simulation (L. K. Anderson 1989; Cooke 1988; Johnson 1988; Scribner 1984). Simulations are contrived situations and problems that reflect essential and significant features of real situations and problems. One of these, the tab item approach (Glaser, Damrin, and Gardner 1954) used by L. K. Anderson, provides the individual with relevant as well as irrelevant information and tracks the individual's path through and selection of the information. Cooke devised a contrived parent-child play situation in which an open-ended instruction allowed a wide range of interpretations by the parent.

The interpretations made were examined as a means of understanding the nature of parents' schemata. Johnson (1988) embedded faults within an electric generator and observed the thinking, knowledge use, and performance of troubleshooters in finding them. Scribner (1984) set up a situation in which individuals were asked to fill dairy orders from milk cases that had been strategically configured to reveal perceptual and thinking processes people used in filling the orders.

In-depth interviews (Cooke 1988; Rehm 1989b) are also an approach to assessment of thinking processes and knowledge organization, but they are time consuming and logistically difficult for teachers to implement. Nevertheless, in special cases, such an approach could provide useful assessment information. Analysis of "thinking out loud" verbal protocols is a way of revealing patterns in people's thinking and knowledge as they work through simulations (L. K. Anderson 1989; Cooke 1988; Ericsson and Simon 1984; Glass 1992; Johnson 1988). Because the analysis of verbal protocols involves time-intensive, extended effort, it is a more reasonable possibility for formal evaluation studies that involve special resources than it is for regular use by teachers. On the other hand, it would be a helpful tool in special cases where a teacher needs to understand a particular student's thinking more deeply.

Asking learners to provide a written interpretation of a situation or problem provides a record of thinking that can be analyzed for knowledge reflected in relation to thinking processes (Thomas and Englund 1989, 1990, 1991). Videotapings of students engaged in a simulation or other activity while thinking out loud provide records that can be analyzed for relationships between actions, thinking, and knowledge (Cooke 1988; Glass 1992). Although teachers are limited in their opportunities to devote long time periods to focused, in-depth observations of individuals, such as those used by Rehm (1987) and Scribner (1984), modifications are possible to make focused observations more feasible. For example, videotaped segments of students engaged in an activity over several weeks or months provides a record that can reflect changes in both actions and the cognition underlying them and spaces the time investment that extended in-depth observation requires over several weeks or months. The resulting tapes can be repeatedly examined, providing important opportunities for self-assessment by the student. Current work by the author suggests that a segment of even 10-15 minutes can provide rich information if the activity is fairly concentrated and the observer is clear about what to look for.

Stimulated recall (Cooke 1988) also provides special opportunities for self-assessment by students. In stimulated recall, a person is videotaped while engaged in an activity (but not asked to think aloud). The tape is then immediately replayed in segments and observed by the individual. After each segment the individual is asked what he or she noticed in the segment and what he or she was thinking at the time. The responses can be tape recorded, transcribed, and analyzed later for assessment purposes or assessed on the spot in a more clinical fashion by the instructor and/or the student.

Thomas and Englund (1990, 1991) used two approaches to assess knowledge organization and integration in their instructional design-focused study. The first procedure, identified as a diagnostic test, was used to determine the degree to which students noticed surface, descriptive features versus deep, meaning-related features. This assessment confronted learners with three scenes that were almost the

same in surface features, but very different in deep features. After they had viewed the scenes, students were given a sheet that listed both surface and deep features and were asked to circle those features they saw as similar across the scenes. Then students were given a second sheet listing the same features and were asked to circle those features they saw as differentiating the scenes. This assessment approach is quickly scored and would be practical for classroom use.

The second assessment procedure, identified as scenario analysis, involved confronting learners with a videotaped situation and asking them to record on paper what they noticed and their reactions. These open-ended responses were then coded according to level of knowledge reflected and linkages among knowledge levels. Although the detailed analysis used in the study is too intensive in time and effort to allow classroom use, responses could be examined for more general features that reveal schemata activated by the scene. Novak and Gowin's (1984) concept mapping is an alternative approach to assessing knowledge organization and integration, one that reflects schema theory and the close relationship between cognitive theory-based instruction and assessment. This technique is readily adaptable to classroom use for instructional as well as assessment purposes. The procedure for scoring students' concept maps is realistic for use by classroom teachers in terms of time and effort required.

Outcomes of Vocational Education

The identification of outcomes as a basis for determining student progress through schooling has been a focus of education agencies in many parts of the country over the past decade. Outcomes identified in such efforts that focus on problem solving, transfer of learning, critical thinking, and other higher cognitive processes reflect the influence of the cognitive movement. Assessment of outcomes in such efforts is often aided by a computerized bank of outcome-keyed items (Fitzpatrick 1991).

What is assessed in vocational education evaluation studies, instructional effectiveness research, and determination of student progress reflects what is considered to be of value. Studies of vocational education outcomes have focused more on basic skills and on economic attainment than on higher levels of cognition. Some basic skill outcomes are sometimes referred to as cognitive in nature; however, they often do not include more complex levels of cognition. Consequently, there is a problem in knowing whether basic skills mean cognitive outcomes and, if they do, whether such cognitive outcomes mean higher levels of cognition or more elementary knowledge storage and recall reflected in traditional approaches to assessment. Two studies relevant to educational outcomes of vocational education reflect the issues surrounding the meaning of the term basic skills. In comparing outcomes of vocational and academic education, Schmidt (1985) identified basic skills as math, reading, and vocabulary. What was actually compared was identified as cognitive outcomes reflected by test scores on reading, math, and vocabulary tests in the High School and Beyond data set. In another study Greenan (1983) identified four areas of basic skills common to all areas of vocational education as reasoning, mathematics, interpersonal relations, and communication. The levels of the skills identified within each of these areas varied widely.

Both Schmidt (1985) and Colardyn and White (1985) compared outcomes of vocational and academic education. These studies found that academic students outscored vocational students on measures

identified in the studies as cognitive measures. In Schmidt's study, high school students who had earned varying numbers of business credits and those who had earned varying numbers of academic credits were identified. Students who had earned two and one-half or more business credits had significantly lower mean scores on math, reading, and vocabulary tests than did students with fewer business credits. Conversely, the more academic credits students had earned, the higher were their mean scores.

Colardyn and White conducted their research at the Conservatoire National des Arts et Metiers in Paris. They sought to learn whether there were differences in the schemata of learners enrolled in a work experience program in addition to their academic programs and the schemata of learners enrolled in only academic programs. The two groups of students were compared regarding their ability to locate the different components of a washing machine and establish the relationships among them from a written description of how such a machine works. Although it was hypothesized that the work experience group would do better because of their experiential opportunities to construct relevant schemata, the academic-only group's performance was superior to that of the work experience group. Several problems make interpretation of this and the Schmidt study ambiguous. No controls for general intelligence or other potentially relevant factors were imposed in either study. In Colardyn and White's study, the numbers of students involved were not reported. In addition, it was reported that almost half of one of the work experience groups refused to participate because they viewed the test as irrelevant to their job training.

Summary and Conclusions

Assessment, more than instruction, seems to be limited by what exists. The image of the paper and pencil test containing convergent questions that have one right answer appears difficult to overcome. Many of the issues and limits surrounding assessment focus on lack of approaches for assessing cognitive processes, knowledge organization, and cognitive development. Further probing suggests that the meanings of assessment more than approaches for doing it are the more fundamental problem. Thinking about the purposes and meanings of assessment has not changed in light of cognitive theory. Consequently, many forms of assessment in current use do not fit cognitive theory-based instruction and will not be made to do so with simply a few adjustments. More fundamental change is required.

The term assessment was deliberately chosen over the term testing as the focus of this chapter. The latter term carves out a much narrower set of possibilities and stays too close to an image of paper and pencil, right and wrong answer-focused means for obtaining evidence regarding learning. The emphasis in cognitive theory-based instruction on self-monitoring and self-assessment raises questions about who controls judgment-making regarding learning. Independent learners need to be able to do self-assessment. The idea of shared control of the learning situation between teacher and learner is reflected in the third chapter more than is the idea of shared control of assessment reflected in research reported in this chapter. Students learn to judge their own thought and actions by having opportunities to engage in doing so under supportive guidance. The degree to which educators are willing to share control of assessment with students will reveal something about the primary purposes for doing assessment. Some of the assessments

discussed here explicitly incorporate or offer rich possibilities for self-assessment by students.

In addition to shared control of assessment, placing more emphasis on formative assessment may also help shift perspectives to ones that more adequately reflect cognitive theory. For example, assessments used in research that offer possibilities for viewing assessment in new ways are often better suited to formative than summative assessment. Adaptation of these assessments could provide valuable diagnostic and learning progress information to teachers as well as to students engaged in self-evaluation.

Regarding evaluation of outcomes of educational programs, there is a need for care in the language used to talk about outcomes and for clarity in the concepts symbolized by the language. For example, basic skills has become an imprecise term having several different meanings.

Framing of evaluation studies of vocational education as comparisons with academic education raises questions about the assumptions underlying why it is desirous to frame a comparison in this way, what is actually being assessed when such comparisons are done, and how the findings of such studies should be interpreted. With respect to the first question, Weber and Puleo's (1988) comparison study (which was not an evaluation study) sought data related to sorting out contradictory perspectives about vocational education in relation to academic education. This study was aimed at gaining a deeper understanding of instructional practices in both vocational and academic education in order to assess the validity of claims made about both, claims relevant to this review in that some concerned engagement of students in higher levels of cognitive activity. The purpose of Schmidt's (1985) research reflected an assumption that vocational education is as effective as academic education in delivering skills identified by Schmidt as cognitive and as having lifelong relevance: basic verbal and mathematics skills. Schmidt's stated purpose was "to sustain and gain additional public support" (for vocational education) (p. 50). The purpose of Colardyn and White's (1985) study reflected an assumption that a work experience learning context leads to different kinds of cognition than does academic education.

With respect to the second question--what is actually being assessed, the extent to which the effectiveness of vocational education is being evaluated in the Schmidt study (versus the general abilities of students who enroll more heavily in business education and those of students who enroll more heavily in academic subjects) is questionable. Because no controls for general ability were included in this study, it is impossible to sort out this question. The same is true of Colardyn and White's study, which also had other problems. One might hypothesize that what was actually being assessed in these studies was students' general abilities as they were reflected in the outcome measures used. On the other hand, Weber and Puleo's study revealed that, compared to academic teachers, vocational teachers emphasized student reading, writing, and extended speaking less. This finding suggests an alternative hypothesis for explaining Schmidt's findings regarding verbal outcomes: Vocational education instruction may not contribute as much as academic education to these outcomes.

Finally, what interpretation should be made of the results of studies that compare educational outcomes of academic and vocational education? How serious is the difference in the outcome scores reported by Schmidt? Do the differences

on the measures used in this study that entail lower levels of cognition imply that similar differences may also exist in higher, more complex levels of cognitive activity? If the general abilities hypothesis is correct, should Schmidt's findings be taken as evidence that supports Oakes' (1985) contention that certain groups of students, ones with lower general ability in this case, are tracked into, or somehow end up in vocational education? If the instructional emphasis hypothesis is correct, does this mean that students having lower verbal skills levels limit their opportunities to improve them by enrolling in vocational education? These exceedingly complex issues suggest that, in designing evaluation studies of cognitive outcomes of vocational education, questions similar to those raised here be considered: Why frame the evaluation this way? What does this design assume and are these assumptions reasonable? What is actually being assessed given the procedures that will be used? Are sufficient controls and other design elements included so that findings will be clearly interpretable?

ISSUES AND IMPLICATIONS

Cognitive theory has generated new understanding concerning learning, thinking, knowledge, teaching, and assessment. Many have suggested that these new understandings imply the need for paradigmatic shifts in educational methods, perspectives, and institutions. Some have pushed even further, suggesting that cognitive theory calls for change in long-established cultural patterns and structures. Literature addressing these issues in relation to vocational education is reviewed in this chapter.

Research

The second and third chapters demonstrate that cognitive theory-focused research is being done in vocational education and by vocational education researchers. However, when one compares the extent of this research with that produced in some areas of education (such as math, science, reading), it is apparent that considerably less such research is being done in vocational education. One possible reason for the lag in cognitive theory-related research in vocational education is that cognitive theory is not as relevant to vocational education as it is to other areas. There is little evidence to suggest that this is the case. On the contrary, vocational educators have claimed for many years that they assist students in developing higher-level cognitive capacities (Herren 1987; Lass and Moss 1988; Moore and Moore 1984). A more plausible explanation is suggested by Crunkilton (1984): Vocational education research does not, to a large extent, focus on teaching-learning processes. Although Crunkilton's analysis of research reported at professional meetings and in professional journals is limited to agricultural education, the process of identifying research for this review suggested that a similar pattern is also evident in other vocational education areas.

Criticisms of vocational education research (Kelly et al.1989) charge that much of it lacks a well-developed conceptual or theoretical base. If vocational education researchers, in general, do not look to theory as a context for their research, and if they do not focus their research on teaching and learning processes, it is not surprising that cognitive theory-based vocational education research is scarce.

The issue of how research is viewed has been discussed in the vocational education literature over the past decade (Coomer 1984, 1985; Garrison 1989; Hultgren 1985; Jax 1984, 1985; Miller 1989, 1991; Smith 1984; Wilsman 1985). Cognitive theory-related concepts are reflected in these discussions. For example, Garrison's (1989) description of postpositivistic research perspectives reflects schema theory: "Facts are not considered to be entirely independent of the theories they verify and confirm. All observation is said to be dependent on the conceptual forestructure of the researcher. This conceptual forestructure leads to selective attention on the part of those doing research" (p. 44). Although the term used is conceptual forestructure, which Garrison does not explicitly define, he implies a cognitive structure that operates, at least in some

ways, like a schema. Other reflections of cognitive theory are evident in discussions of alternative forms of research in vocational education. For example, concern in research with meaning and involvement of participants in developing and directing research reflect cognitive theory-based concepts of self-directed learning, collaboration, and learner-constructed knowledge. Emphasis in research on dialectical processes reflects cognitive theory-based concepts of confronting multiple meanings and using multiple sources of knowledge.

One set of articles illustrates the influence of schemata on inquiry purposes, processes, and findings by discussing how the study of critical thinking differs depending on the research paradigm within which it is conducted (Hultgren 1989; Plihal 1989; Thomas 1989; Way 1989). The study of critical thinking within an empirical/analytical (positivistic) mode of inquiry seeks to improve critical thinking by making it more efficient and better controlled in terms identified by the researcher or scholars. This mode of inquiry defines critical thinking as a set of skills or procedures for thinking, and it yields descriptions of critical thinking, factors affecting critical thinking, causes for critical thinking, antecedents of critical thinking, and explication of processes and products of critical thinking. The study of critical thinking within an interpretive (hermeneutic) mode of inquiry seeks to understand critical thinking as it is experienced by people, to uncover meanings (plural emphasized) of critical thinking. This mode of inquiry defines critical thinking as an experienced, dialectical process guided by principles rather than procedures. It yields multiple, context-embedded perspectives and meanings of critical thinking, including insights that are discovered and are often surprising rather than predicted or anticipated. The study of critical thinking within a critical mode of inquiry uses critical thinking as a means of empowering research participants. Research participants engage in critical thinking for the purposes of becoming aware of and understanding meanings and consequences of social structures and processes and of bringing about change toward freedom from economic, political, sexual, intellectual, or spiritual domination or exploitation. This mode of inquiry defines critical thinking as an integral part of one's personality, a stance toward life, and an inquiry process. This mode yields self-awareness, identification and exposure of ideologies, identification of alternative possibilities, and action toward transforming oneself and society in directions of equity and justice.

Teaching and Learning Processes

Cognitive theory supports conducting teaching in ways that reduce inculcation and a passive stance for learners and increase the degree to which learners have opportunities to question, discuss, and discover for themselves, to "construct" their own knowledge. Being "a guide on the side" rather than "a sage on the stage" is a metaphor that has been used to reflect the shift in the teacher's role necessitated by this kind of learning. Other terms used to identify this "guide on the side" teaching role include cognitive apprenticeship and situated cognition (Brown, Collins, and Duguid 1989; Cognition and Technology Group at Vanderbilt 1990; Collins, Brown, and Holum 1991; Gott 1988; Jones 1992; Raizen 1989; Resnick 1987). A similarly student-centered pattern is also reflected in research that provides insights regarding ways teachers support student creativity: sensitivity to student interests and needs, allowing student choices, providing specific encouragement for creative endeavors, and providing an environment in which failure carries little risk (Rehm 1989b; Stasz et al. 1990).

Crowell (1989) points out that content and process are integrated in such teaching, mutually embedded in each other and inseparable. Groups are arranged "to work through discovery activities, with both individual and group outcomes expected. Roles are assigned to each member and cooperative interaction is encouraged . . . groups explore different activities that relate to various aspects of the same concept . . . and (share) their findings . . . the conceptual emphasis is similar to variations on a theme" (pp. 61-62).

Claus (1989) suggests three essential features of vocational education instruction that promotes analytical thinking and greater equality of opportunity in schools and workplaces: (1) involvement of students in real work or work-like situations, analytical thinking, group process, and significant responsibility for managerial decisions that have real economic consequences; (2) necessity for students to gather broad economic information, market a product, negotiate with work colleagues, and make workplace decisions; and (3) involvement of students in reflective thinking about the structure and functioning of the economy, the conditions and power relations of different kinds of work in the conventional workplace hierarchy, and options for change. Claus contends that such group-managed entrepreneurial projects, if democratically run, encourage students to see themselves not just as workers who follow the directions and decisions of others but as potential participants in a more egalitarian managerial process. Similarly, a perspective reflected by Eyre and Peterat (1990) suggests that students must be helped to question rather than simply accept what is as given, and that, in order to support students in this process, teachers must engage in it themselves.

Even if teachers know that simulations, dialectical dialogue, collaborative structuring of classrooms, and field-anchored experiences are avenues that can support knowledge construction by learners, teacher preparation is likely to have prepared them better to lecture and give tests that measure learners' memory and ability to recall someone else's knowledge. Implications of cognitive theory for teaching and learning processes suggest that teacher education cannot remain untouched.

Teacher Education and Inservice Training

Eyre and Peterat (1990) suggest that attention be given in teacher education to teachers' concepts of thinking, since these concepts are likely to limit or enhance what they do in the classroom to facilitate their students' thinking. Teachers need to be helped to see the complex of factors that are part of the teaching-learning process and to experience in their own education teaching processes that reflect those factors (Crunkilton 1984). If it is believed that teachers should be involved in facilitating thinking among their students, teacher education should (1) help teachers understand and strengthen their own thinking and help others do the same and (2) focus assessment of teacher education students on their thinking processes rather than on just the products of those processes (lesson plans, curriculum outlines) (Claus 1989; Crunkilton 1984; Eyre and Peterat 1990). Forms of assistance provided to teachers should be evaluated for the ways in which they might limit teachers' thinking and creativity. For example, providing ready-made lesson plans, teaching guides, and content outlines may, on the surface, appear to assist teachers, but are also likely to reduce their need to think about their teaching and the teaching-learning process (Crunkilton 1984).

Institutions

Opportunities for teachers to focus teaching and learning processes in their classrooms on higher levels of cognition are influenced by the institutions within which they work. A number of criticisms have charged that schools limit rather than enhance the kind of cognitive development that fits students for life in contemporary society. These criticisms echo charges made in an earlier era that schools isolate students from experience and are discontinuous with daily life and work (Dewey 1938). Although not the only educational area identified as contributing to this problem, vocational education is seen by critics as contributing to the isolation by supplanting hands-on practice and coaching characteristic of apprenticeships in work settings with direct instruction (Gott 1988; Raizen 1989; Resnick 1987). Although some critics acknowledge the relevance of the concern for citizens in a democracy being able to determine their own destiny (Resnick 1987), the major concern of these critics is the perceived discontinuity between what the schools supply and what the real world demands in skilled performers. These perspectives reflect the 100-year-old struggle in the United States regarding whether the purpose of schools and that of vocational education is to supply labor for industry or to prepare citizens for life in a democracy, or both.

Critics of schools as isolation-producing institutions see a return to an apprenticeship form of learning and teaching as a solution. A revised form of apprenticeship necessitated by the increasing limitations on the observational accessibility of key learning is advocated (Raizen 1989). Cognitive apprenticeship is a term applied to this revised form of apprenticeship that makes essential-to-learn, covert thinking processes overt (Collins, Brown, and Holum 1991). Features of cognitive apprenticeships include (Gott 1988) (1) situated learning in which students execute tasks and solve problems in environments that reveal the various intended uses of the knowledge they are acquiring; (2) external support or scaffolding from the tutor or master in the form of ideal modeling of the desired performance, hints, reminders, explanations, and filling in knowledge gaps to assist the apprentice's task execution that fades as the apprentice's skill and autonomy build; and (3) carefully sequenced learning activities that reflect changing student needs at different stages of skill acquisition. Resnick (1987) identifies apprenticeship among the key features of programs effective in facilitating students' learning and thinking capacities. (These features are summarized in the third chapter.) Resnick contends that these same features also characterize out-of-school learning and that there is a need to redirect the focus of schooling to encompass more of the features of successful out-of-school functioning. Resnick (1987) and Raizen (1989) both argue for schooling that more closely reflects the culture of the workplace; however, their concern goes beyond technical skills to include workplace context and social structures. Interestingly, there is little or no mutual cross-referencing evident by those cited here who urge cognitive apprenticeship and by those who focus on cooperative education, internships, and clinical experience (Stone and Wonser 1991).

Research reflects ways in which schools also isolate teachers. Barriers identified by Stasz et al. (1990) as inhibiting teachers' opportunities to conduct their classes in a way that fosters students' higher-order thinking include isolation from the broader school culture including teaching colleagues, from collaborative staff activities, and from school decision making. The separation of vocational and academic education is another isolation-

related concern that has been addressed in recent literature (Claus 1989; Mauter 1988). An undesirable homogeneity of students in each, which limits the diversity of perspectives introduced into the learning environment, is perceived to be the result of this separation. This concern is supported by a schema theory perspective on learning that suggests that diverse perspectives aid learning. It has been argued that schools maintain this separation by offering class schedules that promote tracking and inhibit registration by students in both vocational and academic subjects and by reflecting cultural meanings and ways of thinking that ascribe to vocational education the role of job-specific training and technical skill development and to academic education the role of promoting higher levels of cognitive development (Claus 1989; Mauter 1988; Oakes 1985, 1987).

Although a number of studies concern institutional barriers to teaching and learning at higher cognitive levels, research also reveals institutional supports, several of which reflect the opposite of isolation. Rehm's (1989b) findings indicate that teachers perceived their creativity to be aided by opportunities to meet with other teachers, actively share ideas and emotional support, and cooperate in creative work. Institutional supports identified by Stasz et al. (1990) include access to knowledge, press for achievement, and professional teaching conditions. Access to knowledge was promoted in the interior design class because the teacher had the resources to purchase necessary material to support the house design project and because students had opportunities to learn by working in a local retail store. Press for achievement (institutional pressures that the school exerts to get students to work hard and achieve) was not stressed for vocational students by the school administration. The academic curriculum took precedence over the vocational, and college enrollment figures were used to measure school success. Vocational teachers fostered press for achievement by having high expectations for students and valuing growth in the quality of student work. Claus (1989) cites other work suggesting that this is not always the case in vocational education; vocational teachers may lower their expectations out of compassion for students' expressed frustrations or based on assumptions about what teachers think students can achieve. Professional teaching conditions included a minimum of paperwork or other bureaucratic requirements, a supportive administration, and teacher autonomy in making classroom curriculum and instructional decisions (Stasz et al. 1990). These closely parallel conditions cited by others as supporting teacher creativity (Chantrill 1990; Rehm 1989b).

The issues discussed in this section make it easier to see why some have warned that tinkering with the external trappings of schooling will not result in the kinds of changes in schools called for by the implications of cognitive theory (Michaels 1988; Oakes 1986). The challenge of transforming schools, however, reaches beyond the school as an institution to the people that shape schools and to the depths of the broader cultural context in which schools are set.

Educators and Policy Makers

It is tempting to blame schools for educational problems because doing so provides a sense that someone else will have to act differently if things are going to get better. Schools, however, are us. Unless there is a change in how those who form and maintain schools and educational systems think about teaching and learning, knowledge and education, they will continue to perpetuate barriers to the kinds of change in schools that cognitive theory implies.

Schools and educational systems reflect the perspectives of their leaders. Only tinkering is likely to occur unless educational leaders, researchers, teacher educators, policy makers, and those who conduct the day-to-day activities in educational institutions examine their basic philosophical beliefs about teaching and learning, the nature of human beings, and the kinds of environments that maximize growth for teachers and students; sort out their values; and develop new belief systems (Crowell 1989; McCracken 1983; Michaels 1988; Oakes 1986).

Daines (1986) offers four propositions to consider in such a reorientation of thinking:

- that thinking be legitimized as a worthwhile activity by providing time for people to think, time for people to explain their ideas, time for others to examine them, and time to develop and evaluate them;
- that thinking be respected and recognized as an act of courage and citizenship that makes a contribution to society;
- that different ways of knowing be focused on a problem and that people be encouraged to work together to develop the strength of their collective ideas; and
- that clarity of meaning and coherence of thought be an aim of communication, with individuals coming to understand the importance and power of language to the development of higher-order thinking.

Culture

It is evident that context and environment influence cognition in very subtle but also very powerful ways (Anderson 1986; Scribner 1984). The ways of thinking that prevail in the broader culture influence the culture of schools and how those responsible for shaping schools view the world. The cognitive movement in education challenges a number of the nearest, dearest, and deepest cultural perspectives. Raizen (1989) asserts that the cognitive movement calls for erasing from thinking culturally embedded dichotomies associated with occupations and preparation for them, such as trades and professions, blue collar and white collar, vocational preparation and professional preparation, academic and vocational education, on the grounds that these are becoming obsolete in the modern workplace. Crowell (1989) extends the call further to include the dichotomy of objectivity and subjectivity. Others argue that a technocratic perspective limits people's propensity to engage in higher levels of thinking and that such a perspective dominates the culture (Bullough, Goldstein, and Holt 1984; Thompson 1982). Critics have also argued that the culture is where the roles ascribed to vocational and academic education originate and is the level at which change will need to occur. This cultural perspective of roles reflects vocational education as providing job-specific training and technical skill development and academic education as promoting higher levels of cognitive development (Claus 1989; Mauter 1988).

Despite the rhetoric lauding it, thinking may not truly be valued in U.S. culture and may actually be feared. Because this is a literate society, reading and writing (sometimes referred to by that slippery term, "basic skills") are valued. The importance of reading and writing is generally accepted as a means for surviving and achieving some level of attainment within the social structure. In contrast, thinking has not achieved the status of a culturally valued skill (Hartman-Haas 1981). Much of the rhetoric concerning the importance of thinking in U.S. society reflects a focus on perceived economic

benefits that better thinking is seen as producing. But truly improved thinking throughout the society also implies a population that questions authority and that has the capacity to criticize cultural conventions and to create new cultural forms. Because such capacities threaten the existing order, a culture that gives lip service to the importance of thinking may, at the same time, resist thinking on the part of its people (Claus 1989; Hartman-Haas 1981; Nickerson 1987).

The possibility that thinking may not be valued in a deep way is further reflected in arguments that it is often pushed aside for a higher priority on compliance, a pattern that is reflected in the broader culture and in schools (Claus 1989; Mauter 1988). Claus argues that compliance, rather than complex thinking, is reinforced when, instead of teaching students to rely on their own intellectual capacities to formulate their own thoughts, teachers help them learn to respond to difficult thinking tasks by turning to teachers (and later to supervisors) for answers. Similarly, others (Crunkilton 1984; Eyre and Peterat 1990; McCracken 1983) argue that when teachers accept what is given and fail to question it and draw out the issues underlying it, they miss the potential that an experience has for deep, significant, meaningful learning that helps students become responsible for their own questions, their own thinking, and their own learning.

Summary and Conclusions

The implications of cognitive theory for education and the issues it raises reveal why cognitive theory as a perspective on learning and teaching reaches far beyond teaching methods and techniques. Although methods and techniques are relevant, without more fundamental modifications in perspectives, institutions, and culture, barriers to creating cognitive theory-based education are likely to remain and little significant change occur. Some of the barriers identified in the literature reviewed in this chapter include dualisms that are retained in thinking even though they no longer reflect reality, and ambivalence within the larger culture (and reflected in educators and their institutions) regarding education that facilitates development of higher-level cognitive capacities.

A cultural perspective of vocational education as job-specific training and technical skill development and of academic education as promoting higher levels of cognitive development is called into question by studies presented in the third chapter that link higher levels of cognitive development to vocational instruction. Although Weber and Puleo (1988) provide evidence that vocational instruction does differ from academic instruction on several dimensions, neither their study nor the Stasz et al. (1990) nor Rehm (1987) findings suggest that teaching processes used in secondary vocational education are unlikely to support development of higher levels of cognition. Their findings suggest quite the opposite and point to a potential lack of fit between assumptions reflected by the culture and realities within school programs and classrooms. How representative of vocational education in general the findings of these studies are is a question that will need to be answered through an accumulation of additional similar studies. These studies suggest that causes in addition to the kind of instruction that occurs in vocational education are plausible contributors to patterns of vocational education outcomes. One such plausible contributor is the tracking of certain groups of students into vocational education.

Critics who charge that vocational education has supplanted apprenticeships imply

that vocational education has been a major force in the decline in apprenticeship training. History reflects that the decline in apprenticeship training began more than 100 years ago in this country, before vocational education was established, due to numerous factors, which included changes in the organization and structure of work (Wirth 1980). Vocational education, one result of this decline, may have contributed to a further decline in apprenticeships, but it should not be assumed that had there not been vocational education, apprenticeships would not have suffered decline. What are described by critics as key features of cognitive apprenticeships and programs effective in facilitating students' learning and thinking capacities resemble the features identified in the Stasz et al. (1990) and Weber and Puleo (1988) studies as characterizing vocational education. It may be that secondary vocational education does, or at least can do, a better job of providing such experiences than is assumed by critics. At the same time, the criticisms are goads to vocational educators at all levels to explore the potential of cognitive apprenticeship and situated cognition as guiding metaphors for vocational instruction and to examine vocational education critically for ways it may isolate rather than integrate schooling and life.

CONCLUSIONS, QUESTIONS, AND RECOMMENDATIONS

This chapter represents the author's attempt to take a broad view of the literature reviewed and the discussions in the previous five chapters in order to identify general conclusions, questions, and recommendations.

Value of Higher-Level Cognitive Capacities

The literature overwhelmingly conveys the sense that the development of higher-level cognitive capacities is desirable. Literature reviewed in chapter one, in emphasizing reasons for why such an aim is desirable, raises few questions regarding this aim. Literature reviewed in the four succeeding chapters assumes the desirability of such an aim by focusing on what would be helpful in addressing it: a better understanding of the nature of cognition, learning ways of teaching that promote higher-level cognitive capacities, assessing higher-level cognition, and reforming schools and culture to be more supportive of thinking. Most rationales convey instrumental reasons for the importance of developing higher-level cognitive capacities: They lead to getting a better job, to the nation being able to compete better economically, to people being able to fit better within a changing and complex environment, to improving the quality of family life. The rationale that higher-level cognitive capacities have intrinsic value in a democratic society is also evident, but to a lesser extent.

Some literature suggests that one value of highly developed cognitive capacities is efficiency. People whose cognition is well developed in a certain area can do things faster and better. Other literature suggests that thinking takes time and may delay action, that speed and time pressures hamper the quality of thinking. Although the literature reviewed emphasizes cognition, a significant amount of it also suggests and provides evidence that cognition is intertwined with and contributes to perception and physical skills; to social processes, relationships, and structures; and to affect. The literature also suggests that these other areas influence and contribute to cognition. Thus, it is hard to place a higher value on cognition, for example, than on affect, and for value to be ascribed to any of these dimensions in isolation. Their value, including that of cognition, is in their relationship to each other. Practical reasoning, described as economizing mental and physical effort, as highly varied and tailored to the situation, and as having moral dimensions, reflects both the efficiency view and a view of cognition as interrelated with these other dimensions.

When Cognition Is Developed

The literature reviewed reflects the assumption that educational programs bear considerable, if not sole, responsibility for the development of cognitive capacities. Even the one author (Champagne 1986) who did acknowledge the importance of childhood as a period of cognitive development limited her comments to the contributions of the elementary school. A growing research literature in child devel-

opment is revealing that the far earlier periods of infancy and early childhood are critical in cognitive development and set the stage more than previously realized for later cognitive patterns and possibilities for continued cognitive development. Critical to cognitive development in these early periods are the physical and social environments children experience, environments that are typically provided by their parents. This literature implies that what schools can do in the area of cognitive development is limited or enhanced by this earlier development. Remedial programs reviewed here have as their goal compensating for deficiencies resulting from missed opportunities for earlier development. Provision of such programs by schools is intended to equalize opportunity. Although remediation has been partially successful, it seems unable to compensate fully for missed developmental opportunities at an earlier, critical age.

Research on early development and that revealing the limits of remediation programs suggest that, if society is truly committed to facilitating cognitive development, it will not wait until the school years to support it. Development critical to a person's cognitive capacities occurs far earlier than people have been willing to acknowledge. As a society, helping parents to provide supportive environments for children during their earliest years of development may be one of the most important things that can be done if it is truly thought that the development of intellectual capacity is of value and should be an opportunity available to all children. Programs in vocational education that have as their concern service to families are especially relevant to such efforts. The point is made in several chapters that culture influences cognition. An industrial culture that incorporates quality control at the end rather than during production is perhaps reflected in the tendency to focus on remediating people rather than on providing needed support during their formative years. This support does not mean providing early education programs that teach children earlier what is normally taught in elementary school. Rather, it means making sure that children have opportunities during their earliest years of life to use and develop the learning capacities they come with in exploring an environment that is richly stimulating and socially supportive.

Another way of dealing with the problem of underdeveloped cognitive capacities is made possible by the artificial intelligence movement. By extracting key intellectual functions from people whose capacities are highly developed and computerizing them, they can be multiplied and used to amplify or compensate for the capacities of many people. Although this may be viewed as a solution that is acceptable and adequate by some, it does not address the need in a democracy for citizens who can think for themselves.

Developing Higher-Level Cognitive Capacities in Vocational Education

A view of the educational system as separated into two distinct streams--academic education and vocational education--is evident in the literature. Assumptions reflecting this separation are apparent in studies that compare academic and vocational education and in rationales that argue that different rather than the same students should be served by each. What does the propensity to divide and compare academic and vocational education signify? What assumptions and interests does this propensity reflect? Pursuing such questions is one possible avenue through which the origins and tenacity of this and other dichotomies identified by Raizen (1989)--trades and professions, blue collar and white collar, vocational

preparation and professional preparation--might be better understood.

Does vocational education have any business having the development of higher levels of cognition as a primary aim in the face of expressed views that academic education is a better place to develop higher-level cognitive capacities? Studies suggesting the answer is yes include the following: (1) those revealing significant change in cognitive capacities related to instructional processes used within vocational curriculum; (2) those that compare vocational and academic education and find that, although instructional processes used in each differ, those used in vocational education are consistent with instructional practices that engage students in higher levels of thinking; and (3) those that examine vocational education classrooms in depth and find numerous ways in which students' experiences in these classrooms foster the development of higher-level cognitive capacities. These patterns along with other studies that reflect lower achievement on outcomes of lesser cognitive complexity for vocational students compared to academic students raise many questions that need to be pursued within research designs that enable clear interpretations.

The assumption that purposes of vocational education are focused on preparation for work roles in business and industry is central in much of the literature reviewed. A primary argument reflecting this assumption is that, since occupations are becoming more reliant on cognitive capacities, vocational education should focus on supporting the development of such capacities in its clients. A role for vocational education in supporting development of more general cognitive capacities is also reflected in the literature reviewed and justified in terms of the need in a changing work environment for flexibility and adaptability to changing conditions. Another view of the purposes of vocational education reflected in the literature is the development of cognitive capacities related to individual interests, family and community life, and social transformation. Because cognitive theory is relevant to all of these purposes--those associated with work, family, community, and the broader society--it offers an avenue through which they can be better understood and through which choices among them and possibilities for their integration and synthesis can be more clearly seen. The three cognitive theory perspectives provide lenses through which reflection on purposes of vocational education yields different and potentially complementary insights.

Critics of schools and advocates of cognitive apprenticeship cite the schools' isolation of students from experience in the real world as a major problem and implicate both vocational and academic education as culprits. Yet, research reviewed here offers evidence that vocational education can and does provide students with both experience in the real world as well as in-school experiences that reflect important features of real world experience. Where do supervised occupational experience, cooperative education, and internships or field experiences that are part of vocational education programs fit in relation to the concept of cognitive apprenticeship? This would seem to be a question rich in possibilities for cognitive theory-based vocational education research, for application of cognitive theory within vocational education curriculum and instruction, and for contributions by vocational education to cognitive theory.

Instruction

Characteristics of instruction that emerge from the review and that were listed in Exhibit 1 (p. 39) reflect all three theoreti-

cal perspectives. These may be viewed as "cognitive theory-based guides" for instruction. Although each of the theoretical perspectives contributes a unique understanding of curriculum and instruction, each represents only part of the picture. Information processing focuses instruction on culturally valued cognitive processes whereas knowledge structure theories orient instruction to the creation of learning environments that facilitate learners' construction of their own meanings. Finally, social history theory focuses more intently on the contribution of teacher-learner interaction and the social environment to culturally valued learning. Taken together, the three perspectives offer a more comprehensive view of cognitive theory-based instruction than does any one alone. Tensions between the culture and the individual and between knowing, thinking, and doing reflected throughout educational history are addressed when all three perspectives are integrated. Given the greater comprehensiveness and richness gained through a synthesis of the three theoretical perspectives, it is not surprising that more than one of them is often reflected in cognitive theory-based instruction.

Because all three theoretical perspectives potentially offer something valuable to vocational instruction, it is important for vocational educators and researchers to understand all three perspectives and their implications for instruction. Cognitive task analysis, associated with the information processing approach, and the componential flavor of the information processing perspective may feel the most familiar and comfortable to vocational educators who have a long history of using a behavioral task analysis approach to curriculum. The same pattern of reducing larger entities to their component parts and teaching the component parts are present in information processing approaches--only the focus is on intellectual processes rather than on observable behaviors. Although this may be a place for some vocational educators to start their involvement with cognitive theory-based research, unless other cognitive theories are also explored in relation to vocational education, the contribution of cognitive theory to vocational education could be unduly limited.

Assessment

How assessment is conducted reflects concepts of cognition and what is valued. If efficiency is valued, cognitive processing speed will be measured. If cognition is viewed as separable from other human dimensions and capacities, it will be assessed in isolation rather than in relation to actions, perception, social structures and processes, and affect. If cognition is thought to develop mostly in school, it will be assessed only in relation to what has been taught. If thinking is valued as a process, assessment will focus on it as it is occurring and methodologies that enable this will be developed. If its products are valued, assessment will focus on those.

Breaking free of mind sets regarding what constitutes assessment, assessment materials, and assessment procedures may be one of the most difficult but also one of the most important things that can be done in addressing problems surrounding assessment of higher levels of cognition. One place to start in eliminating limiting mind sets is with the questions of why assessment is done, how the nature of assessment in school compares with that done in other spheres of life, and where the need for reduction of learning achievement to scores originates.

The assessment studies reviewed here represent a start in coming to grips with the implications of cognitive theory for assessment of learning and cognitive

development. There is a long way to go. The efforts reflected here should be extended so that limitations they reflect can be reduced and understanding of assessment deepened.

Research Needs

It seems fair to say that, judging by the cognitive theory-based research reviewed here, the reasons vocational education has lagged behind other educational areas in exploring the relevance of cognitive theory to its problems do not include a sense that cognitive theory has little to offer vocational education. Other possible reasons for the lag can be hypothesized. For example, a number of researchers who are producing cognitive theory-based research in other educational areas started their professional careers as educators in those areas (such as science, math, language, reading) and pursued their higher degrees in cognitive psychology. Few, if any, cognitive psychologists started their professional life as vocational educators. Another possible reason for the lag is reflected in Crunkilton's (1984) observation, noted in the previous chapter, that there seems to be more limited interest among vocational education researchers in problems of teaching and learning than in other issues.

One consequence of the lag is that vocational education has not benefitted to a great extent from cognitive theory. A second consequence is that vocational education has not contributed in ways it might to the development of cognitive theory and to the development of instruction that reflects cognitive theory principles. More research focused on teaching-learning processes in vocational education and incorporating cognitive theory would address these issues and problems. More specifically, studies are needed that investigate the nature of vocational instruction from a cognitive theory perspective. One avenue such studies might take is the exploration of vocational instruction in relation to the concept of cognitive apprenticeship. For example, supervised occupational experience, cooperative education, internships, and field experiences within vocational education could be examined for ways these experiences reflect cognitive apprenticeships and for ways the concept of cognitive apprenticeship could be used to strengthen such experiences. The concept of cognitive apprenticeship might also be explored as a basis for creating new educational structures and experiences.

Research on the nature of cognition as it functions in practice would be an appropriate contribution for vocational education researchers to make to the understanding of cognition, one that will require research of the kind reported in chapter two. The effort here to summarize theories and methodologies that this kind of research involves and to review examples of it may help to spur interest among vocational education researchers in such research activity. This kind of research reflects the need to study cognition in action and in relation to context and other human capacities. The value placed in the social history perspective on studying cognition during a time of social change suggests that the workplace and the family, both contexts of interest in vocational education and undergoing dramatic and rapid change, should be rich contexts for understanding how environment influences the nature of cognition.

Need for Programmatic Research

Programs of research offer opportunities to focus on a significant problem in a logical progression. Programmatic research adds up to something more significant than do most isolated, single-shot

studies. If what is studied is truly significant, it is likely too complex to be well understood in a single study. Research efforts need to be viewed in the context of a larger whole. A programmatic context for research is also likely to focus more intently on the problems that need to be addressed and less on the research needed in order to get a degree or publish an article. Regarding the latter concern, research that is tied to truly significant educational problems will be of interest to researchers in other educational areas as well and is likely to have broader publication opportunities.

One effort to encourage programmatic research linking cognitive theory to vocational education is an inquiry agenda outlined by Thomas and Litowitz (1986). This inquiry agenda outlines programmatic streams of research in three major areas:

- Identifying and organizing problems and contexts central in vocational education
- Describing, documenting, and understanding knowledge, cognitive capacities, and dispositions relevant to the problems and contexts
- Identifying, developing, and assessing curricular designs and instructional processes that support learning and development of that knowledge and those cognitive capacities and dispositions

Several studies reviewed here were conducted within this research program and reflect these areas (L. K. Anderson 1989; Cooke 1988, 1989; Glass 1992; Johnson 1988; Thomas 1988c; Thomas and Englund 1989, 1990, 1991; Westerdahl 1991). Other studies reviewed comprise a second, more specifically focused research program concerning teaching and assessing practical reasoning (Edersheim 1988; Jenkins-Vulgamore 1991; Laster 1982, 1985, 1986a; Manifold 1984; Martin 1988). Programs of research offer an opportunity to involve several people in addressing problems that are of such magnitude they cannot be solved by a single individual. Although individuals who participate in such research programs direct their own research, the program facilitates opportunities to build on others' work and provides researchers with a significant base of resources to draw on. These resources include assembled repositories of research and theoretical literature, databases, repositories of tested instruments, tested research procedures, and expertise in and experience with concepts central to the research program and relevant research procedures. Programmatic research offers such resources to students pursuing doctoral and master's level research, and provides a framework within which faculty colleagues within vocational education and across educational areas can pursue coordinated and collaborative research efforts.

Programs of research offer opportunities to pursue significant problems using several kinds of research and incorporating different theories. For example, incorporating the three theories reviewed here (information processing theory, knowledge structure theories, social history theory) in programs of research on cognition and vocational education would provide different views, much like a prism has different facets. These multiple perspectives focused on a problem area are likely to lead to more adequate understanding than is a single theoretical framework. Likewise, incorporation of different research paradigms within a program of research also focuses attention on different facets of a problem, as is illustrated by the example of critical thinking studied from three different research perspectives (chapter five), and the understanding-focused and experimental studies of instruction (chapter three).

Finally, programmatic research allows a history of working together to be established. By working over time with colleagues and clients on problems of mutual interest, researchers build structures within which research work is facilitated. For example, established working relationships make it easier for practitioners and others interested in using the research to be involved in planning and carrying it out. As practitioners become intimately familiar with the research by working with it and helping to plan it from its inception, they become better able to facilitate it, have more ownership in it, and are more likely to use its findings in their work. As researchers working within such structures develop deeper understanding of and appreciation for the problems of practice, they become better able to understand what kind of research has meaning for practitioners. Such working relationships reflect a joint action partnership in which responsibility for directing and interpreting the research is shared.

Summary

Education from a cognitive theory perspective is not business as usual. For that reason, it is likely to be both hailed and feared depending on one's present perspective of vocational education. Cognitive theory offers rich opportunities for more deeply understanding vocational practice and its implications for vocational education. Cognitive theory also provides a lens through which to gain new insights into the nature of vocational education and its possibilities.

REFERENCES

Items with ED numbers may be ordered from the ERIC Document Reproduction Service, CBIS Federal, 7420 Fullerton Road, Suite 110, Springfield, VA 22153-2852, (800) 443-3742, (703) 440-1400.

Adler, M. *The Paideia Proposal: An Educational Manifesto.* New York: Macmillan, 1982.

Allington, Richard L. "How Policy and Regulation Influence Instruction for At-Risk Learners or Why Poor Readers Rarely Comprehend Well and Probably Never Will." In *Educational Values and Cognitive Instruction: Implications for Reform,* edited by L. Idol and B. F. Jones. Hillsdale, NJ: Lawrence Erlbaum, 1991.

Anderson, E. P. "Gender as a Variable in Teaching Thinking." In *Higher Order Thinking: Definition, Meaning, and Instructional Approaches,* edited by R. G. Thomas. Washington, DC: Home Economics Education Association, 1986. (ERIC Document Reproduction Service No. ED 287 998).

Anderson, J. R. *Cognitive Psychology and Its Implications.* New York: W. H. Freeman., 1985.

Anderson, Lorraine K. "Comparison of Structure of Knowledge and Thinking Processes in Relation to Performance Differences among Experts, Intermediates, and Novices in Solving Housing Selection Problems." Ph.D. diss., University of Minnesota, 1989.

Anderson, Lowell D. "Problem Solving in Technology Education." *Technology Teacher* 49, no. 1 (September-October 1989): 3-7.

Bailey, Thomas. *Changes in the Nature and Structure of Work: Implications for Skill Requirements and Skill For nation.* Berkeley: National Center for Research in Vocational Education, University of California, 1990. (ERIC Document Reproduction Service No. ED 323 295).

Bentley, Richard G. "The Cognitive Organization of Graphic Communication Subject Matter." Ph.D. diss., The Ohio State University, 1984.

Berryman, S. *Solutions.* Washington, DC: National Council on Vocational Education, 1991.

Beyer, Barry K. *Practical Strategies for the Teaching of Thinking.* Needham Heights, MA: Allyn & Bacon, 1987.

Bobbitt, N. "Reflective Thinking: Meaning and Implications for Teaching." In *Higher Order Thinking: Definition, Meaning, and Instructional Approaches,* edited by R. G. Thomas. Washington, DC: Home Economics Education Association, 1986. (ERIC Document Reproduction Service No. ED 287 998).

Borkowski, J. G.; Carr, M.; Rellinger, E.; and Pressley, M. "Self-regulated Cognition: Interdependence of Metacognition, Attribution, and Self-esteem." In *Dimensions of Thinking and Cognitive Instruction,* edited by B. F. Jones and L. Idol. Hillsdale, NJ: Lawrence Erlbaum, 1990.

Boyer, E. *High School: A Report on Secondary Education in America.* New York: Harper and Row, 1983.

Brewer, W. F. "Schemas versus Mental Models in Human Memory." In *Modelling Cognition,* edited by P. E. Morris. New York: Wiley, 1987.

Brown, J.; Collins, A.; and Duguid, P. "Situated Cognition and the Culture of Learning." *Educational Researcher* 18, no. 1 (January-February 1989): 32-42. (ERIC No. EJ 386 603).

Browning, R., and Greenwald, M. "Critical Thinking and Problem Solving: How Much Did We Learn from Our Old Toy Trains?" *Technology Teacher* 49, no. 7 (April 1990): 9-10.

Bullough, R.; Goldstein, S.; and Holt, L. *Human Interests and the Curriculum: Teaching and Learning in a Technological Society.* New York: Teachers College Press, 1984.

Calderhead, J. "Stimulated Recall: A Method for Research on Teaching." *British Journal of Educational Psychology* 51, no. 2 (June 1981): 211-217. (ERIC No. EJ 251 802).

Center for Public Resources. *Basic Skills in the U.S. Work Force.* New York: Center for Public Resources, 1982.

Champagne, Audrey. *Teaching for Workplace Success. Occasional Paper No. 113.* Columbus: National Center for Research in Vocational Education, The Ohio State University, 1986. (ERIC Document Reproduction Service No. ED 268 386).

Chantrill, David. "Need for Creativity and Innovation in Technical Education." *Journal of Technical and Vocational Education* no. 7 (1990): 27-34.

Claus, John F. "Renegotiating Vocational Instruction." *Urban Review* 21, no. 4 (December 1989): 193-207. (ERIC No. EJ 409 761).

Cognition and Technology Group at Vanderbilt. "Anchored Instruction and Its Relationship to Situated Cognition." *Educational Researcher* 19, no. 6 (August-September 1990): 2-10. (ERIC No. EJ 417 590).

Colardyn, Danielle, and White, Kathleen M. "Learning Process and Vocational Experience Attainments." Paper presented at the Conference on Thinking, Cambridge, MA, 1985. (ERIC Document Reproduction Service No. ED 263 331).

Collins, Allan; Brown, John Seely; and Holum, Ann. "Cognitive Apprenticeship: Making Thinking Visible." *American Educator* 15 (1991): 6-11, 38.

Cole, E. "The Relationship between Locus of Control-Field Dependence, and the Academic Self-Concept and Achievement of the Disadvantaged: Implications for Vocational Education." Ed.D. diss., Rutgers University, 1984.

Committee for Economic Development. *Investing in Our Children: Business and the Public Schools.* New York: Committee for Economic Development, 1985. (ERIC Document Reproduction Service No. ED 261 117).

Cooke, B. L. D. "Mental Processes and Knowledge Underlying Expertise in Parenting." In *Thinking Underlying Expertise in Specific Knowledge Domains: Implications for Vocational Education*, edited by R. G. Thomas. St. Paul: Minnesota Research and Development Center for Vocational Education, University of Minnesota, 1988. (ERIC Document Reproduction Service No. ED 300 625).

Cooke, B. L. D. "Cognitive Aspects of Parental Problem Solving." *Journal of Vocational Education Research* 14, no. 2 (Spring 1989): 23-45. (ERIC No. EJ 397 424).

Coomer, Donna. "Critical Science: Approach to Vocational Education Research." *Journal of Vocational Education Research* 9, no. 4 (Fall 1984): 34-50. (ERIC No. EJ 317 893).

Coomer, Donna L. "Critical Science as a Mode of Inquiry: A Critical Study of Educational Evaluation Theory and Practice." *Journal of Vocational Home Economics Education* 3 (1985): 56-77.

Cox, D. E.; Sproles, E. K.; and Sproles, G. B. "Learning Style Variations among Vocational Agriculture Students." *Journal of the American Association of Teacher Educators in Agriculture* 29, no. 1 (Spring 1988): 11-19, 44. (ERIC No. EJ 366 971).

Crowell, Sam. "A New Way of Thinking: The Challenge of the Future." *Educational Leadership* 7, no. 1 (September 1989): 60-63. (ERIC No. EJ 395 109).

Crunkilton, John R. "Problem Solving--The Art and Science of Teaching." *Journal of the American Association of Teacher Educators in Agriculture* 25, no. 2 (Summer 1984): 2, 11-17.

Crunkilton, John R. "Thinking Out Loud about This Process We Call Teaching." *Journal of the American Association of Teacher Educators in Agriculture* 29, no. 1 (Spring 1988): 2-10. (ERIC No. EJ 366 970).

Curtis, Charles K. "Developing Critical Thinking Skills in Nonacademic Social Studies Classes." *Alberta Journal of Educational Research* 26, no. 2 (June 1980): 75-84. (ERIC No. EJ 232 774).

Daines, Jeanette. "Can Higher Order Thinking Skills Be Taught? By What Strategies?" In *Higher Order Thinking: Definition, Meaning, and Instructional Approaches,* edited by R. G. Thomas. Washington, DC: Home Economics Education Association, 1986. (ERIC Document Reproduction Service No. ED 287 998).

Dawson, G. *Reasoning as the Fourth "R."* New York: Joint Council on Economic Education, 1982.

Dewey, John. *Experience and Education.* New York: Macmillan, 1938.

Dinham, Sarah M. "College Teachers' Thinking and Planning: A Qualitative Study in the Design Studio." 1989. (ERIC Document Reproduction Service No. ED 313 373).

Dweck, C. S.; Davidson, W.; Nelson, S.; and [illegible]na, B. "Sex Differences in Learned Helplessness." *Developmental Psychology* 14 (1978): 268-276.

Edersheim, Mary Anne. "The Contribution of Practical Reasoning Instruction and Other Factors to the Decision Making Level of Tenth Grade Home Economics Students." Master's thesis, The Ohio State University, 1988.

Education Commission of the States. *Action for Excellence: A Comprehensive Plan to Improve Our Schools.* Denver, CO: Task Force on Education for Economic Growth, Education Commission of the States, 1983. (ERIC Document Reproduction Service No. ED 235 588).

Ennis, Robert H. "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, 1987.

Ericsson, K. A., and Simon, H. A. *Protocol Analysis.* Cambridge, MA: MIT Press, 1984.

Eyre, L., and Peterat, L. "The Practice of Critical Thinking in Home Economics." *Journal of Vocational Home Economics Education* 8 (1990): 1-7.

Fam, Amy, and Luan, Tay-Koay Siew. "Curriculum and Adolescent Development: A Singapore Perspective." In *Preparation for Adulthood. Proceedings of the Third Asian Workshop on Child and Adolescent Development.* Kuala Lumpur: University of Malaysia, 1984. (ERIC Document Reproduction Service No. ED 273 364).

Federico, Pat-Anthony. *Brain Event-Related Potential Correlates of Concept Learning.* San Diego, CA: Navy Personnel Research and Development Center, 1983a. (ERIC Document Reproduction Service No. ED 229 623).

Federico, Pat-Anthony. "Changes in the Cognitive Components of Achievement as Students Proceed through Computer-Managed Instruction." *Journal of Computer-Based Instruction* 9, no. 4 (Spring 1983b): 156-168. (ERIC No. EJ 281 440).

Fedje, Cheryl. "The Role of Listening, Reading, and Writing Skills in Higher Order Thinking: Implications for Home Economics Instruction." In *Higher Order Thinking: Definition, Meaning, and Instructional Approaches*, edited by R. G. Thomas. Washington, DC: Home Economics Education Association, 1986. (ERIC Document Reproduction Service No. ED 287 998).

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

Feuerstein, R.; Rand, Y.; Hoffman, M.; Egozi, M.; and Shachar-Segev, N. "Intervention Programs for Retarded Performers: Goals, Means, and Expected Outcomes." In *Educational Values and Cognitive Instruction: Implications for Reform*, edited by L. Idol and B. F. Jones. Hillsdale, NJ: Lawrence Erlbaum, 1991.

Fisher, Allan D., and Cole, R. Lee. "Cognitive Mapping and Vocational Students in Selected Oregon Community Colleges." *Journal of Vocational Education Research* 6, no. 3 (Summer 1981): 57-76. (ERIC No. EJ 255 930).

Fitzpatrick, K. A. "Restructuring to Achieve Outcomes of Significance for All Students." *Educational Leadership* 48, no. 8 (May 1991): 18-22. (ERIC No. EJ 425 602).

Franz, John B. "Cognitive Development and Career Retraining in Older Adults." *Educational Gerontology* 9, nos. 5-6 (September-December 1983): 443-462. (ERIC No. EJ 299 142).

Frederiksen, Norman; Glaser, Norman; Lesgold, Alan; and Shafto, Michael G., eds. *Diagnostic Monitoring of Skill and Knowledge Acquisition.* Hillsdale, NJ: Lawrence Erlbaum, 1990.

Gardner, H. *Frames of Mind: The Theory of Multiple Intelligences.* New York: Basic Books, 1983.

Garner, C. William. "Cognitive Development and Teaching Vocational Students." Paper presented at the American Vocational Association Convention, 1986. (ERIC Document Reproduction Service No. ED 277 882).

Garrison, James W. "The Role of Postpositivistic Philosophy of Science in the Renewal of Vocational Education Research." *Journal of Vocational Education Research* 14, no. 3 (Summer 1989): 39-51. (ERIC No. EJ 404 740).

Gilligan, C. *In a Different Voice: Psychological Theory and Women's Development.* Cambridge: Harvard University Press, 1982.

Gisi, L., and Forbes, R. *The Information Society: Are High School Graduates Ready?* Denver: Education Commission of the States: 1982. (ERIC Document Reproduction Service No. ED 223 812).

Glaser, R. *The Nature of Expertise. Occasional Paper No. 107.* Columbus: National Center for Research in Vocational Education, The Ohio State University, 1985. (ERIC Document Reproduction Service No. ED 261 190).

Glaser, R.; Damrin, D.; and Gardner, F. "The Tab Item: A Technique for the Measurement of Proficiency in Diagnostic Problem Solving Tasks." *Educational and Psychological Measurement* 14 (1954): 283-293.

Glass, Alan. "The Effects of Thinking Aloud Pair Problem Solving on Technology Education Students' Thinking Processes, Procedures, and Problem Solutions." Doctoral diss., University of Minnesota, 1992.

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

Gott, S. P. "Apprenticeship Instruction for Real-World Tasks: The Coordination of Procedures, Mental Models, and Strategies." In *Review of Research in Education,* edited by E. Z. Rothkopf. Washington, DC: American Educational Research Association, 1988.

Greenan, James P. "Identification and Validation of Generalizable Skills in Vocational Programs." *Journal of Vocational Education Research* 8, no. 3 (Summer 1983): 46-71. (ERIC No. EJ 290 953).

Greenan, James P., and McCabe, Connie C. "Development and Validation of Generalizable Reasoning Skills Assessment Strategies and Procedures." *Journal of Industrial Teacher Education* 26, no. 3 (Spring 1989): 38-50. (ERIC No. EJ 388 210).

Guster, D. "Cognitive Style and Drafting Performance." *Journal of Vocational Education Research* 11, no. 1 (Winter 1986): 25-40. (ERIC No. EJ 337 125).

Hartman-Haas, Hope J. "Improving Cognitive Skills." *Journal of Developmental and Remedial Education* 5, no. 1 (Fall 1981): 10-12, 29-30. (ERIC No. EJ 254 104).

Henderson, Janet. "Professional Commitment to Cognitive Skill Development." *Journal of the American Association of Teacher Educators in Agriculture* 24, no. 3 (Fall 1983): 71-75. (ERIC No. EJ 285 042).

Herren, Ray. "The Problem Solving Approach: History and Implications." *Journal of Vocational and Technical Education* 4, no. 1 (Fall 1987): 18-24.

Hultgren, F. H. "A Hermeneutic Approach: Reflecting on the Meaning of Curriculum through Interpretation of Student-Teaching Experiences in Home Economics." *Journal of Vocational Home Economics Education* 3 (1985): 32-55.

Hultgren, F. H. "Critical Thinking: Phenomenological and Critical Foundations." In *Higher Order Thinking: Definition, Meaning, and Instructional Approaches*, edited by R. G. Thomas. Washington, DC: Home Economics Education Association, 1986. (ERIC Document Reproduction Service No. ED 287 998).

Hultgren, F. H. "Using Interpretive-Critical Inquiry Perspective to Study Critical Thinking in Home Economics." *Journal of Vocational Home Economics Education* 7, no. 1 (Spring 1989): 10-35. (ERIC No. EJ 390 149).

Hunter, J. "Teaching Higher-Level Thinking Skills." In *Instructional Strategies: An Applied Research Series.* Vol. 8, no. 1. Little Rock, AR: Delta Pi Epsilon, 1992.

Idol, L., Jones, B. F.; and Mayer, R. "Classroom Instruction: The Teaching of Thinking." In *Educational Values and Cognitive Instruction,* edited by L. Idol and B. F. Jones. Hillsdale, NJ: Lawrence Erlbaum, 1991.

Jackman, D. "A Comparison of Learning Styles among Home Economics and Related Field Undergraduates." Ph.D. diss., University of Minnesota, 1987.

James, William Karl. "Development of Creative Problem-Solving Skills." *Technology Teacher* 49, no. 5 (February 1990): 29-30. (ERIC No. EJ 401 989).

Jax, Judy A. "Ethnography: An Approach to Using Interpretive Science in Vocational Education Research." *Journal of Vocational Education Research* 9, no. 4 (Fall 1984): 8-19. (ERIC No. EJ 317 891).

Jax, Judy A. "Alternative Frameworks for Research in the Field of Home Economics." *Journal of Vocational Home Economics Education* 3 (1985): 3-7.

Jenkins-Vulgamore, V. J. "The Relationship of Home Economics Instruction and Other Factors on Early Adolescents' Decision Making Skill Levels." Master's thesis, The Ohio State University, 1991.

Johnson, S. D. "Knowledge and Skill Differences between Expert and Novice Service Technicians on Technical Troubleshooting Tasks." In *Thinking Underlying Expertise in Specific Knowledge Domains: Implications for Vocational Education,* edited by R. G. Thomas. St. Paul: Minnesota Research and Development Center for Vocational Education, University of Minnesota 1988. (ERIC Document Reproduction Service No. ED 300 625).

Johnson, S., and Thomas, R. "Technology Education and the Cognitive Revolution." *Technology Teacher* 51, no. 4 (January 1992): 7-12. (ERIC No. EJ 435 379).

Jones, B. F. "Cognitive Designs in Education." In *Encyclopedia of Educational Research,* 6th ed., edited by M. Aitkin. Riverside, NJ: Macmillan, 1992.

Joyce, B., and Weil, M. *Models of Teaching.* Englewood Cliffs, NJ: Prentice-Hall, 1972.

Kelly, Maureen E.; Sproles, Elizabeth Kendall; Camp, William G.; Hauser, Doreen A.; and Kopf, Diane W. "'The Journal of Vocational and Technical Education': A Review of Articles Submitted and in Print." *Journal of Vocational and Technical Education* 5, no. 2 (Spring 1989): 50-60. (ERIC No. EJ 393 231).

Kendall, E. "Variations in Learning Styles among Secondary Vocational Home Economics Students." *Journal of Vocational and Technical Education* 3, no. 1 (Fall 1986): 13-22. (ERIC No. EJ 344 784).

Kendall, E., and Sproles, G. "Learning Styles among Secondary Vocational Home Economics Students: A Factor Analytic Test of Experiential Learning Theory." *Journal of Vocational Education Research* 11, no. 3 (Summer 1986): 1-15. (ERIC No. EJ 342 131).

Kendall-Sproles, E.; Cox, D.; and Sproles, G. "Characterizing Vocational Students' Learning Styles: A Replication and Generalization of Findings." *Journal of Vocational Education Research* 12, no. 4 (Fall 1987): 1-11. (ERIC No. EJ 363 153).

Kerka, Sandra. *On Second Thought: Using New Cognitive Research in Vocational Education. ERIC Digest No. 53.* Columbus: ERIC Clearinghouse on Adult, Career, and Vocational Education, National Center for Research in Vocational Education, The Ohio State University, 1986. (ERIC Document Reproduction Service No. ED 272 699).

Kowal, Joseph. "The Effects of Constructior al Activities Incorporating the Locus of Control Construct on Motivation in Fourth Grade Students (Elementary Industrial Arts)." Ph.D. diss., The Ohio State University, 1984.

Lachman, R.; Lachman, J.; and Butterfield, E. *Cognitive Psychology and Information Processing: An Introduction.* Hillsdale, NJ: Lawrence Erlbaum, 1979.

Larkin, J. H. "What Kind of Knowledge Transfers?" In *Knowing, Learning, and Instruction: Essays in Honor of Robert Glaser,* edited by L. B. Resnick. Hillsdale, NJ: Lawrence Erlbaum, 1989.

Lass, Cynthia B., and Moss, Jeffrey W. "Problem-Solving in Vocational Education: Evolution of a Basic Skill." *Journal of Vocational and Technical Education* 4, no. 2 (Spring 1988): 3-13.

Laster, J. F. "A Practical Action Teaching Model." *Journal of Home Economics* 74, no. 3 (Fall 1982): 41-44. (ERIC No. EJ 267 914).

Laster, J. F. *Using Cognitive Psychology in Curriculum Planning. Toward Excellence in Secondary Vocational Education. Information Series No. 297.* Columbus: National Center for Research in Vocational Education, The Ohio State University, 1985. (ERIC Document Reproduction Service No. ED 254 656).

Laster, J. "Instructional Strategies for Teaching Practical Reasoning in Consumer Homemaking Classrooms." In *Higher Order Thinking: Definition, Meaning, and*

Instructional Approaches, edited by R. G. Thomas. Washington, DC: Home Economics Education Association, 1986a. (ERIC Document Reproduction Service No. ED 287 998).

Laster, J. F. "Problem Solving: Definition and Meaning." In ***Higher Order Thinking: Definition, Meaning, and Instructional Approaches,*** edited by R. G. Thomas. Washington, DC: Home Economics Education Association, 1986b. (ERIC Document Reproduction Service No. ED 287 998).

Lee, Howard D. ***Thinking Skills and Coaching Strategies Workshop (Menomonie, Wisconsin, January 18-20, 1989). Final Report.*** Menomonie: Center for Vocational, Technical, and Adult Education, University of Wisconsin-Stout, 1989. (ERIC Document Reproduction Service No. ED 321 077).

Lesgold, A.; Bonar, J. G.; Collins, J.; Curran, K.; Eastman, R.; Gitomer, D.; Glaser, R.; Greenberg, L.; Lajoie, S.; Logan, D.; Magone, M.; Shalin, V.; Weiner, A.; Wolf, R.; and Yengo, L. ***Guide to Cognitive Task Analysis.*** Pittsburgh, PA: Learning Research and Development Center, University of Pittsburgh, 1986a.

Lesgold, A.; Lajoie, S.; Eastman, R.; Eggan, G.; Gitomer, D.; Glaser, R.; Greenberg, L.; Logan, D.; Magone, M.; Weiner, A.; Wolf, R.; and Yengo, L. ***Cognitive Task Analysis to Enhance Technical Skills Training and Assessment.*** Pittsburgh, PA: Learning Research and Development Center, University of Pittsburgh, 1986b.

Linn, Robert L. "Dimensions of Thinking: Implications for Testing." In ***Educational Values and Cognitive Instruction: Implications for Reform,*** edited by L. Idol and B. F. Jones. Hillsdale, NJ: Lawrence Erlbaum, 1991.

Lochhead, J. "Teaching Analytic Reasoning Skills through Pair Problem Solving." In ***Thinking and Learning Skills,*** edited by J. W. Segal, S. P. Chipman, and R. Glaser. Hillsdale, NJ: Lawrence Erlbaum, 1985.

Lochhead, J., and Clement, J., eds. ***Cognitive Process Instruction: Research on Teaching Thinking Skills.*** Philadelphia: Franklin Institute Press, 1979. (ERIC Document Reproduction Service No. ED 234 997).

Lochhead, J., and Whimbey, A. "Teaching Analytical Reasoning through Thinking Aloud Pair Problem Solving." ***New Directions for Teaching and Learning*** no. 30 (1987): 73-92. (ERIC No. EJ 355 732).

Luria, A. R. ***Cognitive Development: Its Cultural and Social Foundations,*** translated by M. Lopez-Morillas and L. Solotaroff. Cambridge, MA: Harvard University Press, 1976.

Manifold, S. C. "The Development of a Decision-Making Skills Instrument for Vocational Home Economics Practical Problems." Master's thesis, The Ohio State University, 1984.

Martin, Judy Lynn. "The Effects of Practical Reasoning Instruction on 10th Grade Students' Decision Making Skill Levels." Master's thesis, The Ohio State University, 1988.

Marzano, Robert. "Creating an Educational Paradigm Centered on Learning through Teacher-Directed, Naturalistic Inquiry." In *Educational Values and Cognitive Instruction: Implications for Reform,* edited by L. Idol and B. F. Jones. Hillsdale, NJ: Lawrence Erlbaum, 1991.

Marzano, R. J.; Brandt, R. S.; Hughes, C. S.; Jones, B. F.; Presseisen, B. Z.; Rankin, S. R.; and Suhor, C. *Dimensions of Thinking: A Framework for Curriculum and Instruction.* Alexandria, VA: Association for Supervision and Curriculum Development, 1988. (ERIC Document Reproduction Service No. ED 294 222).

Mauter, Margaret A. *Teaching Higher Order Thinking Skills: Implications for Vocational-Technical Education.* Westerville: Ohio Council on Vocational Education, 1988. (ERIC Document Reproduction Service No. ED 298 312).

McCracken, J. David. "A Profession in Need of Academicians." *Journal of the American Association of Teacher Educators in Agriculture* 24, no. 1 (Spring 1983): 2-12. (ERIC No. EJ 275 815).

McKeough, Anne. "Three Perspectives on Learning and Instruction." In *Toward the Practice of Theory-Based Instruction,* edited by A. McKeough and J. L. Lupart. Hillsdale, NJ: Lawrence Erlbaum, 1991.

Mevarech, Zemira R. "The Role of a Feedback-Corrective Procedure in Developing Psychomotor Application Skills." *Journal of Vocational Education Research* 8, no. 2 (Spring 1983): 22-32. (ERIC No. EJ 287 711).

Michaels, Ken. "Caution: Second-Wave Reform Taking Place." *Educational Leadership* 45, no. 5 (February 1988): 3. (ERIC No. EJ 368 817).

Mielke, Ann. "Critical and Creative Thinking." In *Thinking Skills and Coaching Strategies Workshop,* edited by H. D. Lee. Menomonie: Center for Vocational, Technical, and Adult Education, University of Wisconsin--Stout, 1989. (ERIC Document Reproduction Service No. ED 321 077).

Miles, Curtis. "The 4th 'R' Revisited." *Journal of Developmental and Remedial Education* 5, no. 1 (Fall 1981): 2-4. (ERIC No. EJ 254 102).

Miller, C. "Higher-Order Thinking: An Integrated Approach for Your Classroom." *Vocational Education Journal* 65, no. 6 (October 1990): 26-27, 69. (ERIC No. 414 533).

Miller, Larry E. "An Epistemology for Knowing in Vocational Education." *Journal of Vocational and Technical Education* 5, no. 2 (Spring 1989): 2-12. (ERIC No. EJ 393 227).

Miller, Larry E. "A Systems Approach to Research in Vocational Education." *Journal of Vocational and Technical Education* 8, no. 1 (Fall 1991): 25-34. (ERIC No. EJ 435 274).

Montague, William E. "Application of Cognitive Science Principles: Instructional Heuristics and Mechanisms for Use." Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA, 1986. (ERIC Document Reproduction Service No. ED 275 712).

Moore, G. E., and Moore, B. A. "The Problem Solving Approach to Teaching: Has it Outlived Its Usefulness?" *Journal of the American Association of Teacher Educators in Agriculture* 25, no. 2 (Summer 1984): 3-10. (ERIC No. EJ 301 003).

Moss, J. "LCBE: Limiting Competency-Based Education (or) Let's Curb Behavioral Excesses." *Journal of Industrial Teacher Education* 19, no. 1 (Fall 1981): 14-18. (ERIC No. EJ 257 357).

Mosser, John W. "Field Experience as a Method of Enhancing Student Learning and Cognitive Development in the Liberal Arts." 1989. (ERIC Document Reproduction Service No. ED 315 024).

National Academy of Sciences. *High School and the Changing Workplace: The Employer's View.* Washington, DC: Panel on Secondary School Education for the Changing Workplace of the National Academy of Sciences Committee on Science, Engineering, and Public Policy, National Academy Press, 1984. (ERIC Document Reproduction Service No. ED 244 081).

National Commission on Excellence in Education. *A Nation at Risk: The Imperative for Educational Reform.* Washington, DC: NCEE, 1983. (ERIC Document Reproduction Service No. ED 226 006).

National Commission on Secondary Vocational Education. *The Unfinished Agenda: The Role of Vocational Education in the High School.* Columbus: National Center for Research in Vocational Education, The Ohio State University, 1984. (ERIC Document Reproduction Service No. ED 251 622).

Neisser, U. *Cognition and Reality.* San Francisco: W. H. Freeman, 1976.

Nickerson, R. "Why Teach Thinking?" In *Teaching Thinking Skills: Theory and Practice,* edited by J. B. Baron and R. J. Sternberg. New York: W. H. Freeman, 1987.

Norris, Stephen P. "Informal Reasoning Assessment: Using Verbal Reports of Thinking to Improve Multiple-choice Test Validity." In *Informal Reasoning and Education,* edited by J. Voss, D. Perkins, and J. Segal. Hillsdale, NJ: Lawrence Erlbaum, 1991.

Novak, J. D., and Gowin, D. B. *Learning How to Learn.* Cambridge: Cambridge University Press, 1984.

Nwagbara, Chibu I. "Attitudes of Vocational Teachers toward Reasoning Skills Instruction in Secondary Vocational Programs." Master's thesis, Purdue University, 1990.

Oakes, J. *Keeping Track: How Schools Structure Inequality.* New Haven, CT: Yale University Press, 1985.

Oakes, J. "Beyond Tinkering: Reconstructing Vocational Education. Vocational Education in Secondary Schools: A Revision." In ***Re-visioning Vocational Education in the Secondary School***, edited by G. H. Copa, J. Plihal, and M. A. Johnson. St. Paul: Minnesota Research and Development Center for Vocational Education, University of Minnesota, 1986. (ERIC Document Reproduction Service No. ED 279 846).

Oakes, J. "Tracking in Secondary Schools: A Contextual Perspective." ***Educational Psychologist*** 22 (1987): 129-154.

Ohlsson, S., and Langley, P. "Psychological Evaluation of Path Hypotheses in Cognitive Diagnosis." In ***Learning Issues for Intelligent Tutoring Systems***, edited by H. Mandl and A. Lesgold. New York: Springer-Verlag, 1988.

Ormerod, M. B. "A Model to Exhibit the Interdependence of the Cognitive and Affective Domains of Objectives for Use in Science and Technical Teacher Training." ***Research in Science and Technological Education*** 1, no. 1 (1983): 119-128. (ERIC No. EJ 281 715).

Osborne, Edward W. "Using Problem-Solving Teaching: Theoretical and Philosophical Considerations." Paper presented at a symposium of the American Vocational Education Research Association, St. Louis, MO, December 1988. (ERIC Document Reproduction Service No. ED 305 392).

Osborne, Edward W., and Hamzah, Ramlah. "Use of Problem Solving Teaching among Secondary Agriculture Teachers in Illinois." ***Journal of Agricultural Education*** 30, no. 3 (Fall 1989): 29-36. (ERIC No. EJ 394 644).

Osborne, Edward W., and Matulis, Janet K. "Psychomotor Skill Acquisition in Vocational Education Programs." ***Journal of Vocational and Technical Education*** 4, no. 2 (Spring 1988): 21-30.

Paris, S. G., and Winograd, P. "How Metacognition Can Promote Academic Learning and Instruction." In ***Dimensions of Thinking and Cognitive Instruction***, edited by B. F. Jones and L. Idol. Hillsdale, NJ: Lawrence Erlbaum, 1990.

Pauker, Robert A. ***Teaching Thinking and Reasoning Skills: Problems and Solutions.*** Arlington, VA: American Association of School Administrators, 1987. (ERIC Document Reproduction Service No. ED 308 871).

Paul, R. W. ***Critical Thinking: What Every Person Needs to Survive in a Rapidly Changing World.*** Rohnert Park, CA: Center for Critical Thinking and Moral Critique, Sonoma State University, 1990.

Perkins, D. N. "Thinking Frames: An Integrated Perspective on Teaching Cognitive Skills." In ***Teaching Thinking Skills: Theory and Practice***, edited by J. Baron and R. Sternberg. New York: W. H. Freeman, 1987.

Plihal, J. "Using a Critical Inquiry Perspective to Study Critical Thinking in Home Economics." *Journal of Vocational Home Economics Education* 7, no. 1 (Spring 1989): 36-47. (ERIC No. EJ 390 150).

Prawat, Richard S. "The Value of Ideas." *Educational Researcher* 20, no. 2 (March 1991): 3-10, 30. (ERIC No. EJ 423 942).

Pucel, David J. "An Alternative Approach to Learning." *VocEd* 59, no. 7 (October 1984): 42-44. (ERIC No. EJ 305 063).

Purdin, T. L. "An Evaluation of Critical Thinking Skills of Adults Enrolled in the Ohio Vocational Home Economics Specialized Programs: Transitions, Displaced Homemaker, and GOALS." Master's thesis, The Ohio State University, 1989.

Raizen, S. A. *Reforming Education for Work: A Cognitive Science Perspective.* Berkeley: National Center for Research on Vocational Education, University of California, 1989. (ERIC Document Reproduction Service No. ED 314 642).

Rehm, M. "Vocational Students as Artists." *Journal of Vocational Education Research* 12, no. 1 (Winter 1987): 21-33. (ERIC No. EJ 351 872).

Rehm, M. "Empowering the Creative Spirit: An Inquiry into the Role of Home Economics Education." *Journal of Vocational Home Economics Education* 7 (1989a): 1-12.

Rehm, M. "Factors Affecting Creativity: Perspectives from Home Economics Teachers and Student Teachers." *Journal of Vocational Home Economics Education* 7 (1989b): 13-27.

Resnick, L. B. "Learning in School and Out: The 1987 Presidential Address." *Educational Researcher* 16, no. 9 (December 1987): 13-20. (ERIC No. EJ 368 309).

Resnick, L. B. "Introduction." In *Knowing, Learning, and Instruction: Essays in Honor of Robert Glaser,* edited by L. B. Resnick. Hillsdale, NJ: Lawrence Erlbaum, 1989.

Rojewski, J. W., and Holder, B. H. "Learning Styles of Students in Select Vocational Education Teacher Preparation Programs." *Journal of Vocational and Technical Education* 7, no. 1 (Fall 1990): 25-36.

Ruggiero, V. R. *Teaching Th'nking across the Curriculum.* New York: Harper and Row, 1988.

Rumelhart, David E. "Schemata: The Building Blocks of Cognition." In *Theoretical Issues in Reading Comprehension,* edited by R. Spiro, B. Bruce, and W. Brewer. Hillsdale, NJ: Lawrence Erlbaum, 1980.

Samuels, Marilyn; Roadhouse, Audrey; Conte, Richard; and Zirk, Harry. *Instrumental Enrichment with Low Achieving Adolescents.* Edmonton: Planning Services Branch, Alberta Department of Education, 1984. (ERIC Document Reproduction Service No. ED 263 244).

Schank, R. C., and Abelson, R. P. *Scripts, Plans, Goals, and Understanding: An Inquiry into Human Knowledge Structures.* Hillsdale, NJ: Lawrence Erlbaum, 1977.

Schmidt, J. "Performance on the High School and Beyond Data Set Vocabulary, Reading, and Mathematics Tests Related to Vocational Business Preparation." *Journal of Vocational Education Research* 10, no. 4 (Fall 1985): 49-62. (ERIC No. EJ 335 440).

Schön, D. *The Reflective Practitioner: How Professionals Think in Action.* New York: Basic Books, 1983.

Scribner, Sylvia. "Studying Working Intelligence." In *Everyday Cognition: Its Development in Social Context,* edited by B. Rogoff and J. Lave. Cambridge, MA: Harvard University Press, 1984.

Scribner, Sylvia. "Thinking in Action: Some Characteristics of Practical Thought." In *Practical Intelligence,* edited by R. J. Sternberg and R. K. Wagner. London: Cambridge University Press, 1986.

Secretary's Commission on Achieving Necessary Skills. *What Work Requires of Schools.* Washington, DC: SCANS, U. S. Department of Labor, 1991. (ERIC Document Reproduction Service No. ED 332 054).

Sellwood, P. "The Role of Problem Solving in Developing Thinking Skills." *Technology Teacher* 49, no. 3 (December 1989): 3-10.

Siebold, Bert A. "Effects of Schemata and a Concept Organizer on Cognitive Learning and Skill Acquisition." *Journal of Industrial Teacher Education* 26, no. 4 (Summer 1989): 53-66. (ERIC No. EJ 393 202).

Sizer, T. *Horace's Compromise: The Dilemma of the American High School.* Boston: Houghton Mifflin, 1984.

Smith, Brandon B. "Empirical-Analytic Research Paradigm Research in Vocational Education." *Journal of Vocational Education Research* 9, no. 4 (Fall 1984): 20-33. (ERIC No. EJ 317 892).

Spiro, R. J.; Coulson, R.; Feltovich, P.; and Anderson, D. "Cognitive Flexibility Theory: Advanced Knowledge Acquisition in Ill-Structured Domains." In *Proceedings of the Cognitive Science Society,* edited by V. Patel and G. Groen. Hillsdale, NJ: Lawrence Erlbaum, 1988.

Spiro, R. J.; Vispoel, W. P.; Schmitz, J. G.; Samarapungavan, A.; and Boerger, A. E. "Knowledge Acquisition for Application: Cognitive Flexibility and Transfer in Complex Content Domains." In *Executive Control Processes in Reading,* edited by B. K. Britton and S. M. Glynn. Hillsdale, NJ: Lawrence Erlbaum Associates, 1987.

Stasz, Cathleen; McArthur, David; Lewis, Matthew; and Ramsey, Kimberly. *Teaching and Learning Generic Skills for the Workplace.* Santa Monica, CA: Rand Corporation, 1990. (ERIC Document Reproduction Service No. ED 329 682).

Sternberg, R. J., and Frensch, P. A. *Complex Problem Solving.* Hillsdale, NJ: Lawrence Erlbaum, 1991.

Sternberg, R. J., and Wagner, K. R., eds. *Practical Intelligence: Nature and Origins of Competence in the Everyday World.* Cambridge: Cambridge University Press, 1986.

Stone, James R., III, and Wonser, Renee. "An Experiential Education Perspective on Vocational Education." *Journal of Vocational and Technical Education* 8, no. 1 (Fall 1991): 3-24.

Swartz, R. J. "Critical Thinking, the Curriculum, and the Problem of Transfer." In *Thinking: The Second International Conference,* edited by D. N. Perkins, J. Lochhead, and J. Bishop. Hillsdale, NJ: Lawrence Erlbaum, 1987.

Thode, Brad. "Applying Higher Level Thinking Skills." *Technology Teacher* 49, no. 2 (November 1989): 6-14. (ERIC No. EJ 397 453).

Thomas, R. G. "Home Economics in Secondary Education and the Development of Human Competence." *Journal of Home Economics* 77, no. 3 (Fall 1985): 2-6, 50. (ERIC No. EJ 320 681).

Thomas, R. G. "The Meaning of Higher Order Thinking and Its Implementation in Home Economics Education." In *Higher Order Thinking: Definition, Meaning, and Instructional Approaches,* edited by R. G. Thomas. Washington, DC: Home Economics Education Association, 1986. (ERIC Document Reproduction Service No. ED 287 998).

Thomas, R. G. "Studying Expertise in Specific Knowledge Domains." In *Thinking Underlying Expertise in Specific Knowledge Domains: Implications for Vocational Education,* edited by R. Thomas. St. Paul: Minnesota Research and Development Center for Vocational Education, University of Minnesota, 1988a. (ERIC Document Reproduction Service No. ED 300 625).

Thomas, R. G. "Conclusions and Insights Regarding Expertise in Specific Knowledge Domains and Implications for Research and Educational Practice." In *Thinking Underlying Expertise in Specific Knowledge Domains: Implications for Vocational Education,* edited by R. Thomas. St. Paul: Minnesota Research and Development Center for Vocational Education, University of Minnesota, 1988b. (ERIC Document Reproduction Service No. ED 300 625).

Thomas, R. G. *The Tailored Response Test: An Approach to Assessing Higher Order Thinking Related to Work Roles and Contexts.* St. Paul: Minnesota Research and Development Center for Vocational Education, University of Minnesota, 1988c. (ERIC Document Reproduction Service No. ED 301 770).

Thomas, R. G. "Alternative Research Paradigms: A Contrast Set." *Journal of Vocational Home Economics* 7, no. 1 (Spring 1989): 48-57. (ERIC No. EJ 390 151).

Thomas, R. G., and Englund, M. *Instructional Design for Developing Higher Order Thinking: Vol. I. Knowledge Domain Development.* St. Paul: Minnesota Research and Development Center for Vocational Education, University of Minnesota, 1989. (ERIC Document Reproduction Service No. ED 323 291).

Thomas, R. G., and Englund, M. *Instructional Design for Facilitating Higher Order Thinking: Vol. II. Instructional Design Model.* St. Paul: Minnesota Research and Development Center for Vocational Education, University of Minnesota, 1990. (ERIC Document Reproduction Service No. ED 323 326).

Thomas, R. G., and Englund, M. "Facilitating Cognitive Complexity: Development and Testing of Instructional Design Theory via a Videodisk-Based Learning Environment." *Journal of Vocational Education Research* 16, no. 2 (1991): 75-113.

Thomas, R. G., and Litowitz, L. *Vocational Education and Higher Order Thinking Skills: An Agenda for Inquiry.* St. Paul: Minnesota Research and Development Center for Vocational Education, University of Minnesota, 1986. (ERIC Document Reproduction Service No. ED 279 845).

Thompson, Mark E. "The Educated Perspective." 1982. (ERIC Document Reproduction Service No. ED 218 167).

Underwood, Robert. "Questioning Techniques for the Marketing Teacher." *Business Education Forum* 41, no. 1 (October 1986): 19, 22. (ERIC No. EJ 340 818).

Vygotsky, L. S. *Mind in Society: The Development of Higher Psychological Processes.* Cambridge, MA: Harvard University Press, 1978.

Vygotsky, L. S. "The Genesis of Higher Mental Functions." In *The Concept of Activity in Soviet Psychology,* edited by J. V. Wertsch. Armonk, NY: M. E. Sharpe, 1981.

Vygotsky, L. S. *Thought and Language*, translated by A. Kozulin. Cambridge, MA: MIT Press, 1986.

Wasserman, Selma. "Reflections on Measuring Thinking, While Listening to Mozart's 'Jupiter' Symphony." *Phi Delta Kappan* 70, no. 5 (January 1989): 365-370. (ERIC No. EJ 383 870).

Way, W. "The Role of the Future Homemakers of America Student Organization in Facilitating the Development of Critical Thinking Skills." In *Higher Order Thinking: Definition, Meaning, and Instructional Approaches,* edited by R. G. Thomas. Washington, DC: Home Economics Education Association, 1986. (ERIC Document Reproduction Service No. ED 287 998).

Way, W. "Examining Critical Thinking in Home Economics Education: An Empirical/ Analytical Perspective." *Journal of Vocational Home Economics Education* 7, no. 1 (Spring 1989): 1-9. (ERIC No. EJ 390 148).

Weber, James M., and Puleo, Nancy F. "A Comparison of the Instructional Approaches Used in Secondary Vocational and Nonvocational Classrooms." *Journal of Vocational Education Research* 13, no. 4 (Fall 1988): 49-70. (ERIC No. EJ 390 116).

Westerdahl, Edward John. "Comparison of a Troubleshooting Training Model to the Present Onan Service Training Program Model." Master's thesis, University of Minnesota, 1991.

Whiting, Bryan, and Render, Gary F. "Cognitive and Affectiv Outcomes of Mastery Learning: A Review of 16 Semesters." Paper presented at the annual meeting of the Northern Rocky Mountain Education Research Association, Jackson Hole, WY, 1984. (ERIC Document Reproduction Service No. ED 254 528).

Wilsman, M. J. "A Technical Approach: Predicting the Rationality and Deliberateness of Students' Self-Evaluations from Their Levels of Conceptual Development." *Journal of Vocational Home Economics Education* 3 (1985): 8-31.

Wirth, Arthur G. *Education in the Technological Society: The Vocational-Liberal Studies Controversy in the Early Twentieth Century.* Washington, DC: University Press of America, 1980.

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