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ADAMS, MARILYN JAGER

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ABSTRACT

This paper discusses ways that students can better be taught to think. It argues that poor/low-achieving students served by Chapter 1 of the Education Consolidation and Improvement Act of 1981 could genuinely profit from instruction on thinking and that, for maximum impact, such instruction should be introduced as a course in itself, separate from the regular curricula. The paper also discusses some of the major issues and options to consider before adopting a course on thinking skills for any students. This discussion focuses on and criticizes six useful and successful existing programs on thinking skills, and then describes a new program called "Odyssey: A Curriculum for Thinking" (M. Adams, 1986). This program, jointly developed by Bolt, Beranek and Newman, Harvard University, and the Venezuelan Ministry of Education, was conducted solely in Venezuelan "barrio" schools serving students of low economic status and minimal parental education. In the discussion of all seven programs, particular attention is paid to the distinction between macrological and micrological approaches, and to the special needs of Chapter 1 students. The paper is organized into the following sections; (1) the current status of curricula on thinking; (2) what works and why; (3) the Odyssey program, including an outline of the lessons and an evaluation; and (4) conclusions. A list of references is included. (PS)

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TEACHING THINKING TO CHAPTER 1 STUDENTS

by

Marilyn Jager Adams
BBN Laboratories Inco porated

TEACHING THINKING TO CHAPTER 1 STUDENTS

What is it we want most for students to gain through school? We undoubtedly would agree that it is the ability to manage their lives on their own, competently, considerately, and productively.

What is it that we try hardest to teach to students in school? We undoubtedly must agree that it is reading, writing, mathematics, social studies, and science.

What is the underlying match between our consensual goals and our conventional curriculum? That is, why do we teach the things we do? There are, of course, several answers. First, within these disciplines there lie certain basic survival tools, certain knowledge and skills that all adults ought to have. Beyond that, there are also, for some students in some of these disciplines, the beginnings of what may become career-specific knowledge and skills. But we would argue that, for the random student, the real motive for including any particular topic in the curriculum runs deeper. The real motive, we would argue, derives from the potential value of that topic as a medium for teaching the students about different perspectives and modes of thought that they might apply to their own worlds.

If this is indeed the major goal of our curricular content, then it is not, in the current educational context, serving its purpose. I am willing to assert this on a single argument: The very idea that the real purpose of immersing students in such stuff is to teach thinking is strictly an adult insight.

When I was a student, even a high school student, I operated on the beliefs that the reason for studying history was to memorize the facts, the reason for solving math problems was to get the right answers, and the reason for writing compositions was because we had to. I was not a bad student, and I do not believe these attitudes were atypical. To the contrary, I believe they are very typical of students, now as well as then.

If we truly intend our course materials to be the vehicles as well as the objects of thought, then that goal should not fall into the category of an adult insight. Indeed it should not be an insight at all. It should be obvious, and it should be obvious to students while they are in school; while they are trying to learn what we hope they will have learned by the time they get out.

In this paper, I will discuss ways that we might better teach students to think. The point of my preface is to make clear that, although this goal is currently all the rage, it is neither revolutionary nor flaky. The development of thinking skills has long been a central if somewhat elusive goal of our pedagogical agenda.

The current interest in teaching thinking has been provoked by the onset of the information era, supported by recent advances in cognitive theory, and begged by the results of domestic evaluations and international comparisons of our students' higher-order cognitive skills. In spirit, the movement has been directed more towards fostering excellence than overcoming the opposite. Yet there is the hope that, as the issues become better understood and the curricula multiply and mature, it will yield effective methods for correcting the special problems of low-achieving students.

The Current Status of Curricula on Thinking

In this section, I will provide an overview of existing curricula on thinking skills. I will not attempt a program-by-program description and evaluation of these efforts as such reviews already abound in the open literature (e.g., Chance, 1986; Chipman, Segal, & Glaser, 1985; Costa, 1985; Nickerson, Perkins & Smith, 1985; Segal, Chipman & Glaser, 1985). Instead, I will treat the curricula as a group, doing my best to describe their common assumptions, goals, and problems.

The fundamental assumption motivating all curricula on thinking is that there exists a certain set of skills or processes that are common to thinking in general, regardless of person, domain, or purpose. The common goal of the curricula is to teach those processes and, in that sense, all fall under the general rubric of process-oriented curricula. In terms of approach, however, they subdivide into two groups.

Within the first group, the lessons are built around complex "ecologically valid" materials such as real-world conundrums, specially written stories about the true-to-life problem-posing environments and problem-solving lessons of model compeers, the students' own writing or schoolwork, or even the contents of Great Books (see Costa, 1985). The processes targeted by this first group center on what Paul (1984) has termed "macrological skills," such as creativity and the ability to deal with complex information and multiple points of view.

Within the second group, the lesson materials are abstract, similar to those found in standardized psychometric tests of aptitude: dot matrices, geometric figures, and simple lexical or pictorial multiple-choice items. The processes targeted by this group of programs center on what Paul has termed "micrological skills," such as observation, classification, and sequencing.

A question of primary interest, for both theoretical and practical reasons, is what are the basic and universal processes that these curricula collectively endorse. The task of generating a coherent answer to this question is made difficult, but not impossible, by the cross-program differences in the levels or complexities of the targeted process. However, there are other obstacles to this endeavor. First, and perhaps most surprisingly, the curricula are not uniformly explicit about the processes they are intended to develop (and this is somewhat independent of whether the processes are named or numbered). Second, even when lists of processes are provided, they often reflect a sloppy partitioning of the potential space. As one example, process lists for the Instrumental Enrichment curriculum cite logical reasoning as distinct from inductive and deductive reasoning (Link, 1985; Chance, 1986). As another, among the 60 skills comprising deBono's CoRT Thinking Materials (1975), there is considerable overlap, e.g., (Consider All Factors, Input, Expand and Information), (Opposing Points of View and Examine Both Sides), and (Objectives, Define the Problem, Target, and Purpose). Third, where process overlap clearly does exist between programs, it is often disguised by differences in nomenclature. Thus, what one calls divergent thinking, another calls lateral thinking; what one calls sequencing, another calls operational analyses, and so on.

At a more general level, the vast majority of the programs are directed toward developing students' analytical and logical acumen. But even here, there are ardently voiced differences of opinion. Paul (1984) argues that programs intended to develop such "critical/analytic" thinking skills can be, at best, of limited, short-term value. What students need most, he argues, are "strong-sense" thinking skills, skills that support the dialectic, that generate fair-mindedness and reasoned judgment. These skills, he continues, are based on principled and not procedural thought; they represent a different mode of thinking from that which is emphasized by the critical/analytic approach and cannot be developed through any direct extension thereof.

Edward deBono comes down on the value of critical thinking and logic with at least as much force:

> ...as the teaching of thinking becomes fashionable, there is the serious danger that educators will turn to the only sort of thinking they know: critical thinking.
>
> The emphasis on critical thinking has long been the bane of society and education. (1984, p. 16)

deBono then asserts that what students lack most are creative thinking skills; to master these, they need training in perception. His argument is that:

> If the perceptions are inadequate, they cannot be put right by an excellence of logic. Indeed, there is a real danger that we accept an error-free argument as correct when the logic may be correct, but the perceptions on which it is based are grossly faulty. (1985, p. 367)

Despite the apparent disarray and disagreement, I will argue that there is, in fact, considerable commonality of goals across these programs. I would agree—I'm sure we all would--with Paul's (1984) position that students need to develop the sort of critical but open-minded, flexible, and nonegocentric thinking skills of the dialectic. On the other hand, I would assert that the only rational path to these abilities is through the critical and analytic skills that he rejects. Except to refer to roughly 3,000 years of philosophical scholarship on the issue, I offer no further discussion on Paul's argument.

Similarly, I must agree with deBono, that perceptual inflexibility or a fixedness on bad information is a major cause of irrationality and a major obstacle to creative or productive thinking. On the other hand, short of perfect knowledge, logic is the only recourse we have for detecting the incompleteness or inconsistencies of our perceptions. Actually, deBono himself knows this perfectly well. He acknowledges it time and again in his writings. Moreover, his own curriculum, the <u>CoRT</u> thinking program, is focused on the logical, analytical skills necessary for evaluating one's information and perceptions. DeBono, in short, differs more in posture than stance from the other program developers.

In the final analysis, the major difference between programs is that with which we began: the difference in the levels of the targeted processes and principles (macrological versus micrological) and the nature of the materials (abstract versus real-world) through which they are exercised. In terms of pedagogical goals, even this distinction is empty. First, as mentioned above, the development of macrological processes presumes operational knowledge of the micrological growth; no one would argue to the contrary. In terms of pedagogical effectiveness, however, the two approaches may differ significantly.

A glance at the recent literature suggests there exist scores of programs on thinking skills to choose from. In fact, if one restricts attention to those aimed at school children (as opposed to pre-schoolers, college students, or adults), there really aren't very many. Of these, I will base the discussion in the next section on only six. I have selected these six for the simple reason that they were the programs about which I was able to obtain the most information.

The six programs fall, three and three, into the categories of macrological and micrological. The three macrological programs are <u>CoRT Thinking Materials</u> (deBono, 1975), <u>Philosophy for Children</u> (Lipman, Sharp, & Oscanyan, 1980), and <u>The Productive Thinking Program: A Course in Learning to Think</u> (Covington, Crutchfield, Davies, & Olton, 1974). The three micrological programs are <u>Instrumental Enrichment</u> (Fueurstein, 1980), <u>Intuitive Math</u> (Burke, 1971), and <u>Think</u> (C. Adams, 1971). One of the six programs, <u>Productive Thinking</u>, was designed for fifth and sixth graders. The rest were designed for grades three or four and up.

Later in the paper, I will describe a seventh program, <u>Odyssey: A Curriculum for Thinking</u> (M. Adams, 1986). Like most of the others to be discussed, <u>Odyssey</u> was designed for students in grades four and up. It differs from the others, however, in offering more balanced coverage of the micrological/macrological continuum.

<u>What Works and Why?</u>

The question of what works would seem to be an easy one to answer. One need only examine the evaluation data, right? I regret to report that the evaluation data on these efforts do not allow straightforward comparisons. Where data exist and are easy to obtain, they are often flawed in design and control. The good, if qualified, news is that virtually every reported evaluation includes evidence of some gains, and amidst the various evaluation efforts there are also some extremely positive results.

Even if we put on our blinders and look only at these positive results, there is room for disappointment. To a greater or lesser extent, at least one of the following limitations besets each of the curricula: substantial gains tend to show up only for some students, under the tutelage of only some teachers, and only on tests that are closest in structure and content to the course itself.

In this section, I will address the question of why the courses are more and less effective. I will focus on each of the limitations cited above. As I do so, I will pay particular attention to the distinction between macrological and micrological approaches and to the special needs of Chapter 1 students.

Of the three limitations, the most disheartening is the tendency for significant gains to show up only on tests that are highly similar to the curricula in content and structure. What this means, in a nutshell, is that transfer or generalization of the processes taught in these courses is limited. Yet, transfer is the primary goal of a course on thinking. If the processes don't transfer, they cannot even be called thinking. They can be called learning, or memory, or habit, but not thinking. The purpose of a course on thinking is to enhance students' abilities to face new challenges and to attack novel problems confidently, rationally, and productively. For Chapter 1 students, it is, moreover, to create the intellectual leverage to catch up and move on.

Whether to choose wisely among existing programs or to invent new ones, an understanding of the factors that promote and inhibit transfer is of first-order importance. My own conviction is that when the mind resists doing something that we believe to be intelligent, it is almost always because it is giving precedence to some conflicting but more important behavior. I shall now argue that the mind's apparent resistance to transfer is an exact case in point.

Recent research in cognitive science converges on the conclusion that the human mind is nothing like a piecemeal catalog of knowledge. When you learn about a topic, your memory does not just store away a list of all of the observations, facts, and events about which you have learned. Instead, it stores them away in an intricately interconnected bundle. The interconnections capture the various relationships between those observations, facts, and events that you considered while learning about them. The memory structure created from the interrelated bundle of information you have acquired about any given topic is called a schema (plural: schemata).

Schemata are essential to our ability to understand what we see and hear. For example, if I told you that I had a big dog named Fido, you would, by virtue of your schema about dogs, readily infer that Fido has four feet and fur, that he barks, that he is my pet--you would even have a pretty good notion of how big he might be. If I told you that Kathy, for reasons of genetics, was born without feet, you would feel very little compassion--if you knew she was a goldfish. If I told you that the man who had been sitting across the room from me walked out without leaving any money, you would wonder what in the world I was talking about--unless you knew I was in a restaurant.

Thus, schemata serve to organize and fill out the scant information we typically receive about the world. They are the means by which we are able to use our knowledge and experience to make sense out of raw ambiguity and to find significance in a gesture. But, notice: it was essential to know that Kathy was a goldfish; it was essential to know that I was in a restaurant. The interpretive advantage of the system depends upon your finding the appropriate schema through which to interpret the information at hand.

The goldfish and restaurant examples point up one more important feature of the system: schemata bundle together information that has been related in one's experience; as a consequence, they also separate information that has not. This partitioning of memories by schemata is also generally beneficial. To see why, let us again consider an example. Imagine that you are reading about John Dean in <u>All the President's Men</u> (Woodward & Bernstein, 1976). Not once, as you read along, do you confuse "John" with King John, Pope John, John Cage, or John who was in your fourth-grade class. Not once do you pause to wonder if his family makes pork sausages or if his brother was killed in a car accident. On reading that John was a Baptist, you do not take him to be John the Baptist; you do not even consider the possibility. The point is that when you are thinking within a schema, your thoughts rarely wander to another, no mater how suggestive the cues.

Thus, we see that this partitioning of information by schemata is to also crucial to cognitive coherence. Information that has not been interrelated in your experience is not interrelated in your memory; it is coded in separate schemata. This protects your thoughts from spurious associations and the mental chaos that would result therefrom. In the interest of teaching for transfer, however, an unfortunate side effect is that it also inhibits you from jumping between schemata, even when so doing would give you the most productive edge on a problem.

All of this makes for a very persuasive argument as to why content-oriented efforts to teach thinking skills--i.e., efforts to do so in conjunction with some particular content area such as science, social studies, or arithmetic--are unlikely to succeed. Specifically, if the thinking skills are introduced and developed through specific content, they will, per force, be remembered, understood, and--importantly--accessible only in relation to that content. The resulting schema will hang together as a richly interconnected complex of knowledge about the topic. Here and there, embedded within it, will be a variety of analytic or heuristic processes and principles. From any other domain, it may be possible to access these processes and principles through explicit and pointed analogy. It also may not, depending on how integrally they are encoded in terms of the content. But their spontaneous transfer cannot be expected. If the goal of the course is to teach thinking, if it is to develop a schema that is about thinking, then the course should verv consistently and very unambiguously be about thinking.

Less obviously, perhaps, the foregoing discussion of schema theory also explains why a strictly abstract, micrological approach is unlikely to produce transfer. Within the discourse on thinking skills, such approaches are occasionally described as being "content-free." What is meant by this is that the targeted principles and processes are introduced and exercised through such materials as dot matrices, abstract line drawings, and so on. The nature of the materials is, in turn, held to be the key to transfer: because the principles and processes are developed in the abstract, they should be conceptually neutral and, therefore, equally generalizable to all applicable problem domains.

The argument sounds good, yet there must be something fundamentally wrong with it. The disappointing transfer effects of the micrological curricula are repeated in miniature across scores of training and transfer studies in the psychological literature.

The clue is found in the term "content-free." Can a curriculum really be content-free? The answer is no: The content of a curriculum is the medium of instruction; it is the materials to which the targeted processes and principles are applied; it is the materials through which they are defined and exercised. In terms of content, the difference between content-oriented and content-free curricula is not whether or not they have it; it is whether the content they do have consists of traditional classroom matter or, say, abstract graphic designs of some sort. Most importantly and whichever the case, the content of the course defines the context within which the principle and processes will be retained and through which they may be recalled. If the goal of the course is to teach thinking and, therefore, to maximize transfer, the materials or content through which the course is developed should reflect as diverse and broadly useful a set of problem domains as is possible.

In fact, none of the programs under discussion falls cleanly into the category of abstract and micrological. The <u>Instrumental Enrichment</u> program may come closest; its own developers describe it as "content-free" (Fueurstein, Jensen, Hoffman & Rand, 1985). Yet integral to the full implementation of the Instrumental Enrichment program is a process called "bridging." Each lesson in the Instrumental Enrichment program focuses on one or two general principles, such as "a good strategy for self-checking is to reverse an operation" or "when two stimuli are very similar, more careful analysis is needed to distinguish the differences" (Bransford, Arbitman-Smith, Stein & Vye, 1985, p. 188). Bridging is to occur at the end of each lesson: It consists in having the students produce and critique examples from their own experience that illustrate the relevant principle. Bridging is thus the key to transfer in the Instrumental Enrichment program. Yet, relying as it does on the students' own reminiscences, it must lack the efficiency and scope that a methodically designed set of generalization exercises could achieve. Evaluations of the Instrumental Enrichment program indicate that it does quite well at increasing students' nonverbal IQ scores; as a rule, however, it has not resulted in significant improvements or transfer to general school achievement or nonschool cognitive tasks; interestingly, exceptions to this rule tend to be had where the students' instructor for Instrumental Enrichment is also their instructor for other coursework (Savell, Rachford, & Twohig, 1984).

Each of the other two micrological programs, Intuitive Math and Think, is built around six basic skills (the descriptors in parenthesis are mine, added for clarity):

1. Thingmaking (concept formation);
2. Qualification (description);
3. Classification;
4. Structure Analysis (part-whole analysis);
5. Operation Analysis (sequencing);
6. Seeing Analogies.

The goal is to enhance the students' thinking abilities by exercising these micrological skills over and over, across a diversity of problems of graduated difficulty. The problems are mostly multiple choice, fill-in-the-blanks, and so on. In format, they thus resemble the abstract exercises of the Instrumental Enrichment program. However, excepting those exercises used for introducing the processes, they are not abstract. Rather, the exercises are designed to connect the basic processes to the content and operations of conventional school subjects: mathematics and language arts/reading, respectively. Thus, although the materials reflect a bit of a shotgun approach to content, they do indeed include considerable content. And, because the exercises are consistently presented and analyzed in terms of the six basic thinking skills, it is likely that the students' memory for the course will accrue as a single grand schema.

Both Intuitive Math and Think were specially designed for remedial work with students in grades 4 and up and have been used quite extensively with below-norm inner-city and Chapter 1 populations. Each has been shown to produce not just significant, but often very impressive growth in the average achievement scores of recipient classrooms as measured by a variety of tests (California Achievement Test, Comprehensive Test of Basic Skills, Gates MacGinitie Reading Test, Iowa Test of Basic Skills, Metropolitan Achievement Test, and Stanford Achievement Test) in studies by Worsham and Austin (1983) and Zenke and Alexander (1984).[11]

In contrast with the micrological approaches, the macrological generally avoid the abstract. Instead, it is through a diversity of face-valid materials and the repeated application of the targeted principles and processes to them, that the macrological approaches seek to maximize transfer.

From the perspective of schema theory, this sounds like the right approach. Nonetheless, for the two most extensively used macrological programs, deBono's CoRT and Covington et al.'s Productive Thinking, evidence of transfer, as measured by improvements on standardized tests, is hard to come by (see Mansfield, Busse, & Krepelka, 1978, and Nickerson, Perkins, & Smith, 1985, for summaries).

There is, on the other hand, a standout among the macrological curricula. This is Lipman's Philosophy for Children. Evaluations of this program with middle school (grades 4-8) children have repeatedly shown it to produce significant gains in reading comprehension and/or logical thinking (see Lipman, 1985, for a summary).

Three explanations might be offered for the effectiveness of Lipman's program as compared to its macrological cousins. First, it is a bit of a hybrid on the micro-macro discussion. Lipman argues that higher-order thinking skills are not essentially different from the basic or lower-order logical processes. They are instead but concatenations of the lower-order processes, ways of using them "collaboratively and concertedly" to higher-order ends (1984, p. 55). In keeping with this, the processes and principles covered in Philosophy for Children move progressively from the simpler to the complex, and, to clarify the simpler processes, many of the accompanying exercises are quite abstract. Despite intentions, however, Lipman is nowhere explicit about the identities of the basic processes, and the exercises designed to enhance them lack something in the way of clear or methodical progression. The program is centered upon and strongest with respect to the macrological end of the continuum.

The second possible explanation for the relative effectiveness of Philosophy for Children relates to its focal reading materials. The reading material, for each course in the program, is a novel: a single, well-written book about the continuing episodes of a small set of major characters with complex but consistent personalities. According to Lipman, the power of this medium is the imaginal invitation of fiction; the student comes to know the characters and their world in a deep sense, to identify and sympathize with them and, thereby, to truly participate in their adventure in thinking about thinking. Lipman is surely correct, yet there may be another feature of the use of novels that is at least as important. It gives Lipman the freedom to introduce, reintroduce, and elaborate each logical process across a diversity of real-world situations, simultaneously ensuring that all such instances will be remembered together, in the single evolving schema for the novel as a whole.

In short, Lipman's courses are designed to build upon themselves both thematically and (though with a little more entropy) logically. In combination, these two features must enhance the likelihood that the resulting product, in the student's mind, will be a single, contextually rich but thematically integrated and logically well-articulated schema. From the perspective of schema theory, this would be the ideal.

The third explanation for the success of Philosophy for Children is less interesting than the others, but cannot be overlooked. Specifically, the program seems best suited for scholastically solid, culturally mainstream classrooms. Sternberg (1984) comments that students from lower-class and even lower-middle-class backgrounds might have trouble relating to the stories. Further, the novels would lose at least interest and cohesion except in the hands of fairly good readers. And finally, the program demands a degree of philosophical sophistication, confidence, and mental agility that may be difficult for any but the best teachers to master. It follows, regrettably, that Philosophy for Children is probably not among the best options for widespread Chapter 1 implementation.

To summarize, I have argued on the basis of theory that for purposes of maximizing transfer, a course on thinking skills should result in a single, well-integrated schema. The schema must be centered on the principles and processes the course was intended to develop, and it must be richly and diversely elaborated with concrete or real-world instances of application. Consistently, from the evaluation data, I have shown that the programs yielding the strongest evidence of transfer are precisely those which best meet these theoretically designated criteria.

Through the discussion of the evaluation data, an additional set of variables has also suggested itself. Specifically, of the more successful programs, none was strictly macrological, and none was strictly micrological; none depended solely on abstract exercises, but all employed them from time to time. Is a mixed approach truly better, or is this coincidence? I will discuss this issue in the next section where consideration is turned to the issue of individual differences.

Before moving on, however, I would like to address a lurking caveat. Every one of the programs producing positive results on standardized tests can be criticized on the grounds that it includes exercises resembling the problems on standardized tests. Conversely, Productive Thinking and CoRT, the two programs producing least evidence of transfer as measured by such tests, are also the two most devoid of test-like exercises. For both Productive Thinking and CoRT experimental or taught students have been shown to exceed controls in ideational fluency on problems similar to those found in the respective curricula. The effects of Productive Thinking have been particularly well researched, often demonstrating gains not just in the quantity of ideas students generate, but further in the quality of their ideas and in their intellectual independence and self-confidence (Covington, 1985; Polson & Jefferies, 1985).

The point is that transfer is a grey scale. Its ultimate metric is decidedly not performance on any particular set of test items, standardized or not. On the other hand, true thinking uncontainably promotes learning, understanding, and more thinking. It thus follows that there is one best measure of the success of such a course. That measure would assess whether impact of the course increases with time, whether students who received the course continue to outlearn, outperform, and "outadjust" their peers who did not. On this question, there is unfortunately very little data (but see Fueurstein, 1980, and Lipman, 1976).

Individual Differences

The second problem besetting courses on thinking skills is that many seem to work only with certain students. For programs that work best with the better students, the problem is obvious: Chapter 1 students tend not to be the better students. However, any insensitivity to individual differences takes on more global import when the target population consists of Chapter 1 students. Specifically, as a group, better students tend to be relatively homogeneous in terms of general knowledge and school skills; by most measures they correlate nicely with themselves and each other. The same is not true of low-achieving students; their knowledge, skills, and interests tend to be unpredictable both within and across individuals.

It follows that the most promising program for Chapter 1 implementation will not be geared to either the best or the worst. Rather, to be successful, it must be appropriate across a broad and complex space of individual differences.

This point spills immediately into yet another argument for teaching thinking skills separately rather than as an adjunct to any conventional content area. That is, to think about history, a student must first know a certain amount of history; to read critically, a student must first read at a certain level; etc. Because they offer their developers so much freedom in selecting and structuring content and materials, process-oriented approaches offer a medium that can be relatively free of such impediments. Process-oriented approaches are therefore your best bet if the students to whom you would like to teach thinking skills are either young or low achievers. Process-oriented approaches are also your best bet if the students differ from one another in their entry levels of achievement--and, do note: pullout or not, they always do.

Of the macrological programs, effective use of Philosophy for Children is, as mentioned above, pretty much restricted to better classrooms. Similarly, Productive Thinking has been used most frequently and successfully with above average students (Chance, 1986; Covington, 1985).

Indeed, of the macrological programs, CoRT alone claims equal useability and success across high ability, low ability, and mixed ability groups (deBono, 1985). The wider useability of deBono's program is owed to the nature of his materials. They consist of problems that have no correct answers, but whose proper airing may involve consideration of a number of factors and points of view, all of which should be available through common sense and common knowledge. Examples of these problems include, "What makes a TV or radio program interesting?" "Mail services lose a lot of money. If you were running these services, what alternatives might you suggest?" and "A father forbids his 13 year old daughter to smoke. What is his point of view and what is hers?" (deBono, 1985). The purpose of the problems is to exercise CoRT's "tools" or thinking principles. The CoRT program includes 60 named principles although, as mentioned earlier, there is considerable redundancy among them. In the main, the principles are directed towards brainstorming, suspending judgment while brainstorming, identifying the positive, negative, and interesting or unusual features of the brainstormed ideas, recognizing different points of view, and putting it all together. In class, the principles are named but not defined except by way of the teacher's chosen examples. For the core of each lesson, the students are divided into groups of four or five. Within these groups, they discuss each problem, giving special attention to the tool of the day. Then the groups report their ideas to the class as a whole. In short, the lessons pivot on appealing problems that involve no reading, no writing, no specialized knowledge, and no wrong answers—just talk, and all kinds of people love to talk. Hence, its universal useability.

But what about its success? DeBono eschews standardized tests—"they are not sensitive to the range of thinking skills in which the CoRT program offers instruction" (deBono, 1985, p. 382). He prefers tests of his own devising, testimonials, and examples. Here is an example:

> I was once teaching a demonstration class of 10-year old children in Sydney, Australia. I asked them whether they would like to be given $5 a week for attending school. All 30 of them liked the idea and gave their reasons for doing so, (buy sweets, chewing gum, comics, etc.). I then introduced the idea of the PMI [a CoRT tool] and asked them to apply this to the suggestion, working in groups of five. After 4 minutes, I asked for their output. They raised the following kinds of issues: Parents would stop pocket money, schools would increase charges, bigger boys would beat up smaller ones --and where would the money come from? Twenty-nine out of the 30 had now completely reversed their opinion. This was without any suggestion from me as to which considerations they should bring to mind. This example illustrates the purpose of CoRT thinking: the use of a simple perceptual framework to bring about a conclusion through exploring the experience in a more thorough manner. (deBono, 1985, pp. 385-386)

I have to say that I am underwhelmed by the quality of thought shown in such examples.

I have seen the CoRT program in action. I was highly impressed with the enthusiasm and the mental activity it provoked in the classroom, and am comfortable with the idea that it generally does so. I believe that the CoRT program may exert a strong effect on the attitudes of low achievers, that it may give them a genuine sense of their own permission to think. Such an outcome can only be considered invaluable and should not be downplayed. On the other hand, I remain skeptical about the extent to which the program hones its students' critical or analytic abilities.

The CoRT program aside, it is the micrological courses, Instrumental Enrichment, Think, and Intuitive Math, that have been used most often and most successfully with low-achieving students. I suspect that the apparent advantage of the micrological over the macrological programs is real and derives from the characteristic difference in materials as well as structure. Turning first to materials, all of the micrological programs rely on abstract materials at least for introductory purposes. At a cognitive level, there are two advantages to such materials. First, they offer a means by which the targeted processes and principles can be explicated and exercised without presuming any specialized background knowledge on the part of the students; again, this feature has special merit when the students are of low or mixed achievement levels. Second, abstract exercises, as they are relatively meaningless by definition, remove the conceptual distraction potentiated by content-rich exercises. They thus allow for the instructional exchange (and the resulting memories of it) to be unambiguously focused on the processes and principles at issue.

In terms of structure, the salient aspect of the micrological approaches is that they include explicit instruction and labeling of the micrological principles and processes. Because of this, they are prepared with both the conceptual and terminological scaffolding to analyze and discuss the macrological issues explicitly when they do arise. This is seen as an advantage on two dimensions. First, it provides the necessary components for sound direct instruction. The definitive feature of direct instruction, whether achieved through guided practice, modeling, Socratic inquiry, or discussion, consists in the explicit treatment of the substeps of a thought process and of the considerations pertaining to when and why each of those substeps is appropriate. Instruction of this kind is widely held to be an especially effective means of developing students' appreciation of the intellectual processes as opposed to the contentive products of a discipline (Anderson, Hiebert, Scott, & Wilkinson, 1985; Pintrich, Cross, Kozma, & McKeachie, 1986; Rosenshine, 1986). Without explicitly addressing the substeps of a complex process, the best the macrological approaches can offer is indirect requirements for their exercise (see deBono, 1985). Second, the explicit articulation of the microprocesses, first by themselves and later as components of more complex or concrete challenges, should lead to a stronger core as well as richer and thus more traversable interrelations in the schema the students develop.

Even so, an equally strong but different case can be made for both macrological and content-oriented approaches, especially as they build upon information of real-world and scholastic relevance. The strong proponents of this case are cognitive psychologists, and the reason for their adamancy came as somewhat of a surprise to themselves. For the last 25 years, the field of cognitive psychology has been devoted to understanding the nature and limits of people's intelligent behaviors. Until very recently, the research had been focused all but exclusively on all-purpose processing modes and capabilities. Then, due to a variety of forces—the influence of computer scientists in the field of artificial intelligence, the resistance of language to being usefully modeled in the abstract, the uncontrollable influence of semantics on memory phenomena—researchers began to attend to the effect of knowledge on their experiments instead of trying to cancel it out.

The results have been persuasively summarized by Robert Glaser (1984). In essence, the various processing modes and capabilities that had already been postulated were reaffirmed; they were every bit present and generally behaved as expected in these new, knowledge-rich, experimental designs. The exception was that they differed negligibly across individuals: Whether comparing experts and novices in some domain, high and low scorers on aptitude tests, or even adults and children, the differences in performance proved due, most of all, to differences in knowledge.

All together, the research on knowledge and performance led psychologists to the theory of schemata described earlier in this paper. In particular, results such as those just described virtually force the conclusion that improvement in cognitive skills...

> ...Takes place through the exercise of conceptual and procedural knowledge in the context of specific knowledge domains. Learning and reasoning skills develop not as abstract mechanisms of heuristic search and memory processing. Rather, they develop as the content and concepts of a knowledge domain are attained in learning situations that constrain this knowledge to serve certain purposes and goals. Effective thinking is the result of 'conditionalized' knowledge--knowledge that becomes associated with the conditions and constraints of its use. (Glaser, 1984, p. 99)

A large proportion of the Chapter 1 population is comprised of children who, for reasons of ethnicity, poverty, or parental education, fall outside the mainstream culture of our society. The implication of these issues for such children is so important that it bears restatement.

Cognitive theory and research indicate that the way in which we perceive and interpret our worlds depends most of all on the worlds we have experienced in the past. Our minds can be described as the organized memories of whatever we have experienced, either consciously or tacitly. Thinking, understanding, and learning can be described as processes of retrieving or constructing interrelations among subsets of our knowledge that coherently model the phenomena under consideration.

If this view is correct, then cross-cultural differences in achievement are to be expected. Our knowledge must vary at several different levels with the culture in which we live. At the most basic level, the phenomenal world may differ markedly across cultures, and even where it overlaps, the full or contextually elaborated meanings of particular objects or events may nonetheless differ significantly. To this extent, our direct knowledge of the world, both simple and complex, will be culture specific. Our cultural environment also influences the kinds of knowledge we are likely to gain through vicarious experiences. Culture shapes not only the topics but the social functions of the oral language around us. Further it determines the nature and availability of other sources of vicarious experience, such as books, newspapers, and television programs.

Thus, our cultural environments are strong determiners of the kinds of experiences to which we are haphazardly exposed. In addition, however, there are social differences between cultures which must affect our cognitive development in a more systematic way. Specifically, cultures differ in the uses they make of thinking and knowledge. This impacts not only on the kinds of thinking and learning a culture fosters, but also on the attitudes it fosters toward thinking and learning. In a technologically sophisticated society, thinking and learning are prize commodities. They are highly valued both socially and on the marketplace and, like other prize commodities, are sought in their own right. That is, the technological society carries an atmosphere that is not only conducive to thinking and learning but, further, to thinking and learning about thinking and learning.

Our educational system is both the product and promoter of this cultural syndrome. It is our institutionalized best effort to provide for our children within the system—to pass on our culturally endorsed fortunes, as it were. We have designed our formal educational system to expand and elaborate on those skills and values which our children have, in any case, been reared to accept and pursue. By opening the educational system to children with different backgrounds, we offer to them the opportunity to move into and up in our social structure. The problem is that to the extent children lack the knowledge and values that the system presumes, it must be extremely difficult for them to assimilate those which it offers.

A good course on thinking skills would be an invaluable boost for such children. Ideally, it would give them the critical, analytic, and organizational abilities and attitudes to make the most of the information they do have and will be exposed to. But, for maximum impact, the course must be content-rich. For Chapter 1 students, the provision of content is of utmost importance in itself; it is a fact of intellectual life, that the more you know, the more you learn. Further, harkening back to the section on transfer, the content provides the links through which the learned thinking skills will be activated and applied to issues and challenges encountered beyond the boundaries of the course itself.

Returning to the programs with an eye toward the issue of individual differences, Think and Intuitive Math seem the best choices for Chapter 1 implementation. They are structured for assimilation by low achievers, and their content has been carefully contrived to connect to and enhance the students' performance in language arts and math, respectively.

On the short side, these two programs might be criticized for relying too much on short-format exercises. According to Toczynski (1984), one negative of this spoon-sized delivery system is that the exercises are occasionally found to be simplistic, repetitive, and boring (although the harder exercises are reported to be exciting). Another is that by relying on short-format exercises, which are inherently limited in complexity or dimensionality, the program moves too little toward the dialectical and macrological skills that support more general intellectual independence rather than just grade-level studentship. Moreover, the programs might be criticized for being too closely tied to the academic regimen they seek to enhance and, in particular, to the basic skills of those regimen.

Of particular relevance within this section, the two programs are by no means indifferent to students' entry levels of achievement. Nor, I suspect, could they be, given their concentration on the remediation of domain-specific skills. Instead the programs are deliberately tailored to students' entry levels of achievement. Each has been developed across a series of levels, and Innovation Sciences, Inc., provides pretests for determining the most appropriate level for any given group of students. In keeping with this, the programs appear most successful under a statistical lens: they very often advance the average test scores of the classes with whom they are implemented. However, whether for reasons of pretesting error or non-universal assumptions about the sorts of skills students need, there are inevitably individuals within groups and occasionally whole groups of students for whom the programs produce little or no measurable impact. These drawbacks aside, Think and Intuitive Math look quite attractive for Chapter I purposes. On average, they do seem to arm students with not just the basic skills but, further, the basic understanding and attitude to move on.

Useability by Teachers

The third limitation, that of how easily the course can be implemented, is not a direct problem for Chapter 1 students. Indirectly, however, it is critical. To invest in their widespread dissemination and, thereby, to gamble the time and money they require, we should expect the curricula to be usable and effective in the hands of whichever teachers draw the straw. And we should expect them to be so without requiring undue time for lesson preparation and management in or out of class.

The profession of a teacher is teaching. A good teacher is invaluable precisely for her or his ability to understand, manage, and communicate with students. A well-designed curriculum should support those efforts, not divert them.

I would argue that it is fundamentally irresponsible for a curriculum to list major activities while expecting teachers to invent the materials or the substance of the lessons for getting them done. Of course, there are teachers who like to design their own lessons and materials. Of course, every teacher occasionally runs across materials, topics, or ideas that she or he wants to add to the lesson plan. Of course, all teachers regularly modify and adapt curriculum materials to best suit the interests and abilities of their own students.

However, one should not expect teachers to produce the bulk of their instructional materials any more than one expects medical doctors to invent medicines, actors to direct their own movies, or Presidents to write their own speeches from scratch. To be sure, there are some teachers, doctors, actors, and Presidents who do such things. But whether they do them is really quite independent of how well they carry out the challenges of their principal profession.

By extension of this position, I would further argue that a well-designed curriculum should not require large amounts of inservice training. A heavy inservice requirement is inconsiderate of teachers' time and school budgets. And worse, it is a symptom that the success of the curriculum depends not on the guidance and materials it provides, but on the individual efforts of teachers to interpret and go beyond what it provides.

The considerateness of curriculum materials is even more important if the topic of the course is new. When designing a curriculum in a traditional domain, such as grammar or geography, one can afford to be a little sloppier: teachers will readily fill in the gaps, drawing on their own prior coursework and knowledge of the domain. In contrast, most teachers have not had many courses on thinking skills. To the extent that a curriculum on thinking skills is not self-contained and comprehensible, it would be almost reasonable for teachers to throw up their hands and quit it.

Of the curricula under consideration, both Philosophy for Children and Instrumental Enrichment require lots--on the order of weeks and months--of teacher training, and the outcomes of each appear highly sensitive to teacher variables. For the CoRT program, teacher training is recommended, but deemed unnecessary; on the other hand, even deBono (1985) acknowledges that the success of the lessons must be highly dependent on the teachers' style and mental flexibility. Other than reading through the appropriate sections of the teacher's guide prior to each lesson, Productive Thinking requires no special preparation of teachers; but again, its effectiveness seems to be quite sensitive to individual teacher variables. Finally, both Think and Intuitive Math suggest one week of pretraining for teachers, although effective use of the program by regular classroom teachers has been reported after as little as one day of preparation (Worsham and Austin, 1983). There is a trade-off here: in-lieu of being training intensive, both Think and Intuitive Math are materials intensive. The implementation of these two programs requires purchase of a whole package including such things as individual student work books, "moderator guides" including teacher scripts and answer pages, response pads, tape cassettes, student progress records, and red, white, and blue counters.

One More Program: Odyssey

I turn now to a brand new program entitled Odyssey: A Curriculum for Thinking (M. Adams, 1986). The program was developed through a collaborative effort of Bolt, Beranek, and Newman, Harvard University, and the Venezuelan Ministry of Education. The project was funded by Petroleos of Venezuela and sponsored by Dr. Luis Alberto Machado, then Minister for the Development of Human Intelligence of the Republic of Venezuela. I give the program special attention not just because it is our own and I'm proud of it, but further because (1) it worked as measured by a team of evaluators in whom I have total confidence, (2) it is structurally unique, and (3) it was designed and implemented in the face of exaggerated forms of virtually every curriculum-breaking problem one might imagine.

Problems Confronted

The experimental implementation and evaluation of the program was conducted solely in Venezuelan "barrio" schools, a designation indicating that the students came from homes with low socioeconomic status and minimal parental education. The course was administered exclusively to seventh-grade classes, but the students ranged from 10.6 to 17 years of age. The students, moreover, differed at least as widely from one another in school skills, general knowledge, motivation, social behavior and virtually any other relevant dimension one might name. The teachers with whom we worked, ranged from very marginal to excellent, and we knew this would be true of the teachers who might be asked to use the curriculum in the future. Because the goal was to develop a course that could be widely disseminated in Venezuela in our absence, it had to be self-contained; it had to be designed such that it would be usable without extensive teacher training and such that it would resist deleterious transformations in transmission. Finally, because of the funding system in the schools, we knew that future use of the course in Venezuela would be generally precluded unless the associated materials were inexpensive to purchase.

Curriculum Design

Odyssey is, relative to the previously discussed programs, a come-lately effort. This was a tremendous advantage in terms of defining its structure, as we had both the wisdom of hindsight on previous efforts and the benefit of contemporary theory and research in education and cognitive psychology.

From the outset, our challenge in writing the *Odyssey* curriculum was defined. We sought the focus, analytical force, and pedagogical range of the micrological approaches: we wanted to convey, very explicitly, both the nature of the basic processes and their interrelationships; and we wanted to reach the least advanced students without losing the most advanced. We sought the epistemological leverage of the content-oriented approaches: we knew our thinking skills had to be thoroughly enmeshed in conceptual knowledge of direct scholastic or real-world relevance. We sought the intellectual complexity and dialectical reflection of the macrological approaches. And we wanted the skills we taught to transfer, to be recalled and applied to whatever amenable challenges the students might encounter beyond the confines of the curriculum itself.

To meet this challenge, we exploited the theory of schemata and developed a content-rich but process-centered design within which the macrological is systematically built upon the micrological. In overview, the curriculum we produced consists of six lesson series or books. Each lesson series is divided into two or more units, representing subtopics. The units themselves are comprised of three or more one-hour lessons. Table IV-1 provides a list of series and units and, in parentheses, the number of lessons in each unit. The table

TABLE IV-1: Contents of *Odyssey*

Series and Unit Titles and Descriptions		Number of Lessons
LESSON SERIES I: FOUNDATIONS OF REASONING	21 Total	
Unit 1: Observation and Classification		6
Using dimensions and characteristics to analyze and organize similarities and differences; discovering the basics of classification and hypothesis-testing.		
Unit 2: Ordering		5
Recognizing and extrapolating different types of sequences; discovering special properties of orderable dimensions.		
Unit 3. Hierarchical Classification		3
Exploring the structure and utility of classification hierarchies.		
Unit 4. Analogies: Discovering Relationships		4
Analyzing the dimensional structure of simple and complex analogies.		
Unit 5. Spatial Reasoning and Strategies		3
Developing strategies to solve problems of resource allocation via tangrams.		
LESSON SERIES II. UNDERSTANDING LANGUAGE	16 Total	
Unit 1. Word Relations		6
Appreciating the multidimensional nature of word meanings.		
Unit 2. The Structure of Language		5
Discovering the logic and utility of rhetorical conventions.		
Unit 3: Information and Interpretation		5
Analyzing text for explicit information, implicit information, and point of view.		

LESSON SERIES III: VERBAL REASONING	20 Total	
Unit 1: Assertions Exploring the structure and interpretation of simple propositions.		10
Unit 2: Arguments Analyzing logical arguments; evaluating and constructing complex arguments.		10
LESSON SERIES IV: PROBLEM SOLVING	18 Total	
Unit 1: Linear Representations Constructing linear representations to interpret n-term series problems.		4
Unit 2: Tabular Representations Constructing tabular representations to solve multivariate word problems.		4
Unit 3: Representations by Simulation and Enactment Representing and interpreting dynamic problem spaces through simulation and enactment.		4
Unit 4: Systematic Trial and Error Developing systematic methods for enumerating all possible solutions: developing efficient methods for selecting among such solutions.		2
Unit 5: Thinking Out the Implications Examining the constraints of givens and solutions for problem-solving clues.		3

LESSON SERIES V: DECISION MAKING		10 Total
Unit 1:	Introduction to Decision Making	3
	Identifying and representing alternatives; trading off outcome desirability and likelihood in selecting between alternatives.	
Unit 2:	Gathering and Evaluating Information to Reduce Uncertainty	5
	Appreciating the importance of being thorough in gathering information; evaluating consistency, credibility, and relevance of data.	
Unit 3:	Analyzing Complex Decision Situations	2
	Evaluating complex alternatives in terms of the dimensions on which they differ and the relative desirability of their characteristics on each of those dimensions.	
LESSON SERIES VI: INVENTIVE THINKING		15 Total
Unit 1:	Design	9
	Analyzing the designs of common objects in terms of functional dimensions; inventing designs from functional criteria.	
Unit 2:	Procedures as Designs	6
	Analyzing and inventing procedures in terms of the functional significance of their steps.	
TOTAL LESSONS PREPARED		100

also includes brief descriptions of some of the main objectives of each unit.

In the first lesson series, Foundations of Reasoning, each of our targeted thinking skills is introduced through the sorts of abstract teaching materials typical of micrological approaches. Then, through the balance of the course, these same thinking skills are used, and thereby refined, elaborated and contextualized, over and over again, as the means of developing the various macrological and domain-specific challenges of each of the other lesson series.

Our basic position in designing the curriculum was that thinking, in any domain, involves two basic components: information and interpretation. We therefore designed the course so as to develop a set of processes, concepts, strategies, and attitudes that would support the reflective, methodical, and productive exploitation of these two components.

Of these, it was the processes that served as the backbone of the course. That is, it was the processes that stood as the unifying frame of the grand schema we were trying to instill in the students. At the first level or very base of the schema was the process of analyzing information in terms of dimensions (e.g., color) and characteristics or values on those dimensions (e.g., red, blue, green). Around this core, we build four "first-order" processes: classification, hierarchical classification, sequencing, and analogical reasoning. These are called first-order processes because they are in fact nothing more than structures for comparing characteristics within or between selected dimensions.

Thus, the structure of the course consisted, first, in explicitly and methodically developing the process of dimensional analysis. Upon that, we explicitly and methodically developed the four first-order processes. And, finally, upon those, we explicitly and methodically developed as diverse a set of content-specific and intellectually complex extensions as we could squeeze in. As examples, paragraphs were developed as classes of ideas, and larger text structures as hierarchies. Metaphors, allegories, and families of logical and mathematical word problems were analyzed in terms of the implied dimensions of comparison, explicitly identifying the underlying analogies. Complex decisions were undertaken by identifying the dimensions along which the choices differed from one another and then by ordering their characteristics by preference and their dimensions by importance. And, moving toward the dialectic, students were given considerable exercise in identifying the underlying assumptions and implicit information in text; in identifying the goals and points of view of authors and of the characters in stories; in evaluating and redesigning or rewriting inventions, procedures, and information from different perspectives; in revising opinions; and in compiling, interpreting, and evaluating information on complex, ill-structured problems. Through these excursions, we hoped to extend each of the core processes with the particular conditions and constraints required to make them appropriate to a variety of scholastic and real-world applications.

While structured on process, the curriculum was also rich in concepts. Many of these were specific to a particular domain of application (e.g. antonyms, synonyms, and propositional terms) or to the particular content through which an application was developed (e.g., ballast, adherence, and googol). Moreover, we did not shy from introducing new information to the students. To the contrary, within each domain of application, we made an effort to construct examples and exercises that were both rich and diverse in content. The goal was to make the process-schema rich in knowledge, to maximize the variety of contexts from which it might be spontaneously accessed.

Importantly, there were also a few concepts which were methodically raised and elaborated in every lesson series. Each of these core concepts dealt with some aspect of the nature and quality of the information available for interpretation. They included the concepts of explicit versus implicit information, certain versus probabilistic or suggestive information, positive versus negative information, relative versus absolute information, relevance, consistency, credibility, goals, and point of view.

A number of strategies were also developed and used throughout the course. As examples, these included working backwards, the process of elimination, searching for counter examples, systematic trial and error, and constructing tabular or graphic representations. The essential characteristic of strategies is that they help guide the search for our organization of information. They thus differ from processes in that they play no direct or necessary role in solving a problem. On the other hand, used methodically, they can make the solution of a problem much, much easier.

Finally, the course was intended to instill certain attitudes or modes of learning and thinking in the students. These included, for example, a healthy appreciation of knowledge and the rewards of self-discipline, a willingness to explore and analyze information, a readiness to critique one's beliefs and point of view, a strong notion that the structure of everything, from pencils to literary genre, reflects its intended function, and most of all, the conviction that —whatever it is—it can be understood. We tried to reinforce these attitudes at every possible opportunity.

<u>Useability</u>

The thrust of the course was to be conveyed through direct instruction, modeled on the Socratic inquiry method (Collins & Stevens, 1982), and capitalizing on structured discovery. To maximize useability, the classroom procedure for each lesson in the <u>Odyssey</u> curriculum is presented in the form of a complete script. These scripts are not intended to be used verbatim. Their purpose is instead to provide a detailed and highly imaginable model of the sequence of interactive dialogue and activities through which the embedded lesson plans might be achieved. Their purpose, in other words, is to minimize the need for inservice training. They are offered as an efficient, easy-to-understand means for the teacher to build a usable schema of the intended logic and progression of the course.

The teachers' manual also includes several other features designed to increase the comprehensibility and useability of its lesson content. First, each lesson is prefaced with an explanation of its rationale, its objectives, and its conceptual relationship to other lessons in the curriculum. Second, the text of the classroom procedure for each lesson is divided into topical subsections and methodically formatted in a way that visually contrasts or sets off not only teacher queries and student responses, but also instructions to teachers, information to be written on the board, information about the exercises, and key terms. The purpose of this formatting is to give teachers an easy means of recalling the lesson plan while in class, without having to reread the script itself. By glancing at a page, teachers can easily pick out the information they need to remember, where in the lesson they are, what the key points are, and where they are going next. It is our conviction that some such system of reminders-at-a-glance was a critical component of a usable curriculum: in class, teachers' attention and thought should be freed, to the extent possible, for the challenge of managing and stimulating their students.

Finally, the Odyssey curriculum includes within it all necessary texts, exercises, and demonstration materials (with the very occasional exception of such things as paper clips and poster board). Exercises and texts are provided in the student workbooks and reproduced, with correct answers, in the appropriate spots in the teachers' manual. Demonstration materials are bound in the teachers' manual.

None of this is intended to discourage teachers from extending the curriculum as they see fit. To the contrary, we strongly encourage such extensions: The greater the number of ways that the various components of the course are exercised, the greater and more lasting will be its impact. By providing such thorough conceptual and material support within the curriculum, we hope that we have created a base upon which even the least confident teacher will feel invited to build—to draw other materials and problem situations into the course, and to draw central components of the course into their instruction on other subjects.

Evaluation

Within the time span of the Venezuelan project, we could not ask about long-term effects of the course. We did however, do our best to assess the immediate depth and breadth of the course's effects. In this section, I summarize the design and results of the evaluation effort but, for a more detailed discussion, you are referred to a recent article in the American Psychologist (Nickerson, Herrnstein, deSanchez, & Swets, 1986).[2]

During the 1982-1983 school year, approximately half of the 100 odd lessons in the course were taught by teachers from the Venezuelan school system to about 450 seventh graders (twelve classes) in barrio schools in Barquisimeto, Venezuela. The twelve experimental classes were selected in conjunction with twelve control classes, matched on school and classroom parameters and, insofar as possible, on students' ages, initial abilities, socioeconomic status, and so on.

To assess the impact of the course, all of the students completed a battery of tests at the beginning and end of the school year. One set of these tests, the Target Abilities Tests (TATs), was designed by us to assess students' mastery of the course material per se. The remainder of the battery, however, was put together with an eye toward assessing the general rather than the specific carryover of the course. That is, these tests were selected not to match specifics of the course but to provide a broad range of aptitude and achievement measures.

Three sets of standardized tests were included in the battery: the Cattell Culture Fair Test (CATTELL), which examines pictorially the abilities to extend series, classify, complete matrices or analogies, and establish conditions; the Otis-Lennon School Ability Test (OLSAT), which presents a variety of word problems and is often used in the U.S. to estimate IQ; and eight achievement or General Ability Tests (GATs). In addition, we collected qualitative assessments of the course from teachers, students, and supervisors and administered some less formal tests of reasoning and writing; these measures corroborated the results of the standardized tests.

As must be expected, the test scores of all students, both experimental and control, increased substantially across the school year. However, the gain of the experimental students was significantly greater than that of the control students on each of the tests. One way of indicating the magnitude of the effects is to express the gains realized by the experimental group as a percentage of the gains realized by the control group. In these terms, the gain of the experimental group was 21 percent greater than the gain of the control group on the CATTELL test, 46 percent greater on the OLSAT, 68 percent greater on the GATs, and 117 percent greater on the TATs.

Further, in terms of the raw percentage of correct answers, the gains of the experimental students were virtually constant across initial tests scores. This was very important to us since a major goal in designing the course was to reach not just the quickest and not just the slowest, but all students. Finally, analyses of the data revealed large differences in teacher effectiveness. This was to be expected since our teachers were not selected on the basis of teaching prowess. But the point is that even those students who took the course with the least effective teachers, significantly outgained their controls on the standardized tests. We take this as very positive feedback on our effort to make the curriculum materials universally usable.

Conclusions

I have had two goals in writing this paper. The first has been to argue that Chapter 1 students could genuinely profit from instruction on thinking and that, for maximum impact, such instruction should be introduced as a course in itself, separate from the regular curricula. I underscore "introduced" because, of course, the ultimate goal is to transport such thinking skills to all other curricular and extracurricular endeavors. My second goal has been to discuss some of the major issues and options one ought to consider before adopting a course on thinking skills for use with any given group of students.

The latter discussion was centered on six existing programs on thinking skills. In the interest of making the discussion concrete, I found something to criticize about each of these programs. I would like to clarify, however, that I chose these six programs for discussion because each has been used relatively extensively, with enthusiasm from students and teachers, and with its own brand of success.

Depending on a classroom's particular needs and constraints, any one of them might be a very good candidate for implementation. For a relatively quick program that serves to build confidence or to "open the door" to thinking, CoRT is a good choice. Given relatively homogeneous groups of students and a special interest in enhancing language arts and mathematics understanding, Think and Intuitive Math are good choices. I am less enthusiastic about Instrumental Enrichment because I think, relative to its typical returns, it requires an awful lot of teacher training and classroom time; on the other hand, if the students are markedly below norm, it may well be the best option. Finally, for Chapter 1 students whose performance is close to grade level or above, both Philosophy for Children and Productive Thinking are worth considering. The first of these offers the side benefit of improving reading comprehension scores; the second seems especially effective in increasing intellectual independence.

Beyond these six programs, there are and will be many others from which to choose. I believe the field is expanding not just in number of programs but in sophistication as well. The Odyssey program, which is just now being published, was described as an example of the forthcoming efforts. Although it has not been formally evaluated in the United States, the results of the Venezuelan experiment are very positive. As for the others, please note: just because I could not obtain adequate information about them for present purposes, does not mean there is none or won't be more.

As these programs proliferate, I hope that the present paper will help to define some of the factors governing their appropriateness and potential effectiveness for any given group of students. I hope, moreover, that it will supply some of the motivation and justification for giving the programs serious consideration. For Chapter 1 students especially, the direct teaching of thinking promises to be the best institutionalizable means of developing the competencies and attitudes they need to make the most of their schooling and their lives.

Endnotes

1. Innovative Sciences, Inc., provided me with evaluation reports from the following public schools: Detroit Public Schools/ Region Eight, Detroit, Michigan; Memphis City Schools, Memphis, Tennessee; Morris Central School, Morris, New York; Natchitoches Central High School, Natchitoches, Louisiana; Franklin Pierce School District, Tacoma, Washington; and Taos Junior High School, Taos, New Mexico.

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