Thoughts On Teaching Thinking

A program to enhance thinking skills might reasonably focus on four types of objectives: abilities, methods, knowledge, and attitudes.

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Can thinking be taught? In considering the question whether thinking can be taught, it may be useful to draw a parallel with another issue involving thinking. For at least three decades it has been fashionable in some quarters to debate whether machines (computers) can be made to think. Some attempts to answer this question have defined thinking in such a way as to exclude anything that can be programmed for machines.

However, abilities that once were considered evidence of thinking because they were possessed by persons and not by machines have since been given to machines (for example, the ability to recognize complex patterns, to generate hypotheses, to play intellectually demanding games such as chess). Whenever a machine is given the ability to do something that heretofore was considered to require thinking, people who want to defend the view that machines cannot think are obliged to conclude that that ability that machines did not have but now do, does not require thinking after all.

Thinking can also be defined in such a way as to exclude anything that can be taught. Efforts to teach thinking that appear to be successful can be dismissed with the same arguments used to claim that machines cannot think: "You did not really teach thinking; you just got the students to apply themselves. . . . You just taught them tricks that would make problems easier to solve. . . . You just got them to be careful and to check their work . . . to be more attentive . . . to make more efficient use of resources . . . to budget time and plan activities . . . to apply certain procedures or processes to certain types of tasks . . . none of which really involves teaching *thinking*."

This leads me to conclude that, rather than asking whether thinking can be taught, a more useful question is: What can be done to improve student ability to perform intellectually demanding tasks? Surely the answer to that is not "Nothing."

I suggest that a program to enhance thinking might reasonably focus on four types of objectives: abilities, methods, knowledge, and attitudes. The term *abilities* is intended to connote specific things one might want students to be able to do. *Methods* refers to structured ways of approaching tasks and subsumes the notions of strategies, procedures, and heuristics. *Knowledge* refers to facts, concepts, or principles that one might want students to understand. *Attitudes* refers to points of view, perspectives, or opinions that one might want students to adopt. This taxonomy, like most others, has some arbitrariness about it. It does, however, provide a convenient frame of reference for discussing some important aspects of improving intellectual performance.

Abilities

Some efforts to teach thinking are based on what might be called an "exercise-the-mind" approach, which assumes that the mind is like a muscle in that the more it is exercised the stronger it becomes. According to this view, what students learn is less important than the fact that they learn something, and what they think about is less important than the fact that they do think.

Whether or not the exercise-the-mind assumption is valid, one can make a case for giving students certain abilities because they are useful to have regardless of whether they help strengthen the mind as well. What abilities should be targeted depends on the scope of the program and the level of student for which it is designed. Examples of possible objectives for secondary school students might include abilities to:

- Draw a diagram that represents the critical relationships specified in a problem involving nested classes (All X's are Y's; all Z's are X's; . . .)
- Criticize an argument (on the basis of the validity of the logic or the credibility of its premises)
- Interpret a proverb (adage, epigram, maxim)
- Distinguish between what is given explicitly, what is inferred, and what is hypothesized about a problem
- Generate a set of criteria for evaluating a plan.

Focusing on specific abilities makes at least some of the goals of a program clear and precise. It also sim-

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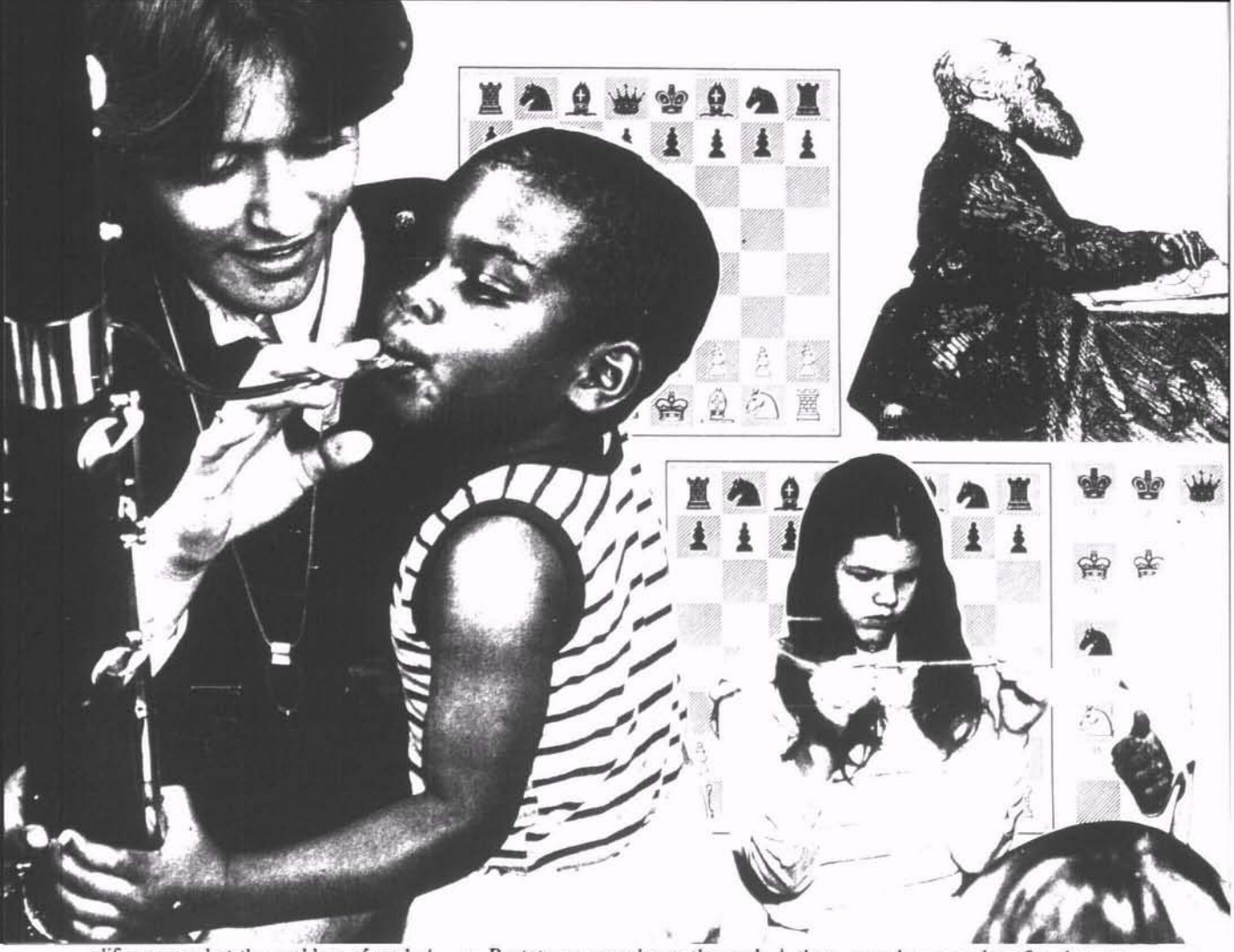


plifies somewhat the problem of evaluation. To the extent that objectives can be expressed in terms of what students should be able to do, success can be measured by determining whether they can in fact do them.

Methods

Many efforts to enhance thinking emphasize the teaching of methods. It is convenient to think of the methods that are taught as falling into two broad categories: (1) generally useful strategies, heuristics, and methodological principles; and (2) step-by-step prescriptions for approaching certain types of tasks.

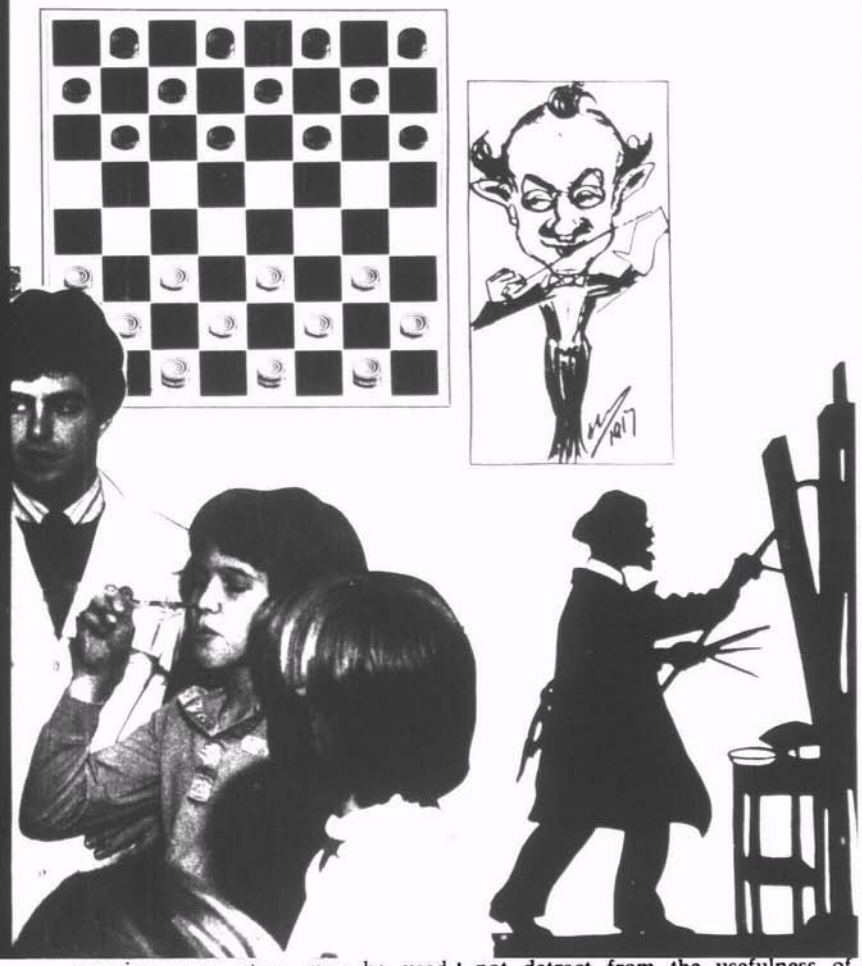
Examples of the first category include:

- Analyze the problem; break it into parts, establish subgoals
- Find a way to represent the important facts and relationships pictorially
- Restate or paraphrase the problem to be sure you understand it
- Work backwards from the goal
- Think of an analogous problem with which you are familiar.

Such strategies, if used conscientiously and appropriately, can be effective. The trick, of course, is to know how and when to apply them. Realizing that a pictorial representation of the important relationships in a problem would be useful is not the same as knowing how to draw a useful picture. But there is a reason to believe that such know-how can be taught.

Several step-by-step prescriptive approaches to various types of tasks (problem solving, memorization, expository writing, studying) have been suggested. It seems unlikely that all of these approaches are equally effective. However, in using a method, there may be some benefits that are relatively independent of the details of that method, assuming the method is not grossly wrong. In other words, it may be that finding the *best* method is less important than the mastery and use of any one of several possibilities.

Figure 1 gives a method—a prescription, if you will—for approaching the kinds of problems encountered in books on problem solving. It is similar in some respects to several prescriptions in the literature, but not identical to any of them. I find it useful, not because it is guaranteed to lead to a solution whenever it is applied, but because it reminds me to do certain things that have proven to be effective many times, and that I might forget to do if I did not have this reminder. It is not always necessary to use every step; and on



occasion some steps may be used several times. I find it easy to believe that another prescription might work equally well or better, but that does not detract from the usefulness of this one.

Another example of a method, any number of variations of which can be effective, is that of a mnemonic system. Numerous systems have been developed to help people remember names, lists, events, and so on. The question of the relative effectiveness of these systems is interesting from a theoretical point of view; but for practical purposes, that question may not be so very important. The evidence is compelling that almost any systematic approach is better than none, and if one wants to improve one's ability to retain things by rote, there are many ways to do so.

Figure 1. A Prescription for Problem Solving.

1. Read and reread the problem *carefully*.
2. State the goal in your own terms.
3. List in short, declarative sentences the facts that are (explicitly or implicitly) given.
4. Try to make a picture (table, graph, diagram) that represents the known facts and relationships.
5. Try to infer some additional facts or relationships from those that are given; add to the list and incorporate it in the picture.
6. Determine what additional information would be sufficient to reach a solution; see if that information can be inferred.
7. Try to infer something *about* the solution (for example, it must be positive; it must be less than X; it cannot be Y).
8. If it is a numerical problem, try extreme cases (for example, solve for 0, 1, 00).
9. If you're stuck, try to find another way to think about the problem; generalize it; particularize it.
10. If you're still stuck, try to solve a similar but simpler problem.
11. If you're still stuck, do something else for awhile.
12. Check your work.

Knowledge

Hayes (1980) warns against the danger of underestimating the amount of knowledge required for expert performance of certain intellectually demanding tasks. Skillful chess players possess large amounts of knowledge about chess board configurations (DeGroot, 1965; Simon, 1980). The fact that few people attain grand master level before ten years of intensive study suggests that knowledge must be accumulated over a relatively long period of time. Major classical composers have seldom produced masterworks (as defined by having five different recordings listed in Schwann's *Record and Tape Guide*) during the first ten years of their productive careers. Hayes draws a similar conclusion with respect to the importance of prolonged intensive preparation in the careers of great painters.

What one can hope to accomplish by the teaching of methods or strategies may be very limited when one's ultimate objective is to improve performance on tasks requiring the use of large amounts of knowledge. Further, Hayes suggests that we greatly underestimate how much knowledge is required to support skilled performance in some cases—such as writing poetry, fiction, or expository prose; or skillfully performing scientific experiments. This is not to suggest, of course, that the teaching of methods has no positive effect on the acquisition and use of expertise; it is simply to caution against overlooking the role of knowledge as an indispensable aspect of skilled performance of many intellectually demanding tasks.

Apropos the problem of teaching thinking, it is useful to distinguish between domain-specific knowledge and knowledge about thinking per se. Clearly one's ability to think effec-

tively within a specific domain will be severely limited if one knows little about that domain. One cannot be expected to solve problems involving chemical analysis if one has no knowledge of chemistry. Although domain-specific knowledge does not ensure that one will think effectively within that domain, the correlation between knowledge and productive thinking within a domain is high: Nobel laureates who are not well informed in their fields are rare.

Most programs to teach thinking do not take the teaching of domain-specific knowledge as an objective. There is an area of knowledge that seems eminently appropriate for a program designed to enhance thinking, however, namely knowledge *about* thinking. Much has been learned about the capabilities and limitations of human beings as thinking creatures, and, in particular, much useful knowledge has been acquired regarding ways in which we characteristically use our thinking abilities less than optimally.

To illustrate the point, we know:

- That we often confuse logical validity and empirical truth
- That when evaluating a favored hypothesis we typically display a strong bias for seeking confirming (rather than disconfirming) evidence
- That what appears to be faulty reasoning often can be attributed to imprecise use of language
- That we are not very good at distinguishing between what we remember about specific events and what we infer about them from our general knowledge of the world
- That we typically overestimate how much we know about matters of which we in fact know very little.

Most people working in this field would probably expect to do more than simply convey such information as this. However I believe that teaching about thinking at primary and secondary school levels deserves more consideration than it has received.

Attitudes

The evidence is abundant that students who are genuinely interested in what they are learning learn more effectively than those who are not. One suspects that those who find the world fascinating are more highly motivated to learn about it than those who find it dull. Conversely, the more one learns about the world the more interesting it is likely to become. One could have a chicken-and-egg debate about whether it is necessary first to have the interest to motivate the acquisition of knowledge, or some knowledge to stimulate interest. One thing is clear, however: *exposure* to information is not sufficient to guarantee either the stimulation of curiosity or the assimilation of knowledge.

How can we instill a sense of curiosity and an attitude of inquisitiveness in students? What in particular can teachers do to increase the chances that their students will take a deep interest in the world around them? An answer that I find particularly convincing is: Have a sense of curiosity and *be* inquisitive. The teacher who finds the world an incredibly interesting place is far more likely to produce inquisitive information-seeking students than one who does not.

It is sad but indisputable that in the process of growing up, most of us seem to lose our sense of wonder. We seem to believe that awe and amazement are signs of intellectual adolescence. We trudge through life with a dullness masquerading as maturity, oblivious to the most amazing aspects of the world. Fortunate is the student whose teacher is childlike in this regard.

Some investigators attach importance to cultivating habits of carefulness and thoughtfulness in intellectual work. It would be rash to suggest that correcting problems of impulsivity and carelessness is all that needs to be done, but these problems may account for a larger fraction of the general problem of ineffective thinking than is typically recognized (Bloom and Broder, 1950; Whimbey, 1980).

The most difficult aspect of improving intellectual performance may be that of effectively fostering positive attitudes. I suspect, however, that this is where the leverage is. It would be interesting to see a list of the attitudes that researchers concerned with the enhancement of thinking consider worth fostering. Here are a few I would suggest:

- A strong belief in the importance of learning, and in the usefulness and intrinsic value of knowledge
- A lively sense of curiosity and inquisitiveness
- A sense of pride in one's work and an appreciation of the importance of carefulness: careful listening, careful reading, careful work
- A proper regard for one's own intellectual potential and also for one's own fallibility
- A respect for opinions differing from one's own.

Considerable effort is being devoted to the development of procedures and programs to enhance thinking. This effort is beginning to produce information that will eventually prove useful for educational purposes. However, it will take time to understand the implications of the results of these efforts, to sort out the variables and their roles as determinants of success or failure, and to develop a theoretical perspective that will have sufficient empirical support and investigator acceptance to provide a solid basis for pedagogy.

There is a danger of underestimating the difficulty of the task. If educational systems have failed in general to teach thinking effectively, the situation is not likely to be reversed easily and quickly. We do not have a well-established theory of cognition to guide these efforts. Time-consuming experimentation will be required. Many false starts will, of necessity, be made. Objectivity will often give way to the promotional zeal of advocates of particular approaches. Disillusionment will sometimes result from expecting too much too soon. But the need is apparent and the risk of failure seems much more acceptable than the decision not to try. ■

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