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ABSTRACT

A thinking-skills course at Montana State University is described, along with recent issues concerning the potential effectiveness of such courses. Advantages and disadvantages of different designs for studying the effects of thinking-skills training are also considered. The focus of the course is: hypothesis formation and evaluation, problem solving, decision making, reasoning, and memory. The general approach is to briefly review cognitive research, especially that which concerns common pitfalls in thinking. Students are introduced to strategies to guide thinking, as well as to situations that illustrate the usefulness of different strategies. Practice in using the strategies is also provided. Short writing assignments are incorporated, since writing skills and thinking skills seem to be linked. In addition to subjective techniques for assessing thinking-skills courses, the following objective techniques are discussed: final examinations, performance in other courses, intelligence or critical-thinking tests, and Piagetian tasks. It is suggested that multivariate statistical techniques be used to explore changes in the underlying structure of cognitive skills and knowledge. (SW)

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Cognitive Skills: Enhancement and Assessment Issues

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A lingering question for cognitive and educational psychologists is whether or not thinking skills can be enhanced by using various kinds of instruction. This question has become increasingly important in recent years, as many universities (including Montana State University) have taken steps to implement or to revise a general core curriculum for all students. Typically, such a core of required courses might include several basic skills courses, such as writing, speech, and mathematics. Some universities are now also requiring a general thinking-skills course for all students. One reason why there has been a tendency to require such a course lately is that many people--professors, legislators, and so on--have observed that college students often do not seem to acquire basic critical thinking skills. Another reason is that cognitive approaches have come to dominate psychology, and many cognitive psychologists have recently realized that attempts to apply the knowledge gained are important for the further development of the field.

First, we will briefly describe the main characteristics of a thinking-skills course that we have been teaching at

Montana State University. Then we will discuss some recent issues concerning the potential effectiveness of such courses that arise from a consideration of the differences between the thinking of novices and experts on any particular subject. Finally, we will discuss advantages and disadvantages of different designs for research on the effects of thinking-skills training.

THINKING-SKILLS COURSE

For about the last ten years, one of us (RAB) has taught an upper-division course on cognitive processes. As the field has matured, the course has included more and more direct instruction in practical thinking skills. Eventually, this practical training was simply occupying too much of the course, and it was apparent that this instruction could easily be offered in a separate course. In deciding what to include in a beginning level thinking-skills course, we naturally considered five major categories of cognitive skills. These five categories, then, formed the focus of the course: hypothesis formation and evaluation, problem solving, decision making, reasoning, and memory. We expect that this selection might gradually change as our teaching of general thinking skills evolves. Nevertheless, we are currently satisfied with these emphases.

Cognitive Strategies

Our general approach is to briefly review cognitive research, especially that which concerns common pitfalls in thinking. Then we introduce the students to various strategies to guide thinking, illustrate the situations in which certain strategies may be useful, and provide examples and practice in the use of these strategies. For example, we attempt to enhance our students' reasoning skills by introducing them to a specific strategy involving Venn diagrams, we teach them various problem-solving heuristics, and we introduce a decision-making strategy involving decision trees. Because we cannot assume that all students have the same amount of knowledge in any particular domain, we try to generate examples from the shared experiences of all of our students, mostly involving everyday situations. We will have more to say about the issue of teaching thinking in the context of domain-specific knowledge later.

Managerial Strategy

Some research, such as that of Schoenfeld (1979), suggests that students who are taught cognitive strategies may not be able to use them because they seem to lack the metacognitive skills needed to organize their use of the strategies. In earlier times, the difficulty might have been seen to cause a failure of the instruction to "transfer" into the everyday realm. One possible solution to the problem is to accompany the instruction in cognitive strategies with a general metacognitive plan--what Schoenfeld refers to as a "managerial strategy," and what others refer to as "executive control." A diagram of such a managerial strategy resembles a flow-chart depicting the major steps required from an initial analysis of a problem situation to the evaluation of a tentative solution.

Recursive loops are explicitly built in to depict and circumvent the many dead-ends that even an expert might encounter. In the past, we have simply taught Schoenfeld's diagram--his managerial strategy; but in the future, we plan to have students construct their own overall plan, then compare it with one like Schoenfeld's.

Ecological Relevance

Another possible way of solving the "transfer" problem is to use many different kinds of everyday examples to illustrate the wide range of potential use of cognitive strategies. As a generalization from some past research, using abstract, puzzle-like problems with little "real-world" relevance seems contra-indicated. Some of the previous attempts to teach general thinking skills were probably doomed to failur rom the start because of the lack of ecological relevance of the exercises and examples. Our goal for a thinking-skills course should not merely be to improve performance on standard intelligence, aptitude, or critical-thinking tests. Those kinds of tests often contain rather artificial items with little or no ecological validity.

Writing and Thinking

Much recent work suggests that there is an intimate link between the development of skills needed to write clear expository prose and the development of effective thinking skills. Whenever possible we have tried to incorporate short writing assignments in our course. We think that this may be especially important whenever some more abstract or mathematical strategy or technique is taught, such as Bayes' theorem. In general, though, having to write a description of various techniques, various stages in problem solving, or various types of decisions probably brings students to a deeper understanding of the interrelationships among the components involved. Thus, writing assignments are an essential aspect of our thinking-skills course.

THINKING AND DOMAIN-SPECIFIC KNOWLEDGE

Recently, some research on the cognitive processes of experts and the development of expert systems has become cited with greater frequency by some cognitive scientists. This evidence seems to suggest that any attempt to teach general thinking skills is likely to fail. Resnick (1983a), for example, argued in a recent article in Science that cognitive performance depends intimately on knowledge related to a specific task, not merely "disembodied 'processes of thinking'" (p. 478). This claim seems quite appropriate in the light of what is known about cognitive processes. However, in a subsequent letter Resnick (1983b) asserted that specific knowledge affects the form of a person's reasoning and that "if reasoning can be taught, it can probably only be done in the context of specific domains of knowledge" (p. 1006).

In a recent review article, Glaser (1984) suggested similarly that "thinking is greatly influenced by experience with new information" (p. 98). He argued that a broad spectrum of thinking skills might be more effectively enhanced while providing education in content-specific domains of knowledge than by teaching special thinking-skills courses or programs. In short, both Resnick and Glaser have argued that the available evidence indicates the futility of attempting to teach general thinking skills outside the context of domain-specific knowledge and training.

One of us has recently asserted that there is actually little or no evidence that thinking is not able to be enhanced by general thinking-skills courses or programs (Block, in press). Instead, the meager evidence that is available suggests that general thinking-skills courses or programs might have a substantial, positive effect that will be transferrable into a variety of content-specific domains. What we desperately need at the present time is additional evidence that there are ways of teaching general thinking skills which will produce a long-lasting enhancement of the students' ability to think effectively--and to do so in a wide variety of contexts and situations. Unless we are able to provide that sort of evidence rather quickly, theoretical arguments like those of Resnick and Glaser will necessarily be recognized as valid. We think that we need much more evidence before we can even begin to understand the complex relationships between general thinking-skills training, domain-specific knowledge, and transfer of training.

ASSESSING THINKING-SKILLS COURSES

Unfortunately, much of the evidence that is needed is difficult to obtain. Nevertheless, let us take a critical look at the assessment of thinking skills. As we argued earlier, it is essential that we assess the progress made in enhancing the critical thinking skills of our students. The development of thinking-skills courses or programs must be accompanied by the use of appropriate assessment techniques.

Subjective Techniques

Generally speaking, assessment can either be subjective or objective. The subjective techniques are interesting, but not very convincing to most people because of biases, demand characteristics, and so on. Subjective assessment can be obtained from the professor, the students, or both. It would be surprising indeed if the professor were not enthusiastic about the effects of the course, and we evaluate our thinking-skills course positively. Our students, though, are also very positive. In addition to using a more traditional course evaluation form, we asked our students: "Do you feel that you are a better thinker as a result of having taken this course?" Nearly all said "yes", citing such changes as: "I have learned to look in depth at problems," "I think things through," "I have learned more ways to solve problems and a more creative way of thinking," and so on. A positive attitude is important, and our students seem to have one.

Objective Techniques

Final examination. Naturally, a skeptic will remain skeptical, so we need to use some objective kinds of measures. But what? We could compare the performance of our students on a final course exam with that of a matched control group. However, if the exam contains items on which our students received direct instruction, no one would be terribly surprised if their performance was better.

Performance in other courses. We could look at a person's overall grade-point average following the course. Unfortunately, at many universities critical-thinking skills might tend to be punished rather than rewarded, especially if the student challenges a professor's thinking on some topic. Further, we cannot control differences in the difficulty level of courses which students elect to take.

Intelligence or critical-thinking tests. Another proposed way of assessing improvements in thinking is to see whether or not intelligence or critical-thinking test scores are higher after taking a course. Evidence indicates that, in fact, IQ scores can be increased as a result of intensive problem-solving or thinking-skills programs (see Sternberg & Detterman, 1983). However, there is the lingering question of whether or not these improvements are merely the result of training in test-taking--what is called "teaching for the test"--rather than truly general enhancements of thinking skills.

Piagetian tasks. Much the same could be said about the apparent progression of some thinking-skills students from concrete operational thought into formal operational thought. Although this might reflect a broadly applicable enhancement of thinking skills, we again do not know to what extent the teaching program has taught students simply to perform well on the Piagetian tasks.

Thinking Skills and Knowledge Structures

The major problem with all of these assessment techniques is that one never knows the extent to which the thinking skills that have been taught are restricted in generality to those that are required to perform well on the test. There are a few ways around this problem, though.

First, one could explicitly teach only a subset of the skills--those necessary to perform well on about half of the item types on the criterion test--and not teach another subset of skills--those necessary to perform well on another half of the item types on the test. Then one could see the extent to which thinking skills necessary to perform well on the latter subset of test-item types are either the same as or are transferrable from the skills that were explicitly taught. The main drawback to this type of thinking-skills instruction is that it is still "teaching for the test"--even if only for about half of the item types on the test. Few instructors and even fewer students would find this kind of instruction satisfying.

There is another alternative, however. Rather than assess performance on a criterion test solely in terms of the number of correct responses, one could use multivariate statistical techniques, such as cluster analysis and factor analysis, to explore changes in the underlying structure of cognitive skills and knowledge.

One excellent example of this kind of technique is the work of Schoenfeld and Herrmann (1982). They were interested in differences between expert and novice mathematical problem solvers, specifically in the perception of problems and in the underlying "knowledge structures." Rather than testing their subjects on mathematical problems and scoring performance in terms of correct or incorrect answers, they asked subjects simply to categorize a number of mathematical problems. Subjects sorted the problems into different piles on the basis of their similarity. A cluster analysis revealed that mathematical novices tended to classify problems on the basis of "surface structure." However, both mathematics professors and students who had taken an intensive 18-day course on problem-solving strategies tended to classify the test problems according to principles relevant to problem solution--what might be called a "deep structure" of mathematics problems.

We think that Schoenfeld and Herrmann's research exhibits a powerful method for assessing changes in thinking skills in such a way that alternative explanations for the expected enhancements are ruled out. In addition, their research is a good example of the kind of work that is urgently needed on the relationship between general thinking skills and domain-specific knowledge.

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