CHAPTER 6

COGNITIVE SKILLS AND THEIR TRANSFER: DISCUSSION

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Abstract

Transfer is involved in all learning, remembering, problem solving and cognitive activities. Thus we need to think of dimensions and extent of transfer rather than simply consider transfer versus non-transfer. Moreover, we should consider transfer of motivation as well as transfer of learned cognitions if we are to understand transfer of learning in educational situations and be helpful to educators. Metacognitive, as well as cognitive, strategies are useful in facilitating transfer in many situations even though they may overload or interfere with transfer in situations where automatized responses are appropriate. We need research to determine when metacognition should be called into play. Research is also needed on the interaction of cognitive and motivational variables affecting transfer.

Introduction

Transfer is paradoxical. When we want it, we do not get it. Yet it occurs all of the time. Frequently we fail to recognize it because we hide it under other names. As Voss (this issue) points out, all learning and remembering involves transfer. We never *use* learning in exactly the same situation in which we have learned it. Even in the laboratory, recall is in a different context than that in which the original learning occurred, for neither the situation nor the learner can be held constant. Time does not stand still. The learner has changed even if only a short time has lapsed since the original learning. In non-laboratory settings, of course, the changes are much greater. Rather than a sharp boundary we have transfer dimensions. All use of learning involves transfer.

We ordinarily think of transfer as the use of previous learning in a situation somewhat different from the situation in which learning took place. But, just as Mayer and Greeno (1972) differentiated between "near" and "far" transfer, I would argue that transfer is involved in situations that range from very little, to very great differences from the learning situation. If someone responds in a relatively skillful or habitual way, we say that this is evidence of *learning* or remembering. If the situation is at least superficially different from the

original situation we say that *transfer* has occurred. If the needed response is not obvious, we describe the behavior as *problem solving*. And, if learning is applied in a situation very different from that in which it was learned we describe it as *creativity*.

Pea (this issue) has made the important point that one of the constraints on the external validity of laboratory studies of transfer and problem solving is that the experimenter assumes motivation for the task. In natural settings motivation differs from situation to situation and from individual to individual. I was particularly interested in the methods used to elicit motivation in the studies reported in the preceding chapters. For example, Voss's real problems in contemporary society, and Pea's real world, "hands on", problems seem well-chosen for motivational as well as cognitive attributes.

Metacognition

What is the role of metacognition? In my course, "Learning to Learn", I emphasize becoming aware of one's own learning skills and strategies. My assumption is that students will be more effective learners if they are aware of alternative strategies and can choose an alternative if their first attempt is not working well. In this issue Voss, Spada, and Salomon all suggest that teaching metacognition may interfere with, rather than facilitate, effective performance. "Low-road" transfer in Salomon's terms may be more effective than mindful, "high-road" transfer in most situations.

This is a valid concern, but it seems to me not to be that of metacognition versus no metacognition. Rather the question is: When is metacognition useful? In early stages of learning, introducing conceptual, metacognitive elements may simply add another confusing element to an already difficult learning situation; later introduction of metacognition and explicit verbalization may facilitate the integration and transfer of skills; still later, when skills have been automatized, introducing metacognition may interfere with smooth, skillful performance. In this sense metacognition is like problem solving.

Elshout (1987) described a region of problematicity: if one thinks of problems as ranging from very easy to unsolvable, there is a region containing problems to which the problem solver can respond more or less automatically using well-learned algorithms or procedures. Problems involving complexities or barriers not easily handled by routine procedures fall into a middle region of problematicity, and beyond this region lie problems so difficult that the problem solver has no algorithms or heuristics to apply and is lost. Similarly we might describe Elshout's middle region as a region of "metacognicity" in which the learner needs to consider alternative strategies for the use of previous learning.

The point is that different processes may be useful at different stages of learning. This generalization is also likely to apply to the use of different mental images or representations of concepts, such as the mathematical concepts discussed by Putnam (this issue). His suggestion that children be exposed to a variety of representations seems well-grounded. We need research on how many, and what kinds of, representations are useful for which students at which stages of learning.

Teaching for Transfer

Each contributor to this issue has given some suggestions about how we can teach for

transfer. Voss warns against teaching weak methods separately from content instruction; Spada suggests providing an environment that will support hypothesis formation and searches for relevant information; Pea admonishes us to wean students from dependence on the teacher and to help them practice their skills across multiple domains. Only Salomon and Globerson advocate a directive approach with the teacher actively guiding instruction. Salomon and Globerson recommend *practice* for "low road" automatic transfer and mindful *abstraction* for "high road," thoughtful transfer. The instructional procedures emphasizing these two roads to transfer seem to fit both with theory and previous research.

As most of the papers in this issue point out, spontaneous transfer is not nearly as frequent as one would expect, even with the best of instruction. In reading Salomon and Globerson's paper, I nodded agreement with their statement that low road transfer depends on amount of practice and variability of context, and, like them, I feel that we still need to go beyond the major principles they suggest. Similarly I applaud Putnam's suggestion that students should both *practice doing* mathematics and *talk about* mathematical procedures and concepts. Whether we emphasize common elements, verbalization of meaningful understanding, analogical reasoning or any of the other approaches to the conditions affecting transfer, we are still looking primarily at the original learning and later transfer situations and the learner's use of knowledge acquired in the original situation. Could we not move to another level? In analyzing learning outcomes I have emphasized the fact that teachers are both teaching knowledge at a basic level and simultaneously teaching skills and strategies for learning (McKeachie, 1986). Similarly, could we not teach skills and knowledge and at the same time teach mindful transferability?

The problem that remains, as I see it, is not just one of the relationships between the knowledge or skill learned and the knowledge or skill demanded in the transfer situation. Rather, I would ask whether or not it is possible to develop metacognitive skills or strategies that facilitate transfer of a variety of previously learned concepts and skills to a variety of new situations. In short, can we teach learners to think about, or be mindful of, any previous knowledge that may be relevant when they encounter a problem? Can we teach transfer habits, transfer heuristics, or transfer motives that transcend specific situations?

Pea's description of culturally-influenced categorization systems of problem types approaches this notion of "transfer skill" or "metacognitive strategies for transfer". Voss's description of categorization in transfer of knowledge for problem solving is, also, I believe, an example of the sort of metacognitive transfer strategy to which I refer. Can it be that one of the secrets of transfer is the ability to see broad, inclusive categories whose elements have common dimensions? As Pea implies the expert has a much richer and more complex knowledge base from which to create such categories and to recognize the similarities and differences between the source and target situations.

What are the skills to be taught? Can we teach Salomon and Globerson's mindfulness or Pea's transfer attitude as skills that lead to high road transfer? I suspect that this is not easy and not likely to result from a single course. But it may well be that attention given to transfer in several courses *would* have a lasting, transferable effect. Moreover, giving a conceptual understanding of *why* mindfulness and other skills are useful, should promote high road transfer.

Perhaps self-monitoring skill is also a candidate for consistent teaching in several courses as a general skill for facilitating transfer. It is one of the most basic metacognitive skills — one with applications in learning and problem-solving situations of all kinds. De Corte and Verschaffel (1981) have already demonstrated success in teaching children self-

monitoring in arithmetic. Pea (this issue) has stressed the importance of the learner's self-concept and motivation as variables determining transfer, and it is likely that they are particularly important in self-monitoring. Why do learners or problem solvers fail to check to see if they understand a learning task, or to determine whether their solution to a problem is correct? It may well be that failure of self-monitoring is due to *fear* that one will discover that one is wrong. If a learner is already confused, lacking in self-esteem, and hoping to get away from the task as rapidly as possible, getting a poor grade *later* is less painful than finding that one has not understood and must start over.

Motivation for Transfer

We usually think of transfer as involving cognitive skills, but I am intrigued by the possibility of transfer of motivation and by Pea's broader notion of creating cultures of transfer thinking. While motivation theory typically involves an interaction of person and situation variables, it also has incorporated individual difference variables believed to characterize individuals across some range of situations. Such motivational variables as need for achievement, self-competence, and internal locus of control are thought of as learned and learnable, yet relatively stable and generalizable across situations involving achievement standards. If we can develop achievement motivation, a sense of self-competence, and other aspects of motivation for learning, we might be facilitating the development of important transferable human characteristics that would, in turn, increase the likelihood of transfer of cognitive skills. Although one's sense of self-competence may vary across domains of achievement, most students have self-perceptions of their own general intelligence and their *general* competence in learning and problem solving.

One of the variables that should affect "mindfulness", in Salomon and Globerson's terms, is the individual's motivation and sense of self-competence. Unmotivated learners are likely to withdraw or proceed mindlessly; anxious learners are likely to regress to simple trial-and-error; hopeless learners give up. Sternberg (1986) suggest that either too little or too much self-confidence can be a stumbling block to the use of intellectual skills. Too much self confidence can lead to mindlessness, and too little to withdrawal; for mindful transfer to take place, learners and problem solvers need to have sufficient self-competence and achievement motivation to tackle and stick to the task involving transfer. Metacognitive processes are probably relevant to motivation. It seems reasonable to hypothesize that learners who are aware of alternative strategies are likely to have higher expectations for success than those who simply tackle a task without thinking. Moreover awareness of alternatives affects flexibility, a key component of intellectual ability.

In addition to general motivational aspects of personality, such as self-competence, motivational strategies may also be candidates for teaching. The strategy of breaking long-term goals into related intermediate and immediate goals might well transfer to a variety of transfer situations.

Knowledge and Intelligence

Almost all modern accounts of learning and problem solving point to the importance of domain-specific knowledge. The chief point of contention between those who advocate

teaching cognitive skills directly and those who argue that it is only profitable to teach skills in connection with a given domain of knowledge is in the transferability of the skills. I argue that one of the relevant issues in this debate is the degree to which metacognitive processes are learned. Success in transfer depends on analyzing situations and determining which skills are relevant. Certainly an important dimension differentiating situations for an individual is the amount of domain-specific knowledge he or she has in each situation. Some skills or principles may be relevant in domains in which one has much previous knowledge; others may be relevant for domains in which one has little prior knowledge.

Both Spada and Voss (this issue) deal with knowledge application in solving new problems — in Spada's case, ecological knowledge, and, in Voss's case, knowledge of political science and economics. Voss stresses that in order to recognize the possibility of transfer, one must categorize problems so that the similarities between previous problems and the current problem are apparent. Voss distinguishes two aspects of transfer that are illustrated by Putnam's point (this issue) that we expect mathematics learning to transfer both to the learning of more advanced mathematics and to a variety of practical problems in everyday life. It is little wonder that some students fail to recognize the transferability of their learning in situations so phenomenally different. And, as Pea and Voss suggests (this issue), there is also a failure to transfer prior practical learning to formal education.

The problem is that even when people recognize their need for knowledge they may not see that knowledge they have is relevant. Spada studies the ways in which subjects recognize such needs for knowledge and the processes used in seeking and using it in a dynamic situation involving the interaction of several variables. It would be particularly interesting to test subjects on all three of Spada's experimental settings to determine what knowledge and skills transferred from one experiment to another. Do they now access relevant knowledge and skills more flexibly? Can we teach students to see school learning as part of everyday life?

Conclusion

As I read these papers, I could not help thinking of discussions of the "g" factor in intelligence which is characterized by flexibility. Very likely the skills described by "g" include those we have discussed here under the rubric "transfer".

Spada's conclusion is a good summary of all the papers; that is, transfer depends upon domain-specific knowledge, general cognitive skills, and goals and values. We can facilitate that transfer by labeling and verbalizing the processes involved and eventually move toward Pea's vision of a culture of transfer thinking. To undergird educational progress we need research that deals not only with cognitive aspects of transfer but also with the interacting motivational cognitions that determine whether or not learners actually transfer the learning potentially transferable. The concepts of learned helplessness, self-efficacy, and self-regulated learning — concepts prominent in the domain of research on educational motivation — need now to be integrated with our more bloodless cognitive concepts in studies linking laboratory research with research in educational settings.

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