Teaching for Transfer: Classroom Instructional Implications

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A review of the literature reveals that obstacles to the successful transfer of basic skills, knowledge, and thinking skills during classroom instructional time differ depending on which of three components of expertise is entailed: conceptual understanding, domain-specific basic skills, or domain-specific strategies. This article, accordingly, focuses on conceptual understanding and transfer, conceptual knowledge and problems of activation, lateral and vertical transfer of automated basic skills, rational task analysis, and strategy transfer. Curriculum and instructional implications are also discussed.

Although the transfer of basic skills, knowledge, and thinking skills is integral to our educational aspirations and expectations, many students believe that little of what they learned in school benefited them later in life. Not surprisingly, transfer of learning persists as one of the most vexing problems in the classroom (Borich & Tombari, 1997). Cognitive and educational psychologists, however, have made notable progress in understanding and surmounting problems of transfer. The picture currently emerging suggests that impediments to transfer differ depending on which of three components of expertise is entailed: (1) conceptual understanding, (2) domain-specific basic skills, or (3) domain-specific strategies (Gagne, Yekovich, & Yekovich, 1993). Since the factors that influence transfer differ to some extent for these three components of expertise, each of these areas will be discussed separately.

Conceptual Understanding

The probability of successful transfer is contingent upon the quality of one's conceptual understanding of a problem (Chmielewski & Dansereau, 1998). Researchers have repeatedly demonstrated this principle in a variety of domains, including generating and interpreting computer programs (Mayer, 1975), solving science problems (Bromage & Mayer, 1981), troubleshooting problems associated with mechanical or electrical systems (Tenney & Kurland, 1988), and writing (Case & McKeough, 1990).

The Paradoxical Nature of Activating Conceptual Knowledge

Merely possessing conceptual knowledge appropriate for a given problem-solving domain does not guarantee that such knowledge will be activated when useful for solving a novel problem (Perfetto, Bransford, & Franks, 1983). This paradox is perplexing and is far from being completely understood. Nonetheless, progress is being made by focusing on three areas of research: (a) production of a problem-solving context, (b) anchored instruction, and (c) cognitive apprenticeship.

Production of a problem-solving context. Some researchers (Bransford, Vye, Knizer, & Risko, 1990) believe that if students are to successfully activate conceptual knowledge in a problem-solving context, then they should learn this knowledge originally in a problem-solving context to facilitate recall.

Anchored instruction. Bransford and his colleagues (Bransford et al, 1990) have also focused on anchored instruction: a pedagogic approach that provides students with opportunities to gain pertinent knowledge in the context of trying to solve complex, authentic problems. Although this approach is promising, the degree or extent of transfer achieved is not known.

Cognitive apprenticeship. Cognitive apprenticeship, like anchored instruction, places learners in a problem-solving context: The learner is treated like a novice who will be apprenticed to an expert (Borich & Tombari, 1997). Although this approach has well-documented effects on transfer of strategies, its impact on improving activation of conceptual knowledge is less well-documented (Gagné, Yekovich, & Yekovich, 1993).

Domain-specific Basic Skills

Some of the relevant knowledge students identify for successfully solving a novel problem is frequently in the form of automated basic skills that are represented in procedural form. Fortunately, these automated basic skills will not need to be re-learned for the novel problem, allowing for great savings in time, since proceduralization—a time-consuming process—is obviated for some of the skills inherent in the new solutions.

Lateral and Vertical Transfer

Gagné's (1970) research distinguishes between two forms of transfer: lateral and vertical. According to Gagné, lateral transfer refers to the application of some known knowledge in a new context but at a level of complexity comparable to the old context. Singley and Anderson's

(1989) skill-overlap hypothesis echoes the same thing: the degree of lateral transfer between skills is directly related to the degree of overlap of the skills. For instance, using the skills associated with driving a car to learn how to drive a truck is an example of lateral transfer. Vertical transfer, on the other hand, involves the use of known knowledge to acquire more complex knowledge that embodies the known knowledge (Gagné, Yekovich, & Yekovich, 1993). In this type of transfer, lower-level skills often facilitate the acquisition of higher-level skills by contributing to and functioning as prerequisites for them. Rational task analysis embodies and reflects far transfer, too: a task is logically decomposed into simpler and simpler elements. Activities lower in this hierarchical set-up are more simple than activities higher in the hierarchy. Moreover, these simpler activities are incorporated in the more complex activities to which they point. Initially learning the principles of wind flow that are essential when designing a windmill and then applying these principles to direct a sailboat's sails is an example of far transfer.

Domain-specific Strategies

While the degree of skill overlap between the new skill and the known skill is significant for the lateral and vertical transfer of basic skills, in strategy learning, the strategy user's conscious evaluation of a strategy's effectiveness is one of the preeminent factors affecting transfer (Brown, Campione, & Barclay, 1979).

Other Factors Impacting Strategy Transfer

According to Pressley, Borkowski, and Schneider (1987), four other factors, in addition to learner self-evaluation, critically impact strategy transfer:

Knowledge of when and how to apply a strategy. One factor involves the degree of knowledge a student has regarding why, how, and when a strategy works (O'Sulllivan & Pressley, 1984; Pressley, Borkowski, & Schneider, 1987). This metacognitive knowledge forms the conceptual basis for strategy transfer.

Imputing success to effort and employment of strategies. A student's belief that his/her efforts are instrumental in achieving success is a second factor. More specifically, those who persevere are more likely to employ a variety of strategies in order to determine which one(s) work (Clifford, 1984).

Ability to screen out distracting thoughts. The ability to screen out distracting thoughts is a third factor. Students who can screen out such distractions have more cognitive capacity available to analyze what is required for the new task (Kuhl, 1985).

Degree of relevant declarative knowledge. A fourth factor entails the quality and quantity of schemata available when performing a task. Such knowledge is instrumental because many strategies require it for their successful implementation. More specifically, activating prior knowledge enables the reader to generate elaborated memory structures to accommodate the new information being employed. As a strategy, however, knowledge activation cannot be transferred to situations in which the reader lacks requisite knowledge (Walker, 1987).

Instructional Implications

Since transferring knowledge to novel problem situations may be contingent upon an individual's conceptual understanding, it makes sense to ensure that one's curriculum pays adequate attention to the conceptual basis of a problem area. Unfortunately, doing this is more difficult than it appears because the effective conceptual basis of numerous problem areas is not known. Consequently, the wrong conceptual information is taught (Means & Gott, 1988).

The performance of cognitive analyses of expertise, employing the expert-novice paradigm, is the most valid and reliable method to obtain information about the conceptual understanding essential for transfer in a problem domain. This approach, however, is very expensive; so many instructional designers informally interview subject matter experts. Relevant conceptual knowledge is identified through think-aloud protocols, derived from experts thinking aloud while solving some novel problems.

Ironically, according to Gagné, Yekovich, and Yekovich (1993), the problem of knowledge activation will still exist, even with a successful solution to the practical problem of expensive elicitation techniques. They suggest that more basic research is required in this area. For example, how do people who activate relevant knowledge differ from those who fail to do so? Are problems represented differently by them? Are they more persevering? In addition, to what extent are the promising instructional strategies of cognitive apprenticeship and anchored instruction effective for transfer?

The validity of skill hierarchies and prerequisite skills is rejected by many teachers because some curriculum materials are rigid and boring for both student and teacher. However, none of this invalidates the overwhelming evidence demonstrating the necessity of prerequisites in various skill domains. Accordingly, teachers should feel free to reject or modify curriculum materials that do not benefit students; however, it would be unwise for them to reject the notion of prerequisite skill relationships (Singley & Anderson, 1989).

Strategy transfer is typically enhanced if the new task is analogous to a task for which the student has previously learned to apply the strategy. In addition, the new task must be represented in a manner that stimulates thoughts relative to appropriate strategies. How this new task is represented seems to be influenced by at least four factors: (1) students' ability to evaluate the utility of the target strategy, (2) students' knowledge regarding why, how, and when a strategy works, (3) students' belief that their efforts are instrumental in achieving success, and (4) students' ability to screen out distracting thought—providing more cognitive capacity available to analyze what is required for the new task.

Ostensibly, the transfer of skills and knowledge remains a matter of great interest to educators. It is an issue that has spawned substantial controversy among psychologists. Recent progress on this topic, however, has begun to provide us with a better grasp of it. Nonetheless, there is still a great deal to be learned.

References

Borich, G. D. & Tombari, M. L. (1997). *Educational psychology: A contemporary approach*. (2nd ed.) New York: Longman.

Bransford, J. D., Vye, N., Kinzer, C., & Risko, V. (1990). Teaching thinking and content knowledge: Toward an integrated approach. In B. F.Jones, & L. Idol (Eds.), *Dimensions of thinking and cognitive instruction* (pp. 381-413). Hillsdale,NJ: Lawrence Erlbaum Associates.

Bromage, B. K., & Mayer, R. E. (1981). Relationship between what is remembered and creative problem-solving performance in science learning. *Journal of Educational psychology*, *73*, 451-461.

Brown, A. L., Campione, J. C., & Barclay, C. R. (1979). Training self-checking routines for estimating test readiness: Generalizations from list learning to prose recall. *Child Development*, *50*, 501-512.

Case, R., & McKeough, A. (1990). Schooling and the development of central conceptual structrures: An example from the domain of children's narrative. *Internalization Journal of Educational Research*, *13*, 835-856.

Chmielewski, T. L. & Dansereau, D. F. (1998). Enhancing the recall of text: Knowledge mapping training promotes implicit transfer. *Journal of Educational Psychology*, *90* (3), 407-413.

Clifford, M. M. (1984). Thoughts on a theory of constructive failure. *Educational Psychologist*, 19, 108-120.

Gagné, R. M. (1970). *The conditions of learning* (2nd ed.). New York, NY: Holt, Rinehart, and Winston.

Gagné, E. D., Yekovich, C. W., and Yekovich, F. R. (1993). *The Cognitive Psychology of School Learning.* (2nd ed.). New York: Harper Collins College Publishers.

Kuhl, J. (1985). Volitional mediators of cognition-behavior consistency: self-regulatory processes and action control versus state orientation. In J. Kuhl & J. Beckmann (Eds.), *Action Control: From Cognition to Behavior* (pp. 101-128).

Means, B., & Gott, S. P. (1988). Cognitive task analysis as a basis for tutor development: Articulating abstract knowledge representations. In J. Psotka, D. Massey, & S. A. Mutter (Eds.), *Intelligent tutoring systems: Lessons learned*. (pp. 59-83). Hillsdale, NJ:Lawrence Erlbaum Associates.

Means, B., & Roth, C. (1988). *Some outcomes of a cognitive analysis of trouble-shooting*. Paper presented at the meeting of the American Psychological Association, Atlanta, GA.

O'Sullivan, J. T., & Pressley, M. (1984). Completeness of instruction and strategy transfer. *Journal of Experimental Child Psychology*, *38*, 275-288.

Perfetto, G. A., Bransford, J. D., & Franks, J. J. (1983). Constraints on access in a problem solving context. *Memory & Cognition*, *11*, 24-31.

Pressley, M., Borkowski, J. G., & Schneider, W. (1987). Cognitive strategies: Good strategy users coordinate metacognition and knowledge. In R. Vasta, & G. Whitehurst (Eds.), *Annals of Child Development,* Vol. 4, (pp. 80-129). Greenwich, CT: JAI Press.

Singley, M. K., & Anderson, J. R. (1989). *The transfer of cognitive skill*. Cambridge, MA:Harvard University Press.

Tenney, Y. L., & Kurland, L. C. (1988). The development of troubleshooting expertise in radar mechanics. In J. Psotka, L.D . Massey, & S. A. Mutter (Eds.), *Intelligent tutoring systems: Lessons learned*. (pp. 59-83). Hillsdale, NJ: Lawrence Erlbaum Associates.

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