Metacognition: Relevance to Instructional Design

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Abstract. Research in the field of cognitive psychology has led to evidence that proficient learners or performers have an awareness of their own cognition that manifests itself in strategic control of behavior. These findings are of particular significance to instructional designers because of their promising impact on instructional theories and models. Instruction can be enhanced through the incorporation of metacognitive aspects in the instruction and the resultant effects on the learner should be positive in terms of motivation and overall performance.

Introduction

In their review of the current literature pertaining to the steadily expanding field of instructional psychology, Gagne and Dick (1983) note the increased contributions emanating from research in the domain of cognitive psychology. Of particular significance to instructional design is the concept of metacognition because of its promising impact on instructional theories. Interest in this area has expanded from an initial focus on memory phenomena (Flavell, 1971) to widespread investigation in the field of reading research (Baker & Brown, 1984).

These new insights into the domain of cognitive functioning undoubtedly will affect the prescriptive nature of instructional theories, and designers should be aware of its relevance to their field. The purpose of this paper is to provide a definition of metacognition and to describe what the authors consider to be the effects of incorporating metacognitive aspects into instruction.

Metacognition Defined

In order to define this concept, the authors conducted an in-depth review, synthesis, and interpretation of the writings of Ann Brown, John Flavell, and Scott Paris (Brown, 1980; Baker & Brown, 1984; Flavell, 1979; Flavell & Wellman, 1977; Paris, Lipson, & Wixson, 1983). Generally speaking, the term metacognition is used to refer to a body of knowledge that reflects on knowledge itself. It involves an awareness of the mental processes and strategies required for the performance of any cognitive endeavor. This knowledge is manifested in the form of strategic control of the processes necessary for successful performance. Two interdependent phenomena involved in metacognition, knowledge and regulation, require full consideration here.

Knowledge About Cognition

As shown in the left portion of Figure 1, metacognitive knowledge refers to an individual's awareness of his or her own cognitive resources in relation to the task. That is, the learner is aware of personal strengths and weaknesses as well as the requirements of the task or learning situation and has useful knowledge which enables him or her to predict how the two will interact for acceptable performance.

For metacognitive awareness, the learner needs three kinds of knowledge: declarative knowledge (knowing *what*), procedural knowledge (knowing *how*), as well as what Paris et al. (1983) refer to as conditional knowledge (knowing *when* and *why*). Figure 2 illustrates that declarative knowledge pertains to self and task characteristics as well as related strategies, while procedural and conditional knowledge relate to task-relevant strategies.

To illustrate how these types of knowledge function in a task or learning situation, consider the following example. Suppose that a proficient learner is faced with the task of reading an article about rodents, about which he must prepare a simple oral report. The learner demonstrates declarative knowledge of personal resources when he thinks, "I already know something about rodents." and "I usually remember informational-type text easier than I do stories." Declarative knowledge of task characteristics is evident when the learner thinks, "Reporting on the infor-

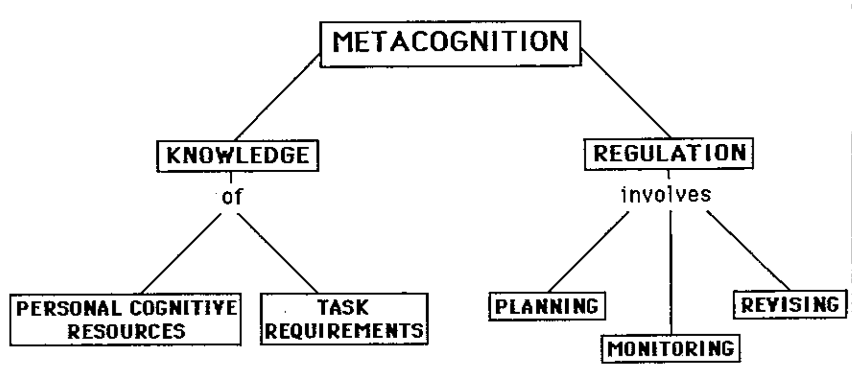

Figure 1. The components of metacognition

mation in this article will require that I understand and remember it." and "This type of text usually consists of main ideas and supporting details." In order to match an appropriate strategy with the task, the learner calls on his store of task-related declarative and conditional knowledge, thinking, "I know that outlining and summarizing informational text is a good strategy for organizing and remembering the information because it forces me to identify the important details, so it should work well in this case." (encompassing the what, when and why). Procedural knowledge is what accounts for the learner's ability to execute the skill of summarizing or outlining.

Regulation of Cognition

Regulation is the more observable aspect of metacognition and presupposes the existence of knowledge, since it is assumed that a strategic action is based on existing knowledge. Referring again to Figure 1, planning, monitoring, and revising comprise this regulatory component. Cognitive processes are orchestrated by the efficient, strategic learner so that optimum learning, understanding, or performance occurs.

Planning refers to the cognitive processes that function to control information processing or task performance from the outset. Planning is goal related, requires task and self knowledge, and involves the initial selection of relevant strategies. Consider again the learner who must prepare an oral report on rodents. Planning is the underlying process when he acts upon the conditional and declarative knowledge and chooses to use outlining and summarizing as appropriate strategies for organizing and remembering the information.

Monitoring involves ongoing executive control of mental processes and is a crucial component of metacognition. Essentially, this regulatory function consists of checking and evaluating to determine whether the task matches preconceived notions about it, whether selected strategies are working, whether task performance is adequate, or whether comprehension is proceeding as it should. The student in our example may find that he is having difficulty understanding the information in the article about rodents.

When selected strategies or current operations are deemed inadequate or unsuccessful by the learner for some reason, a change in strategy must be made. This is where *revision* of cognitive regulation is involved. Being cognizant that a problem exists is only the first step. The learner must also know the source of the problem and recognize the utility of intervention at this point. Then he must be able to determine which compensation strategies, or what Baker and Brown (1984) refer to as "fix-up" strategies, to invoke in order to adapt or modify the situation to bring about a successful outcome. Demonstrating metacognitive skills, the student who realizes that he is having problems with the information about rodents may decide that the comprehension problem has arisen from the fact that the main ideas are not clearly stated and that the text is not well organized. He may then decide that before he can neatly summarize and outline the information, he will need to expend additional effort to extract the main ideas using comprehension strategies that require drawing inferences.

Skeptics of the existence of a construct such as metacognition will say at this point that they doubt that anyone proceeds through such a regimen of conscious processing in an attempt to perform a task. This is true, in part, since much of this processing is carried out below the level of consciousness. The apparent disparity here can be explained by various researchers' descriptions of the relationship between cognitive processing and learner competence in a given task.

In his analysis of competent performance, Glaser (1976) describes the difference between a novice and an expert. In contrast to the slow, awkward, deliberate actions of a novice, an expert's performance is covert and, most importantly, automatic. That is, a competent performer responds to internalized strategies for thinking and problem solving that result in performance that is consistent, relatively fast, and precise. This is supported by research that suggests that when mental processes are used often, they become automated and more efficient (Gagne, 1983; LaBerge & Samuels, 1974; Shiffrin & Schneider, 1977), and are performed below the level of consciousness; indeed, they become inaccessible to conscious awareness, even for the purpose of verbally reporting on them (Ericsson & Simon, 1984). However, by using difficult, unorganized material in their study, Afflerbach and Johnston (1986) were successful in

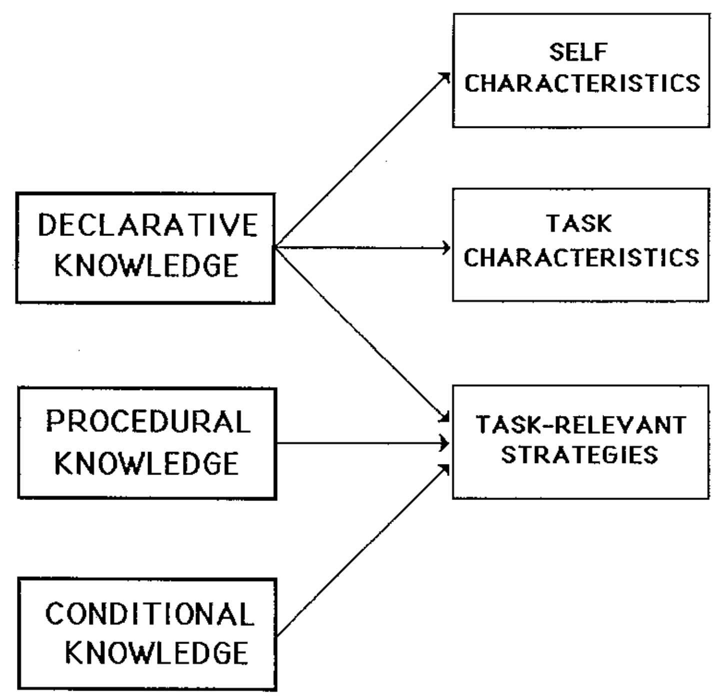

Figure 2. The requisite types of knowledge

getting expert readers to de-automate and report on the processes they used in generating main ideas from text. The think-aloud protocols from this research served to illustrate that when the task becomes more difficult, even expert readers *consciously* plan, monitor, and revise as a means to successful performance.

Thus, as long as the demands of the task match the competence of the performer, or until some difficult or novel situation arises, an expert learner who possesses metacognitive skills proceeds in the "automatic pilot" mode described by Brown (1980), with most of the mental operations being controlled at the subconscious level.

With this definition in mind, the remainder of the paper will investigate how aspects of metacognition can be implemented for instruction and the consequent effects on the learner.

taught not as ends in themselves, but rather as means to achieving ends in terms of overall performance.

While the research on metacognition as a construct is relatively recent and is confounded by problems with operational definitions and research methods, it appears to hold some promise for the improvement of instruction (Lohman, 1986). The authors suggest that incorporating metacognitive aspects into what Glaser (1976) describes as the conditions of learning will enhance instruction and result in competence of a higher level: Competence that involves strategic, self-controlled behavior and the ability to adapt to changing conditions. Transcending *skilled* behavior, *strategic* behavior is characterized by the notion of intentionality and purpose on the part of the learner; that is, the learner deliberately selects, controls, and monitors strategies to achieve desired goals or objectives (Keller, 1983; Paris et al., 1983).

The competent performer responds to internalized strategies for thinking and problem solving that results in consistent performance.

Implications for Instruction

The Instruction

Too often in education or training, simple competence (i.e., the ability to perform) becomes the desired goal of skill instruction, reminiscent of the behavioristic influences that pervaded the field until the early 1970s (Bower & Hilgard, 1981). A skill is taught, practiced, and then evaluated. If performance is acceptable, the next skill is taught and so on. Generally, it is declarative and procedural knowledge that receive the most emphasis in instruction (Winograd & Hare, in press). Most educators and trainers would agree that simply equipping learners with a repertoire of skills is not sufficient to promote independence on the part of the learner, nor does it guarantee that the learner will see the relationship between lower-order tasks (i.e., discriminations) and the higher-order performance of cognitive strategies (Gagne, 1985). From an instructional viewpoint, skills must be

Specifically, the authors advocate that the traditional systematic design of instruction (see Andrews & Goodson, 1980) be extended to incorporate learning of conditional knowledge (i.e., knowing when a skill or strategy is appropriate and why), as well as learning of task-relevant strategies for planning, monitoring, and revising. Essentially, this means that stated terminal objectives would encompass not only the learner's ability to perform, but also his or her ability to behave strategically and adaptively.

Because of this broadened view of terminal behavior, several aspects of design such as learner and task analyses, performance objectives, and evaluation instruments would be affected and would need to be adapted accordingly. The aspect most greatly affected involves the design of instructional strategies. The change would be reflected in the manner in which skills are presented. For example, after gaining the attention of the learner, most suggested instructional strategies focus almost exclusively on the presentation of the *what* (declarative knowledge) and/or *how* (procedural knowledge) of the skill to be learned. These necessary types of knowledge are then enhanced through subsequent practice, feedback, and follow-up activities (Dick & Carey, 1985; Gagne & Briggs, 1979). Unfortunately, much of the conditional knowledge of when to use the skill and why it is significant is frequently left to the learner to acquire through incidental experience. Brown and Palincsar (1982) have shown that without instruction about the significance of the skill, effort by the learner to maintain and generalize the skill quickly diminishes.

It is suggested then, as outlined by Paris and his colleagues (1983), that to facilitate the learner's ability to use a new skill properly, conditional knowledge must be included during initial learning of the skill. The learner should be informed of the importance of the skill (the *why*) during the initial focusing of attention. Raynor (1974) has suggested that this will increase the student's motivation for using and maintaining a new skill because its significance for the student is immediately revealed. Likewise, as suggested by Baumann & Schmitt (1986), after the presentation of the *what* and/or *how* of the skill, students should also be informed and given examples of *when* the task is relevant or not relevant. Practice items requiring the student to identify when and why the skill is significant will reinforce the conditional as well as the declarative and procedural knowledge.

To illustrate this instructional format in a training situation, consider the following modification of a traditional method of instruction. In a recent training study involving teaching quality control techniques to assembly line workers (Keefer, 1986), no special consideration was given to relaying conditional knowledge. The modularized instructional materials were designed to teach the task in four steps prior to assessment of the assembly line workers' performance. The steps were as follows:

Step 1: Declarative knowledge (*what*) was communicated as the workers were told that the materials were designed to teach them to read and interpret quality control charts used throughout their organization.

Step 2: Procedural knowledge (*how*) was presented. After the workers were assisted in recalling specific math skills, the stimulus materials and information required to master the task were presented. Examples of the charts with various readings were given and the workers were shown how to record and interpret the data.

Step 3: Workers practiced using the charts and interpreting the results.

Step 4: Workers were given feedback.

In contrast, an instructional strategy modified to include the communication of conditional knowledge would alert the workers to the nature and importance of the quality control charts and would be as follows:

Step 1: Declarative knowledge would be presented (same as above).

Step 2: Conditional knowledge (*why* and *when*) would be added by instructing the workers about the importance of the skill and the appropriate time for its use. It would be explained that if the assembly line workers could read and interpret quality control charts during production, mistakes would be caught earlier and the product saved. This is because, traditionally, quality control measures are taken after a specific number of items have been produced.

Step 3: Procedural knowledge would be presented (same as above).

Step 4: Workers would practice using the charts as well as practice determining when and why to use them. This step would provide for rehearsal and reinforcement of both conditional and procedural knowledge.

Step 5: Workers would be given feedback (same as above).

It is true that some learners intuitively understand such things as the significance and utility of trained skills or strategies without explicit instruction. However, since metacognition is a developmental skill that does not automatically increase with age (Brown, 1980; Markman, 1977), it would seem that supplementing instruction with metacognitive aspects would prove beneficial to most learners.

Compelling evidence that such instruction results in a higher level of competence has been documented by a comparison of skills-training studies undertaken by Brown and Palicsar (1982). They point out that students who received "blind training," that is, instruction in only the *performance* of skills, achieved improved performance, but failed to use the skills subsequently on their own or to generalize them to similar situations (Belmont & Butterfield, 1979). In contrast, students who received "informed training," that is, instruction that includes the rationale, significance, and utility of the trained activity, not only improved performance, but also demonstrated maintenance of the skill in appropriate situations (Kendall, Borkowski, & Cavanaugh, 1980; Kennedy & Miller, 1976; Paris, Newman, & McVey, 1981). Taking competence a step further, students who received "self-control training," that is, additional, explicit instruction in task-specific executive skills such as planning and monitoring, exhibited increased outcomes in terms of independent production and awareness of appropriate skill use, strategy effectiveness, and self-regulation (Brown & Barclay, 1976; Brown, Campione, & Barclay, 1979).

The learning strategies curriculum that was developed and reported by Dansereau (1978) addressed the issue of providing the learner with the means by which to control intellectual processing. His work, however, focused on *general* strategies that presumably facilitate *all* learning and are encompassed in a self-contained curriculum. The present proposal pertains to knowledge and control at the task-specific level for all instruction, with the assumption that such information will transfer to broader, but similar areas. This is consistent with Gagne and Smith's (1967) notion of training for vertical and lateral transfer; that is, instruction that includes information about the integration of subskills into higher level skills and the application of skills in appropriate situations (i.e., conditional knowledge). In addition, Gagne (1985) has noted the immense diversity of task-specific cognitive strategies, expressing doubt that general strategic thinking can be trained with more than moderate success.

The Learner

Instruction that provides conditional knowledge and self-regulatory components will no doubt have several positive effects on the learner in terms of overall performance. First, implicit within the concept of strategic learner behavior is the notion that motivation is the impetus for selected actions; that is, the relationship between skill and will as described by Paris et al. (1983). Keller (1979) focused on the relationship between effort or motivation and one's overall performance in his initial description of the motivational aspects of instructional design. He concluded that the degree to which effort is invested is heavily influenced by the skill's perceived instrumental value for attaining a desired future goal. In other words, more effort is typically expended to acquire, maintain, and implement those skills that are perceived as being relevant and useful.

By supplying information about *why* and *when* a strategy or skill would be relevant to the learner, conditional knowledge provides an integral link between the skill and the motivation necessary for its implementation. Research that investigated differential effects of instruction with and without conditional knowledge (Duffy, Roehler, Meloth, Polin, Rackliffe, Tracy & Vavrus, 1985) demonstrated that students who received conditional knowledge not only produced greater achievements than the control group, but additionally increased their efforts to use and maintain the newly learned strategies.

Second, as previously noted, research in several disciplines indicates that a major distinction between experts and novices in any content area is the difference in their use of self-controlled strategic behavior (Glaser, 1976). Experts tend to plan their alternatives before undertaking a specific action, as well as to monitor and revise their behaviors when appropriate. Each of these is an indication of experts' incorporation of the metacognitive aspects within self-regulation. Likewise, students can learn to be strategic as they begin to use one or more of these self-regulatory components (Fish & Pervan, 1985; Paris et al., 1983). For example, Paris and Myers (1981) observed students in several fourth grade reading groups as they prepared to be tested on an assigned reading task. They noted that those finishing the test with the highest scores engaged in more strategic behaviors, such as taking notes, asking questions, and using the dictionary, than did those students with poorer overall performances. The researchers concluded that achievement was enhanced as students planned and monitored their learning and employed compensation strategies when necessary. In various other content areas, self-regulatory components have been used in areas ranging from controlling inappropriate behavior (Bornstein & Quevillon, 1976) to improving math skills (Genshaft & Hirt, 1980).

Finally, combining the conditional

knowledge and the self-regulatory components, learners quickly gain confidence in their own abilities to use the skill appropriately and to achieve predictable outcomes. Learners increase their effort to acquire and maintain skills that produce outcomes that are attributable to their own behavior and not to luck or other external forces (deCharms, 1968; Weiner, 1974). As confidence with a skill and the outcome expectancies increase, the skill can then be used more strategically by the student to increase performance in a number of areas.

Conclusion

In conclusion, metacognition involves knowledge and regulation of cognitive processes resulting in strategic and adaptive behavior on the part of the learner. The authors advocated that the design of instruction, specifically the instructional strategies component, be extended to incorporate learning of conditional knowledge as well as self-regulatory components. There is evidence to support the notion that such instruction results in a higher level of competence. Such enhanced instruction should have positive effects on the learner in terms of motivation and overall performance.

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