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ABSTRACT

Two types of instructional design strategies, hints and learner control, that can be used to enhance metacognitive strategies in problem solving, are discussed. Metacognition refers to the active monitoring and consequent self-regulation for which one's own mental activities become the objects of reflection. Hints provide guidance that can lead learners to the correct solution, as they provide information, the stimulus for accurate problem solving, and cognitive support. Learner control provides learners with opportunities to analyze their own comprehension and needs and to use instructional components according to analyzed needs. The metacognitive strategies acquired through instruction supported by hints and learner control may be those that are transferred to other contexts and facilitate further learning activities. As learners increase their confidence, they may attempt to modify and improve their own metacognitive strategies even when they are not required. (Contains 21 references.) (SLD)

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Hints and Learner Control for Metacognitive Strategies in Problem Solving

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HINTS AND LEARNER CONTROL FOR METACOGNITIVE STRATEGIES IN PROBLEM SOLVING

This paper focuses on two types of instructional design strategies (i.e., hints and learner control) that can be used to enhance metacognitive strategies in problem solving. Hints are often referred to as cues, clues, prompts or facilitators, and learner control as student control or internal locus of instructional control. In this paper, the terms, hints and learner control are used.

Metacognition refers to the active monitoring and consequent self-regulation for which one's own cognitive mental activities become the objects of reflection (Flavell, 1987). According to Meichenbaum, Burland, Gruson and Camerson (1985), "metacognition refers to cognitions about cognitions or the executive decision-making process in which the individual must both carry out cognitive operations and oversee his/her progress" (p.5). It has a means-ends character, that aims to reflect upon, evaluate and guide cognitive activities in an effective manner (Perkins, Simmonson and Tishman, 1989).

Representative activities of metacognition include: analyzing and characterizing a problem; understanding what one needs to know; reflecting upon what one knows or does not know in order to get to the solution; making a plan for the solution; using one's cognitive resources and time on the basis of a plan made ahead; monitoring progress; evaluating the outcomes of the plan; and revising the plan (Brown, 1987; Gagne and Glaser, 1987). In learner-controlled instruction, similar learning activities are involved, by requiring learners to keep on a path of active self-regulation, and to purposefully use control options. Additionally, hints can speed and facilitate such processes of learning. Metacognitive strategies acquired through the instruction supported by hints and learner control are those that are useful for problem-solving.

In the following portion of this paper, detailed discussion on hints and learner control will be provided.

HINTS

what they are

Those who attempt to solve problems need some guidance, which can lead them to the correct solution throughout the whole process. Such guidance can be provided in a form of hints. According to Sabban (1985), hints can serve the following roles: 1) hints can stop the ongoing action or thought; 2) hints can provide a stimulant for the correct solution; 3) hints can intentionally mislead solution processes; and 4) hints can serve as a measure of success in problem solving.

why they are important

Instruction for higher-order problem-solving skills requires continuous trial and error, and the higher-order skills are compatible to learning strategy, metastrategy or metacognitive strategy (Derry and Murphy, 1986). For such instruction, hints can provide the best opportunity to initiate a new direction towards a correct solution and thus to facilitate learning when a problem solver faces trouble in progress (Sabban, 1985).

Hints can provide not only information but also stimulus for accurate problem solving by helping learners identify the major factors and underlying intention of a problem, reorganize the problem for the solution, retrieve related skills or knowledge, select appropriate strategies, and conduct problem-solving. The intent of hints is to encourage learners to work within an externally supported learning environment, in which they can conduct knowledge compilation, overcome the problem of inert knowledge and production deficiency, and develop metacognitive inner-dialogue strategies.

Hints can activate knowledge compilation processes, the translation processes of declarative knowledge to procedural knowledge. According to Gagne (1985), one of the two major types of procedural knowledge is action-sequence, which indicates the procedures to carry out sequences of symbolic operations. In developing action-sequence procedures, knowledge compilation processes are required. Gagne argues that external prompts can support the compilation processes by guiding sequential steps.

Also, hints can provide learners with cognitive support, that can compensate for the deficiency in their cognitive processing. While difficulties that learners face during problem-solving are often due to missing knowledge, in many cases those are due to inert knowledge or fragile knowledge, failing to retrieve related knowledge or to correctly combine retrieved knowledge (Perkins, Schwartz and Simmons, 1988). Especially, developmentally immature learners often exhibit production deficiencies, the failure to access and employ processing capabilities that they may actually possess (Brown, 1974). Production deficiencies may occur due to the learners' failure to recognize the usefulness of a particular set of skills in a certain learning situation as well as the desire to perform such skills.

While missing knowledge needs more review and practice to consolidate the knowledge base, inert knowledge (and production deficiency as well) requires special instructional remedy so that learners can employ knowledge and skills to work with (Perkins, Schwartz and Simmons, 1988). According to Perkins, Schwartz and Simmons, hints can be integrated into the design of instruction for the special remedy.

In addition, hints can encourage learners not only to recall and apply previously acquired learning skills but also to make such process automatic. According to Derry and Murphy (1986), the enhancement of learning abilities requires the development of not only specific learning skills but also executive control skills that automatically accesses and combines skills needed for learning. This can be applied to problem-solving abilities as well. On this point, hints can help the enhancement of executive control skills (Bonk and Reynolds, 1992). Further, according to Derry and Murphy (1986), executive control skills are those that maintain and transfer metacognitive strategies.

how to provide them

A theme emerged repeatedly in research conducted from a metacognitive perspective is that executive control skills cannot be trained directly, but must be gradually developed and automated over a long period (Derry and Murphy, 1986). Hints can be used in designing guided instruction for the training of executive control skills.

Many of metacognitive strategies related to executive control skills cannot be made explicit. Moreover, even given explicit strategies, the use of the strategies highly depends on the way in which they are embedded in instruction (Collins, Brown and Newman, 1986).

Because of these problems, Collins, Brown and Newman argue that instruction should be designed to provide learners with the opportunity to observe and engage in using an expert's strategies and related knowledge to help them understand how these strategies and knowledge fit together and cue off. On this point, they suggest the cognitive apprenticeship method which reflects modeling-coaching-fading paradigm. This paradigm is designed to help learners acquire an integrated set of metacognitive as well as cognitive strategies through observation and guided practice.

Modeling involves the demonstration of an expert's task performance, which can help learners observe and build a conceptual model of the task performance. Coaching consists of observing learners while they carry out a task and offering help as needed. Fading refers to the gradual removal of the help as learners can perform the task on their own.

In integrating hints into the design of problem-solving instruction, an expert's uses of hints can be demonstrated by prescribed instruction or by a teacher. Then, learners can have the opportunity to use the hints as they carry out a given task, while they can get help as needed. The processes of learners' performance need to be analyzed to determine when they no longer need hints. When there is an evidence of automatic initiation and use of metacognitive strategies, hints can be gradually phases out from the instruction. Through this learning process supported by hints, learners can gain control over their uses of metacognitive strategies in problem solving, and this control can become internalized.

LEARNER CONTROL

what it is

Concerning the loci of instructional control, the control can be assigned either to a program or to a learner. While program control presents instructional components on the basis of prescribed rules with little choice given to learners, learner control provides learners with opportunities to analyze their own comprehension and needs and to use instructional components according to the analyzed needs.

why it is important

Advocating learner control, Merrill (1984) conjectures an internal model of metacognition inside each learner that directs and orchestrates how s/he uses control over instructional components to enhance the present state of knowledge. On the basis of the model, a learner makes decisions and examines how the decisions work out, and through these processes, s/he can learn "how to learn".

Under learner control, learners need to be aware of control options and deliberately make decisions about the use of options. Therefore, individual learners are situated in the position to actively analyze the nature of a task, to estimate their understanding of the given task, to select activities to be performed in accomplishing the task, to decide how to perform the selected activities, and to evaluate the results of their decisions, while continuously monitoring their own cognitive processes and performances (Holmes, Robinson, and Steward, 1985; Merrill, 1984).

Through the instruction, learners can continuously practice conscious reflection on their cognitive abilities, task demands and learning strategies, and learn how to manage their own thinking processes and learning activities in order to achieve desired goals of instruction. Thus, through the exploration of given tasks and use of self-regulatory mechanism, they can be led to enhance their abilities to perform and behave strategically.

As a result, through learner controlled instruction, learners can be able to integrate new learning materials thoroughly within their existing knowledge schema, and enhance their metacognitive strategies in an effective way (Merrill, 1984; Rubincam and Olivier, 1985).

how to provide it

Significant efforts have been devoted to research on learner control, but the results have been diverse, making generalization difficult. Thus, although the question as to whether instructional designers should assign control to a learner or to a program has been frequently asked, it has not been resolved.

This may be due to the lack of instructional design supports that take off some of the cognitive burden provided by the unique learning environmen, and guide learners to effectively go through the instruction (Jo, 1991). On this point, recommendations made by theory and research need to be integrated into the design of instruction to help learners consciously make decisions over their own learning and build effective learning strategies.

First, control opti.ns should be clearly labeled to help learners use control options effectively (Reigeluth and Stein, 1983). Second, immediate feedback, continuous advice on learners' on-going progress and summaries of their uses of control options should be presented to help learners make "informed decisions" about their own learning (Hannafin, 1984; Kinzie, 1988; Lepper and Malone, 1987). Third, basic requirement over important instructional components should be provided to learners in order to assure that they do not bypass the components (Kinzie, 1988). Fourth, prior to instruction, pretraining should be provided to learners to help them become familiar with the novel learning system with control options, perform conscious cognitive information processing, and understand objectives, procedures and values involved in building their own learning strategies (Hannafin, 1984; Holmes et al., 1985; Kinzie, 1988; Merrill, 1984; Schmitt and Newby, 1985). Schmitt and Newby (1985) argue that if learners learn when and why they need to use such strategic approaches (conditional knowledge) along with learning what they are (declarative knowledge) and how to use them (procedural knowledge), the learners can quickly gain competence and confidence in their own abilities to use the approaches appropriately and to achieve excellent outcomes. Thus, pretraining can contribute to helping learners gain such knowledge.

The metacognitive strategies acquired through the instruction supported by hints and learner control may be those that are transferred to other contexts and facilitate further learning activities. As learners' confidence increases through such instruction, they may attempt to modify and improve their own metacognitive strategies even when they are not required (Kinzie, 1988).

This paper has dealt with theoretical aspects of the effects of hints and learner control in enhancing metacognitive strategies. Concerning the potential of the two design strategies, much effort needs to be devoted to research in order to verify the theory and to uncover the details of learning experiences gained through the instruction. In addition, due to the importance of strategic approaches guided by hints and learner control, research should attempt to monitor learners' conscious cognitive activities involved in their learning processes.

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