Metacognition

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Learning depends, in part, on the effective use of basic cognitive processes such as memory and attention, the activation of relevant background knowledge, and the deployment of cognitive strategies to achieve particular goals. To ensure that the basic processes are used effectively, that the activated knowledge is indeed relevant, and that appropriate strategies are being deployed, learners also need to have awareness and control of their cognitive processes. This higher-level cognition was given the label metacognition by American developmental psychologist John Flavell (1976).

The term metacognition literally means cognition about cognition, or more informally, thinking about thinking. Flavell defined metacognition as knowledge about cognition and control of cognition. The knowledge component encompasses what one knows about cognition, including knowledge about oneself as a learner, about aspects of the task at hand, and about strategies needed to carry out the task effectively. The control component encompasses the strategies one uses to make cognitive progress, such as planning how to approach a task, evaluating progress as the task is being completed, and changing tactics if difficulties arise.

HISTORICAL ROOTS OF INQUIRY IN METACOGNITION

Research on metacognition had its origins in the 1970s work of Flavell (1976, 1979) and another prominent developmental psychologist, Ann Brown (1943–1999). This work focused on children's metamemory, that is, their knowledge and control of their memory processes. In a landmark study, Kreutzer, Leonard, and Flavell, interviewed children in kindergarten and grades 1, 3, and 5 to determine their knowledge of how their memories work. Open-ended questions were asked about a variety of hypothetical situations tapping knowledge of person, task, and strategy variables influencing memory. For example, children were asked how they could be sure to remember to take their skates to school with them the next day and how they would remember a phone number, and whether it would be easier or harder to remember a list of words they had already studied. Responses revealed that even the youngest children had some knowledge of the workings of their memory, but that older children had greater insights.

Brown's early interest in metacognition was reflected in the title of a 1978 chapter, “Knowing when, where, and how to remember: A problem of metacognition.” Her 1970s research on how well children were able to

assess their readiness to be tested on recall of simple materials, such as pictures of common objects, evolved naturally into research on the role of metacognition in studying academic materials and comprehending prose. Her 1980 chapter in a book on theoretical models of reading introduced metacognition to the community of reading researchers and helped to fuel the most active line of domain-specific inquiry in metacognition.

Although Flavell and Brown are credited with introducing the term metacognition, they were not the first to study phenomena that was to be called metacognitive. From the beginning of the twentieth century reading researchers were documenting the importance of monitoring and regulating one's comprehension processes. Memory researchers were studying feelings of knowing and memory monitoring from at least the 1960s. Information processing models from the 1970s included executive control systems that regulate basic cognitive processes.

In addition, Soviet psychologist Lev Vygotsky (1896–1934) and Swiss psychologist Jean Piaget (1896–1980) included processes regarded as metacognitive in their theories of children's thinking. Vygotsky theorized that children develop the capacity for self-regulation through interaction with more knowledgeable others. These individuals initially assume responsibility for monitoring progress, setting goals, planning activities, allocating attention, and so on. Gradually, responsibility for these executive processes is given over to the child, who becomes increasingly capable of regulating his or her own cognitive activities. This transition from other-regulation to self-regulation is in the early 2000s regarded as a hallmark of metacognitive development. Piaget theorized that peers challenge one another's thoughts and thus advance their cognitive development. Inducing children to reflect on their own thinking is in fact inducing metacognition.

Vygotsky's theory provides the foundation for contemporary classroom interventions that begin with explicit instruction on the part of the teacher, followed by modeling and guided practice of cognitive and metacognitive strategies, with a gradual release of responsibility to the student.

Piaget's theory has been built upon by contemporary researchers, including Palincsar and Brown, to reveal that peer discussion and collaboration help students to monitor their own understanding and build new strategic capabilities.

IMPORTANCE OF METACOGNITION IN THEORIES OF LEARNING AND INSTRUCTION

The implicit focus on metacognitive processes in early theories of information processing and cognitive development gave way to an explicit focus in contemporary theories of learning and instruction. Within a decade of the seminal work of Flavell and Brown, hundreds of laboratory studies had accumulated showing that metacognitive knowledge and control were associated with more successful cognitive performance, and applied research confirmed the practical importance of metacognition in the classroom. When students have knowledge and control of their own cognitive processes, learning is enhanced; this assertion holds regardless of the domain of learning, whether reading, writing, science, mathematics, or any other activity that involves thinking.

Evidence that metacognition is firmly entrenched in theorizing about how students learn comes from two influential national committees charged with reviewing and synthesizing the research on learning in the 1990s. Early in the decade a taskforce of the American Psychological Association, under the leadership of Nadine Lambert and Barbara McCombs, developed a set of learner-centered psychological principles intended as guidelines for school redesign and reform. Informing the principles was a model of learning that integrated the following factors: cognitive, metacognitive, motivational, affective, developmental, social, and

individual differences. Meta-cognition was featured in one of the 14 learner-centered principles: “Thinking about thinking: Higher order strategies for selecting and monitoring mental operations facilitate creative and critical thinking.” In justifying this principle the authors noted that instructional approaches that foster metacognition can enhance not only student learning but also student responsibility for learning.

Later in the 1990s a committee of the National Research Council, led by John Bransford, Ann Brown, and Rodney Cocking, similarly concluded that metacognition is a key factor in learning that should be deliberately cultivated. They emphasized the particularly important role that metacognition plays in promoting transfer of learning. That is, students can more readily apply knowledge acquired in one context to another context if they have more awareness of themselves as learners, if they monitor their strategies and resources, and if they assess their readiness for tests and other performances.

Although metacognition is a term that may still need to be defined to the general public, it is well represented in most college-level textbooks in cognitive, developmental, and educational psychology. Further information about the role of metacognition to learning and instruction can be found in numerous articles, chapters, and edited books, including those by DeSoete and Veenman; Hacker, Dunlosky and Graesser; Hartman; Israel and colleagues; Miller; Paris; Schneider and Lockl; Schraw and Impara; and Sternberg.

DEVELOPMENTAL AND INDIVIDUAL DIFFERENCES IN METACOGNITION

The early research on metacognition was conducted by developmental psychologists whose particular interest was in age-related changes. Flavell, Brown, and their colleagues documented substantial growth in knowledge and control of memory. Researchers demonstrated similar developmental trends in other cognitive enterprises, including communication, comprehension, problem solving, and attention. A consistent pattern in the domain of reading documented in the early years by Baker and Brown but still found in the early 2000s is that younger readers have little awareness that they must attempt to make sense of text; they focus on reading as a decoding process, rather than as a meaning-getting process.

Metacognitive growth is gradual throughout childhood, adolescence, and even into adulthood.

One cannot simply assert that an individual has or does not have metacognition. Metacognition is not a unitary construct, either across domains or within domains, nor is the deployment of a metacognitive strategy all or none. There are degrees in the effectiveness with which strategies can be applied. Children show primitive abilities to plan and check their activities on simple tasks during the preschool years, but even advanced students in higher education show metacognitive limitations on more difficult tasks.

A parallel line of inquiry that grew up alongside the developmental work focused on individual differences in metacognition, typically involving comparisons of better and poorer students, or students with and without a learning disability. Again, the pattern has been quite consistent, with better students demonstrating more knowledge and control of the processes involved in a given domain, whether it is studying, reading, writing, mathematics, or scientific problem solving. Ability-related differences in knowledge about cognition, like developmental differences, have been documented in countless studies, across age groups ranging from early childhood through later adulthood.

The compelling body of descriptive evidence that younger and less-skilled students have limited metacognitive knowledge and control led psychologists to ask whether metacognition could be deliberately fostered and if so, whether it would enhance children's success in school. Experimental research conducted as early as the 1980s provided an affirmative answer. Although the evidence became clear that increasing

students' metacognitive awareness and control can improve learning, Baker points out that the relation between metacognition and learning is not unidirectional. Rather, reciprocal causation is most likely; that is, improvements in metacognition contribute to improvements in learning, which in turn contribute to further improvements in metacognition.

ASSESSMENT OF METACOGNITION

A variety of approaches have been used to measure meta-cognition, and considerable controversy exists as to the best ways to assess it. The tools that one selects must be suited to the developmental levels of the students and the purposes of the assessments. Multiple measures are recommended because they can provide converging evidence; if the same findings are obtained with different tools, the researcher or educator can be more confident in his or her conclusions.

The most frequently used approach to assess both metacognitive knowledge and metacognitive control is to ask students directly what they know or what they do while engaging in particular cognitive activities. Verbal reports are typically elicited through structured interviews, such as that originally used by Flavell, or by questionnaires that include multiple response options to a series of items. Most questionnaires are domain specific (e.g., they focus only on reading or only on math), but some are intended to be more domain general. A domain-specific inventory might tap a student's understanding of variables that affect reading outcomes and of strategies that are effective for comprehending text. An example of a well-validated inventory is Mokhtari and Reichard's Metacognitive Awareness of Reading Strategies Inventory. A domaingeneral inventory might assess an individual's knowledge about cognition (including declarative, procedural, and conditional knowledge) and regulation of cognition (including planning, monitoring, debugging, and evaluating learning). An example of a well-validated inventory is Schraw and Dennison's Metacognitive Awareness Inventory. Another valuable self-report option for assessing metacognitive control is to ask students to think aloud about what they are doing and thinking as they solve a problem or read a text.

Technological advances have led to more sophisticated and sensitive ways of assessing metacognitive control. Students can be asked to engage in a task while process measures are being collected online. For example, to assess metacognitive control during reading, a passage may be presented to the reader on a computer screen. Patterns of movement through the text are collected automatically, revealing whether the reader paused at a particular point, whether he or she looked back at previous text, or whether he or she jumped ahead. In many cases, the texts participants read contain errors that were deliberately introduced to make the text difficult to understand. Patterns of movement through the texts reveal processes of comprehension monitoring, or the lack thereof. These process measures are often supplemented by asking readers to reflect on what they were thinking or to answer follow-up comprehension questions. Online processing tasks can also be used to track cognitive monitoring while performing other activities such as mathematical problem solving, writing, computer programming, and vocabulary learning. An advantage of these approaches is that they reveal what students actually do instead of what they say they do. Research using online measures reveals the same developmental and ability-related differences documented through verbal reports.

Still another general approach to assessing metacog-nition is used primarily by researchers studying basic cognitive processes. In judgments of learning tasks, students are presented with to-be-learned material, such as a list of words or a passage, and they are given a test over the material. They are then asked to judge how well they learned the material or how well they answered the comprehension questions. Judgments of learning are then examined in relation to actual performance. A related approach assesses feelings of knowing or knowledge monitoring; it involves presenting students with material and asking them how well they think they would perform on a test. For example, they might be presented with a list of vocabulary

words and asked how many they would be able to define or a set of math problems and asked how many they can solve. They are then asked to complete the task, and their performance is compared to their predictions. Even students at the college level generally are not very good at monitoring their learning, but research has shown that a host of factors influences their success, such as item difficulty and familiarity of the to-be-learned materials, and that they can be taught to monitor more effectively.

Researchers are the most frequent users of metacog-nitive assessments, but classroom teachers and school psychologists have also become interested in evaluating their students' metacognitive knowledge and control. According to Baker and Cerro, it is important to be mindful of the limitations of the tools that are used and the conclusions that can be drawn. For example, a limitation of questionnaires is that there is not necessarily a correspondence between what people say they do and what they actually do. Comparisons of questionnaire responses with performance measures on a given task often yield rather low correlations. In addition, people often respond according to what they think they should say, rather than what they actually believe or do. Despite their limitations, verbal reports can be valid and reliable sources of information about cognitive processes when carefully elicited and interpreted, as can more direct processing measures.

INSTRUCTIONAL IMPLICATIONS

Classroom-based intervention studies began to be implemented in the 1980s shortly after laboratory studies provided solid evidence that metacognitive knowledge and control could be fostered through direct instruction. These interventions typically are domain specific, undertaken not with the goal of increasing metacognition for its own sake, but rather with the goal of increasing learning. Teacher-led interventions using metacognitively oriented reading instruction have resulted in gains in students' metacognition as well as comprehension. One program developed by Michael Pressley and colleagues, known as Transactional Strategies Instruction, is effective with children as early as second grade. Similarly, teacher-led interventions have been devised and successfully implemented to help students plan, monitor, and evaluate their own thinking during mathematical problem solving. Peer collaboration and discussion play a vital role in the classroom as students make explicit their cognitive processes, assumptions, and strategies. Evidence that metacognitive intervention is effective is in the early 2000s so strong that disciplinary organizations and national panels recommend that metacognition be included in teacher preparation and in classroom curricula.

See also:Brown, Ann Leslie 1943-1999, Cognitive Strategies, Piaget, Jean 1896-1980, Pressley, G. Michael 1951-2006, Reciprocal Teaching, Self-Regulated Learning, Theories of Learning, Theory of Mind, Vygotsky, Lev Semenovich 1896-1934

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