Instructional Science **26:** 113–125, 1998.

Promoting general metacognitive awareness

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Abstract. I describe two aspects of metacognition, knowledge of cognition and regulation of cognition, and how they are related to domain-specific knowledge and cognitive abilities. I argue that metacognitive knowledge is multidimensional, domain-general in nature, and teachable. Four instructional strategies are described for promoting the construction and acquisition of metacognitive awareness. These include promoting general awareness, improving self-knowledge and regulatory skills, and promoting learning environments that are conducive to the construction and use of metacognition.

This paper makes three proposals: (a) metacognition is a multidimensional phenomenon, (b) it is domain-general in nature, and (c) metacognitive knowledge and regulation can be improved using a variety of instructional strategies. Let me acknowledge at the beginning that each of these proposals is somewhat speculative. While there is a limited amount of research that supports them, more research is needed to clarify them. Each one of these proposals is addressed in a separate section of the paper. The first makes a distinction between knowledge of cognition and regulation of cognition. The second summarizes some of the recent research examining the relationship of metacognition to expertise and cognitive abilities. The third section describes four general instructional strategies for improving metacognition. These include fostering construction of new knowledge, explicating conditional knowledge, automatizing a monitoring heuristic, and creating a supportive motivational environment in the classroom. I conclude with a few thoughts about general cognitive skills instruction.

A framework for understanding metacognition

Researchers have been studying metacognition for over twenty years. Most agree that cognition and metacognition differ in that cognitive skills are necessary to perform a task, while metacognition is necessary to understand how the task was performed (Garner, 1987). Most researchers also make a distinction between two components of metacognition, *knowledge of cognition* and *regulation of cognition* (although see Flavell (1987) for a alternative view). Knowledge of cognition refers to what individuals know about their own cognition or about cognition in general. It includes at least three different kinds of metacognitive awareness: declarative, procedural, and conditional knowledge (Brown, 1987; Jacobs & Paris, 1987; Schraw & Moshman, 1995). Declarative knowledge refers to knowing "about" things. Procedural knowledge refers to knowing "how" to do things. Conditional knowledge refers to knowing the "why" and "when" aspects of cognition.

Declarative knowledge includes knowledge about oneself as a learner and about what factors influence one's performance. For example, research examining what learners know about their own memory indicates that adults have more knowledge than children about the cognitive processes associated with memory (Baker, 1989). Similarly, good learners appear to have more knowledge about different aspects of memory such as capacity limitations, rehearsal, and distributed learning (Garner, 1987; Schneider & Pressley, 1989).

Procedural knowledge refers to knowledge about doing things. Much of this knowledge is represented as heuristics and strategies. Individuals with a high degree of procedural knowledge perform tasks more automatically, are more likely to possess a larger repertoire of strategies, to sequence strategies effectively (Pressley, Borkowski & Schneider, 1987), and use qualitatively different strategies to solve problems (Glaser & Chi, 1988). Typical examples include how to chunk and categorize new information.

Conditional knowledge refers to knowing when and why to use declarative and procedural knowledge (Garner, 1990). For example, effective learners know when and what information to rehearse. Conditional knowledge is important because it helps students selectively allocate their resources and use strategies more effectively (Reynolds, 1992). Conditional knowledge also enables students to adjust to the changing situational demands of each learning task.

Regulation of cognition refers to a set of activities that help students control their learning. Research supports the assumption that metacognitive regulation improves performance in a number of ways, including better use of attentional resources, better use of existing strategies, and a greater awareness of comprehension breakdowns. A number of studies report significant improvement in learning when regulatory skills and an understanding of how to use these skills are included as part of classroom instruction (Cross & Paris, 1988; Brown & Palincsar, 1989). These studies are important because they suggest that even younger students can acquire metacognitive skills via instruction. Although further research is needed, it is likely that improving one aspect of regulation (e.g., planning) may improve others (e.g., monitoring).

Although a number of regulatory skills has been described in the literature (see Schraw & Dennison (1994) for a description), three essential skills are included in all accounts: planning, monitoring, and evaluation (Jacobs & Paris, 1987). Planning involves the selection of appropriate strategies and the allocation of resources that affect performance. Examples include making predictions before reading, strategy sequencing, and allocating time or attention selectively before beginning a task. For example, studies of skilled writers reveal that the ability to plan develops throughout childhood and adolescence, improving dramatically between the ages of 10 and 14 (Berieter & Scardamalia, 1987). Older, more experienced writers engage in more global as opposed to local planning. In addition, more experienced writers are better able to plan effectively regardless of text "content", whereas poor writers are unable to do so.

Monitoring refers to one's on-line awareness of comprehension and task performance. The ability to engage in periodic self-testing while learning is a good example. Research indicates that monitoring ability develops slowly and is quite poor in children and even adults (Pressley & Ghatala, 1990). However, several recent studies have found a link between metacognitive knowledge and monitoring accuracy (Schraw, 1994; Schraw, Dunkle, Bendixen & Roedel, 1995). Studies also suggest that monitoring ability improves with training and practice (Delclos & Harrington, 1991).

Evaluating refers to appraising the products and efficiency of one's learning. Typical examples include re-evaluating one's goals and conclusions. A number of studies indicate that metacognitive knowledge and regulatory skills such as planning are related to evaluation (see Baker, 1989). With respect to text revisions, Bereiter & Scardamalia (1987) found that poor writers were less able than good writers to adopt the reader's perspective and had more difficulty "diagnosing" text problems and correcting them.

There are two main points I would like to emphasize about knowledge of cognition and regulation of cognition. The first is that the two are related to one another. For example, Swanson (1990) found that declarative knowledge of cognition facilitated regulation of problem solving among fifth and sixth-grade students. Schraw (1994) reported that college students' judgments of their ability to monitor their reading comprehension were significantly related to their observed monitoring accuracy and test performance. Pintrich and colleagues (Pintrich & DeGroot, 1990; Wolters & Pintrich, this volume) found that knowledge of strategies was related to self-reported strategy use. Schraw, Horn, Thorndike-Christ & Bruning (1995) reported a similar finding.

The second is that both components appear to span a wide variety of subject areas and domains – that is, they are domain-general in nature. Gourgey (this volume) reported anecdotally that metacognition in mathematics is the same as in reading. She also reviewed four general strategies (i.e., identifying main goals, self-monitoring, self-questioning, and self-assessment) that have been shown to improve learning in all domains. Schraw et al. (1995) provided empirical evidence to support the conclusion that adult learners possess a general monitoring skill. Wolters and Pintrich (this volume) reported that strategy use and self-regulation were correlated highly in three separate domains.

In summary, metacognition consists of knowledge and regulatory skills that are used to control one's cognition. While metacognition is used in a general sense to subsume a number of individual components, all of these components are intercorrelated (Schraw & Dennison, 1994), and yield two general components corresponding to knowledge about cognition and regulation of cognition. Preliminary evidence suggests these two components are intercorrelated somewhere in the $r = 0.50$ range.

Issues of generality

Two questions come to mind when one asserts that metacognition is a domain-general phenomenon. The first is how domain-general metacognitive knowledge is related to domain-specific (i.e., encapsulated) knowledge. Despite two decades of research, those interested in the study of expertise typically do not draw a clear distinction between cognitive and metacognitive skills (Glaser & Chi, 1988; Ericsson & Smith, 1991). Most researchers appear to assume to that both types of knowledge are encapsulated within rigid domain boundaries (Siegler & Jenkins, 1989). My own view is that cognitive skills tend to be encapsulated within domains or subject areas, whereas metacognitive skills span multiple domains, even when those domains have little in common. Evidence supporting this view has been provided by Schraw et al. (1995) and Wolters and Pintrich (this volume). A detailed discussion of the generalization process is provided by Karmiloff-Smith (1992).

A second question is how metacognition is related to cognitive abilities. There is growing consensus that the acquisition of metacognition does not depend strongly on IQ, at least as it correlates with group-administered, paper-and-pencil tests. In a recent comprehensive review, Alexander, Carr and Schwanenflugel (1995) reported that content-specific knowledge was modestly related to IQ, and that strategies and comprehension monitoring were not related at all. These findings are consistent with the main conclusion from the skill acquisition literature that IQ is of greatest importance in the early stages of skill acquisition, but is unrelated to skilled performance during latter stages of learning (Ackerman, 1987). Indeed, Alexander et al. (1995) have referred to traditional measures of IQ as a threshold variable that constrains knowledge acquisition initially, but becomes far less important as other skills, such as task-specific strategies and general metacognitive knowledge, come into play. Well organized instruction or the use of effective learning strategies may in large part compensate for differences in IQ. In many cases, sustained practice and teacher modeling leads to the acquisition of relevant task-specific knowledge as well as general metacognitive knowledge that is either independent or moderately correlated with traditional IQ scores (Ericsson, Krampe & Tesch-Romer, 1993).

In general, one can expect metacognitive knowledge and regulation to improve as expertise within a particular domain improves. Though there is substantial debate on this point, many researchers believe that metacognitive knowledge is domain- or task-specific initially. As students acquire more metacognitive knowledge in a number of domains, they may construct general metacognitive knowledge (e.g., understanding limitations on memory) and regulatory skills (e.g., selecting appropriate learning strategies) that cut across all academic domains (see Schraw & Moshman, 1995). Older students in particular may construct general metacognitive skills that cut across a wide variety of tasks. This suggests that as students advance, they not only acquire more metacognitive knowledge, but use this knowledge in a more flexible manner, particularly in new areas of learning.

Metacognitive knowledge may also compensate for low ability or lack of relevant prior knowledge. One especially compelling case in point was provided by Swanson (1990), who found that metacognitive knowledge compensated for IQ when comparing fifth and sixth-grade students' problem solving. High-metacognition students reported using fewer strategies, but solved problems more effectively than low-metacognition students, regardless of measured ability level. This study suggested two important findings. One was that metacognitive knowledge is not strongly correlated with ability, although there does appear to be a modest, positive relationship between the two (Alexander et al., 1995). Second, metacognitive knowledge contributes to successful problem solving over and above the contribution of IQ and task-relevant strategies. These findings suggest that one may have average ability as measured by paper-and-pencil tests, yet possess a high degree of regulatory knowledge.

In summary, there is reason to believe that metacognitive knowledge and regulation are qualitatively different from other cognitive skills (Karmiloff-Smith, 1992; Schraw & Moshman, 1995). Metacognition appears to be more durable and general than domain-encapsulated cognitive skills. While high levels of domain-specific knowledge may facilitate the acquisition and use of metacognition, domain knowledge does not guarantee higher levels of metacognition. Moreover, individuals high on the metacognitive awareness dimension may use this knowledge to compensate for domain-specific knowledge, although this point requires further research.

Promoting metacognitive awareness

Thus far, I have argued that metacognition differs from cognition, is multidimensional, and domain-general in nature. The gist of my argument has been that metacognition fills a unique niche in the self-regulatory phylum, by providing domain-general knowledge and regulatory skills that enable individuals to control cognition in multiple domains. Metacognition is flexible and indispensable in my view. How then might one go about improving these skills?

There are four general ways to increase metacognition in classroom settings (Hartman & Sternberg, 1993). These include promoting general awareness of the importance of metacognition, improving knowledge of cognition, improving regulation of cognition, and fostering environments that promote metacognitive awareness. I examine each of these separately, then make several summary comments about the utility of general skills instruction.

Promoting general awareness

Students need to understand the distinction between cognition and metacognition to become self-regulated. Teachers, other students, and reflection each play an important role in this process. Teachers model both cognitive and metacognitive skills for their students. The more explicit this modeling, the more likely it is that students will develop cognitive and metacognitive skills (Butler & Winne, 1995). Other students provide effective models as well, and in many situations, are better models than teachers (Schunk, 1989). Frequently, students are better able to model cognitive and metacognitive skills, and provide a powerful rationale for these skills within the student's zone of proximal development, compared to teachers.

Extended practice and reflection play crucial roles in the construction of metacognitive knowledge and regulatory skills. This is especially true when students are given regular opportunities to reflect on one's successes and failures (Kuhn, Schauble & Garcia-Mila, 1992; Siegler & Jenkins, 1989). Studies examining the construction of theories of mind also suggest that reflection, both as a solitary and group endeavor, contributes to the breadth and sophistication of such theories (Astington, 1993; Montgomery, 1992).

In teaching my own classes at the university, and when observing skilled teachers in their classrooms, several instructional principles emerge regarding the promotion of metacognitive awareness. The first is for teachers to take the time to discuss the importance of metacognitive knowledge and regulation, including the unique role it plays in self-regulated learning (Schon, 1987). Second, teachers should make a concerted effort to model their own metacognition for their students. Too often teachers discuss and model their cognition (i.e., how to perform a task) without modeling metacognition (i.e., how they think about and monitor their performance). For example, as a former math major, I have seen hundreds of mathematical proofs performed in college classrooms, but I cannot ever remember any of my instructors describing their thought processes (i.e., a metacognitive analysis of their proof) as they performed the proof. Third, teachers should allot time for group discussion and reflection, despite the many pressures from jam-packed curricula and district performance demands (Rogoff, 1990).

Improving knowledge of cognition

Earlier, I made a distinction between knowledge of cognition and regulation of cognition. The former included three subcomponents; declarative, procedural, and conditional knowledge. I have used an instructional aid for a number of years to improve knowledge of cognition. Many of my former students who are public school teachers have adopted this aid as well, which I refer to as a *strategy evaluation matrix* (SEM). A sample of a SEM is shown in Figure 1. Many anecdotal reports suggest it is an effective way to increase metacognitive knowledge. In addition, empirical studies also suggest that using summary matrices like the SEM may significantly improve learning (Jonassen, Beissner & Yacci, 1993).

Figure 1 includes information about how to use several strategies, the conditions under which these strategy are most useful, and a brief rationale for why one might wish to use them. The purpose of each row of the SEM is to promote explicit declarative (column 1), procedural (column 2), and conditional (columns 3 and 4) knowledge about each strategy. Of course, comparing strategies across rows adds an even more sophisticated level of conditional knowledge about one's strategy repertoire.

There are a variety of ways that a teacher could use a SEM in the classroom. The basic idea is to ask students, either individually or in a group, to complete each row of the matrix over the course of the school year. As an illustration, imagine a fourth-grade teacher who introduces the SEM during the first week of school. He informs students that they will focus on one new strategy each month, and should practice four additional strategies throughout the year that can be included in the SEM. Students are given time each week to reflect individually and as a small group about strategy use. Reflection time might include exchanging thoughts with other students about when and where to use a strategy. Extra credit can be earned by interviewing other students in the

Strategy	How to Use	When to Use	Why to Use
Skim	Search for headings, highlighted words, previews, summaries	Prior to reading an extended text	Provides conceptual overview, helps to focus one's attention
Slow down	Stop, read, and think about information	When information seems especially important	Enhances focus of one's attention
Activate prior knowledge	Pause and think about what you already know. Ask what you don't know	Prior to reading or an unfamiliar task	Makes new information easier to learn and remember
Mental integration	Relate main ideas. Use these to construct a theme or conclusion.	When learning complex information or a deeper understanding is needed.	Reduces memory load. Promotes deeper level of understanding.
Diagrams	Identify main ideas, connect them, list supporting details under main ideas, connect supporting details	When there is a lot of interrelated factual info	Helps identify main ideas, organize them into categories. Reduces memory load.

Figure 1. A strategy evaluation matrix.

same grade, or older students, about their strategy use. Students are expected to revise their SEMs as if a mini-portfolio.

Teachers I know who use SEMs find them very useful. One strength of SEMs is that they promote strategy use (i.e., a cognitive skill), which is known to significantly improve performance. A second strength is that SEMs promote explicit metacognitive awareness, even among younger students (i.e., K-6). A third strength is that SEMs encourage students to actively construct knowledge about how, when, and where to use strategies.

Improving regulation of cognition

SEMs presumably are effective at improving knowledge of cognition, but may not impact regulation. One approach that I have used is a *regulatory checklist* (RC). The purpose of the RC is to provide an overarching heuristic that facilitates the regulation of cognition. Figure 2 provides an example of an RC modeled after the problem solving prompt card used by King (1991). Figure 2 shows three main categories, including planning, monitoring, and evaluating. The RC enables novice learners to implement a systematic regulatory sequence that helps them control their performance.

Research by King (1991) found that fifth-grade students who used a checklist similar to Figure 2 outperformed control students on a number of measures, including written problem solving, asking strategic questions,

Planning
1. What is the nature of the task?
2. What is my goal?
3. What kind of information and strategies do I need?
4. How much time and resources will I need?

Monitoring
1. Do I have a clear understanding of what I am doing?
2. Does the task make sense?
3. Am I reaching my goals?
4. Do I need to make changes?

Evaluating
1. Have I reached my goal?
2. What worked?
3. What didn't work?
4. Would I do things differently next time?

Figure 2. A regulatory checklist.

and elaborating information. King concluded that explicit prompts in the form of checklists help students to be more strategic and systematic when solving problems. In a related study, Delclos and Harrington (1991) examined fifth and sixth-grader's ability to solve computer problems after assignment to one of three conditions. The first group received specific problem solving training, the second received problem solving plus self-monitoring training, while the third received no training. The self-monitoring problem solving group solved more of the difficult problems than either of the remaining groups and took less time to do so. Although the self-monitoring group did not use an explicit checklist as did King (1991), steps in the self-monitoring process were quite similar to those used by King. Together, these studies provided experimental support for the utility of regulatory checklists.

Fostering conducive environments

Metacognitive skills do not exist in a vacuum. All too often, students possess knowledge and strategies that are appropriate for a task, but do not use them. One reason is that students fail to engage and persist in a challenging task, or fail to attribute their success to the use of strategies and self-regulation. Sometimes students do not make the effort needed to do well at a task because they believe that intellectual ability, and specifically a lack of it, makes extra effort useless.

A number of recent motivational theories have addressed these issues directly. In general, successful students have a greater sense of self-efficacy, attribute their success to controllable factors such as effort and strategy use, and persevere when faced with challenging circumstances (Graham & Weiner, 1996; Schunk, 1989). However, one of the most salient characteristics of successful learners is their goal orientation (Dweck & Leggett, 1988). Students with mastery orientations seek to improve their competence. Those with performance orientations seek to prove their competence. A number of studies indicate that high-mastery students are more successful overall because they persevere, experience less anxiety, use more strategies, and attribute their success to controllable causes (Ames & Archer, 1988).

These findings raise concerns about the kind of goal orientations teachers promote in the classroom. Placing a strong emphasis on performance may lead to performance goals (Midgley, Anderman & Hicks, 1995). In contrast, focusing on increasing one's current level of performance, rewarding increased effort and persistence, and strategy use may create a mastery environment. One potential advantage of classrooms that promote mastery is that students may acquire a broader repertoire of strategies, may be more likely to use strategies, and acquire more metacognitive knowledge about regulating strategy use (Schraw et al., 1995).

Promoting general skills

One of my goals in writing this paper was to argue in defense of general cognitive skills. While most subject areas rely in part on specific skills that are of little use in other domains (e.g., using the quadratic formula), there are a large number of general strategies that aid learning in any domain. Using SEMs and RCs help promote knowledge about individual strategies, as well as metacognitive knowledge about how to use those strategies. Teacher and student modeling provide knowledge about how experts, or those who are more expert than the observer, think about problems and attempt to solve them. Modeling of regulatory skills such as planning, monitoring, and self-evaluating are especially important. Every teacher should make a concerted effort to model explicitly these behaviors.

There are many other skills that help students to think better that I did not discuss. One example is critical thinking skills such as evaluating evidence (Halpern, 1989). Another example is scientific reasoning skills such as hypothesis testing (Kuhn, 1989). These skills can be taught, and when they are, are of tremendous benefit to all students. Research suggests that many students can improve with respect to critical and scientific thinking, given three conditions (Kuhn, 1989; Rogoff, 1990). One is that they spend a sufficient amount of time applying the targeted skills in a meaningful context. A second is that they have the opportunity to observe skilled experts using the skills. A third, and one that is especially important for developing metacognitive awareness, is to have access to an expert's reflection on what he or she is doing, and how well it is being done.

Educational research and practice strongly support the notion of general cognitive skills instruction. High quality instruction enables students of all ages to construct domain-specific and domain-general strategies, metacognitive knowledge about themselves and their cognitive skills, and how to better regulate their cognition. The starting point in this endeavor is for teachers (or expert students) to ask themselves what skills and strategies are important within the specific domain they teach, how they constructed these skills within their own repertoire of cognitive skills, and what they can tell their students about using these skills intelligently.

Conclusions

Metacognition is essential to successful learning because it enables individuals to better manage their cognitive skills, and to determine weaknesses that can be corrected by constructing new cognitive skills. Almost anyone who can perform a skill is capable of metacognition – that is, thinking about how they perform that skill. Promoting metacognition begins with building an awareness among learners that metacognition exists, differs from cognition, and increases academic success. The next step is to teach strategies, and more importantly, to help students construct explicit knowledge about when and where to use strategies. A flexible strategy repertoire can be used next to make careful regulatory decisions that enable individuals to plan, monitor, and evaluate their learning.

These goals can be met through a variety of instructional practices. My own preference is for an interactive approach that blends direct instruction, teacher and expert student modeling, reflection on the part of students, and group activities that allow students to share their knowledge about cognition. Currently, there are a number of successful programs to use as illustrative models (see, for example, A. Brown & Palincsar, 1989; R. Brown & Pressley, 1994; Cross & Paris, 1988). All of these programs indicate that metacognitive knowledge and regulation can be improved through classroom instructional practices, and that students use these newly acquired skills to improve performance.

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