

An Analytical Literature Review of the Effects of Metacognitive Teaching Strategies in Primary and Secondary Student Populations

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Abstract

Metacognition has been an area of interest to educational researchers for more than 40 years. A large body of literature exists on this topic, both theoretical and empirical. However, there are few studies that summarize specific instructional practices for improving students' capacity for metacognitive thinking. Similarly, there is a dearth of evidence showing how specific practices are implemented to affect student achievement. This study remediates gaps in these areas by identifying instructional approaches that promote metacognitive thinking in primary and secondary student populations using analytical literature review methods. Educational textbooks were examined for keywords associated with metacognition. Five terms were identified, including metacognition, strategy, planning, monitoring, and evaluating. These terms were then used to conduct searches in the Educational Resources Information Center database. Search criteria included peer reviewed empirical studies with primary and secondary student populations. Studies involving postsecondary students and electronic learning environments were excluded. Thirteen studies were found. These studies were organized into categories using analytical coding procedures. Results were compiled into three summaries. The first summary identifies features of the learning environment which foster metacognitive strategy use, such as an engaging curriculum and supportive instruction. The second summary identifies specific metacognitive strategies, such as modeling, mnemonics, and semantic webs. The third summary describes specific instructional practices for teaching metacognitive strategy use by classroom practitioners. Implications of the findings are discussed and suggestions for future research are identified.

Keywords: metacognition, strategy, planning, monitoring, evaluating, reflective assessment

1 Introduction

It has been nearly four decades since the term "metacognition" was introduced by psychologist John Flavell. The term itself derives from the Greek word *meta*

(after or beyond) and the Latin word *cognoscere* (to know or ponder). Flavell described the term as a heightened awareness of one's thought processes, that is, "knowledge concerning one's own metacognitive processes or anything related to them" (Flavell, 1976, p. 232). Others, including Brown (1987), Barell (1991), Metcalfe and Shimamura (1994), and Zhang (2010), while basically accepting Flavell's description, have expanded the term to reference such cognitive activities as reflection, sentience, self-regulation, self-assessment, and even executive function.

The pedagogical promise and possibilities of metacognition suggest "value-added" strategies or techniques in the sense that students might do something more than attempt to solve problems and engage in learning; they might also reflect on *what and how* they have learned as a result of their experiences (Krathwohl, 2002; Nückles, Hübner, Dümer, & Renkl, 2010; Wilson & Smetana, 2011). This is in itself hardly a novel idea. The writings of Socrates and Confucius, to cite two examples from antiquity, underline the importance of the reflective life. This interest in metacognition has persisted across time. One result is the accretion of a substantial body of literature about metacognitive theory and metacognitive training, such as the meta-analytic research conducted by Dignath and Büttner (2008), and Hattie, Biggs, and Purdie (1996). Nevertheless, Pintrich (2002, p. 224) writes that, "because metacognitive knowledge in general is positively linked to student learning (see Black & Wiliam, 1998; Gulikers, Bastiaens, Kirschner, & Kester, 2006; Michalsky, Mevarech, & Haibi, 2009), explicitly teaching metacognitive knowledge to facilitate its development is needed." However, the literature tends to describe methods for teaching metacognitive thinking in theoretical and general terms, with little discussion of specific practices, such as the kind that Pintrich calls for. Similarly, there is a shortage of evidence assessing the effects that specific methods exert on student achievement. Remediating this research gap is the focus of this investigation into the literature on the application of metacognitive strategies in classroom settings. Specifically, this study identifies classroom-based practices and evaluates their effects, following the analytical literature research method used by Simonsen, Fairbanks, Briesch, Myers, and Sugai (2008).

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Using this approach, in comparison to meta-analysis or meta-synthesis, is better suited to answering the research questions of this study, which focus on practical application, and not the identification of relationships or description of new concepts (Cornin, Ryan, & Coughlan, 2008).

1.1 Definitions

Metacognition is a concept of cognitive psychology that “focuses on the active participation of the individual in his or her thinking process” (Stewart & Landine, 1995, p. 17). A wide range of definitions and interpretations of the term metacognition have been accumulated (Manning & Payne, 1996) since it was first used by Flavell. Flavell’s (1979, p. 906) expanded description included knowledge of strategy, task, and one’s own cognition. These three related kinds of metacognitive knowledge continue to be perceived as essential components of the learning process (Krathwohl, 2002; Pintrich, 2002). Brief definitions of each follow:

1.1.1 Knowledge of Strategy

Strategic knowledge refers to knowledge of strategies for learning and thinking (Pintrich, 2002). According to Pressley and Harris (1990), strategy is defined as a procedure for accomplishing an academic task. Alternatively, metacognitive strategies refer to a learners’ knowledge of their own cognitive processes (Dignath & Büttner, 2008). An example of strategic knowledge is when a student uses a learning strategy, such as a “think aloud” or “I learned statement” as a reflective self-assessment tool.

1.1.2 Knowledge of Task

Knowledge of tasks and their contexts includes different types of cognitive tasks as well as the classroom and culturally normative knowledge of the conditions under which these strategies might be used (Pintrich, 2002). Flavell (1979, pp. 906-907) suggests that “goals (or tasks) refer to the objectives of a cognitive enterprise.” In addition to their mastery of several types of strategies, students should acquire knowledge about how, when, why, and where to apply these strategies (Veenman, Van Hout-Wolters, & Afflerbach, 2006). An example of task knowledge is when a student consciously understands a lesson objective, activity, or procedure as explained by a teacher or due to a repeated classroom routine.

1.1.3 Knowledge of Self

Knowledge of one’s own cognition is a critically important component of metacognitive knowledge. “Metacognitive knowledge involves knowledge about cognition in general, as well as awareness of and knowledge about one’s own cognition” (Pintrich, 2002, p. 219). Ideally, when students are aware of their strengths and weakness as learners (knowledge of self), they are able to choose a learning strategy (knowledge of strategy) that is aligned with the task at hand (knowledge of task).

Pressley and Harris (1990) recommended the following teacher behaviors for promoting strategy instruction: (1) demonstrating the strategy in the context of a meaningful academic task, (2) introducing strategies one at a time, (3) providing feedback and opportunities for practice, and (4) assisting students that struggle with the strategy on an individual basis. Additional recommendations for teachers regarding strategy instruction have included explaining the steps of direct task performance, verbal modeling, systematic prompts, and teacher to student dialogue and questioning (Reid & Lienemann, 2006). Flavell (1979, p. 906) stated that “metacognitive experiences are any conscious cognitive or affective experiences that accompany and pertain to any intellectual enterprise. An example would be the sudden feeling that you do not understand something another person just said.”

1.2 Study Purpose

As theory and research in the area of metacognitive thinking has grown, so too has the interest in general approaches for engaging students in metacognitive training, especially as this training characterizes elements of self-reflection. While some sources, such as educational textbooks, emphasize the importance of metacognition, and identify some of its characteristics, there is a lack of empirical evidence regarding the effects of specific instructional strategies or the way in which these strategies are deployed in classroom settings (Dignath & Büttner, 2008; Pintrich, 2002). In this review three categories of teaching practices were identified that bridge the gap between the theory underlying metacognitive training and the practical application of these methods in classrooms. The purpose of this investigation is to summarize factors associated with metacognitive training, including classroom characteristics and specific learning strategies, and then to analyze the effects that these factors exert on student achievement.

1.3 Research Questions

The research questions for this investigation follow: (1) Which types of teaching practices foster metacognitive strategy use? (2) How are these practices summarized as ways for planning, monitoring, and evaluating thinking? And, (3) what do these practices look like when they are used in primary and secondary classrooms?

2 Methodology

2.1 Identifying Search Terms

Researchers associate a variety of terms with metacognition, including self-assessment, self-regulated learning, reflective thinking, reflective assessment,

and integrated assessment, among others. Given these variations, it was necessary to identify keywords consistently cited in the literature. However, searching the Education Resources Information Center (ERIC) database for *metacognition* produced 2,600 results. Similarly, searching ERIC for *self-regulation* produced 1,050 results. In order to refine these searches, educational textbooks were used to formulate delimiting criteria. The approach of using educational textbooks to identify keywords and associated terms was used by Simonsen et al. (2008) and suggested by Cornin et al. (2008). The textbooks used for this purpose included those authored by Savage, Savage, and Armstrong (2012); Fisher and Frey (2008); Gredler (2005); Guthrie (2003); Joyce and Weil (1996); Arends and Kilcher (2010); Lapp and Fisher (2011); Mastascusa, Snyder, and Hoyt (2011).

Each of these textbooks contains a section on metacognition with some variance in length and detail. For example, Guthrie (2003) suggests that metacognition involves many different types of knowledge, such as task knowledge, strategy knowledge, self-knowledge, and goal knowledge. Alternatively, Arends and Kilcher (2010) use terms such as self-regulation and self-monitoring, along with descriptions of specific strategies, such as restudy and self-talk. A third source, Gredler (2005), describes general approaches for engaging students in metacognition, such as delivering explicit instruction on strategy use and providing practice opportunities.

Despite the variety of terms found in these textbooks for describing metacognition, some words appeared more regularly than others. For example, *strategy* was used in six of the eight texts. Similarly, *monitoring* appeared in all but two of the textbooks. Synonyms for *planning* and *evaluating*, such as setting, choosing, and assessing, appeared in half of the texts. The terms most often associated with metacognition across all eight of the textbooks included strategy, monitoring, planning and evaluating.

Additional sources corroborate the use of these terms for describing metacognition. For example, Haidar and Al Naqabi (2008), Leutwyler (2009) and Schraw (1998) suggest that there are three types of metacognitive strategies, including strategies for planning, monitoring, and evaluating metacognitive activity. Planning strategies involve selecting an approach and allocating resources to complete a task or reach a goal (Dignath & Büttner, 2008). For example, a learner decides to study flash cards for 10 minutes per day for five days to prepare for a test. The method is flash card study and time is the resource, specifically 10 minutes per day for five days. Monitoring involves checking one's understanding or ability (Dignath & Büttner, 2008). For example, self-testing for information

recall, which happens as part of flash card study, is a monitoring strategy. Evaluating occurs when a learner judges the suitability of outcomes, products, or approaches. Checking the solution to a mathematics problem using a three-step procedure is an example of evaluating.

As a result of textbook analyses, and validation through additional sources, five search terms were selected, including *metacognition*, *strategy*, *planning*, *monitoring*, and *evaluating*.

2.2 Selection Criteria

A total of three searches were conducted in the ERIC database. Search results yielded 136 peer-reviewed studies published between 1989 and 2012. From these results, 13 studies were selected for analysis. Studies were included if they (1) occurred in a classroom setting, (2) involved primary or secondary student populations, (3) used an experimental or quasi-experimental design, and (4) described the intervention sufficiently for practitioner use. Studies were excluded if they involved online or computerized instruction or consisted of exceptional populations such as students with behavioral disorders, gifted students, or bilingual students.

These 13 studies were then organized into four groups using analytical coding procedures (Richards, 2005). The first group of studies fit the selection criteria, but they also included additional factors, such as longitudinal data, correlations, or emphasis on teacher training. These studies were used to identify features of the learning environment for fostering metacognitive strategy use. Three studies focused on metacognitive planning strategies and another three focused on metacognitive monitoring strategies. Two studies focused on metacognitive evaluating strategies.

3 Results

3.1 Features of the Learning Environment for Teaching Metacognitive Strategies

Five of the 13 studies were selected for reporting features of the learning environment which foster metacognitive strategy use. Analytical coding methods were used to identify these five features, including (1) engaging curriculum, (2) assessment integration, (3) consistent practice, (4) explicit strategy instruction, and (5) verbalizing.

The studies analyzed here suggest that metacognitive strategy use is rare in comparison to traditional teaching approaches. For example, Kistner et al. (2010) found that German mathematics teachers spent little time instructing their students how to learn effectively. Similarly, Leutwyler (2009) suggested that traditional curricula and instructional practices are insufficient for promoting metacognitive

thinking. Rather, elements such as explicit focus on learning processes or emphasis of deep understanding are necessary (Leutwyler, 2009). As a result, students tend not to use or refine their metacognitive strategies over time (Leutwyler, 2009). More often, the features necessary for fostering metacognitive learning seem to be absent during regular lessons, even though many of these features are associated with positive gains in achievement over time (Kistner et al., 2010).

3.2 Engaging Curriculum

One of the critical features of the learning environment for fostering metacognitive strategy use is an engaging curriculum (Leutwyler, 2009). A curriculum which integrates student interest, active learning, and collaboration, results in frequent opportunities for students to use metacognitive thinking skills. However, as Haidar and Al Naqabi (2008) suggest, traditional teaching practices do not encourage students to reflect on their thinking. For example, the characteristics of an engaging curriculum, such as constructivism, self-direction, and transfer are often used infrequently in comparison to more direct methods such as whole class instruction (Kistner et al., 2010). Nevertheless, adjusting a curriculum to be more engaging for students can have a substantial effect on the quality and quantity of metacognitive strategy use. Some general examples for making a curriculum more engaging include integrating student choice, problem-based learning, and concept teaching (Haidar & Al Naqabi, 2008; Leon-Guerrero, 2008; Scharlach, 2008).

3.3 Assessment Integration

As students move through each grade, their understanding of the school system improves. Brookhart (2001, p. 165) defined this evolution as “studenting” which means that students figure out what the teacher expects of them and then they learn to do these activities well. One way that students learn what the teacher wants is through assessments, such as tests and quizzes. Often, classroom assessments dictate the kind of skills and knowledge that students are expected to learn. An assessment can show convergent or divergent questions. Convergent questions require a specific answer, such as calculating the solution to a mathematics problem (Guilford, 2007). Alternatively, divergent questions are open-ended, for which there are many possible answers, such as questions dealing with moral dilemmas (Guilford, 2007).

Some researchers have suggested that education reform efforts have led to an over-emphasis of convergent questioning (Brown & Clift, 2010). Moreover, Leon-Guerrero (2008) stated that divergent questioning is a necessary characteristic of metacognitive strategy use so

that students will reflect on and evaluate their performance. Similarly, since assessments focus student attention on important knowledge and skills, assessment questions that require the use of metacognitive strategies are necessary. For example, questions that emphasize self-checking or evaluation of one’s strengths and weaknesses (Haidar & Al Naqabi, 2008).

There is evidence to show that students will apply metacognitive strategies in an unbalanced way when assessments emphasize convergent thinking. For example, Haidar and Al Naqabi (2008) found that science students engaged in significant amounts of planning to solve stoichiometry problems. However, students did this in order to set up problems and apply algorithms. Students did not utilize any additional strategies that require monitoring or evaluating because such strategies were not perceived by students as being important for performing well on assessments.

3.4 Consistent Practice

Although Kistner et al. (2010) found that strategy instruction did indeed take place in classrooms, they also reported that it was applied with wide variation, anywhere from 10 to 40 strategy instructions per lesson. Similarly, when strategies were taught, they were often cognitive in nature, and not metacognitive (Kistner et al., 2010). For example, teachers often used strategies for elaborating, organizing, or repeating information (Kistner et al., 2010; Leon-Guerrero, 2008). As a result, providing consistent practice opportunities is another feature for fostering metacognitive strategy use. Scharlach (2008) suggests teaching multiple metacognitive strategies, such as making predictions, visualizing, and summarizing. Scharlach (2008) also suggests that these strategies be used repeatedly across multiple lessons in order to produce tangible gains in student achievement. However, providing consistent practice opportunities must be accompanied by evaluation. For example, students should be prompted to judge the effectiveness of their learning method by considering past performance with respect to established goals (Leon-Guerrero, 2008).

3.5 Explicit Strategy Instruction

A factor closely related to providing consistent practice opportunities is the *method* used for instructing metacognitive strategies. Generally, teachers use implicit methods, rather than explicit (Kistner et al., 2010). For example, in an analysis of 60 lessons from 20 German mathematics teachers, Kistner et al. (2010) found that on average, teachers taught strategies through implicit instruction in comparison to explicit instruction at a ratio of 5 to 1. Instructing students implicitly on the use of a

strategy means modeling it without explaining how the strategy is effective. Alternatively, modeling a strategy for students while simultaneously verbalizing one's thought processes or asking targeted questions during the demonstration is a form of explicit strategy instruction. Explicit strategy instruction is positively correlated with achievement gains, while using an implicit method is less so (Kistner et al., 2010). Nevertheless, students can be trained to engage in metacognitive strategy use, such as proof reading work, even though they may not be entirely aware of the benefits (Haidar & Al Naqabi, 2008).

According to the literature reviewed in this report, the most significant gains in student achievement result when students are taught the use of metacognitive strategies in explicit ways. Characteristics of explicit teaching include direct instruction, modeling, explaining the benefits of using the strategy, and providing repeated opportunities for using the strategy in guided and independent practice formats (Scharlach, 2008).

3.6 Verbalizing

A fifth factor is to accompany strategy modeling and strategy practice with verbalizations. Providing explanations as a part of strategy modeling promotes explicit strategy instruction (Scharlach, 2008). Likewise, students who conduct internalized self-talk, thinking aloud, or talking with a partner while they execute the steps of a strategy, show an improved ability to manage academic tasks (Haidar & Al Naqabi, 2008; Leon-Guerrero, 2008). Careful questioning also has a significant impact on how effectively students use metacognitive strategies (Leon-Guerrero, 2008). Posing thoughtful questions prompts students to select and use strategies, while also raising their awareness about how and why they are using them. Having students tell a partner about the steps they took to solve a

problem, the reasons they chose a particular study method, or the effects of a strategy on performance are examples of verbalizing. Table 1 shows a summary of environmental features useful for deploying metacognitive strategies.

3.7 Instructional Methods for Promoting Metacognitive Thinking

The remaining eight studies were organized according to whether they focused on metacognitive planning, monitoring, or evaluating strategies. In the following sections, a brief summary of each study is shown, along with a description of the intervention. Cohen's *d* effect sizes (*ES*), which are defined as the proportion of variability on a dependent variable that can be attributed to an independent variable (Sheskin, 2007), were also calculated and reported in order to provide a general understanding for practitioners of how these strategies affect student achievement (see Appendix for the formula used to calculate effect sizes).

3.8 Planning Strategies

Brunstein and Glaser (2011) studied the effects of self-regulation strategies on 117 grade four students using a pretest-posttest design with intact classrooms assigned to a treatment and comparison condition. The dependent variable measured characteristics of students' writing. Results showed that students in the treatment group scored higher across writing measures, such as story plans, text revisions, and story quality at a statistically significant level ($p < .001$).

The self-regulation intervention consisted of multiple parts. Students used graphic organizers, mnemonics, checklists, and diagrams to plan their writing (Brunstein & Glaser, 2011). Each of these strategies prompted students to include critical story elements, such as identifying the setting, characters, and climax. The graphic organizer,

Table 1 Features of the Environment for Teaching Metacognitive Strategies

Factor	Example	Supporting Reference
Engaging curriculum	Student choice	Leutwyler (2009)
	Problem-based learning	Scharlach (2008)
	Concept teaching	
Assessment integration	Divergent questioning	Guilford (2007)
	Self-assessment	Brown and Clift (2010)
	Analyzing past performance	
Consistent practice	Repetition across lessons	Leon-Guerrero (2008)
	Guided and independent practice	Kistner et al. (2010)
Explicit strategy instruction	Modeling with explanations	Kistner et al. (2010)
	Targeted questioning	
Verbalizing	Think aloud	Haidar and Al Naqabi (2008)
	Questioning	Leon-Guerrero (2008)
	Partner talk	

checklist, and diagram also served as a platform for teacher feedback.

The treatment included modeling of metacognitive strategies throughout the intervention. For example, the teacher brainstormed writing ideas with students and then compared these ideas to the checklists and diagrams (Brunstein & Glaser, 2011). Moreover, students kept a record of whether or not they had attained their writing goals. To set goals, students inspected their performance on previous writing tasks and then considered the number of points they wanted to earn on their next story.

In a similar study, Tracy, Reid, and Graham (2009) examined the effects of self-regulation strategies on 127 grade three students. This study used intact classrooms with a pretest-posttest, treatment and control group design. The dependent variable consisted of scores on student written stories. Results showed that students in the treatment condition wrote more words and earned higher scores on story elements, such as setting, characters, and main idea, at a statistically significant level ($p < .01$) in comparison to students in the control group.

Tracy et al. (2009) organized the intervention into four stages, including *developing background knowledge*, *discuss it*, *model it*, and *support*. During the background knowledge phase, students learned two mnemonics for planning and organizing writing. In addition, students verbalized their understanding as they answered questions about story elements. In the discussion phase, the teacher modeled and practiced identifying story parts and discussed these aloud with students. Students also graphed the number of parts shown in their stories using colors and numbers to correspond to specific elements. In the modeling phase, the teacher led students through guided practice to write a story. Furthermore, the teacher used verbalizing and a graphic organizer to model procedures. In the support phase, students wrote stories and used goal setting to prompt inclusion of story elements. Last, students checked that they had included all of the story parts by coloring squares on a diagram.

Fidalgo, Torrance, and Garcia (2008) conducted a study with 77 grade eight students using a posttest only design. The study included control and treatment groups organized from intact classrooms. Before administering the treatment, the researchers analyzed supplemental measures, such as grades, to assess group equivalency. The dependent variables included scores from student written essays and self-report survey items.

Results showed statistically significant differences ($p < .05$) between the treatment and control groups on writing quality, coherence, and structure (Fidalgo et al., 2008). According to results from self-report items, students in the treatment group spent more time planning for writing, but

less time on actual writing at a statistically significant level ($p < .05$).

Fidalgo et al. (2008) used four stages for implementing the intervention. First, the teacher delivered explicit instruction on how to use the strategy along with an explanation of its benefits. Two mnemonics were used to prompt inclusion of writing elements such as objective, main idea, and audience. Second, the teacher modeled how to use the strategies to create a writing outline. Students duplicated the teacher's planning procedures by writing along with the teacher during this stage. In stage three, students practiced using the writing strategies with a partner. Students wrote and verbalized their thinking during the writing process, while partners observed and made suggestions. In the final stage, students rehearsed through guided and independent practice.

The interventions used by Brunstein and Glaser (2011), Tracy et al. (2009), and Fidalgo et al. (2008) showed effect sizes of .85, .39, and .69, respectively (see Table 1). The average *ES* of the three studies was .62. This means that using the planning strategies described in these studies improved student writing quality by 23 percentile points. One interpretation of these results is that a student scoring at the 50th percentile on writing quality measures would be predicted to score at about the 73rd percentile after intervention. Table 2 shows a summary of the effects of planning strategies on student achievement as it relates to writing quality.

3.9 Monitoring Strategies

Huff and Nietfeld (2009) examined the effects of reading comprehension monitoring strategies on 118 grade five students. A pretest and posttest was administered to treatment, comparison, and control groups organized from intact classrooms. Results showed that students who received training in comprehension monitoring were more confident in their responses to reading comprehension questions, according to Likert-type self-report items, at a statistically significant level ($p < .01$).

The intervention began with the teacher explaining the purpose of learning monitoring strategies (Huff & Nietfeld, 2009). Then, with the teacher's guidance, students identified strategies for improving their understanding of a text passage such as rereading, summarizing, and adjusting reading speed. The teacher modeled these strategies with verbalization. As students practiced reading passages, they paused twice to respond to three monitoring prompts, such as, "this text made sense to me and I understood it well" (Huff & Nietfeld, 2009, p. 168). Students responded to these prompts using a Likert scale and a line diagram. After reading, students answered comprehension questions such as "Who was the main character?" and "Why is it important

Table 2 Effects of Planning Strategies on Achievement

Strategies	Area	Supporting Reference	ES
Modeling Goal attainment Checklist Diagram Mnemonic Graphic organizer	Writing Quality	Brunstein and Glaser (2011)	.85
Modeling Goal attainment Mnemonic Graphic organizer	Writing Quality	Tracy et al. (2009)	.39
Modeling Checklist Mnemonic Guided practice	Writing Quality	Fidalgo et al. (2008)	.61

Note: Average ES for the three studies was .62. This predicts a 23 percentile point increase on a normal distribution of student performance for writing quality.

to think about your level of understanding while you read?" (Huff & Nietfeld, 2009, p. 168). Students compared their answers to comprehension questions with a set of correct answers provided by the teacher.

Reynolds and Perin (2009) used a pretest-posttest design with intact classrooms assigned to treatment and comparison groups to study the effects of summarizing text. The study was conducted with 121 students in grade seven social studies. They found that students in the treatment group scored higher on a test covering content-specific reading passages at a statistically significant level ($p < .01$).

The intervention, called *plan and write for summarization*, used a mnemonic to prompt students to take notes from text passages and then organize them for writing passage summaries. For example, one step directed students to "pick out the big idea and underline the important parts," along with listing main ideas with supporting details (Reynolds & Perin, 2009, p. 283). In a fashion similar to previous studies, the strategies were presented to students with modeling, verbalizing, and multiple opportunities for guided practice. Students also used goal setting and diagrams to plan their summaries.

Boulware-Gooden, Carreker, Thornhill, and Joshi (2007) studied 119 grade three students using a pretest-posttest design with treatment and comparison groups. The purpose of the study was to determine the effectiveness of systematic direct instruction of multiple metacognitive strategies designed to assist students in comprehending text. Results showed that the intervention group improved significantly over the comparison group both in vocabulary acquisition and reading comprehension ($p < .05$).

The intervention involved five strategies, which were administered across 30 lessons. First the teacher used a

question, picture, or riddle to interest students in lesson content. This was accompanied with an explanation of the purpose and usefulness of the strategies that students were learning. Second, new vocabulary words were introduced to students one or two at a time using a semantic web, which defines a word by showing synonyms, antonyms, and other related words in a web format. Third, the teacher modeled reading passages to students, followed by guided and independent reading practice. Fourth, students summarized the main idea and supporting details of a passage by answering comprehension questions. The main idea and supporting details were organized graphically, using colored note cards. Last, the teacher asked convergent and divergent reading comprehension questions throughout each lesson. Students responded to these questions by answering aloud.

According to analyses of monitoring interventions, the studies conducted by Huff and Nietfeld (2009), Reynolds and Perin (2009), and Boulware-Gooden et al. (2007) showed an average effect size of .91. This means that student performance on comprehension, recall, and vocabulary acquisition improved by 31 percentile points. Table 3 summarizes the effects of monitoring strategies on student achievement as it relates to text comprehension and vocabulary acquisition.

3.10 Evaluating Strategies

Zirkle and Ellis (2010) studied the effects of spaced repetition with self-testing as a way to increase long-term memory of geographic place-names on a map of Middle America. The study was conducted with 69 grade six students using a pretest-posttest design with intact classrooms assigned to treatment and comparison groups. Results showed that students in the treatment group scored

higher on a test which assessed their ability to accurately recall place-names on a map at a statistically significant level ($p < .01$).

The intervention consisted of two parts. First, the teacher identified locations on a map through direct instruction. Second, students practiced locating place-names for themselves. However, during practice sessions, students also engaged in self-testing. Students were instructed to examine the map key, which was printed on the back side of a blank practice map, in order to refresh their memory and complete the practice session.

Similarly, Ramdass and Zimmerman (2008) studied the effects of training students to use self-correction strategies to improve mathematics achievement with 42 grade five and six students. The study employed a pretest-posttest with random assignment to treatment and control groups. Results showed that students in the treatment group solved long-division problems more accurately in comparison to students in the control group at a statistically significant level ($p < .05$).

The intervention consisted of three phases (Ramdass & Zimmerman, 2008). First, students in both groups learned a step-by-step solution strategy to solve division problems. Second, the teacher in the treatment classroom taught students how to check their answers by multiplying the quotient by the divisor and then comparing the result with the final answer. Third, students in the treatment group used a checklist to guide self-correcting procedures.

Unlike previous studies examined in this review, the studies by Zirkle and Ellis (2010) and Ramdass and Zimmerman (2008) lasted less than three days and intervention training lasted between 10 and 45 minutes. However, the average *ES* calculated from the two studies was .71, which would result in an increase of 26 percentile points for students using evaluating strategies on similar recall and mathematics problem solving tasks. Table 4 summarizes the effects of evaluating strategies on student achievement as it relates to information recall and algorithmic problem solving.

Table 3 Effects of Monitoring Strategies on Achievement

Monitoring Strategies	Area	Supporting Reference	<i>ES</i>
Modeling Diagram Answer checking Monitoring prompts during reading	Confidence at comprehending text	Huff and Nietfeld (2009)	.60
Modeling Diagram for notes Note-taking and outlining Summarization Goal setting Guided practice	Content knowledge recall from text passages	Reynolds and Perin (2009)	1.49
Modeling Semantic web Guided practice Independent practice Comprehension questions Convergent and divergent questioning	Vocabulary acquisition and comprehension of text	Boulware-Gooden et al. (2007)	.65

Note: Average *ES* for the three studies was .91. This predicts a 31 percentile point increase on a normal distribution of student performance on similar measures.

Table 4 Effects of Evaluating Strategies on Achievement

Monitoring Strategies	Area	Supporting Reference	<i>ES</i>
Modeling Independent practice Diagram (map) Self-testing Answer checking	Recall of geographic place-names on a map	Zirkle and Ellis (2010)	1.05
Modeling Answer checking Checklist	Mathematics achievement, solving long division problems	Ramdass and Zimmerman, (2008)	.36

Note: Average *ES* for the three studies was .71. This predicts a 26 percentile point increase on a normal distribution of student performance on similar measures.

4 Discussion

Results of the literature review show that modeling was used in each of the eight studies for teaching metacognitive planning, monitoring, and evaluating strategies. Modeling involves showing students specific procedures to follow for using a strategy. It also involves explaining to students the usefulness of the strategy. Often, the studies describe the teacher modeling the strategy visually and through verbalization. For example, as teachers model, they also verbalize what they are doing, why they are doing it, and ways for overcoming obstacles. The consistent use of modeling supports claims made by Kistner et al. (2010) that effective strategy instruction be shown to students through explicit methods.

The second most common strategy was diagramming. Diagrams were used in four of the studies. However, if concept maps, semantic webs, and geographic maps are included as diagrams, then the number increases to seven. Similar to modeling, diagrams were used across all three metacognitive categories: planning, monitoring, and evaluating. Some researchers suggest that visual learning methods are more memorable (Medina, 2008) and engaging (Pressley & McCormick, 2007). The frequent use of diagrams, which resulted in positive achievement gains, supports these conclusions.

The third most common strategy was practice, both guided and independent. If both forms of practice are counted together, then they appeared in four of the eight

studies, across all three metacognitive categories. As in the case of modeling, researchers have suggested that consistent practice is one of the characteristics of effective metacognitive strategy instruction (Kistner et al., 2010; Leon-Guerrero, 2008).

Four additional strategies were used in three out of the eight studies, including mnemonics, answer checking, checklist, and goal attainment. However, mnemonics were used specifically for planning writing. Alternatively, answer checking, checklist, and goal attainment were used across two metacognitive categories. A summary of the most frequently used strategies is shown on Table 5.

4.1 Research to Practice

A frequently used method for modeling metacognitive strategy use, according to the studies examined in this review, is *Think Aloud*. Think Aloud means verbalizing the steps or procedures of a strategy as it is being deployed. It also involves posing questions, identifying resources, and reciting affirmations. For example, a teacher might say the following while modeling a strategy for solving a one-step algebra equation, "The first step is to identify the unknown variable ... there it is, x . Now I look to see if there is a coefficient greater than 1. Yes, the coefficient in this equation is 2. I can go to the next step."

Teachers can use an *I Learned Statement* to conclude *Think Aloud* modeling. I Learned Statements are spoken or written summaries of what has been learned after completing an academic task. In keeping with the algebra

Table 5 Frequently Used Strategies across Metacognitive Categories

Strategy	Metacognitive Category	Characteristics and Examples
Teacher models	Planning, monitoring, evaluating	Explicit instruction of procedures Direct instruction Explanation of benefits of using strategy Verbalization during demonstration Spoken and written summaries
Diagram	Planning, monitoring, evaluating	Shapes and lines showing connection Concept maps Semantic web Graphs
Practice	Planning, monitoring, evaluating	Guided with teacher help and feedback Independent Repetition
Answer checking	Monitoring, evaluating	Compare responses to answer key Peers check each other
Checklist	Planning, evaluating	Prompt to do something Reminder
Goal attainment	Planning, monitoring	Assessment of previous performance Record keeping Goal setting

example, a teacher might summarize her learning by saying or writing the following comment for students, “I learned how to divide all of the expressions in an equation by the coefficient to reduce it to one.” Think Aloud and I Learned Statements show a positive effect on achievement when they are used by teachers and students (Bond & Ellis, in press; Lan, 2005). When teachers model the use of Think Aloud or I Learned strategies as teaching devices designed to enable students to understand how they work, then of course, students can be encouraged or required to use them on their own (Ellis & Denton, 2010; Ellis & Evans, 2010).

Another method for implementing metacognitive strategy use is diagramming. There are a number of approaches for making academic diagrams, including concept maps, mind maps, geography maps, semantic webs, flow charts, and graphs. A flexible format for integrating diagrams as an instructional approach is *Learning Illustrated* (Ellis, 2010), where students create drawings to show their understanding of concepts, information, or procedures. For example, students could use a t-chart to identify sources of renewable and nonrenewable energy in science class (see Figure 1). Along with the results of this analytical review, there are a number of other sources showing that visual modes of learning have a significant impact on achievement (McBride & Doshier, 2002; Read & Barnsley, 1977; Stenberg, 2006).

Renewable	Nonrenewable
Solar	Fossil fuels
Wind	Coal
Hydroelectric	Petroleum oil
Biomass	Natural gas
Biofuel	Uranium
Geothermal	
Ocean energy	

Figure 1 T-Chart Showing Renewable and Nonrenewable Energy Sources in Science

Whether students speak, write, or illustrate their thinking, practice is a critical element. Effective practice is both guided and independent. Guided practice means that the teacher orchestrates student use of the strategy through examples, demonstrations, and feedback. Having students imitate the teacher’s use of the strategy is also appropriate when students are first exposed to the strategy. Independent practice is assigned once students demonstrate sufficient

mastery. Whatever product students create as a result of independent practice also receives teacher feedback and is used to check student understanding.

For example, guided and independent practice for teaching students to write an introduction to an essay includes the following teacher and student activity: (1) the teacher demonstrates steps for writing by following a mnemonic while students observe; (2) students replicate the steps in-class with a subject different from the one used during demonstration; (3) the teacher circulates and observes student writing and provides feedback as students write; (4) students write a second introduction, on a new topic, independently; (5) the teacher provides feedback, and the process repeats.

Practice is essential for effective strategy use, but it is an insufficient condition for integrating metacognitive thinking. Students need opportunities to make sense of their learning. A useful method for doing this is summarization. Creating a summary means distilling information into a synthesized form by showing main points with supporting details through deletion, substitution, and reorganization. Summarizing, along with note-taking which is a form of summary, has shown a positive effect on student achievement (Marzano, Pickering, & Pollock, 2001). A practical format for summarizing is *The Week in Review* (Ellis, 2010). For this activity, students summarize what they have learned over the course of a week. The summary can be constructed independently or collaboratively and then shared in class. The contents of *The Week in Review* also serve as an informal check of student learning as well as a bridge to connect current subject matter with upcoming subject matter.

Teachers can have students summarize in divergent ways, such as compiling lists of I Learned Statements after a week of instruction. Alternatively, summaries can be convergent, such as structured note-taking. There are two additional instructional practices, derived from the literature analyzed in this review, that tend to prompt convergent outcomes, including answer checking and checklists.

Answer checking occurs when students generate responses and compare them to pre-established solutions, such as those found on an answer key. Like practice activities, answer checking that fosters metacognitive thinking is more effective when accompanied by specific self-monitoring questions, such as “Why is my answer different in comparison to the answer key?” or, “What steps did I take to get this answer?”

Checklists are similar to answer checking since they involve making comparisons. However, the purpose of a checklist is to prompt specific behaviors by having students identify complete or incomplete activities. To revisit the example of having students write an introduction to an

essay, the teacher may use a mnemonic, such as SIPPS: select an approach, interest the reader, present the main idea, provide background information, and signal what is ahead. In this example, the mnemonic works both as a reminder and checklist for including specific elements. Requiring that students interact with the checklist, such as filling in a box, circling *yes-no*, or placing a check, increases the likelihood of complying with the behavior or performing the task. Figure 2 shows an example checklist.

The final method under examination in this review is goal attainment, which is also positively associated with student achievement (Marzano, 2009). An important characteristic of goal attainment is analysis of past performance, such as using scores from previous writing tasks to set new performance goals (Brunstein & Glaser, 2011). For example, students color-in squares on a performance graph indicating that they have achieved specific writing goals (Tracy et al., 2009). Another method for combining goal attainment and analysis of past performance is *Record Keeping* (Ellis, 2010). Procedures for Record Keeping include having students evaluate their own performance data over time, such as graphing the number of push-ups performed in physical education, scores earned on quizzes in history class, or keeping track of time spent studying and doing homework.

Finally, there are a number of alternative data sources that show convergent validity with the results presented in this discussion. For example, according to Marzano et al. (2001), diagrams, practice, summarizing, checklists, and goal setting show an average effect size of .76. Similarly, Think Aloud, I Learned Statements, The Week in Review, and Record Keeping, which are classified as reflective assessment practices (Ellis, 2010), show a collective *ES* of .39 (Ellis, 2011). Finally, the combined *ES* from studies analyzed in this report was .75. Taken together, metacognitive strategy use predicts an increase of 14 to 27 percentile points on a normal distribution of performance. In practical terms, a student who performs at the 50th percentile on a normally distributed achievement measure could improve performance to the 64th or 77th percentile.

5 Conclusion

The results of this study make a supportive statement regarding the value of metacognitive strategies in teaching and learning. The metacognitive conditions, practices, and strategies that have been identified in this review summarizes empirical evidence aligned with the theory presented by Flavell (1979) and explored by researchers that have investigated this topic over the last four decades.

5.1 Research Questions

At the onset of this investigation three research questions were identified which drove the review of the literature, analysis of research, and subsequent discussion. A summary of the results for each follows.

5.1.1 Practices that Foster Metacognitive Strategy Use

Five environmental features were identified that enhance the effectiveness of metacognitive strategies. While these do not describe specific practices, they do suggest necessary conditions for effective metacognitive training. These factors include engaging curriculum, assessment integration, consistent practice, explicit strategy instruction, and verbalizing. Interestingly, it was also found that use of metacognitive strategies was less common in comparison to traditional teaching approaches, at least from the studies analyzed in this review, which were investigating metacognitive interventions (Kistner et al., 2010; Leutwyler, 2009).

5.1.2 Planning, Monitoring, and Evaluating Thinking

Eight studies were analyzed to determine instructional methods that promote metacognitive thinking. Included among planning strategies were modeling, goal attainment, checklists, diagrams, mnemonics, graphic organizers, and guided practice. An average effect size of the three studies reviewed for metacognitive planning was .62. Among the monitoring strategies identified in the analysis were modeling, diagramming, answer checking, and practicing. The average effect size was .91 for monitoring. Finally, strategies for evaluating thinking included modeling, independent practice, self-testing, and answer checking. An average effect size for evaluating was .71. These large

Did I include these elements in the introduction of my essay? (fill-in Yes or No)

Yes	No	S -- select an approach, such as providing an example
Yes	No	I -- interest the reader with a story or anecdote
Yes	No	P -- present the main idea
Yes	No	P -- provide background information
Yes	No	S -- signal what's ahead

Figure 2 Checklist for Writing the Introduction to an Essay

effect sizes suggest the need for replication and further study in order to make more definitive claims.

5.2 Examples of Effective Practice

According to the research analyzed in this review, metacognitive strategies are applicable across different disciplines and grade levels and they are effective for teaching both content knowledge and academic skills. Instructional practices most frequently used included teacher modeling with Think Aloud, diagramming, practice, answer checking, checklists, and goal attainment.

5.3 Limitations

While the results of this investigation contribute to the body of research on metacognition and improving classroom practice and student learning, there are also limitations. These include the fixed number of studies that were reviewed and the focus on elementary and middle school populations. A total of 13 studies were included; five to describe general characteristics and eight which were analyzed. The purpose of this study was not to provide a meta-analysis or meta-synthesis of metacognitive strategy training, which has been done (see Dignath & Büttner, 2008; Hattie, Biggs, & Purdie, 1996). As a result, the findings reported here are not intended to be generalizable, but they are useful for practitioners. In addition, the reviewed studies included participants from grades three through eight. Studies including participants below grade three and above grade eight were not found which fit the search criteria.

5.4 Implications for Future Research

The answers to the three research questions contribute to the body of empirical research on the effects of metacognitive strategies on achievement. This investigation, however, has also raised many related questions that might be pursued in future research. Three recommendations follow that are of particular importance.

First, further research needs to be done on the collective effects of metacognitive strategies. While research continues to emerge showing that metacognitive knowledge, strategy, and understanding positively impact achievement of individual students, little research has been conducted regarding group learning, such as that achieved by an entire class. This is a promising area of research that will provide valuable and timely evidence regarding the increased use of group achievement data as factors in performance evaluations.

Second, more research on the effects of goal attainment should be conducted. For example, common sense would tell us that if a teacher challenged a class to read 1,000 books during a semester that individually (and collectively) increased learning would occur. While student monitoring of

their own goal attainment is supported in the literature (Ellis, 2010; Marzano, 2009), further research on collective goal attainment is needed. Finally, research needs to be conducted on the role of administrators, instructional coaches, and mentors in gathering evidence of metacognitive strategy use. As educators and politicians are focused on value-added teacher evaluation and the use of multiple measures, metacognitive strategies offer the potential of collecting and compiling small-scale formative achievement data embedded in the teaching and learning process. Since the classroom use of metacognitive strategies has a certain level of empirical evidence to support it, the next logical step is to find ways to explore broader implementation of these practices. The results should be twofold: first, student learning may well increase; second, a body of easily accessible formative data may be available.

5.5 Closing Remarks

The pattern of moderate to large effect sizes found in the reviewed studies must be interpreted judiciously. Given the seemingly never-ending call for improved academic performance by schools, it is tempting to think of the metacognitive approaches examined here as a little used if not well-established pathway to higher student achievement. Effect size is to be sure an indicator of practical significance of findings, but we suggest a word of caution pending the building up of an even more substantial database of empirical evidence. To think of the research findings reported here as promising studies in need of replication and expanded investigation is certainly more realistic. The preponderance of evidence that does exist points to the tentative conclusion that students learn more when they reflect on their learning. This is not a new idea. More evidence may well reinforce this conclusion as it relates to achievement. We think it will.

Schools and classrooms are complex seemingly refractory places where a multitude of variables interact, often with confounding results. To ask students to reflect on their learning is to open Pandora's Box. Who knows what will fly out once the lid is pried? To what extent are classrooms typically places where students are given voice not merely to think about how well they have learned an assignment but also to express their ideas of an assignment's worth? Metacognition is thinking reflectively about learning, and thinking about learning raises questions of truth, trust, openness, intrinsic worth, and even about how one ought to spend one's time. To the extent that metacognition is constrained to levels of considering how one solved a problem or how much time it took is better than no reflection at all. But to limit metacognition to that depth diminishes the spirit of the idea. Surely a teacher who seeks to have students practice reflective thought must model it and value it for what it truly is, an ongoing reciprocal self- and

shared-assessment of all participants' growth, including that of the teacher. The great advocate of reflective thinking, John Dewey, famously wrote more than a century ago that schools will improve when teachers become learners and learners become teachers. That was good advice then, and it is good advice now.

Appendix

The following equation was used to calculate the value of Cohen's *d* effect sizes (*ES*).

Cohen's $d = M_1 - M_2 / (s \text{ pooled})$ where $s \text{ pooled} = \sqrt{[(s_1^2 + s_2^2) / 2]}$

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