Cultivating Minds:
Five Big Ideas for Connecting Implications of Mind, Brain, and Education Research to Classroom Practice

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Regular physical activity and proper nutrition are also key components of the Body-Brain System, helping to improve learning and enhance positive changes in the brain. Exercise is a powerful medicine for mood. In fact, a study by Duke University researchers suggests that exercise may be more effective than medication as a long-term solution to alleviate mild to moderate depression (Traver & Sargent, 2011). Exercise also stimulates the production of brain-derived neurotrophic factor, or BDNF, which helps neurons and synapses grow (Ratey, 2008). Students exposed to a systematic exercise program not only achieved high levels of wellness, but also performed among the best in the world in math and science. Proper nutrition similarly has a powerful influence on cognitive performance. Studies indicate that good nutrition can enhance student achievement, reduce classroom behavior problems, and increase the quality of higher-order thinking (Nussbaum, 2010).

The Value of Metacognition

The fifth big idea, which we unpack in Chapter 6, is one that teachers can give to their students as a gift that lasts a lifetime. Hattie (2012) describes teaching as a process of creating change in the student's cognitive system. Indeed, a good deal of evidence indicates that going to school has a positive effect on students' cognitive abilities—even when the emphasis is only on basic skills like reading and writing: "American research from the first half of the 20th Century … showed schooling's influence on children's general cognitive abilities beyond specific skills and factual knowledge" (Baker, Salinas, & Eslinger, 2012, p. 7). When one considers the dramatic expansion of schooling in this country—only half of school-aged children were enrolled in school 100 years ago (Baker et al., 2012)—it seems clear that a larger population is developing cognitive skills than ever before.

In fact, research has shown that IQ scores have increased from one generation to the next in 30 countries around the world, including the United States. Called the "Flynn effect" for the researcher who first reported this trend (James Flynn, 1987), the exact cause of this rapid increase is unknown, but scholars speculate that education has played a significant role:

> It seems likely that the ultimate cause of IQ gains is the Industrial Revolution, which produced a need for increased intellectual skills that modern societies somehow rose to meet. The intermediate causes of IQ gains may include such factors as a more favorable ratio of adults to children, better schooling, more cognitively demanding jobs, and more cognitively challenging leisure. (Nisbett et al., 2012, p. 12)

Such findings provide hope that education is already doing a great deal to build students' cognitive skills. Yet as we discuss in greater detail later in this chapter, the demands of today's educational and workforce systems require students to continue developing ever more advanced thinking skills. A foundation in plasticity, potential, and intelligence reinforces the fact that these skills can be taught—that all students have the potential to become better thinkers. Furthermore, an explicit focus on teaching metacognitive skills along with cognitive skills can help students get smarter about their own learning. As we describe in Chapter 6, metacognitive skills can be developed early in school—not just in later grades, as previously assumed. Students can learn how to gather information, explore and elaborate on it, and communicate what they have learned, applying metacognition to assess how they reach solutions. Such skills are particularly valuable in helping students develop into more sophisticated, self-directed learners in all content areas and in demonstrating their mastery of the Common Core State Standards. In short, improving metacognition empowers students to take control of their learning, or "drive their brains" as we say in our work in teacher education (Wilson & Conyers, 2011b).

Chapter 6
Big Idea #5: Metacognition as a Path to Becoming Functionally Smarter

"A metacognitive approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them."

—M. Suzanne Donovan and John Bransford (2005, pp. 1–2)

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How might you become functionally smarter and guide your students to do so?

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The title of this text promises five big ideas for teaching and learning, foundational concepts that are closely intertwined—from neuroplasticity to potential to the malleability of intelligence to the way the body and brain work together to support learning. This chapter explores the fifth component, that of *metacognition*, or thinking about one's thinking with the goal of enhancing learning. In its simplest terms, metacognition involves being mindful of one's thinking processes, such as strategies to puzzle out the meaning of an unfamiliar word or improve recall of specific facts. The goal of teaching students to be metacognitive is to guide them to consciously recognize when and how to employ the thinking and problem-solving strategies that work best for them. Decades of research (Bransford, Brown, & Cocking, 2000; Dunlosky & Metcalfe, 2009; Hattie, 2009; Wang, Haertel, & Walberg, 1993) analyzing hundreds of classroom studies offer support for explicit instruction on metacognition and cognitive strategies as one of the most effective ways to improve school performance and to help students achieve

their academic potential. Arguably, guiding students to become metacognitive may be one of the most important aspects of schooling if we are engaged in education that cultivates minds.

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Perspectives on Metacognition

Blair: Our curriculum requirements are so dense that we need to dedicate all the instructional time we have to the core subject matter of reading, writing, math, science, and social studies.

Jamie: We incorporate into our curriculum explicit instruction about cognitive and metacognitive strategies and encourage students to take charge of their learning by using these thinking skills. A student told me just the other day, "Thinking about my thinking makes me learn all my subjects better, and it even helps me get along with other people!"

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As Jamie notes in the Perspectives on Metacognition box, teaching students to think about their thinking—about what worked and didn't work as they learned new material and how they can improve their cognitive processing in the future—makes them better, more effective learners. Explicit instruction on metacognitive strategies supports the *process* of learning and can be applied across *content* areas and in students' lives outside of school. Teaching and modeling these strategies helps students to become more independent and self-directed learners. An apt metaphor is teaching students "to drive their brains" (Wilson & Conyers, 2011b).

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From Teachers for Teachers

Donna Garland, who teaches second graders at Hamilton Crossing Elementary School in Cartersville, Georgia, includes daily exercises for maintaining a positive learning state and focusing attention on metacognitive strategies to enhance learning. Mrs. Garland's students have

each colored and personalized a "brain car" cartoon, which they keep posted at their desks as a reminder that they have the power to drive their brains.

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Metacognition Through the Ages

The idea that we can enhance our ability to learn through the conscious employment of thinking strategies can be traced back to the teachings of ancient Greek philosophers. Socrates believed that knowledge comes from within ourselves, and he exhorted his students to reflect on their own thinking through what we now call Socratic questioning. The word *mnemonics* also has its roots in ancient Greece; people have long relied on rhymes, phrases, acronyms, and symbols to aid in remembering important facts. As just one example, in the Middle Ages, people were taught the Abbey Memory System, in which a series of objects were memorized in specific locations of an abbey as a way to support recall (Dunlosky & Metcalfe, 2009). The 17th century British philosopher John Locke proposed that we gain knowledge by reflecting on our experiences and our perceptions of the world around us.

The term *metacognition* dates back to Flavell's work in the 1970s (Flavell, 1979), but the study of how cognitive processes develop is best known from the work of theorists in the field of psychology over the greater part of the past century. Jean Piaget's theories of cognitive development explored how children reflect on problems and consider different possibilities (Piaget, 1977; Fisher, 1998). Russian psychologist Lev Vygotsky (1962) examined the deep connection between speech and cognitive development and was among the first to propose that deliberate mastery of higher-order thinking skills is crucial to the development of knowledge. Reuven Feuerstein (Feuerstein, Feuerstein, & Falik, 2010; Feuerstein, Rand, Hoffman, & Miller, 1980) is also known for an approach that assists educators and psychologists to guide youth with

learning challenges to "learn how to learn" and to become better thinkers through the use of cognitive and metacognitive processes.

Thinking About Thinking: Two Layers of Learning

Much has been written about the impact of explicit instruction on metacognition on students' academic success. Dunlosky and Metcalfe (2009) summarize the research on emphasizing self-regulation, or teaching children to monitor and control their learning. Markman (1979), who studied monitoring as a comprehension strategy, reported that if students double-check what they learned and what they didn't understand when listening to a presentation or reading a passage, for example, their understanding and recall are better than those of students who are not taught to monitor.

In his synthesis of more than 800 meta-analyses focused on student achievement, Hattie (2009) differentiates between two layers of problem solving: (1) applying a strategy to solve a problem and (2) selecting and monitoring that strategy. That second layer is metacognition, which Hattie describes as "higher-order thinking which involves active control over the cognitive process engaged in learning" (p. 188). As just one example, teaching students to use the HEAR strategy (one of several cognitive tools presented later in this chapter) to improve their listening and selective attention involves the first layer of problem solving, while teaching them to know when to use this strategy and to monitor how effectively they use it constitutes the second layer—the realm of metacognition. Hattie identifies several areas where teaching students to think about their use of thinking strategies has been demonstrated to have significant positive impact on school performance:

- Organizing and transforming, such as creating an outline before writing a paper;
- Self-consequences, such as rewarding oneself with an enjoyable activity after completing an assignment;
- Self-instruction, such as verbalizing the steps in solving a math problem;
- Self-evaluation, such as rereading and correcting an essay exam before submitting it; and
- Seeking help, such as looking up unfamiliar words or organizing a study group.

An earlier meta-analysis by Wang, Haertel, and Walberg (1993) also assembled research showing that the most fundamental learning characteristic of high academic achievers is the use of metacognition. The authors classified 28 categories related to student learning into 6 broad themes, including school organization, board policy, classroom instruction, and student characteristics, and scored those themes based on evidence of their positive influence on learning. Students' use of metacognition and effective instruction by teachers on the use of those strategies were found to be crucial in increasing student achievement across grade levels.

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In Sum

A wide range of educational research indicates that explicit instruction on cognitive and metacognitive strategies improves school performance.

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Along the same lines, a cross-disciplinary model that relied on research and theory from psychology, philosophy, and education articulated five dimensions of thinking—with metacognition among them—to inform the planning of curriculum and instruction (Marzano et al., 1988). The researchers advocated for teaching students to be aware of their thinking and to take charge of their learning by applying cognitive strategies. Cawelti (2004) reported that

metacognition, in the form of self-monitoring and self-teaching, is a necessary prerequisite for learning content knowledge and skills, such as those needed for reading and writing. Reliance on these critical thinking abilities helps students become independent learners. Equally important are the findings of Cawelti and others (Brown, Pressley, Van Meter, & Schuder, 1996; Feuerstein, Falik, Rand, & Feuerstein, 2006; Feuerstein, Feuerstein, & Falik, 2010; Graham, MacArthur, & Schwartz, 1995) that these skills can be taught and that students who learn how and when to use these strategies outperform those who do not learn to use them. Palinscar and Brown (1984) led a classic study to teach seventh graders to improve their reading comprehension through the use of study strategies, including summarizing, questioning, clarifying, and predicting; the researchers used reciprocal teaching, in which tutors and students took turns modeling and discussing how to use the strategies to monitor comprehension.

A metacognitive approach to instruction that guides students to define their individual learning goals and monitor their progress in achieving them can help develop a variety of essential skills. The following table provides practical examples of metacognition in action based on key strategies identified by Bransford, Brown, and Cocking (2000).

Metacognitive strategies	**Examples of strategies in action**
Gathering the information necessary to understand print	Looking for clues about the meaning of unfamiliar words in the text and then looking up the words online or in a dictionary to verify and clarify meaning
Assessing thinking and behavior they are using to obtain meaning from print	Asking questions such as, Does this passage make sense? How can I look at this in a new way to understand it better? How does it connect with what I already know about this subject? Where can I find out more information?
Using adequate planning behavior as they prepare to complete learning tasks	Developing a to-do list for researching and writing a paper; finding a space free of distractions for reading
Requiring precision and accuracy in their work and studies	Double-checking the operational symbols and calculations in math equations to verify the answers. Reviewing writing to see if word choices are the best and most specific to convey meaning and if ideas are expressed well enough to be fully understood.
Adequately attending to a given task	Listening carefully and taking notes during a presentation; paraphrasing what the speaker has said to ensure understanding
Finishing tasks on time	Devising a step-by-step schedule for a research project
Learning from feedback and	Revising a paper based on constructive comments from a teacher

spontaneously monitoring and correcting their own mistakes	and/or peers; reviewing answers on a test before handing it in
Using self-regulation while learning	Summarizing the action and interaction of characters in each chapter of a novel and predicting what will happen next. Noticing when one's mind wanders while reading informational content and developing strategies to maintain focus.

Connecting Metacognition and Executive Function

Executive function is a term used to describe the brain processes and mental faculties that support metacognition. Goldberg (2009) describes the prefrontal cortex as the brain's "chief executive officer" for its role "in forming goals and objectives and then in devising plans of action required to obtain these goals. It selects the cognitive skills required to implement the plans, coordinates these skills, and applies them in correct order" (p. 23). The prefrontal cortex, located in the brain's frontal lobes, is also active in monitoring and evaluating the achievement of goals and in assessing the relative success in executing plans of action, which are tasks central to metacognition. Thus, by teaching students to be more metacognitive, teachers aim to help them harness the power of their brains' executive function.

Carlson (2011) cites cognitive flexibility, inhibitory control, and working memory as other examples of executive function. Developing these mental faculties can help students improve their attention to learning; identify and observe rules in taking tests, conducting experiments, and accomplishing other learning tasks; plan the steps necessary to complete complex tasks; and delay gratification, such as rewarding themselves with a favorite activity after completing a school assignment. In her research, Carlson used imaginative storytelling to encourage preschoolers to engage in symbolic play as a way to stimulate flexible and abstract thinking—with the aim of demonstrating that it is possible to measure and begin promoting executive function in very young children. She cited other studies indicating that the degree of

executive function demonstrated as children mature and progress from reflexive to reflective behavior may be evident in a variety of academic and social outcomes in adulthood, ranging from criminal behavior to personal health habits to collegiate achievement. Guidance from parents, teachers, and other influential adults and an environment conducive to developing these higher-order thinking skills are crucial aspects of this maturation process.

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In Sum

Teaching students to be more metacognitive may harness the power of their brains' executive function, which is responsible for making, monitoring, and evaluating the achievement of goals and for assessing the execution of plans of action.

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Teaching and Facilitating the Use of Cognitive Strategies

Thus, a crucial finding in the research about metacognition and executive function is that the skills and strategies that permit students to take charge of their learning can be taught. Through explicit instruction, modeling, and encouragement, students can learn to identify and overcome deficiencies in comprehension, reasoning, problem solving, and communication. The aim is to equip students with a "toolbox" of specific cognitive strategies and to teach them how and when to use these tools to successfully master learning and problem-solving challenges inside and outside the classroom. Brown (1997) suggested that students at all levels of current ability can make learning gains if they are taught these strategies. Drawing on Vygotsky, she noted that students can go beyond their zone of proximal development—the difference between what they can do independently and what they can do with the guidance of a teacher or more advanced peer—if they are taught strategies for learning.