Connecting Brain Research with Dimensions of Learning

By linking what we know about how the brain works with a framework for teaching and learning, we can improve the likelihood that various education reforms will actually help students learn—including students with special needs.

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In the past 10 years, teachers have been bombarded by education reform initiatives, including standards-based instruction, teaching to students’ learning styles, performance-based instruction, multiple intelligences, and, most recently, brain-based learning. In addition, during the 1990s, the Individuals with Disabilities Education Act (IDEA) mandated that students with disabilities have access to the general education curriculum. This mandate has resulted in more students with special needs being taught in general education classrooms (Lombardi & Butera, 1998).

Meeting the needs of diverse learners can be challenging enough for teachers without the charge of determining how to incorporate reform initiatives into practice. Merely superimposing reforms upon existing practices and requirements is generally ineffective. Education initiatives that link current practice with promising new research in neurological and cognitive sciences, however, offer real possibilities for improving teaching and learning, especially for students with diverse learning needs.

Scientists and researchers are making exciting new discoveries related to how the brain processes and stores information (Sousa, 1998). This research has the potential to unlock the mysteries of learning itself. For example, recent research highlights the differences in brain anatomy of students with learning disabilities and attention deficits that can shed light on their performance in the classroom (Semrud-Clikeman et al., 2000). Yet, despite the enormous implications of such research, it is not being effectively disseminated to education practitioners, who, among all professionals, need it most (Sousa, 1998).

How can we familiarize teachers with brain-based learning so that they can apply this latest research to meet the needs of all students, including those with disabilities, in the general education classroom? A basic precept of brain-based research states that learning is best achieved when linked with the learner’s previous knowledge, experience, or understanding of a given subject or concept (Perry, 2000). Therefore, we can assume that the use of brain-based research would be most effective when combined with previously established frameworks for teaching and learning (Brandt, 1999).

One such framework that Roland Park Elementary/Middle School has used since 1994 is the Dimensions of Learning model (Marzano, 1992). Roland Park, a Blue Ribbon School of Excellence in Baltimore, Maryland, has steadily improved the achievement of its 1,350 students during the past six years. Our progress, in part, may be attributed to our use of Dimensions of Learning, which addresses the development of higher-order thinking skills. Robert Marzano describes the five dimensions as “loose metaphors for how the mind works during learning” (1992, p. 2). Linking the five dimensions with the latest brain research suggests a number of best practices for teaching all children—especially students with learning disabilities.

**Dimension One: Positive Attitudes**

Dimension One explains that a student’s attitudes and perceptions serve as filters that enhance or inhibit natural learning. Although educators may have long suspected that attitudes affect learning, brain research clearly supports the link between emotions and cognition. Robert Leamnson (2000) explains that neural pathways connect the limbic system, the brain’s emotional center, to
the frontal lobes, which play a major role in learning. In addition, hormones alter the chemical makeup of the brain of a person under stress. When the person is threatened, chemicals are released that can impair memory and learning (Jensen, 1998).

**Best Practices**

- Provide a challenging yet supportive classroom environment by reducing the stress that may come from embarrassment because of academic difficulties or peer rejection. At Roland Park, we make students feel more comfortable by assigning a “peer buddy” as a homework helper, arranging for tutoring in study skills and test-taking strategies, and providing special meetings outside of class time to encourage a trusting teacher-student relationship.

- Teach peer acceptance and social behaviors explicitly. Students with learning disabilities may experience an added fear of rejection from the stigma of special education. Our teachers hold class meetings to encourage social acceptance and interaction, use literature and history to provide instructional materials that demonstrate acceptance of diversity, and model an attitude of acceptance and appreciation for those with different learning styles and needs.

- To cement long-term memory, connect emotions to learning. Techniques such as dramatizations, humor, movement, or arts integration can arouse the emotional systems of the brain and stimulate peak performance. For example, teachers may tell a funny instructional story at the beginning of class to foster a relaxed yet supportive atmosphere.

**Dimension Two: Acquiring and Integrating Knowledge**

Dimension Two pertains to the acquisition and integration of knowledge. Marzano (1992) proposes that learning new information must occur within the context of what the learner already knows and must be adequately assimilated so that the information can be used easily in new situations.

Much of brain-based research has focused on how the brain acquires, stores, and uses information (Valiant, 1998). Learning occurs through the growth of neural connections, stimulated by the passage of electrical current along nerve cells and enhanced by chemicals discharged into the synapse between neighboring cells. The more often the “trail is blazed,” the more automatic a task or memory becomes (Buchel, Coull, & Friston, 1999). Therefore, the more a student repeats a learning task, the greater the connectivity. Researchers also point out that different parts of the brain store particular parts of a memory (Fishback, 1999). For example, one part of the brain might store the lyrics of a song and another part, the melody. Further, Leammson (2000) explains that the brain must reconstruct a memory each time the person recalls the memory. Learning thus requires both the acquisition of information and the ability to retrieve and reconstruct that information whenever necessary. Evidence from brain-mapping technology indicates that individual differences in learning styles affect this retrieval process. In a study that investigated the differences between normal and disabled readers in visual-perceptual tasks, Richard S. Kruk and Dale M. Willows (2001) found significant processing differences that affected the rate of visual processing for students with reading disabilities. Jean Robertson (2000) suggests that the inability to shift control from the right to the left hemisphere of the brain may cause early reading disorders.

**Best Practices**

- Present new information within the context of prior knowledge and previously learned content (Perry, 2000). For example, students may better understand the bicameral system of U.S. government by comparing it with their own student government.
Allow students to repeat learning tasks to cement them in memory (Sprenger, 1998). This is especially important for activities that require an automatic response, such as blending phonemes into words (Shaywitz, 1998) or mastering math facts.

Use mnemonics, which can significantly increase the memory of content (Carney & Levin, 2000), especially for students with special needs (Lombardi & Butera, 1998). For example, telling students to "write with their FEAT" can remind them to use the transition words "for example" or "according to" to introduce supportive text in their writing.

Use visually stimulating material and manipulatives to activate the right hemisphere of the brain and text presentation to activate the left hemisphere (Robertson, 2000). The right brain's visual-spatial skills can be activated with features such as a balance scale to help visualize algebraic equations or pictures and graphs to enhance the meaning of text.

Integrate art, music, and movement into learning activities to activate multiple parts of the brain and enhance learning (Rauscher et al., 1997; Vogel, 2000). For example, students can learn how the earth's tilt and rotation create seasons through body movements—tilting the body toward the center of a circle to simulate spring; turning and tilting away from the center to simulate fall.

Dimension Three: Extending and Refining Knowledge
Extending and refining knowledge requires examining it in a deeper, more analytical way by doing such things as comparing, classifying, inducing, deducing, analyzing errors, constructing support, abstracting, and analyzing perspective (Marzano, 1992). The thinking skills involved in Dimension Three require that the brain use multiple and complex systems of retrieval and integration (Lowery, 1998). Ron Brandt (2000) states that brain research supports thinking-skills programs that have students compare and classify familiar concepts. He explains that neurons that often fire at the same time as certain other neurons become more likely to fire whenever those other neurons fire. . . . We use less brain energy when performing familiar functions than when learning new skills. (p. 75)

Best Practices
- Design tasks that allow students to use prior knowledge to learn new information. For example, students use their prior understanding of photosynthesis to explain the differences between plant and animal cells.
- Offer students an opportunity to compare their performances with model responses and to analyze their error patterns. For example, when asking students to write an essay, provide a model paper that clearly identifies the main idea, supporting details, transition words, and conclusion. Let students use the model to organize their own writing.
- Teach students to identify general patterns that underlie concepts. For example, compare the leadership characteristics of current leaders with those of successful leaders of the past.

Dimension Four: Using Knowledge Meaningfully
Marzano (1992) states that we learn best when we need information to accomplish a goal. Using Dimension Four thinking strategies, students apply information in activities that require them to make decisions, investigate, conduct experiments, and solve real-world problems. Brain research confirms that this type of experiential learning activates the area of the brain responsible for higher-order thinking (Sousa, 1998). Moreover, enriched instruction has been shown to produce significant chemical changes in the brains of students with learning disabilities—changes that indicate less exertion of effort in learning (Richards et al., 2000). A similar study (Bower, 1999) indicated that reinforcement of active learning tasks improves brain efficiency.

Lemmnson (2000) warns, however, that merely providing students with hands-on activities does not guarantee learning. Teachers must pair physical activities with problem-solving tasks to connect the "acting modules" of the brain—the motor cortex—with the "thinking modules"—the frontal lobes. Such experiences increase memory and learning, thereby modifying brain structures (Kandel & Squire, 2000).

Best Practices
- Assign students active, hands-on tasks that require them to investigate, analyze, and solve problems using real-world applications (Green, 1999). For example, students can apply the formula for the area of a rectangle by determining how much paint it would take to paint a room given the dimensions of walls, doors, and windows.
- Allow students to use multiple ways to demonstrate learning, such as inventions, experiments, dramatizations, visual displays, music, and oral presentations. For instance, assigning groups of students to write scripts and perform skits to represent each of the 12 labors of Hercules makes this myth come alive.
Dimension Five: Habits of Mind
Dimension Five describes the mental habits that enable students to facilitate their own learning. These habits include monitoring one's own thinking (metacognitive thinking), goal setting, maintaining one's own standards of evaluation, self-regulating, and applying one's unique learning style to future learning situations. Understanding and facilitating one's own learning style is especially important for students with learning disabilities. According to Martin Languis (1998), brain-mapping tests reveal individual differences in brain organization and structure that relate to specific differences in learning style. Studies showed that students who were more skilled in spatial-visualization tasks such as visualizing three-dimensional objects demonstrated different brain-processing patterns compared with less-skilled students. Students, however, significantly improved their scores in spatial-visualization assessments after taking courses that taught them specific learning strategies such as the use of imagery, graphic organizers, and puzzles.

Best Practices
- Provide ways for students to engage in metacognitive reflection. Students benefit from the use of think logs, reflective journals, and group discussions within a cooperative learning setting.
- Include reflective discussions of lessons to foster the habit of reflection on learning. Ask students to record one important concept that they learned from the lesson and several important facts.

Putting the Research to Use
Although most researchers agree that our understanding of the human brain is in its infancy, the explosion of research in the field of neurology and cognitive sciences in the past 10 years can and should play an important role in education reform, especially for students who demonstrate differences in their thinking and learning patterns. If teachers combine brain research with a thinking skills framework such as Dimensions of Learning as we have at Roland Park Elementary/Middle School, the research will translate more effectively into practice. Our use of this model has resulted in exciting learning experiences for students as well as increased scores on our state performance assessment every year since 1994. Moreover, the potential of brain research to provide new approaches to teaching students with information-processing difficulties makes its use all the more vital in classrooms today. Students with learning differences, including those with learning disabilities who are in general education classrooms, deserve to have available to them a program of research-based instruction to nurture and enhance both thinking and learning.

References

Author’s note: This manuscript was developed, in part, under Grant #H325DD990062 awarded to Johns Hopkins University from the U.S. Department of Education. However, its contents do not necessarily represent the policy of that agency, and no endorsement by the federal government should be inferred.

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