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Brain Research: Implications to Diverse Learners

A growing understanding of the way the brain functions offers new insights into the minds of students at all stages of development.

This decade marks one of the most productive eras of neurological research, which offers exciting opportunities for the educational enhancement of our classrooms. The latest research is being embraced by progressive educational systems and the necessary means for positive reforms are already beginning to be implemented. A brain-based education uses research in neuroscience on how the brain works to gain an understanding of how students learn and develop in a classroom. Psychology and neuroscience have finally begun to merge to combine how the mind learns, absorbs and thinks with how the brain functions and develops. New research bridges gaps between incomplete conceptions of the brain such as those involving the popular "right brain versus left brain" theory. Current developments in neuroscience allow for a new appreciation of the complexity and individuality with which human beings learn and grow.

Brain-based research deals with classroom-relevant concerns, such as sensory perception, attention, memory, and how emotions affect learning (Goleman, 1995; LeDoux, 1996; Pert, 1997; and Sprenger, 1999). Similar studies describe the brain's "ways of seeing one's self" (Godwin, 2000); perception, attention, and the four theaters of the brain (Ratey, 2002); and a "celebration of neurons—an educator's guide to the human brain" (Sylwester, 2001). The literature on brain-based education is quickly emerging, and several studies make direct connections between the biology of the human brain and teaching and learning (Caine and Caine, 1991, 1997; Greenenough, et al., 1993; Kotulak, 1997; Majoy, 1993; Pinker, 1997; Zadina, 2004; and Zull, 2002). Significant work by Petitto (2003) and other brain researchers led to the discovery of brain tissues related to the biology of language and learning. Indeed, neurolinguistic studies enable educators in a multilingual setting to understand and apply strategies of teaching and learning—for example, in teaching English as a second language (Dehaene, 1999; Dhority and Jensen, 1998; Fabbro, 2001; Genesee (2000); Hernandez, et al., 2000; Kuhl, 1997; and Mack, 2003. According to Zadina (2004), the goals for studying brain research include (1) reaching as many children as possible, (2) teaching to individual differences, (3) diversifying teaching strategies, and (4) maximizing the brain's natural learning processes.

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Diversity in Brain Development

Learning, as a brain function, *is a biological process invented for survival*. It is the organism responding to its environment. Indeed, learning is the formation of new synapses and dentrite branching (Zull, 2002). Moreover, multiple intelligences *guru*, Howard Gardner (1993), describes intelligence as the biopsychological potential to process information in certain ways in order to solve problems or fashion products that are valued in a culture or community. Certainly, intelligence is a brain-body-environment structure and function system. Zull (2002) further adds: "we don't actually know what students will need in the curriculum. Those needs change and are changing more rapidly each decade. But what will not change is biology. The brain becomes the determining factor in thinking about education for this very reason." He concludes: "the curriculum should enable the firing of the right networks

and neurons (lesson strategies), create repeated firings (practice) and should make the learner feel good."

Our brains are fascinating, intricate structures, with unique complexities that continue to marvel researchers and teachers alike. Altogether, the human brain contains 100 billion nerve cells that make 1,000 trillion synaptic connection points with one another (D'Arcangelo, 1998). We are constantly organizing and reorganizing our brains, changing both the physical structure of the brain and the knowledge we hold (Bransford and Cocking, eds, 2000). Young minds in particular hold great potential, as new learning windows of opportunity quickly present themselves and children acquire new knowledge at a remarkable rate. Amidst this complexity, researchers have found information on the brain that can bring wonderful new insight to our classrooms.

In children, the stages of learning and development manifest themselves through the ability to make connections and construct patterns. Lawrence Lowery (1990) has explored the ways children seek patterns as a means of explaining how humans develop mentally. He believes that understanding means to know relationships, that the ability to know relationships depends on prior knowledge. As learners construct an understanding of themselves, they advance from viewing a single object and discarding it, grouping two objects with a single attribute, grouping multiple objects, and eventually logically organizing and reorganizing objects based on need and criteria, and using hierarchical standards.

Research on memory and retention is also a vital asset to teachers. Although lecture continues to be the most widely used method in the classroom, countless studies indicate that students retain the most by teaching others, practicing by doing, and discussing in groups. Immediate, active use of learning is clearly the best means of retaining information (Sousa, 1995). In addition, students have peak and low times during the day and the course of lessons in which they tend to take in the most information towards the beginning of lessons, and then experience "down time" when retention decreases (Sousa). Therefore, shorter, diverse lessons with different means of instruction may be much more effective than an ongoing lecture environment. As a corollary, sleep (*resting the brain*) is critical in consolidating learning.

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Finally, classroom setting and the emotions of students play significant roles in the ability to learn. Experiences generate emotions, which bring relevancy and meaning to students (Jensen, 1998). Teaching tied to positive emotional experiences will lead students to generate new thought and motivation to learn. Teachers can enhance classroom environments in many ways. One important practice is to link the indoors with outdoors for movement to stimulate the uptake of oxygen, which has a positive effect on learning. Another is to create a rich stimulating environment through hands-on activities and classrooms with rich colors, textures, and students' work to indicate "ownership" of knowledge (Lackney, 1998). Earlier studies by Greenenough, et al., (1993) and Karni, et al. (1995), indicated that an enriched (stimulating) environment affects growth in the brain.

Diverse, Experiential Approach to Teaching and Learning

Memory is reassembled from many locations in the brain. The brain seems to sort information in *where* (dorsal) and *what* (ventral) pathways. Zadina (2004) suggests engaging students in multiple pathways by using language, sensory motor activities, metaphor, humor, spatial-temporal activities, music and emotion. Furthermore, using *language*—which, by the way, is *our best form of communication*—activates the frontal lobes. Teachers need to apply multiple strategies and opportunities for oral communication (talking, listening, reading) as well as written ways of communication (reading and writing). Gopnick, et al. (1999), observe that the brain seems "to love to learn from other people!"

Although lecturing continues to be the most widely employed method in classrooms across the country, research on the way we learn indicates that lecturing is not always very effective. Several additional strategies should be employed to maximize the amount students retain. Constructivism encourages learning through interaction to develop a personal understanding of information. The fun-

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damental concept of constructivism is that the basis for all learning is discovery. Piaget (1973) writes: "to understand is to discover, or reconstruct by discovery, and such conditions must be complied with if in the future individuals are to be formed who are capable of production and creativity and not simple repetition." Student initiated experimentation and invention are encouraged in a diverse, constructivist and experiential classroom. Open-ended questioning is valued because it allows for reflective thought, creative response, and unique commentary. Finally, students are allowed to process and challenge the information they hear or seek though personal discovery. These methods allow students to make "sense" of what they learn in class and to give the new information meaning.

Learning Styles: Teaching to Diversity

Tileston (2000) indicates that the best teaching practices that define teaching competencies relate brain research, learning styles, and standards-based education. A student's Learning Style can be defined as "the way that he or she concentrates on, processes, internal-izes, and remembers new and difficult academic information or skills" (Shaughnessy, 1998).

Recent research in learning styles examines the different ways in which individuals learn and process information and acquire new skills. Clearly, the concepts of right and left hemisphere processing are also relevant to these theories of learning. Moreover, Perini, et al. (1997), advocate integrating learning styles and multiple intelligences. In addition, learning styles may be influenced by such factors as age, gender and cultural background. Evidence shows students achieve more in a shorter amount of time when teachers know how to teach to the students' individual learning styles. Teachers must cater to the learning styles and diversity of learners. This requires constant attention to elements such as noise and music, light, social structure, mobility, and the design of the classroom. The presence of different learning styles indicates the need to create opportunities for diverse learning experiences. It is evident that sensory information and the classroom atmosphere significantly contribute to the way students learn.

Reflective Teaching and Learning and the Concept of "Wait Time"

Another concept, the idea of reflective teaching and learning, maintains that students learn by reviewing and reflecting on their work, not simply by just completing a task or listening to a lecture. Techniques including keeping journals and preparing portfolios reveal the progress of a student while allowing the student to develop a sense of pride in his or her work. A new method involving videotaping classes, especially group situations, devotes time to a student's personal reflection. Reflective learning methods provide a valuable opportunity for self-examination and a greater overall understanding of a student's individual role in his or her learning process.

The closely related theory of "Wait Time" is based on the idea that students need time to individually process what they have learned. Teachers must encourage this "processing" time instead of automatically asking their students to repeat back information they have just covered or heard in lecture. Recent studies also indicate that the brain seems to exhibit *plasticity* (Gage, et al., 1999)—and one way this is demonstrated is through "experiential learning." This means that the brain has the ability to change as a result of rich experience through active, personal and engaging learning activities.

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Conclusion

A growing understanding of the way the brain functions offers new insights into the minds of students at all stages of development. Unfortunately, curriculum often mismatches content and teaching practices with the thinking and learning processes of students. Teachers must promote active learning through incorporation of research on brain-based education and the corresponding academic

needs of the student. "The teacher is a reflective practitioner and decision maker. Teachers must understand the theories, continue to study them, reflect upon them, and make appropriate applications for their own students and their own situations" (Guild, 1997). Advancements in neurological science and the growing understanding of the interconnectedness of the brain and mind present new possibilities that can lead to the enhancement of the quality of instruction for all students. The knowledge of how students pay attention, take in new information, process that information, and then store knowledge in memory is crucial for teachers. In addition, practices using areas such as Learning Styles, Constructivism, and Reflective Teaching (Wait-time) are all valuable applications of the research and practice of brain-compatible learning.

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