

2006

Brain-compatible research: using brain-based techniques to positively impact student learning

Laurie A. Herson

University of South Florida

Follow this and additional works at: <http://scholarcommons.usf.edu/etd>



Part of the [American Studies Commons](#)

Scholar Commons Citation

Herson, Laurie A., "Brain-compatible research: using brain-based techniques to positively impact student learning" (2006). *Graduate Theses and Dissertations*.

<http://scholarcommons.usf.edu/etd/2557>

This Ed. Specialist is brought to you for free and open access by the Graduate School at Scholar Commons. It has been accepted for inclusion in Graduate Theses and Dissertations by an authorized administrator of Scholar Commons. For more information, please contact scholarcommons@usf.edu.

Brain-Compatible Research:
Using Brain-Based Techniques to Positively Impact Student Learning

By

Laurie A. Herson

A thesis submitted in partial fulfillment
Of the requirements for the degree of
Education Specialist
Department of Educational Leadership and Policy Studies
College of Education
University of South Florida

Major Professor: Carol Mullen, Ph.D.
William Benjamin, Ph.D.
Elizabeth A. Ethridge, Ed.D.

Date of Approval:
June 19, 2006

Keywords: elementary teaching techniques, elementary education, cognitive-based learning, brain-compatible research, brain-based classroom management

Copyright 2006, Laurie A. Herson

Acknowledgements

I would like to express my deepest thanks to Dr. Carol Mullen of the Department of Educational Leadership & Policy Studies for her generous and untiring efforts helping me not only with this study, but also for her constant mentoring, resolute yet compassionate guidance, and dedication to the educational profession. Her commitment to her students and the professoriate earmarks her as a caring and gifted teacher of the highest caliber, and as an outstanding member of the University of South Florida faculty.

Thanks is also extended to the other members of my committee, Drs. William Benjamin and Elizabeth Ethridge, also education faculty, for their encouragement, support, and insightful suggestions. Those in Dr. Mullen's Writers in Training (WIT) doctoral group, especially Carol Burg, Kristy Cantu, Rahim Jones, Jan Hutinger, and Larry Plank, provided multiple reviews of this manuscript during meetings at Dr. Mullen's home: The feedback and constant support of my peer group is much appreciated. In addition to these people, I would like to express gratitude to my family members for their patience and sacrifices during my travels on this educational journey.

This thesis is dedicated to the students I have had the pleasure and honor of teaching over the course of my teaching career as an elementary and middle school educator and also to my family who made sacrifices so I could finish my degrees.

Table of Contents

Abstract	iii
Introduction	1
Writer's Bias	3
Structure and Focus	3
Background Issues	4
Classroom teacher concern	5
What is Brain Based Instruction?	6
Importance of Brain Based Classrooms	8
Focus on the Brain	9
General Brain Based Categories	10
Emotional Intelligence and Safe Environments	12
Body Movement and the Brain	14
Student Choice	16
Elements of Time in the Brain-Based Classroom	19
Enrichment of Environments to Promote Academic Growth	23
Student Assessment and Feedback	26
Student Collaboration	29
Impact on Education	31
Summary and Concluding Thoughts	32
Future Directions of Brain-Based Education	33

Brain-Compatible Research:
Using Brain-Based Techniques to Positively Impact Student Learning

Laurie A. Herson

ABSTRACT

This thesis discusses brain-based methodology and how educators can use brain-based techniques to impact, support, and advance cognitive growth. Current research on learning and memory is enabling educators to better understand how the brain learns and what environmental factors assist in or detract from student learning. Brain-based learning techniques are considered by brain-based researchers to be one way to create a learning environment that fosters student learning at individual academic levels while concurrently challenging each student and promoting academic growth. Teachers can further student academic advancement through the direct manipulation of the classroom environment rather than by purchasing particular programs that promise results.

Introduction

Teachers who utilize brain-based strategies in the classroom to enhance their students' performance are seemingly better able to positively impact learners on social, emotional, and cognitive levels. The following two questions guided this thesis. First, what are the main concepts that brain-based researchers in general are using? Laura Erlauer's (2003) seven fundamental categories provide a list of the recurring themes that brain-based researchers use as documentation and that this thesis will also utilize. Erlauer has been an educator practitioner at the kindergarten, 3rd grade, and 7th grade levels. She has also served as a coordinator for gifted students. Her research on classroom brain-based learning, experiences, and master's of science degree, complete with a principal and curriculum license, have all prepared her for the task of synthesizing the most recent brain-based research; additionally, she provides fellow educators with practical classroom implementation guidelines. Her knowledge in the area of brain-based education is such that the University of Wisconsin's College of Professional Studies and other colleges, offer graduate and undergraduate level courses based largely upon her work. She has authored and coauthored various articles and books on brain-based learning. Erlauer is currently an elementary school principal and actively presents brain-based research at conferences (McGraw-Hill, 2000-2005). Erlauer's key concepts consist of emotional wellness and safety, body movement, student choice, elements of time, enrichment, assessment and feedback, and collaboration.

The second question I ask is how do these brain-based techniques impact student learning in a positive manner? The impact appears to be different than that of curriculum programs still under development which continue to permeate educational systems in

hopes of improving student learning. Brain-compatible research is helping teachers to positively impact student learning by explaining to teachers how to support students with their academic and social needs. For example, one of the seven main areas this literature review of brain based strategies delves into is providing a safe and supportive environment for all students. Maintaining an emotionally safe classroom appears to improve student learning through stress reduction. Understanding the concept of emotional wellness may assist educators in understanding how emotions in the school environment can both negatively and positively impact learning (Cain & Cain, 1991; Erlauer, 2003; Jensen, 2005; Tileston, 2004). The literature shows that it is important that educators become familiar with and understand the general categories of brain-based learning techniques as a means to enhance student learning. As Wolfe (2001) clearly states “The more we understand the brain, the better we will be able to design instruction to match how it learns best” (p. 2).

Brain-based learning is generally defined as the understanding of the relationship between the educational environment and the complexities of the human brain. Brain-based learning requires basic knowledge of the specific areas of the brain that are impacted and then manipulating the classroom to provide a positive learning environment to increase academic growth (Erlauer, 2003; Jensen, 1996, 2005; Jones, 2003; Sprenger, 2002; Wolfe, 2001).

This thesis examines researched techniques and strategies of brain-based classrooms, the impact of utilizing these concepts, and how teachers can incorporate such techniques as providing authentic learning opportunities that include hands-on activities,

making connections to real-life applications and potential career applications, and also offering students choices and options throughout the instructional day.

Writer's Bias

I am an elementary and middle school educator who has experienced the constant and often distracting shifting of the curriculum focus towards various programs and the never-ending pursuit of new theories designed to minimize the achievement gap or at least make adequate yearly gains. From this perspective, it is my intention to identify within Erlauer's (2003) seven conceptual areas what researchers call brain-based techniques and how teachers might use them to positively impact students. This thesis reviews multiple strategies educators may incorporate into the learning environment in accordance with research that supports brain-based classrooms as a way to enhance student learning.

Structure and Focus

Various documents from the body of literature used for this discussion include books, peer-reviewed journals, databases such as *LexisNexis* and *Wilsonweb*, along with other Internet Web sites.

This paper focuses on and explores the current discussion on brain-based research. It shows how brain-based techniques may assist educators in better meeting students' needs. Research reveals how important it is for teachers to adapt their classrooms to meet both the emotional and academic needs of students (Cain & Cain, 1991; Erlauer, 2003; Jensen, 2005; Sprenger, 2002; Wolfe, 2001). Based on previous study of this topic, I located several researchers in the field of learning and memory who specify that negative stress appears to be the most harmful factor that interferes with

learning. It also appears essential that teachers possess the necessary skills to create a learning environment that provides safe harbor, trust, and the appropriate level of challenge to eradicate or at best minimize the deleterious effects of negative stress as perceived by students (Erlauer, 2003; Jensen, 1998, 2005; Sprenger, 2002).

From my current white-middle class perspective, I view my teaching experiences at predominately low socioeconomic schools, as personal and relevant experience with students experiencing stress. These students come from neighborhoods and home environments where financial capital is limited in contrast with my adult experiences. These students' stress levels are often compounded because they have little or no control over their environment. Self-confidence may also be negatively impacted by stress. As Jones (2003) states, "A common concern in challenging children, however, is that it can cause stress. Excessive stress is counterproductive to learning, not to mention to the emotional health of the child" (p. 86). One researcher specifically suggests that teachers can meet stressed students' needs on a daily basis when brain-based techniques are frequently and consistently implemented (Sprenger, 2002).

Once teachers experience the positive impact on students from using several brain-based strategies, it is likely that they will be able to incorporate other researched techniques, such as reducing classroom stress, allowing for appropriate movement and choice, and making curriculum meaningful through cognitive challenges, projects, and enrichment, once teachers experience positive impact on students through utilization of several brain-based strategies.

Background Issues

Researchers suggest that brain-based classrooms positively affect students' learning (Cain & Cain, 1991; Erlauer, 2003; Jensen, 2005; Sprenger, 2002). Such results tend to support my query: How do brain-based techniques positively impact student learning? Here I review the literature on brain-based techniques and how the learning environment can be changed by utilizing brain-based concepts (Cain & Cain, 1991; Cain, Cain, McClintic, & Klimek, 2005; Erlauer, 2003; Jensen, 1996, 2005; Sprenger, 2002). Having students learn early in their educational journey about their brain and brain-based concepts, such as how to have positive social, stress management, and coping skills, might help produce young citizens who can better contribute to our communities and who will be prepared for the stressful economic global community they will find themselves competing in as they reach adulthood. As Darling-Hammond, Bransford, LePage, Hammerness, and Duffy (2005) state, "Informational processing" is beneficial "to help people learn about the cognitive processes that underlie their own abilities to learn and solve problems. This knowledge is often called 'metacognition.'" (p. 57). These authors further state that explaining metacognition to students has been undertaken where teachers say, "You are the owners and operators of your own brain. But it came without an instruction book. It pays to learn how it works" (p. 57).

Classroom Teacher Concerns

As an elementary teacher of several years, I have found that many elementary school teachers are weary of changing their educational focus as text book adoptions occur. Researchers and curriculum developers tout these latest programs as *a product* that will impact student learning and assist in closing the achievement gap. I have taught in several schools and school systems that have invested in numerous products and

expended tremendous amounts of time, money, and energy adopting new products, materials, and programs. In my opinion, all too often, when the results are not what were expected or a state requirement was not met, a new program is ushered in to account for the short fall, and the cycle repeats. Not only are resources wasted, but many teachers feel little or no sense of accomplishment in terms of real progress, growth, or change in student learning.

I have heard many complaints from educators that the constant redirecting of the educational focus does not allow for continuity to achieve academic growth. In my opinion formed from personal observations, these new programs do not remain in implementation long enough for educators to accurately gauge whether positive results could have been garnered. In the educational arena, where immediate results are in high demand, there seems to be little willingness to adhere to a program if academic growth does not meet the local, state, or federal requirements. Pressure from all levels in the educational system pulls educators from product to product in hopes of finding a way to educate students that hastens closing the achievement gap. In contrast, brain-based strategies have the proven potential to assist teachers to depend more on their own skills to positively impact student learning rather than relying on a revolving product purchased when dollars are available.

What Is Brain-Based Instruction?

Brain-based instruction is the process of focusing primarily on the learner's learning by understanding how the brain functions and incorporates new information into its schema. Jensen (1996) explains this learning style as "An approach to learning which favors the brain's best natural operational principles, with the goal of attaining maximum

attention, understanding, meaning and memory” (p. i). The emphasis is no longer placed on what the teacher’s lecture is about but rather on what each learner in the classroom is doing or learning (Erlauer, 2003). The educator creates the environment and coordinates the events in that setting in order to meet the learner’s emotional, social and academic needs. A key concept in brain-based learning is that the learner requires a challenging, supportive learning environment while the educator facilitates the learning process as educational activities transpire (Cain & Cain, 1991; Erlauer, 2003; Jones, 2003; Sprenger, 2002).

Erick Jensen is one notable author in the area of brain-based learning and research. In *Teaching with the Brain in Mind* (2005), he states that “If you want to understand human learning you’d better understand the brain” (p. ix). Researchers in this area of study are sending this same message to educators. Many of the authors of the books used in this thesis, began their work with a section that provides the reader with the physiology of the brain and explains why it is important to have a basic understanding of the primary functions and interactions within the brain (Cain & Cain 1991; Hart, 1983; Jensen 2005; Smilkstein, 2003; Sprenger, 2002; Tileston, 2004; Wolfe, 2001).

Research demonstrates that what brain-based researchers classify as brain-based techniques have actually been in existence since the beginning of education. In essence, educators intuitively noticed what techniques worked best with their students and repeated those efforts. Brain-based researchers are identifying the areas of the brain where activity is present when the brain is learning (Erlauer, 2003; Jensen, 1998, 2005; Sprenger, 2002; Wolfe, 2001). Some researchers are suggesting that certain strategies can be employed in the classroom to replicate the opportunity for the brain to transfer

information into short-term memory and finally secure the learning into long-term memory (e.g., Jensen, 1998; Wolfe, 2001).

Although many teachers naturally use some brain-based techniques, Erlauer (2003) and others show how teachers could use even more from the vast array of researched techniques to impact the learning environment for the good of their pupils (Cain & Cain, 1991; Jones, 2003; Smilkstein, 2003; Sprenger, 2002; Wolfe, 2001). Tileston (2004) encourages teachers to “create patterns and connections between what the learner already knows and the new learning.” as well as “provide students with examples and non-examples” to help brains build patterns (p. 44). Respect, challenge, safety and opportunity to learn naturally are some of the brain-based strategies Smilkstein (2003) discusses.

Brain-based strategies are not products or programs available for purchase. Rather, researchers propose that brain-based strategies and techniques are changes in teacher behavior. However, these behavioral changes must be long-term if the learner is to be positively impacted. Since a product is not involved, teachers will be responsible for sustaining the change. Researchers say that school-based educators who institute the techniques can impact the learner’s environment and therefore enhance the learning of their students (Cain, & Cain, 1991; Erlauer, 2002; Jones, 2003; Sprenger, 2002).

Importance of Brain-Based Classrooms

Brain research shows that when a student’s needs are met, retention of what is taught increases. Much of this gain is attributed to the positive interaction between the student and his or her environment (Cain & Cain, 1991; Erlauer, 2003; Jensen, 1998, 2005; Sprenger, 2002). This research suggests that educators might benefit from having a

basic understanding of the relationship between the brain and the learning environment as well as how to better develop and capitalize on a positive classroom.

The literature reviewed did not produce findings regarding how many teacher education programs are incorporating brain-based instruction into their degree programs. However, Jensen (2005) does have a formal brain-based program that he provides for the purpose of educator training via professional development, conferences, speaking, and week-long training sessions. Even without formal professional development or college course work on brain-based strategies, educators frequently end up implementing key fundamentals of brain-based instruction on their own accord (Erlauer, 2003). But why should each teacher have to learn these skills via cause-and-effect over many years when proven brain-based techniques can be taught and put into practice almost immediately? Even if teachers choose not to implement brain-based techniques, researchers imply that the simple act of being aware of brain-based research and its findings can inform them about the interactions that occur in their own classrooms each day (Erlauer, 2003; Jensen, 2005; Wolfe, 2001).

Focus on the Brain

By design, the brain is formatted for learning (Erlauer, 2003). From reading the literature, it appears that individuals perceive their environment based on their own perspective. This perception becomes their sense of reality. It is imperative that educators understand the importance of developing and enhancing each student's aptitude. To do so, educators need to understand the brain's various parts and functions and how environmental factors impact this vital organ (Cain & Cain, 1991; Erlauer, 2003; Jensen, 1998; Smilkstein, 2003; Sprenger, 2002; Wolfe, 2001).

General Brain-Based Categories

This thesis explores the current discussion on brain-based research and how incorporating brain-based strategies and techniques from Erlauer's (2003) seven general categories (emotional wellness and safety, body movement, student choice, elements of time, enrichment, assessment and feedback, and collaboration) can assist with meeting students' needs. With so many educational products available, it is probable that one of the most influential methods in positively impacting student learning is how the teacher manages the classroom. Some of the classroom management skills that are also brain-based techniques include setting classroom rules and consequences, using rubrics for assignments, establishing goals, and providing timely, positive feedback. These types of skills appear to support positive academic gains in a classroom environment (Cain & Cain, 1991; Erlauer, 2003; Jensen, 2005; Sprenger, 2002). One might expect teachers to increase the use of brain-based techniques in the classroom as research shows positive academic growth in student learning (Cain et al., 2005).

Medical and technological improvements in recent years have provided insight useful to education and the various advances in brain research have been applied to current applications in the classroom with excellent results (Erlauer, 2003; Smilkstein, 2003; Wolfe, 2001). Erlauer (2003) expands on the utility of using this newly gained brain knowledge based on recent technological gains by stating,

More knowledge about the brain has been exposed in the past few years than in man's entire history. Part of this massive knowledge gain is directly due to technological advances, especially in devices capable of measuring the living brain as it is functioning. The data gathered by researchers is showing that the

classroom focus needs to be directed onto the actions of the learners, and what the learners are learning, not how the teachers teach, as has been the case in modern education. (p. 1)

To become learning experts, Erlauer (2003) encourages educators “to know strategies that have always worked and what new teaching and learning methods will be even more successful” (p. 1). This astute comment sums up the outlook needed for implementing a brain-based classroom:

The good news for educators is that although it will take a lot of time and effort to develop a brain-compatible classroom, no teacher is starting from scratch. Every teacher out there is already successfully implementing effective teaching practices. Many traditional instructional strategies are, and have always been, brain compatible. (Erlauer, 2003, p. 2)

While striving to implement numerous brain-based techniques that cover the seven general categories may seem daunting at first, researchers such as Cain and Cain, Erlauer, Jensen, Jones, Smilkstein, Wolfe, and others recognize that most teachers are already utilizing strategies that fit under the brain-based umbrella of techniques. Many teachers may find that their approach to teaching is, in fact, a form of brain-based learning. For educators that want a permanent change to take place, implementation of some techniques may not be enough. In fact, as Erlauer (2003) argues “lasting improvement requires new practices sustained over a long period of time” (p. 3). This is different than the adoption of any innovation. Brain-based instruction helps learners learn when teachers “slowly and deliberately learn, share, modify, reflect, and institutionalize this new teaching method” (Erlauer, 2003, p. 2).

Most brain-based researchers feel it is necessary for teachers to have a general working knowledge of the brain prior to initiating these strategies (Cain, & Cain, 1991; Erlauer, 2003; Jensen, 1998, 2005; Smilkstein, 2003; Sprenger, 2002, 2003; Wolfe, 2001). With this knowledge, teachers can implement techniques that target specific student needs.

Emotional Intelligence and Safe Environments

A paramount theme of brain-based research is how emotional wellness impacts memories, as reported by Erlauer (2003):

Because memories are so closely tied to emotions, teachers bear a heavy responsibility every day because they evoke emotions and mold memories in each of their students. The close tie between emotions and memory can be a double-edged sword for educators. We've learned that permanent learning almost always has an emotional component. Teachers can use this knowledge productively by fostering positive emotions in their students while learning, thus strengthening the opportunity for remembering the academic concepts. Conversely, teachers who cause or allow stressful, threatening, or fearful occurrences in the classroom are building memories of those negative issues, rather than important academic concepts. (p. 13)

A teacher may want to develop an environment that is emotional but in a positive way, so that learning becomes permanent. As Jones (2003) states, "rich learning tasks plant rich memories. The more parts of the brain involved in a learning activity, the more likely a strong memory will result" (p. 103). Educators must manage the classroom for the appropriate level of challenge and enrichment for all the students.

Researchers seem to be communicating that while classrooms must be emotional, the classroom should be free of stress or fear. Negative environments tend to detract from learning. Teachers must counter harmful situations with positive environmental factors to diminish the effect. In reference to Maslow's Hierarchy of Needs, when individuals are attending to safety and security needs that have been neglected, learning is not the primary function of the brain. As reported by Sprenger (2003), "When all physiological needs are satisfied and are no longer controlling thoughts and behaviors, the need for security becomes active. Our students often show the need for safety and security" (p. 3).

Unfortunately, schools across America have many students who exhibit signs of stress. Multiple brain-based techniques can be used to combat this situation. Two examples include student choice and student seating that encourages student collaboration (Erlauer, 2003; Jensen 1996, 1998, 2005; Sprenger, 2003). Erlauer (2003) identifies categories and techniques for teachers to implement in the class to diminish stress. These general categories are in agreement with the research undertaken by Jensen (2005), Sprenger (2003), and other brain-based researchers (Smilkstein, 2003; Wolfe, 2001), although the wording each uses is unique. When creating a brain-based classroom, Erlauer (2003) states teachers may find it beneficial to weave Daniel Goleman's five emotional intelligence tips into everyday classroom life" (p. 14). Insights from the research highlight that teaching emotional self-control to students diminishes stress at the individual level, supports classroom harmony, and supports cognitive growth:

- Self-awareness (monitor one's own feelings).
- Self-management (manage the feelings so they do not disrupt life).
- Self-motivation (maintaining a positive, productive state).

- Other-awareness (detecting emotions in others and feeling empathetic).
- Relationship management (interacting smoothly with others creates positive social skills). (Erlauer, 2003; Sprenger, 2003).

Teachers can foster self-esteem by providing meaningful tasks for students to accomplish. Helping students set reasonable goals enables them to build a sense of pride. It also teaches them stress management techniques, such as time management, deep breathing, conflict resolution skills, positive social skills and visualization (Cain et al., 2005; Erlauer, 2003; Jensen, 2005; Jones, 2003; Smilkstein, 2003; Wolfe, 2001).

Research has also shown that establishing classroom rituals and routines for students takes some of the stressful unknowns out of the school day. Acknowledging individual and group efforts and special events through celebrations, community service projects, and programs help foster a sense of belonging. Actions like having a school mascot, song and colors help create a beneficial, inclusive community for all students (Cain et al., 2005; Erlauer, 2003; Jensen, 2005; Smilkstein, 2003).

Having clear academic and behavioral expectations allows students to predict what is expected of them during school hours. Insisting on respectful behavior toward all people in the school and encouraging students to participate in developing class rules allows them to take ownership of their behavior and develop an attachment to the school (Erlauer, 2003; Wolfe, 2001).

Body Movement and the Brain

Being a role model will always be an important teaching tool for educators, not only in terms of educational issues but for exemplifying healthy living (Erlauer, 2003). The brain is a vital organ that needs the best nutrient-rich foods available. Researchers

suggest, as do many nutritionists and doctors, that vegetables, water, sleep, movement, and oxygen are all critical for a healthy brain primed for learning (Erlauer, 2003, Jensen, 2005; Sprenger, 2003; Wolfe, 2001).

One brain-based philosophy is to teach parents and students about proper nutrition—nutrition that will nourish the brain. Many times there are too many hours between breakfast and lunch. Allowing time for a healthy snack in the morning and possibly in the afternoon supports providing nutrition to the brain more frequently. Teachers might also allow students to keep water bottles at their desks for frequent hydration and they should set an example by drinking water. In *We're Born to Learn*, Smilkstein (2003) shares how

The brain is less than 3% of the body weight. However, it uses 20% of the body's energy or fuel. There are two sources of this energy or fuel: the glucose in the carbohydrates we eat in food and the oxygen we breathe in from the air and drink in water. (p. 69)

Good nutrition and healthy safe environments are essential for academic growth (Jensen, 2005; Smilkstein, 2003; Sprenger, 2003).

Just as we want to teach parents about healthy food choices, parents could assist teachers by ensuring that their children get a full 8 hours of sleep each night. Missed sleep cycles equate to the missed transfer of learning into long-term memory (Erlauer, 2003; Wolfe, 2001).

Teachers need to champion opportunities for frequent movement throughout the school day. This activity includes physical education classes, active lessons, standing, and stretching exercises. Changing the location of lessons provides vivid memory triggers

(Erlauer, 2003; Jensen, 2005; Jones, 2003). One important research finding about movement is detailed by Jones (2003):

Beyond change of state, honoring learning preferences, and multisensory input, there are yet other considerations for mindful use of movement in learning tasks. The basal ganglia and cerebellum, important brain regions for control of muscle movement, also help coordinate thought via connections with the frontal lobe (Hannaford, 1995). There now is evidence that the cerebellum stimulates many more areas of the brain than previously thought, including those associated with cognitive function.

Movement and learning have constant interplay. (p. 35)

Teachers can also enhance the classroom environment by introducing specific objects into the room. Opening windows to replace stale air and placing plants in classrooms to increase oxygen levels are advantages for brain-based classrooms, as oxygen is critical for brain function. National Aeronautics and Space Administration research shows dracaena, ficus, and chrysanthemums produce relatively large amounts of oxygen (Jensen, 1998).

Through research I have found that teachers need to keep all the aspects of body and brain in mind as they convey knowledge. Some minor changes may make learning more permanent. These helpful practices may optimize learning and make the difference between gaining a lifelong understanding of a concept or muddling through a lesson one more day.

Student Choice

Educators should take student curriculum choices into consideration as a motivational force. As Cain and colleagues (2005) inform us, “students can learn more effectively when their interests and ideas are engaged and honored” (p. 67). One researcher known for his work on rewards is Kohn (1993): he states, “Deprive children of self-determination and you deprive them of motivation. If learning is a matter of following orders, students simply will not take to it in the way they would if they had some say” (p. 221). Research shows that

The human brain likes interesting activities, relevant knowledge, and choices. Consequently, students do benefit from having meaningful choices in their learning and school environment because when people are allowed to make choices, interest, motivation, and effort are all increased while stress is decreased. (Erlauer, 2003, p. 74)

The belief that students need background knowledge as a foundation for new learning is widely accepted in the teaching profession. Educators are currently in position to benefit from the wealth of new knowledge available because of brain research. Fusing content relevance with choice motivates students, especially when discussions apply to future careers. A brain-based teacher emphasizes the direct and indirect links between curricular areas for students, and explains how content overlaps. This style of teaching includes choices for experiential, authentic learning opportunities through hands-on learning simulations, guest speakers, and field trips (Cain et al., 2005; Erlauer, 2003; Jones, 2003).

Educators can use the element of student choice to build background knowledge. Typically students are more motivated to learn if they have a say in the topic. Jensen (2003) sums up the student choice and motivation connection this way,

Brain states rule our motivations and behaviors. Start with meaningful, developmentally appropriate curriculum, and add learner choice and positive social groupings. Create the challenge, build a supportive environment with compelling biases and get out of the way! (p. 111)

Teaching students about multiple intelligences, learning styles, and how their brain functions may help with metacognition. Brain-based teachers consider planning lessons to accommodate students' individual needs (Cain et al., 2005; Sprenger, 2002, 2003). One teaching technique that incorporates multiple intelligences is project-based learning. This method regularly allows for individual choices and fosters research skills. In her book *Differentiation through Learning Styles and Memory* (2003), Marilee Sprenger explains how differences in learning styles occur:

Just as most of us develop a preference for using one hand or the other, and that becomes 'dominant,' many people likewise appear to have dominate sensory pathways. Through their experiences, genetics, and brain development, one of these senses has come to operate better for them than others. (p. 33)

This might explain the need for teachers to provide options for differentiated levels or expectations of assignments to account for those who need an extra challenge or have learning difficulties. Teachers need to identify when student learning is not happening. Knowing how the brain chunks and categorizes information is useful to

teachers in helping students connect new information to prior knowledge (Erlauer, 2003; Jones, 2003; Wolfe, 2001). Teachers also need to know their students' learning needs and how to adjust the learning environment to accommodate those needs. Otherwise, the actual amount of learning may be reduced because the learner is not motivated or plainly does not understand what is to be learned (Jones, 2003; Wolfe, 2001).

Elements of Time in the Brain-Based Classroom

Time is the one resource that can never be replaced and the one thing teachers never seem to have enough of in a day. The three recurring main points in the literature dealing with time are time on task, need for more time, and opportune time periods for learning (Erlauer, 2003; Smilkstein, 2003). Erlauer (2003) highlights research that shows that students need a break in mental activity as often as every 20 minutes.

This mental break can be as simple as a change in the way students are working with the topic at hand. For example, if a teacher has lectured, then a short time for students to discuss the topic with a neighbor will allow the students' brains to shift. The students will still be on topic, however in a new way that will enable the brain to remain focused. (p. 77)

Because time is irreplaceable and needed for learning to go from short-term to long-term memory, teachers must be conscious of the clock. Smilkstein states that those teachers cognizant with brain-based strategies "would give students more opportunities and time to grow their knowledge structures through sufficient specific practicing and processing" (p. 128). Erlauer's research shows that

Practice over time for mastery of a new skill. After four practice sessions, students will reach a competence level of 47.9[%] of complete mastery. It

will take students 20 more practice sessions, about 24 times in all, to reach 80[%] competency. For storage into long-term memory, it is better to learn a few concepts very thoroughly than many concepts vaguely. (p. 82)

The use of hands-on activities can assist with the thorough exploration of new concepts. For years, manipulatives have been encouraged in all educational subjects because they allow abstract concepts to become concrete for the learner (Cain et al., 2005; Erlauer, 2003; Jensen, 2005; Smilkstein, 2003; Sprenger, 2003; Wolfe, 2001).

Brain researchers are finding that teaching practices that help students make the greatest gains are not the rote practice drills, but rather hands-on learning activities that include discussions, projects, reflection, looking for patterns, enrichment, sharing with peers, and comparing and contrasting, or problem solving (Cain et al., 2005; Jensen, 2005; Smilkstein, 2003; Wolfe, 2001). Teachers usually forgo all the extras for the rote practice to learn a subject's content. Research has shown that practice through application of the higher-level thinking skills positively affects the brain's long-term memory (Cain et al., 2005; Erlauer, 2003; Jensen, 2005; Jones, 2003; Sprenger, 2003).

One of the more interesting aspects about time is the concept that there are "opportune time periods for learning within a person's life" (Erlauer, 2003, p. 86). David Sousa and other researchers are finding that these favorable periods are like open windows during certain spans of time in maturation for optimum learning to occur. While skills may be learned at many points during a person's life, there are specific phases where certain skills seem to be more readily learned (Cain et al., 2005). What I found that impacts the teaching profession most from Erlauer's research on brain-based strategies is that the windows for maximum learning open and close for all of the following skills

prior to the age of 10. That would be fourth grade for the following: Math/Spatial (1–5 years), Language/Vocabulary (9 months–4 years), Gross Motor Skills (14 months–9 years), Emotions (birth–2.5 years old), Second Language (1 year–10 years), Fine Motor Skills (5–10 years), Playing Music (3–10 years), Visual and Auditory Acuity (3 months–6 months), Logical Reasoning (7–10 years), and Reading (4.5–9 years).

Erlauer (2003) emphasizes that these are *not* the only opportunities to learn these skills; rather, these are the primary periods for growth for these skills. Children develop at different rates, and therefore, enter or exit these periods at different paces. These are only the general time frames for each to occur. Just as there are opportune times to learn, there are critical times during a lesson when learning takes place. The first 20 minutes of a lesson are golden. After this timeframe, the brain needs a break from the task at hand. This means teachers might want to switch activities to accommodate the brain's need to process learning (Erlauer, 2003; Jones, 2003).

In effect, then, students may not be able to pay attention to any one form of instruction for more than 20 minutes. Addressing students' attention shift with a new teaching method before their attention travels away from the topic at hand is one brain-based technique that can be used to help enhance greater student focus. When learning is interesting and fun, students typically want to stay on task. Another brain-based technique to keep students engaged is to call on them randomly rather than selecting only those with raised hands. In a brain-based setting random selection would be instituted in a supportive manner, not conducted in a stressful way (Erlauer, 2003; Jones, 2003). One way teachers can accomplish random questioning without placing undue stress on

students is to use open-ended questioning techniques that reflect respect for all types of responses.

Reviewing concepts taught is important to brain-based teaching. Some concepts take 24 repetitions before mastery is achieved. Time for reflection during everyday classroom practice allows students' brains to develop meaning and personal relevance from the concepts introduced (Jones, 2003). Integrating a subject's content into other academic areas shows the student the cross-curriculum relevance. The more connections made, the more the brain is able to make sense of learning. The more the brain is able to make more sense of learning, the more time is available for higher-level thinking and thorough application of the lesson's skills (Cain et al., 2005; Erlauer, 2003; Jensen, 2005; Sprenger, 2003; Wolfe, 2001). The "use of the 20-2-20 rule may help students retain learning, re-explain within 20 minutes, review and apply within 2 days, reflect upon and further apply within 20 days" (Erlauer, 2003, p. 96).

Because brain-based researchers such as Erlauer, Sousa and others suggest that there are opportune time periods for learning, educators at all levels might want to find ways to convey this knowledge about learning and development to parents, caregivers, and guardians. Time is required for the brain to fully develop and function at its highest level. Placing premature, excessively high expectations on students is not a sound brain-based practice.

Arranging the classroom schedule with circadian rhythms in mind might maximize the use of the brain's most alert times. All four school districts I have taught in (North Carolina, Kansas, Virginia, and Florida) have required or highly suggested teachers to instruct the most important lesson first thing in the morning when the brain is

most fresh. Educators should try to incorporate active learning during the downtime of the day (early afternoon) to keep the brain and body engaged in learning. Rotating various subjects during the down time of the day will lessen the focus solely on one subject. The novelty of a sliding subject schedule may encourage students to keep their brain focused, while some students may not handle the constant change. Teachers using brain-based strategies would be wise to take into consideration the overriding educational impact. Brain-based educators should also be aware of the ideal time periods for learning within a teacher's lesson. As Erlauer (2003) and Sousa (1998) point out,

Think of lessons in 22- or 44-minute blocks of time depending on the learner's age. Help the learners by using the first 10–20 minutes (1st prime time) of each lesson for teaching the newest and or most important information. Do not use that time for review or non-instructional tasks. Alter the mode of learning during the two–four minutes of downtime in the middle of the lesson to provide a break to the brain. Use the last 10–20 minutes (2nd prime time) of each lesson for tying the new information to past learning, or for application of the new concepts by using hands on techniques if possible (Erlauer, 2003, p. 96).

Educators may never have all the time they want or need to positively impact cognitive growth of students, but by developing time management skills vital to maximize learning, teachers might see their students achieve higher academic growth. Practicing strategies that maximize time is most important. Time is limited, and it is crucial that teachers make the most of what is available to them.

Enrichment of Environments to Promote Academic Growth

Enrichment for the brain is the process of growing hundreds of dendrites, much like the image of a tree root ball, through the process of providing problem solving and musical activity, as well as providing for a physical environment that is intriguing (Erlauer, 2003). Problem solving, as Erlauer (2003) describes in relation to a study by another researcher (Robert Slywester), is,

Most beneficial when it involves various sections of the brain at the same time; multiple neural pathways are developed in students' minds when we facilitate problem solving by pairing a class discussion with building a model, sketching a picture, or watching a demonstration. Plus, the brain really does not care if it ever discovers a solution or not; it is the high-level thinking process that develops new dendrites in the brain, making it grow more intelligent. (p. 98)

Teachers in the brain-based classroom primarily play the role of facilitator and/or supporter as students grapple with problems and issues (Erlauer, 2003; Sprenger, 2003). It is when students problem solve and investigate possible outcomes that the brain develops alternative neural pathways. These pathways have come to be evidence of the brain functioning in an enriched environment. The student must do the mental exercises for the growth to occur (Cain et al., 2005; Erlauer, 2003; Jensen, 2005; Sprenger, 2003; Wolfe, 2001).

One common way to enrich the learning environment is through the use of music. Music is known to impact people's emotions and moods. Positron Emission Tomography (PET) scans have been used to track areas of the brain that are activated based on the type of music that is played and by what emotions surface as a result of the music. Music has the capacity to cause the brain to release endorphins, a natural pain reliever for the body

(Erlauer, 2003; Jones, 2003; Sprenger, 2003). One interesting fact research has uncovered is that in all cultures observers were able to identify the intended mood the music was supposed to illicit (Erlauer, 2003).

Other objects to bring into the brain-based classroom to positively impact learning include word walls and other curriculum-based posters. Such items may be helping teachers more than previously suspected or known. Two brain-based researchers' findings tell us "that over half of what a student learns does not come from what the teacher is saying but rather from the surrounding environment" (Jensen, 1998; Erlauer, 2003, p. 105). This may very well coincide with the attention span of children. As minds shift from listening to instruction, students could be focusing on the print material of their environment or anything else that catches their eye in the room.

Erlauer (2003) has shown that even the aromas of a classroom have been identified as environmental impacts. She explains that "Fresh air is preferable, and scents such as peppermint, lavender, lemon, jasmine, and lily of the valley have shown to improve performance and increase alertness and productivity" (p. 111). Erlauer's (2003) research has found that some scientists have indicated that "smell might affect the limbic system in the brain, which controls some of the emotional and memory operations. This means smells can generate memories and strong emotional responses" (p. 111).

I was astounded to learn, that by age 5, children's' brains are well on their way to being weeded of unused dendrites. Regrowing or growing dendrites requires more effort from learners and especially educators to create the environment for the growth to occur, particularly if the windows of opportunity discussed earlier have passed or if the child is

under stress. How many of our students do not have any stress at all? This is how Erlauer (2003) summarizes this maturation process,

If brain cells are not sparked to grow new dendrites through learning, they will die. That is why babies are born with trillions of brain cells, yet adults have only a couple hundred billion left. Sadly, trained educators typically have very little influence over children from infancy through 5 years old, when those trillions of brain cells are especially hungry for growth. However, it is never too late to grow new dendrites by learning new information and skills. Teachers have an awesome and exciting responsibility for changing students' lives by helping them to learn. (p. 111).

Student Assessment and Feedback

States and districts are holding teachers accountable for teaching essential curriculum, and state tests are monitoring that instruction via state test scores. Brain-based researchers also see teaching essential knowledge and social skills as important to brain-based instruction. Erlauer (2003) states how assessment is important,

As the paradigm shifts in education toward teaching more meaningful concepts and skills, assessment practices must change as well. In-depth evaluation of learning means assessment must be an ongoing part of the learning process and, as often as possible, should be as authentic as the learning. (p. 114)

Teachers typically use in-class assessments aligned with their instruction. These assessments may represent the student's actual learning much more clearly than

standardized tests. Through careful analysis of standardized test data, instructional strengths and weaknesses may be more likely to be appropriately identified and corrected. Erlauer (2003) distinguishes between tests and assessment: “Tests are a form of assessment. Alternative assessments are all forms of assessment other than standardized tests. Alternative assessments are student-centered and curriculum-based and are therefore far more brain-compatible than standardized tests” (p. 116).

One of the critical aspects of assessment is to know what kind of assessment, why assessment is occurring, and what the data reveal to the analyzer. In the National Academy of Education’s (2005) book *A Good Teacher in Every Classroom* the point is made that “the demands on teachers have grown with the advent of standards-based reforms that presume that teachers will use data about student learning to help students acquire skills they have missed or are struggling to learn” (p. 15). Of course teachers need to conduct assessments that match the instructional delivery method used to teach the content. The results may then be used to drive the instructional decisions and choices. Teachers must always consider how valid assessments are before using them (Berk, 2001; Erlauer, 2003).

The most informal form of assessment in the brain-based classroom is to simply watch and listen to students. These day to day, real-time observations are what teachers focus on to analyze and make decisions for the academic goals, the styles of instructional delivery, and specific content decisions that are ultimately made.

In contrast to the informal assessment process is formal assessment. This is product-based assessment, such as essays, performances, short answer questions, oral

presentations, portfolios, exhibitions, and demonstrations. One important distinction Erlauer (2003) highlights is that,

To be considered authentic, or brain compatible, an assessment should involve the students in meaningful, significant tasks that are open-ended, occur over time, and allow for the demonstration of competence in more than one way. This form of assessment involves high-level thinking and usually problem solving, with predetermined high standards that are known by both the teacher and the student. (p. 119)

Brain-based assessments take into account many different avenues for students to demonstrate what they have learned, not just through multiple choice questions. As we know, tests are just one form of assessment. The use of product-based assessments in addition to or instead of written tests can give the evaluator a better understanding of what the student really understands, not just what he or she is able to recall from short-term memory. To obtain a greater understanding of what a student has learned, it is better for educators to implement a wide range of assessment practices, both formal and informal (Berk, 2001; Erlauer, 2003; Jensen, 2005).

Assessment is not the end of learning but should guide continued learning. Some suggested ways to implement varying assessment is to match assessment to the instruction, and conversely, to consider students' differing multiple intelligences when designing assessment methods, infusing assessment into daily practices, and making assessments as authentic or real-world as possible. Important brain-based assessment skills for teachers include having students synthesize, evaluate, or apply the new

knowledge and promoting emotional wellness and safe environment principles in assessment situations (Berk, 2001; Erlauer, 2003; Jensen, 2005; Jones, 2003).

In the brain-based classroom, the other half of assessment is effective feedback. Jensen (2005) explains that “getting enough good-quality, accurate feedback may be the single greatest variable for improving learning. The feedback must be corrective and positive enough to tell the student what the desired change must be” (p. 55). Feedback can be either planned or spontaneous in nature. Educators may choose to give individual or whole group feedback, but it is important that it is prompt and specific. Allowing for logical, natural feedback to occur is also important. Examples given for this included the crash of a paper airplane model to the applause from peers. Erlauer (2003) adds that educators can make immediate, interactive feedback part of the learning process so students can avoid learning and practicing something that is incorrect. This has implications in assigning homework. Erlauer recommends that students should never be allowed to practice skills they have not been taught. This is different from problem solving and struggling through one problem to discover knowledge (Berk, 2001; Jensen, 2005; Jones, 2003).

Student Collaboration

Collaboration is the process of learning through social communication with others, self-reflection, and group reflection based on cooperation in an intellectual effort, such as cooperative learning. Erlauer (2003) supports the premise put forth by Cain and Cain (1991) that the cooperative learning model is brain-base compatible because as Erlauer reports,

An innate function for the brain is to search for meaning. Collaborative learning provides the brain with the means to explore new information in a problem solving situation.

- Humans are social and, therefore, like to learn from others and with others.
- Working with other people tends to elicit stronger emotional responses to the work. . . . Emotionally laden information tends to be remembered by the brain easily and permanently.
- Humans like to contemplate varying viewpoints. Multiple viewpoints tend to occur regularly in collaborative learning.
- Working toward a common goal is ingrained in collaborative teamwork. The brain tends to function well with the challenge of a goal, and students like the feeling of success after reaching a goal.
- People can understand a large, general concept while simultaneously learning and working with related specific detail.
- Collaborative groups are designed to be supportive and cooperative by nature; competition and the threat these evoke are not present. We know the brain functions best in a non-threatening setting because it can focus on high-level thinking using its frontal cortex, rather than its reptilian brain which operates under fight-or-flight condition. (pp. 136–137)

Working collaboratively does not come naturally to most students; therefore, they need to be taught the social skills to be able to do so. They also need to know the how and why of collaboration. Clear goals are essential for groups to be successful on designated academic tasks. Erlauer further states

Collaborative teamwork occurs when the group has a goal to reach and is cooperatively striving to accomplish the tasks at hand in order to achieve success with the goal. Students will do this, too, as long as they know the purpose and the expectations for the work. (p. 145)

Brain-based teachers predetermine a goal or purpose for the work giving a sense of purpose for the brain to work toward (Cain & Cain, 1991; Erlauer, 2003). The teacher partners students frequently, and in varying teams, even letting students choose, sometimes with the teacher choosing, and sometimes using random assignment. Teachers instruct students on active listening skills. The use of pair-share is also a collaborative brain-based strategy used to minimize student stress in risking an answer in front of the entire class (Cain & Cain, 1991; Erlauer, 2003).

Impact on Education

What the research on brain-based educational techniques seems to indicate is that teachers should continue to learn how to implement classroom techniques that support students' growth both socially and academically. There is nothing suggested from the resources reviewed that would harm students or educators. However, as with any technique or program that is carried out to an extreme, an unhealthy educational atmosphere could develop. When one looks over the strategies that are recommended as well as proven to have a positive impact on the education of children, it is hard to comprehend how any educator could determine brain-based educational techniques, used appropriately, would be unacceptable for the classroom environment.

From my research on the topic, I believe it is important for educational researchers to adopt and adapt current brain research so that the classroom teacher may

better and more effectively meet the emotional and academic needs of the students. In the United States, far too many students are dropping out of education at the earliest legally allowed age, hurting them and ultimately our society. Education must begin to foster a positive environment that interests students in the academic task long enough to provide the most basic high school equivalent education possible. The impact on these students and our country as a whole would likely prove to be negative should we fail.

Summary and Concluding Thoughts

There seems to be many small but significant steps, strategies, techniques, and considerations that educators need to be aware of to assist in enhancing the young student's brain and cognitive development. From reviewing the literature, it appears that the sooner teachers implement brain-compatible techniques in their classrooms, the stronger the learning outcomes will be. A caution to new practitioners of brain-based strategies is to view the techniques not as recipes to fix students but rather as techniques to be practiced in a reflective, thoughtful, and knowledgeable manner in order to assist students obtain positive academic and social growth.

It may appear overwhelming when one looks at all the tips and techniques that go into creating a functioning brain-based learning environment. It can almost appear unattainable at first glance; however, upon reflection, one can find that multiple layers of brain activities are ongoing in the classroom. With much concentration and planning, brain-based applications seem to be naturally infused into teaching practices and on a daily basis.

Making the transformation into a brain-based supportive environment will require dedicated, long-range planning and flexibility in teaching and assessment styles. It is

possible, but teachers, including myself, must be reflective enough to realize whether we are actually implementing changes that fit this research-based model of instruction and learning.

Future Directions of Brain-Based Education

This review of the literature lends itself to a follow-up work that would include a study of the brain based techniques that elementary teachers perceive they are using. Other future areas of interest to educators might include the growing body of knowledge in the areas of gender differences and multiple intelligences, and how the differences both physically and physiologically impact male and female brains in the classroom. A brain based classroom may be the optimal learning environment that incorporates these differences in learning modalities.

One would hope that further studies and discoveries about the workings of the brain and memory would provide greater opportunities for educators to create educational environments where a larger number of students' individual learning needs would be met. The ability to positively impact the achievement gap through further brain based study, one that supports learning and increases academic gains in the classroom, should be a goal that future neurological researchers strive towards as part of their efforts to unlock the secrets of cognition. The more we learn about how the brain learns, the more able we will be to prepare America's children for classroom success and also to rise to the economic challenges endemic with globalization.

References

- Berk, L. (2001). *Awakening children's minds: How parents and teachers can make a difference*. Oxford, NY: Oxford University Press.
- Cain, R., & Cain, G. (1991). *Making connections: Teaching and the human brain*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Cain, R., Cain, G., McClintic, C., & Klimek, K. (2005). *12 brain/mind learning principles in action: The fieldbook for making connections, teaching, and the human brain*. Thousand Oaks, CA: Corwin Press.
- Darling-Hammond, L., Bransford, J., LePage P., Hammerness, K., & Duffy, H. (2005). *Preparing teachers for a changing world: What teachers should learn and be able to do*. San Francisco, CA: Jossey-Bass.
- Erlauer, L. (2003). *The brain-compatible classroom: Using what we know about learning to improve teaching*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Jensen, E. (1996). *Brain-based learning and teaching*. Del Mar, CA: Turning Point Publishing.
- Jensen, E. (1998). *Teaching with the brain in mind*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Jensen, E. (2005). *Teaching with the brain in mind* (2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.
- Jones, S. (2003). *Blueprint for student success: A guide to research-based teaching practices, K-12*. Thousand Oaks, CA: Corwin Press.

- Kohn, A. (1993). *Punished by rewards: The trouble with gold stars, incentive plans, A's, praise, and other bribes*. New York, NY: Houghton Mifflin.
- McGraw-Hill Companies, Inc. (2000-2005). *Worthwhile reading, education up close, teaching today*. Retrieved June 19, 2006, from <http://www.glencoe.com/sec/teachingtoday/educationupclose.phtml/36>
- National Academy of Education (2005). *A good teacher in every classroom*. San Francisco, CA: Jossey-Bass.
- Smilkstein, R. (2003). *We're born to learn: Using the brain's natural learning process to create today's curriculum*. Thousand Oaks, CA: Corwin Press.
- Sousa, D. (1998). *How the brain learns: More new insights for educators*. A presentation on August 18, 1998, in Port Washington, Wisconsin.
- Sprenger, M. (2002). *Becoming a "wiz" at brain-based teaching: How to make every year your best year*. Thousand Oaks, CA: Corwin Press.
- Sprenger, M. (2003). *Differentiation through learning styles and memory*. Thousand Oaks, CA: Corwin Press.
- Tileston, D. W. (2004). *What every teacher should know about learning, memory, and the brain*. Thousand Oaks, CA: Corwin Press.
- Wolfe, P. (2001). *Brain matters: Translating research into classroom practice*. Alexandria, VA: Association for Supervision and Curriculum Development.