INCREASING ELEMENTARY LEVEL ACADEMIC PERFORMANCE THROUGH BRAIN-BASED TEACHING STRATEGIES

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A Research Paper
Submitted in Partial Fulfillment of the
Requirements for the
Master of Education Degree
With a Major in

Education

Approved: 2 Semester Credits

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The Graduate College
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May, 2003

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ABSTRACT

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Increasing Elementary Level Academic Performance
(Title)

Through Brain-Based Teaching Strategies

Education	Dr. Edwin Biggerstaff	May, 2003	45
(Graduate Major)	(Research Advisor)	(Month/Year)	(No. of Pages)

American Psychological Association (APA) Publication Manual
(Name of Style Manual Used in this Study)

The purpose of this study was to assist upper elementary students achieve better academically. This study included a comprehensive review and critical analysis of research and literature concerning the brain, the learning process, factors affecting retention of learning, success stories involving brain-based learning, suggestions for optimal learning, and skepticism/caution. Conclusions were drawn and recommendations were given to educators and administrators.

Research has suggested that the brain is a very complex organ. Scientists have determined that the human brain is divided into two hemispheres, the left and right. Each hemisphere is responsible for processing information differently. Within each hemisphere, the brain is further divided into lobes. The occipital, frontal, parietal, and temporal lobes have been identified as the locations where learning takes place. Each lobe is responsible for different types of learning.

In order for learning to take place, the brain must make emotional connections with the information being processed. In other words, you must be involved in the learning process. The greater the emotional connection, the better chance the brain has at learning or mastering the material. If, however, the brain experiences stress, the brain will likely “downshift” and focus on survival needs rather than acquiring the learning material.

The researcher has reviewed several success stories have been identified in which students have been taught using brain-based strategies. These success stories include students from all ethnic and socio-economic backgrounds within the United States.
In addition to the review of success stories, the researcher also identified several brain-based teaching strategies that could be incorporated into the upper elementary classroom.

In order to improve the quality of instruction and improve student performance in our schools the researcher recommended that teachers evaluate their individual learning styles before investigating implementation of brain-based teaching. After an internal evaluation, selections of a variety of teaching strategies that involve more activity with students could be incorporated into the teaching curriculum. Recommendations were also given to administrators to allow for more flexibility in the daily scheduling for brain-based techniques to be incorporated into the classroom. In addition, educators need to be given more preparation time, which would also include teacher inservice. Finally, the researcher recommended evaluation of the daily schedule to allow “specials teachers” the opportunity to plan and implement cross-curriculum as a tool to enhance the learning process.

ACKNOWLEDGEMENTS

The completion of this project was made possible with the unconditional support of my family, especially, my husband Tracy, and daughter Aimee. There were times when I was not sure I could complete such a task in addition to my everyday routine. I spent several nights a week studying for the classes that helped prepare me for this project. I made multiple trips to Wausau for weekend classes yet, they were there to cheer me on. I am certain they will be delighted, as I am, to know I will now have more time to be involved with the family evening activities.

There is one more important piece to the success of my efforts. I would also like to thank Dr. Ed Biggerstaff for his involvement and guidance throughout the project. His positive suggestions and encouragements have made me feel good about the work I have accomplished. I am filled with pride knowing that I have accomplished such an undertaking.

TABLE OF CONTENTS

CHAPTER ONE

Introduction

With the “Decade of the Brain” proclaimed for the 1990’s behind us, how have we faired? Recently there has been an influx of information about how the human brain works. We have seen many successes in the medical field. “We have a much better understanding of mental illnesses and the drugs that ameliorate them. Treatment for tumors, seizures, and other brain diseases and disorders has become much more successful” (Wolfe & Brandt, 1998, p. 8). Which leaves an important question to be answered, what about the educational community? Could it be possible that the Decade of the Brain has ushered in the Decade of Education? (Wolfe & Brandt, 1998).

Educators are notorious for searching for new ways to present curriculum to students. This is especially true at the elementary level. Yet there are times when experienced teachers do not feel the need to change because they have seen so many “new” teaching strategies come and go. A hesitant, experienced teacher might say, “Why try it? This new idea will be outdated with a new approach cycling in a year or two.” For example, in reading, the phonics approach gained popularity and then was replaced, or “updated” by the whole language approach. After a period of time, the trend made a full circle and the phonics approach reappeared with the new terminology or prior methodology returning to the classrooms with a phonics approach.

However, an experienced teacher’s hesitancy has some truth behind it. Education seems to be based upon a collection of ideas that have been formulated through theories and experiments, allowing for a wide variety of strategies to be used in the educational setting.

Wolfe and Brandt (1998) declared:

> Researchers especially caution educators to resist the temptation to adopt policies on the basis of a single study or to use neuroscience as a promotional tool for a pet program. Much work needs to be done before the results of scientific studies can be taken into the classroom. The reluctance of scientists to sanction a quick marriage between neuroscience and education makes sense. Brain research does not—and may never—tell us specifically what we should do in a classroom. At this point it does not “prove” that a particular strategy will increase student understanding. That is not currently the purpose of neuroscience research. Its purpose is to learn how the brain functions. (p.8)

They also caution we need to critically read and analyze the research before making decisions. Understanding the process of the brain as it processes information is critical for educators otherwise “we will be vulnerable to pseudoscientific fads, inappropriate generalizations, and dubious programs” (Wolfe & Brandt, 1998, p. 8).

In Sousa’s study (cited in Hardiman, 2001) “Scientists and researchers are making exciting new discoveries related to how the brain processes and stores information” (p. 52). Educators must understand the importance of the brain’s functions and how it relates to education.

Wolfe and Brandt (1998) state:

> Then, with our knowledge of educational practice, we must determine if and how brain research informs the practice. Educators have a vast background of knowledge about teaching and learning. This knowledge has been gained from educational research, cognitive science, and long

> experience. Given this knowledge base, educators are in the best position to know how the research does – or does not—supplement, explain, or validate current practices. (p. 9)

"Developments in neuroscience and cognitive science, as well as research on effective teaching methods, provide valuable applications for the classroom" (Westwater & Wolfe, 2000, p. 49).

Westwater and Wolfe (2000) declare:

> Educational researchers have demonstrated that previous experience enhances the understanding of new information. Today, however, we are in a better position to understand why it happens: If the brain can retrieve stored information that is similar to new information, it is more likely to make sense of the new information. This leads to increased understanding and retention. (p. 50)

The environment also plays a major factor in the brain's development. For many decades, intelligence and character were believed to be hereditary, or in our genes. Today, research has found that about 30 to 60 percent of our brain is wired from genetics, but 40 to 70 percent of what we learn is from the environment in which we live (Jensen, 1998). Educators need to focus on this opportunity and create quality-learning environments. They need to keep a focus on the positive aspects of the learning process and create a safe and nurturing environment for all.

In this comprehensive analysis of the literature, the researcher will investigate the studies of brain research as it correlates with the learning capabilities of the human brain. As a result of the analysis, the researcher will have a stronger understanding of the brain's function and the relation between learning strategies and the how the brain best learns. This will benefit the teachers in the classroom and their instruction of students. The researcher needs to keep in mind that no two brains learn the same way (Meyer & Rose, 2000). The book, *The hero's journey: How educators can transform schools and improve learning*, suggested "the need for the educator, school and system to recognize that emotion, feeling, relationship, and human interaction all influence learning (Brown & Moffett, 1999, p. 29). "The enormous progress begin made in modern cognitive theory and recent brain research confirms the vital link between emotions and learning" (Brown & Moffett, 1999, p. 30).

Statement of the Problem

This study seeks to explore a better understanding of the human brain and how brain-based learning enhances the learning of elementary students. In the educational field, there are many approaches to teaching a subject. The difficulty arises when an educator does not know the most effective way to present the material.

Purpose of the Study

The purpose of this study was to assist upper elementary students achieve better academically. This was accomplished through a comparative study of the research and literature associated with the use of brain-compatible teaching research in the upper elementary classroom environment with the assistance of brain-based teaching strategies. In addition, the researcher analyzed the studies and formulated recommendations with suggested activities.

Research Objectives

This study addressed three main objectives. They were:

1. To determine the function of the brain as it relates to learning.

2. To review the most recent documentation between research and educational practices.
3. To formulate recommendations to help educators in the upper elementary grades utilize brain-based teaching strategies.

Definition of Terms

The definitions of terms are as follows:

Brain-based teaching – Research that has identified brain regions and the Processes that are involved in learning [definition from Prigge, 2002]

Brain-compatible – Creating learning opportunities that allows the brain to function at its best.

Elementary School– Including grades Kindergarten through fifth grade.

Intermediate grades – Including grades third through fifth.

CHAPTER 2

Literature Review

Introduction

Within the last several years, educators have been a part of an educational reform. The focus on teaching instruction has emphasized the importance of brain-based learning. The purpose of this literature review is to gain a better understanding of the structure of the brain and the flexibility for learning to take place. Throughout the years, researchers have recognized how several parts of the brain work in terms of learning. These researchers have also identified some of the processes for creating long and short-term memory that are associated with learning. With these findings, educators are beginning to implement brain-based teaching strategies into the classroom. Documentation indicates there are success stories.

The Brain

A quote from Lewis Thomas' *The Medusa and the Snail* (cited in Sousa, 2001) provides insight to the complexity of the brain:

> *You start out as a single cell derived from the coupling of a sperm and egg; this divides into two, then four, then eight, and so on, and at a certain stage there emerges a single cell which will have as all its progeny the human brain. The mere existence of that cell should be one of the great astonishments of the earth.* (p. 1)

In order to better understand brain-based learning, the brain must be examined. Anne Westwater and Pat Wolfe (2000, p. 49) posed an interesting question "what is the fundamental purpose of the brain?" The answer is simply put, "the survival of the individual and the species" (Westwater & Wolf, 2000, p. 49).

A closer look into the make-up of the human brain will focus the attention to the recent technological scientific findings. Ron Brandt (1997) sets the tone for the complexity involved:

> And even when you looked at a brain, you didn't know what you were seeing -- 100 billion neurons, plus 10 times as many glial cells (support cells). How many is 100 billion? Well, there are about 100,000 hairs on the average head, so that would be all the hairs on the heads of a million people – that's how many neurons you have in your brain. You can put 30,000 neurons into a space the size of a pinhead. (p. 16)

Eric Jensen (1998), a well-known brain-compatible guru, explained that the average human brain weighs about 3 pounds and includes 78% water, 10% fat, and 8% protein. The outer part of the brain is covered with convolutions, or folds. These folds are part of the cerebral cortex. The purposes of the folds are to increase the surface area. The design of the brain gives humans unbelievable flexibility for learning.

When the brain is divided in half, two cerebral hemispheres are created, a left and right. The connections between these two hemispheres are bundles of nerve fibers. With current research, many preconceptions of the roles these hemispheres play have been outdated. One fact remains, "each side of the brain processes things differently" (Jensen, 1998, p. 8). For example, "the left hemisphere processes things more in parts and sequentially" (Jensen, 1998, p. 8). While the right hemisphere is faster to recognize negative emotions and the left, positive emotions. (Jensen, 1998)

Jensen (1998) continues to describe the brain with further explanation:

> Scientists divide the brain into four areas called lobes. They are occipital,

> frontal, parietal, and temporal. The occipital lobe is in the middle back of the brain. It's primary responsible for vision. The frontal lobe is the area around your forehead. It's involved with purposeful acts like judgment, creativity, problem solving, and planning. The parietal lobe is on the top back area. Its duties include processing higher sensory and language functions. The temporal lobes (left and right side) are above and around the ears. This area is primarily responsible for hearing, memory, meaning and language. There are some overlaps in the functions of the lobes. (p. 8-9)

Within the parts of the brain, the process of learning takes place.

The Learning Brain

The human brain's ultimate function is to learn. In an interview between Marcia D'Arcangelo (2000) and Steven Petersen, a Professor of Neurology from Washington University School of Medicine, Petersen states that research has proven:

> Neuroscience and cognitive science have clearly shown us that the brain has multiple memory systems. Two of the systems are explicit (or declarative) memory and procedural (or implicit) memory. The explicit memory system involves remembering something consciously, for example, what you had for breakfast yesterday. Procedural memories come from interactive learning or skill development. Different brain parts seem to so those two jobs. (p. 70)

"To learn, you have to be involved, to have some emotion" (D'Arcangelo, 2000, p.70). The stimulus could be from something the brain already knows or something that is new to the brain. The more times the learning is repeated, the better chance the neural pathway will become more efficient. Research has noted that "novices use more of their brain, but they are less efficient at how they use it. This quality illustrates how quickly our brain adapts and rewires itself" (Jensen, 1998, p. 13).

Stimulation of the brain is doing something new. Examples might include: visiting a new place, listening to new music, solving a new problem, and seeing a new movie. The stimulus is converted into nervous impulses. These impulses "travel to extraction and sorting stations like the thalamus, located in the middle of the brain. In intentional behavior, a multisensory convergence takes place and the "map" is quickly formed in the hippocampus (Freeman cited in Jensen, 1998, p. 13). From there, the signals are sent to specific areas of the brain.

According to neuroscientists, learning and memory are two separate issues. However, the two must be discussed together. Without having a memory to recall what you have learned, there is no evidence that learning took place. The connections these two concepts have continue to puzzle researchers. According to Saltus (cited in Jensen, 1998), more than 50 years ago, a great Canadian psychologist, Donald Hebb, hypothesized that "learning occurs when a cell requires less input from another cell the next time it's activated (Jensen, 1998, p. 14). The idea was followed up by a research team lead by Nobel laureates Susumu Tonegawa and Eric Kandel when they "identified a single, specific gene that activates this critical memory formation" (Jensen, 1998, p. 14). The results indicated a possible reason why some people have a better memory than others. Part of the process is controlled by genes (Jensen, 1998). Siegfried (1997) (cited in Jensen, 1998) suggests a visual to help follow in this process:

> A cell is electrically stimulated over and over so that it excites a nearby cell. If a weaker stimulus is then applied to the neighboring cell a short

> time later, the cell's ability to get excited is enhanced. Another effect helps us to learn too. LTD (long-term depression) occurs when a synapse is altered so that it is less likely to fire. By making the wrong connection less likely, quicker learning is promoted. This occurs when we do trial-and-error learning. (p. 14)

Learning Takes Place

Every day teachers enter into their classrooms with lesson plans, experience, and the hope that what they present will be understood, remembered, and useful to their students. For this hope to be realized "depends largely on the knowledge base that these teachers use in designing those plans and, perhaps more important, on the instructional techniques they select during the lessons. Teachers try to change the human brain every day. The more they know about how it learns, the more successful they can be. As Francis Bacon said four centuries ago, "Knowledge is power"" (Sousa, 2001, p. 3).

As educators, most of our lessons, almost without exception, are presented through a singular sensory. If we were to allow each child the advantage of multiple senses, wouldn't each child have a far greater chance that he or she would be able to draw many more associations. "More simply, by using multisensory techniques, we, as educators, will be able to stimulate more neural pathways within the brain" (Christie 2000, p. 329).

If our future leaders and workers, are to learn to their best ability and if they are to benefit themselves and society, we must honor their own individual learning systems. As Hamer and Copeland (1998) (cited in Given, 2002) advise in *Living with Our Genes: Why They Matter More Than You Think*:

> Giving children love and knowledge is as essential as giving them food, but at some point, parents [and teachers] must understand that children are already on a path beyond anyone's choosing. Children are who they are, and parents [as well as teachers] are better off getting to know their own children than trying to mold them into some ideal created out of thin air. Children are to be discovered as well as shaped; they should be allowed and encouraged to develop to their own potential…. Each of us is born into the world as someone; we spend the rest of our lives trying to find out who. (p. 25) (p. viii)

As educators, it is important to know enough about brain research to help students develop into the best *who* they can possibly be. We can "rely on the five major neurobiological learning systems to construct a well-organized educational framework that makes lesson planning exhilarating and implementing our plan exciting" (Given, 2002, p. viii).

Factors Affecting Retention of Learning

In today's society, many children's lives are surrounded by threats to learning. Renate Nummela Caine (1997) points out there are a number of children who experience abuse, malnourishment, poverty, family and community violence. "Children who have lived with extreme threat develop perceptual loops; they look for certain signals in the environment that to some extent replicate their own experiences" (Caine, 1997, p. 12). This creates an unhealthy situation for brains coping with stress.

Students who enter the classroom with home environments with high-stress are the first to show difficulties in learning. "A brain in a state of fear or perceived threat is likely to become "downshifted" (Hart, 1998), an instantaneous biological response that focused only on what is necessary for survival" (Caine, 2000, p. 59). Students who have downshifted show difficulties "paying attention because their brains preseverate, continuously repeating thoughts or unresolved emotional issues" (Caine, 2000, p. 59). In addition to the brain dealing with unresolved issues, a powerful stress hormone, cortisol, is present in these situations (Caine, 2000).

With the emotional threats involved in these situations, downshifted students can learn. Memorizing can occur because "repetition provides a sense of safety when you feel helpless" (Caine, 1997, p. 12). However, "real learning—making connections, higher-order thinking, and creativity – is incompatible with that kind of environment" (Caine, 1997, p. 12).

Success Stories Involving Brain-Based Learning

Just how effective can brain-based learning techniques be in the elementary classroom? One such success story has been found at Roland Park Elementary/Middle School in Baltimore, Maryland. A framework, known as the Dimensions of Learning model, has been incorporated into the teaching of their 1,350 students. Over the last six years, the school has seen a steady improvement in academic achievement.

Robert Marzano described the dimensions as "loose metaphores for how the mind works during learning" (cited in Hardiman, 2001). Combining the five dimensions with the latest brain research suggests a good practice for teaching all children.

The five dimensions involved in the teaching strategies for the school include: positive attitudes, acquiring and integrating knowledge, extending and refining knowledge, using knowledge meaningfully and habits of the mind.

Ask any classroom teacher about the success rate of a student with a good attitude verses a student with a poor attitude. Your answer will be directly related to the attitude in question. The consensus will be overwhelming in favor of success with the student identified with a good attitude. Robert Leamnson (cited in Hardiman, 2001) suggested brain research supports this link between emotions and cognition. An explanation from Robert Leamnson verified “neural pathways connect the limbic system, the brain’s emotional center, to the frontal lobes, which play a major role in learning” (cited in Hardiman, 2001, p. 52-53). In addition, learning and memory can become impaired when the individual is under stress (Jensen cited in Hardiman, 2001).

To encourage positive attitudes in the school, Roland Park strives to provide a supportive classroom environment by limiting the amount of stress related to academic performance or peer pressure. Teachers encourage social interactions by conducting classroom meetings and using history and literature to demonstrate acceptance of diversity. Techniques to enhance long-term memory emphasized the emotions to learning. Dramatizations, movement, integration of arts, and humor stimulated strong performances.

Dimension two, acquiring and integrating knowledge, falls into the understanding that in order for new learning to occur, the learner must obtain information based upon what the learner already knows. From Valiant and Buchel (cited in Hardiman, 2001), acquiring and integrating knowledge can be compared with the focus of brain-based research on how the brain acquires, stores and uses information. “Learning occurs through the growth of neural connections, stimulated by the passage of electrical currents along nerve cells and enhanced by chemicals charged into the synapse between neighboring cells. The more often the “trail is blazed,” the more automatic a task or memory becomes” (Valiant & Buchel cited in Hardiman, 2001). Therefore, allowing more opportunities to repeat a learning task, the greater the connectivity. Leamnson (cited in Hardiman, 2001) "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." (p. 52)

Examples to enhance acquiring and integrating knowledge would include: repeat learning to cement concepts into memory (such as mastery of math facts), "using visually stimulating material and manipulatives to activate the right hemisphere of the brain and text presentation to activate the left hemisphere" (Robertson cited in Hardiman, 2001, p. 54), activating multiple parts of the brain such as movement, art and music (Rauscher et al.; Vogel cited in Hardiman, 2001), and using mnemonics to increase the memory of content (Carney & Levin cited in Hardiman, 2001).

Extending and refining knowledge is dimension three. This type of integration requires examination in a more in depth study. Classroom activities would include: comparing, classifying, analyzing errors, deducing, inducing, constructing support, abstracting and analyzing perspective (Marzano cited in Hardiman, 2001). Lowery (cited in Hardiman, 2001) stated the idea behind dimension three is to have the brain "use multiple and complex systems of retrieval and integration"(p. 54).

> Brandt 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. (cited in Hardiman, 2001, p. 75)

Hardiman (2001) reported best practices of this dimension might include: designing tasks that allow students to use prior knowledge before introducing a new topic, providing tools that allow students to identify general patterns that underlie concepts, and offering students the chance to compare their work with models so that they can analyze their error patterns.

The fourth dimension is identified as using knowledge meaningfully. Information is best learned when we feel the need to know the information in order to accomplish a goal (Marzano cited in Hardiman, 2001). Activating areas of the brain responsible for higher-order thinking is the key to this dimension. However, teachers should be cautious as to how the development of these activities is created. "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 cited in Hardiman, 2001, p. 54).

Green (cited in Hardiman, 2001) provides suggested lessons. These might include allowing students to be actively involved with hand-on tasks that require investigation, analyzing and problem solving as it applies to world applications, or using multiple ways to demonstrate learning through inventions, visual displays, oral presentations, dramatizations and music.

The fifth dimension used in the framework is known as habits of mind. The goal is to monitor one's own thinking, or utilizing metacognitive thinking, goal setting, self-evaluation, and applying one's learning style to future learning opportunities.

To implement best practices one might allow for self-reflection or group discussions for a learning setting. This can also include a reflective discussion allowing students to record an important concept they have learned with key points to support their facts.

In a suburb of New Jersey is the home to George C. Baker School. This K-4 school has "received national Blue Ribbon recognition from the U.S. Department of Education" (Bucko, 1998, para. 1). In the early 1990's, Baker School was influenced to make major changes in the current instructional practices. The publication of *Making Connections* (1991) by Renate and Geoffery Caine and the renovation and extensive expansion planned for the school, provided the opportunity to focus Baker School on how the brain learns (Bucko, 1998).

The school took a close look at the different areas that could have an effect on the implementation of a school-wide brain-based environment. First, since remodeling was occurring during this transition, emphasis was put on determining "the location of important instructional spaces, such as the media center, Technology Center (computer room), art, and music rooms" (Bucko, 1998, para. 4). The investigation resulted a centralized location of the media and Technology Center and a sound resistant wing for the music room. As for the interior enhancements to the school, mauve and blue were chosen to provide a relaxed and pleasing environment for the hallways and classrooms. Carpet was added in these areas as well to reduce the institutional feel and sound (Bucko, 1998).

With the influence of the superintendent's strong interest in the instructional practice, Baker School adapted "the well-known Instructional Theory Into Practice model of instruction" (Bucko, 1998, para. 6). The adopted model is in close relationship to brain compatible learning. "First, the brain's prior learning is activated and prepared to receive new knowledge in content specific locations and with relevant connections. Second, meaning of lesson content is made clear so that real world applications can be well understood. Teachers actively involve learners by asking students what they have learned, what they are confused about, and what they would like to know more about" (Bucko, 1998, para. 6).

The teachers were also trained in cooperative learning strategies that connected content related brain areas with the linguistic and social aspects of learning. These cooperative activities often focused around thematic content with problem-based objectives. "It is understood that the more parts of the brain that are meaningfully touched during instruction, the greater the likelihood that the learning will be retained in long term memory" (Bucko, 1998, para. 7).

Another key process of learning that teachers were asked to focus on was the excitement and enthusiasm they brought towards learning. Teachers should act enthusiastically. They should also set [high] expectations for students. These expectations for students "have proven to be an important ingredient for high levels of student performance" (Bucko, 1998, para. 8).

With the completion of the new building and the training of teachers, Baker School needed to establish a sense of safety and security within the building to contribute to the maximizing of learning. From the suggestions published by Caine and Caine, the school understood that when an environment is of low threat and of high challenge, learning is maximized. To accomplish this task, a "low threat" climate was centered around the "Bakers School Golden Rule – "Treat others the way you want to be treated" and the school motto 'Bakers Bears-Learning and Caring'" (Bucko, 1998, para. 10). The adoption of the teddy bear created an inviting, warm and secure atmosphere. The safe environment was established with the highly visible adult presence and through the help of volunteers working in the classrooms, media center and variety of special events (Bucko, 1998).

Scheduling of a long school day was also in need of review. In order to maximize learning among elementary school students, one must be active and alert. Baker School took advantage of this by adding a whole grade weekly music aerobic lesson to their physical education class and daily recess schedule. Not only did these activities keep the mind alert, but the development of motor skills was involved as well.

One last scheduling area of focus was the current structure of the school year. With the extended two to three month vacation, student learning is lost. As a solution to this dilemma, the teachers of Baker School "wrote a summer activity book for parents to use with students. The books provide 10-15 minutes per day of academic review plus literature assignments" (Bucko, 1998, para. 16). With the implementation of the above insights to optimal learning, Baker School has created a successful brain compatible learning environment.

A K-6, Chapter 1, elementary school in Rio Linda, California, includes students from low socioeconomic and often dysfunctional families. During the 1993-94 school year, Dry Creek Elementary was struggling with both poor standardized tests and exceedingly high student turnover rates. "After three years of immersion in brain-based learning theory and practice" (Caine & Caine, 1995, p. 43), Dry Creek now has a stronger [sense] of how students learn. The success story of this school demonstrates how changes can have a positive impact on learning.

Renate Nummela Caine and Geoffrey Caine, authors of *Making Connections – Teaching and the Human Brain*, chose Dry Creek Elementary to apply their "new theory of how people learn based on current research in the cognitive and neurosciences. We wanted to demonstrate that our theory could serve as a practical guide for a dynamic way of approaching teaching and learning" (Caine & Caine, 1995, p. 43).

The process began with the observation of current teaching practices at the school. Caine and Caine reported all teachers "had embraced the traditional model of learning and teaching- their mental model" (Caine & Caine, 1995, p. 44). The mental model reflected the teacher's idea of their role in the learning process, based upon personal experiences in school.

The traditional style of instruction has been teacher-dominated with the help of resources such as lectures, textbooks, and possibly videos. The assessment used, in this traditional style, would lend itself to multiple-choice and true-false questions. These types of assessments are designed to determine whether students can answer the textbook or teacher's questions (Caine & Caine, 1995).

The approach Caine and Caine wanted to incorporate into the school's instruction was brain-based teaching and learning. In contrast to the traditional style of instruction, "brain-based teaching and learning takes a holistic approach, looking at teaching developmentally, socioculturally, and in other broad ways" (Caine & Caine, 1995, p. 44). The need to move instruction from memorizing information to learning the importance of patterning and parallel processor played a key role in the implementation of the author's suggestions. In other words, using our brain's natural tendency for meaningful learning, that is complex and nonlinear (Caine & Caine, 1995).

Looking at this approach in another way, brain-based learning is a response to a set of questions, Caine and Caine (1995) believe Wheatley (1993) has beautifully formulated:

> What are the sources of order? How do we create organizational coherence where activities correspond to purpose? How do we create structures that move with change, that are flexible and adaptive, that

> enable rather than constrain? How do we resolve personal needs for freedom and autonomy with organizational needs for predictions and control? (p. 45)

To put Caine and Caine's theory into practice, changing the assumptions about learning, teaching and schools need to be addressed. The first step was to involve the teachers with opportunities that allowed them to understand how *they* learn. However, the ultimate goal was to unveil the creativity of teachers and other staff and encourage them to "take chances based on a much broader understanding of the curriculum" (Caine & Caine, 1995, p. 45). Thus emphasizing "brain-based learning is improvisational" (Caine & Caine, 1995, p. 45). Another goal added to the transition was to provide academic enhancement. This would give teachers the opportunity to gain knowledge through greater content knowledge.

The events leading to the implementation of this brain-based approach began with some hesitations among the teachers. Many teachers wanted instant solutions. Caine and Caine quickly realized that their theory needed to become a mental model. To help make a change in the mental model, a perceptual change involving three elements working together needed to be established. These models included: 1) Relaxed alertness, that is creation of a challenging, but nonthreatening, environment, 2) Orchrastrated immersion in complex experience and 3) Continuous active process of ongoing changes and experiences to consolidate the emergent mental model (Caine & Caine, 1995).

To establish the goal of element one, the Dry Creek teachers needed to understand that brain-based learning requires reflection and other aspects of active processing. Therefore, teachers had to free themselves of reluctancy to share ideas, among colleagues, in the exploration of ideas for an environment that was as nonjudgmental as possible (Caine & Caine, 1995). During the training for element two, all adults, from administrator, cafeteria worker, librarian, secretary and teachers were encouraged to be included in the process of seeing themselves contributing, either directly or indirectly, to children's learning. Finally, in element three, the importance of reflection was emphasized as an important process of how the learning process takes place in a brain-based environment.

Caine and Caine began their work at Dry Creek with the expectations that the students would achieve academically, but not until the end of the third year. However, they saw steady improvements in the standardized test scores from the beginning. The most impressive, in academic strides, were that of special education students (Caine & Caine, 1995). In addition, Dry Creek received recognition with a distinguished school award toward the end of the first year on the school's commitment to these ideas. The "California Elementary Task Force reported "It's Elementary," which is highly compatible with brain-based instruction" (Caine & Caine, 1995, p. 43). The school was also recognized, filmed, and had their story aired on the Learning Channel by the National Education Association.

Now Dry Creek Elementary is "a learning community with cross fertilization of learning in the school as a whole" (Caine & Caine, 1995, p. 47). The communication between parents and teachers is more positive and friendly. "Classrooms have been redesigned to reflect a more natural, dynamic approach to learning" (Caine & Caine, 1995, p. 47). The teachers have maintained their enthusiasm and interest for teaching. They have also created bonds with other teachers, whom they may have never associated with in years past, in their commitment to make the school stronger. Caine and Caine (1995) also shared anonymous survey comments that the principal conducted. They included comments such as:

> It's great getting to know group members in a new way… There's a feeling of excitement here… People are working the their colleagues, sharing the kids in their classes through peer tutoring, cross-age work, and study buddies. We're not as isolated as we used to be… The process was often exhausting, but it was a rich place to be as an educator. The biggest change I see is that, yes, this is a community of learners. It's moving from my class to our kids. (p. 47)

As Caine and Caine reflect on their implementation of their theory of how people learn, they have found Dry Creek is a good example of how these theories can be incorporated into the classrooms. Although there have been adjustments throughout the experience, Dry Creek "continues to prove that our theory works with average teachers and children" (Caine & Caine, 1995, p. 47).

Another success story focuses around a high-performing Valley Park Elementary School in Kansas City, Kansas. "Through a partnership with the Center for the Advancement of Reform in Education (CARE) at Rockhurst University in Kansas City, Missouri, Valley Park staff members focused on brain-compatible practices" (Caufield, Kidd & Kocher, 2000, p. 62).

The team focused on brain research that seemed reliable, valid and usable in the classroom. These brain-compatible findings would then be implemented into the current classroom practice. "On the basis of their research, the Valley Park staff members used the following findings from neuroscience research as a foundation for their work" (Caufield, Kidd & Kocher, 2000, p. 62).

"*The brain changes physiologically as a result of experience*" (Caufield, Kidd &

Kocher, 2000, p. 62). An individual's environment plays a major role in the ability for his or her brain to function. External experiences, a concept called neural plasticity, allows for the brain to change its structure and function according to the experience (D'Arcangelo cited in Caufield, Kidd & Kocher, 2000). The brain's function is to learn, however, when experiences are too easy or too hard, learning falters (Caufield, Kidd & Kocher, 2000, p. 62).

"*Emotion influences learning*" (Caufield, Kidd & Kocher, 2000, p. 62). "Daniel Goleman's *Emotional Intelligence* (1994) and Joseph LeDoux's *The Emotional Brain* (1996), in particular, have advanced our understanding of the role of emotions in learning (Caufield, Kidd & Kocher, 2000, p. 62). Research has determined that people are more likely to retain what they have learned when their brain recognizes the experience as useful. This is particularly true in a positive environment. On the other hand, if the brain experiences something that is threatening, learning shuts down (Caufield, Kidd & Kocher, 2000, p. 62).

"*Intelligence is multiple.* Human intelligence encompasses a far wider and more universal set of competencies than a single general intelligence" (Gardner, 1985, cited in Caufield, Kidd & Kocher, 2000, p. 62).

As a result of their investigations, CARE and Valley Park created a program "based on the following key brain-compatible classroom practices: a safe, nonthreatening environment; active and meaningful learning; rich, stimulating, varied input; and accurate, timely, and helpful feedback" (Jennings & Caulfield, 1997 cited in Caufield, Kidd & Kocher, 2000, p. 63).

To address the newly adopted theories, the staff created an environment with "core virtues: compassion, courage, honesty, perseverance, respect, responsibility, and self-discipline" (Caufield, Kidd & Kocher, 2000, p. 63). These virtues were displayed in the hallways, modeled and practiced, which brought in "a strong sense of emotional and physical safety" (Caufield, Kidd & Kocher, 2000, p. 63).

To make the connection of more meaningful, the staff developed yearlong themes based around the districts' objectives. These themed opportunities were created with the help of collaboration between teachers and specialists that focused on skills and concepts, from core areas, designed to excite and made sense to the children. Evaluations of these themes included perfomanced-based assessments with the use of rubrics by both the students and teachers (Caufield, Kidd & Kocher, 2000).

Through the help of joint planning, students find the concepts being carried into other specialties. Although the concept may be the same, the different modality taps into the multiple intelligences. This opportunity allows students to see the connections and the practical applications to help in remembering the knowledge or skill (Caufield, Kidd & Kocher, 2000).

In addition to the themed concepts carried throughout the school, Valley Park makes an effort to educate the students in grades 2 thru 5 on the research of the brain and how this affects their own thinking and learning. The idea of this focus is "if students understand brain anatomy and the physiology (form and function) at their developmental level, they can become better partners in the learning" (Caufield, Kidd & Kocher, 2000, p. 64).

Today, Valley Park is focused on refining and tailoring the instructional delivery based upon the current knowledge of the science of learning. Parental support remains strong. Although the bottom line to the efforts of all involved is student achievement, the school also realizes that "another key factor is to cultivate a love of learning in competent, caring individuals. Students learn best through rich experiences, while they also learn to appreciate one another's talents and needs" (Caufield, Kidd & Kocher, 2000, p. 65).

Suggestions for Optimal Learning

An example of a brain-based approach to language arts includes a poetry unit that goes beyond the creative haiku or other forms of poetry that appeal to children. For the most part, most children do not understand or *feel* poetry. So, turn the classroom into a coffeehouse. Allow the kids to help set it up. Have low lights, candles on the tables, tablecloths, and music playing softly in the background. Invite adults from the community and school to come into the classroom to read and talk about their favorite poetry. This experience will give the students a sense of what poetry is all about and show them how poetry is valued by adults in the real world (Caine, 1997).

Caine (1997) suggests that a science lesson on owl pellets can provide an opportunity for a lesson in brain-based learning. This allows aspiring students to take apart owl pellets and answer real, live questions, such as "You know, I'm wondering – how does an owl's stomach know how to separate the meat from the bones?" (Caine, 1997, p. 13). This type of questioning provides powerful possibilities for students to investigate instead of following the traditional guided activity by a set of predetermined questions.

Christie (2000) suggests an exercise to stimulate the auditory and visual receptions along with the expressive senses titled: *Do You See What I See?* With the help of a reading textbook, a tape and tape recorder, the following steps are taken:

> Step 1: The teacher will tape a passage or page onto a cassette (amount and passage is teacher discretionary). Step 2: Have student attempt to

> silently read page (visual mode), and then have student orally record his reading (oral expressive mode). Step 3: Place cassette in and have student listen to tape (auditory receptive mode) while reading passage (auditory receptive, and visual receptive) Step 4: Have students retape their passage a second time (oral expression, visual input). Step 5: Listen to the first and second taping (auditory input) noting the mistakes and corrections made (allowing the brain to receive, interpret, and process auditory input). (p. 329)

Another lesson provided by Christie (2000) involving tactile-motor-kinesthetic senses is called: *You Can't Touch It.* This particular lesson can be incorporated into a writing unit on descriptive writing. With the help of materials that have distinct feelings of shape, contour and texture, such as a sponge ball, a ruler, a pencil and a wool sweater, can aid in the effectiveness of this lesson. The guidelines for this lesson are as follows:

> Step 1: The student must first be blindfolded. Have students reach down into a burlap bag, select one item with their LEFT HAND very carefully, touching and caressing the article. Remove the blindfold. Step 2: Have students return to their seat and then close his/her eyes. Have students visualize the item they felt (Revisualization). Step 3: Have student write all adjectives, which they can think of, on paper. Step 4: Repeat Step 1, except this time pick up identical items with their RIGHT HAND. Step 5: Revisualize object in mind (eyes again closed). Write down any additional adjectives which come to mind. Step 6: Use adjective compilation to develop sentence structure, paragraph development, story writing, divergent thinking, and convergent thinking are all examples of

> closure. (p. 330)

As part of a science lesson on the brain, one might follow the suggestions by Patt Walsh (2000) to demonstrate the structure of the brain by using your own hands. This strategy incorporates three learning styles: visual, auditory, and kinesthetic to enhance the learning with the help of movement, communication and demonstration. As suggested by Healy (1990) (cited in Walsh, 2000) "the palm of the hand represents the cell body, the extended fingers represent dendrites, and the arm represents the cell's tail or axon" (p.76). Walsh (2000) gives the following ideas about the brain:

> When I bring both hands together (folded at the knuckles) with thumbs facing me, I see the size of my 3-pound brain. When I separate these hand positions, I see that I have right and left sides to my brain. The two thumbs remind me that I have two frontal lobes that aren't separate entities but are joined together by my corpus callosum – the interlocking fibers that allow both sides of the brain to communicate with each other. When I look inside at my interlocked fingers and count the number of digits, I am reminded of Howard Gardner's theory of mutiple intelligences, which currently identifies eight different product-producing and problem-solving capacities in various regions of the brain (Armstrong, 2000). (p. 76)

Cardellichio and Field (1997) suggest "teaching strategies that overcome the brain's natural tendency to limit information can open students' minds to new ideas and creative mental habits" (p. 33). Seven strategies were determined to enhance the structure of inquiry in the design of curriculum. They are as follows: hypothetical thinking, reversal, application of different symbol systems, analogy, analysis of point of view, completion and web analysis. "All these strategies are related to one another in that they provoke divergent thinking" (Cardellichio & Field, 1997, p. 36).

Within the hypothetical thinking strategy, stimulation to neural growth is found "because it forces us to conceive of issues and consequences other than the standard and expected one" (Cardellichio & Field, 1997, p. 34). For example, in social studies, one might ask: "What would have happened if Columbus had landed on the West Coast of North America? What if the colonies had lost the Revolutionary War?" (Cardellichio & Field, 1997, p. 34-35). The goal behind these questions is "in the follow-up questions that clarify both the complexity of forces that create events and inter-relate web of circumstances that follow from them." This type of question usually takes on the general format: "What if this had happened? What if this were not true? What if this had not occurred? What if I would do something I can not do?" (Cardellichio & Field, 1997, p. 35).

When trying to get beyond the information presented, reversal provides "a specific kind of hypothetical thinking that highlights attributes of events or situations that might otherwise go unnoticed" (Cardellichio & Field, 1997, p. 35). Some questions might include: "What if your mother had your father's job and your father had your mother's job? What happens if I reverse the addends in a math problem? Can I do this in a subtraction problem?" (Cardellichio & Field, 1997, p. 35). Questions to focus on the reversal technique include: "What caused this? How does this change if I go backward? What if I turn this upside down or sideways? What if ___ had happened first?" (Cardellichio & Field, 1997, p. 35).

The third strategy, application of different symbol systems, might get students to use language to explain something that is usually done with numbers. Questions that lend themselves to this strategy include: "Can I make this into a word problem? Can I make this into a number problem? Can I draw a picture of this? Can I represent this in a musical terms? Can I act it out? Can I make a dance to represent this?" (Cardellichio & Field, 1997, p. 35).

To explore more creativity, analogy, is another process of mental extension. Looking for correspondences between two ideas such as the Pythagorean theorem and a cooking recipe creates "new insight about both elements of the analogy" (Cardellichio & Field, 1997, p. 35). To stimulate the analogical thinking, one might ask "How is this like ___?" (Cardellichio & Field, 1997, p. 35).

To determine why someone holds a certain opinion or belief can be considered with the analysis of point of view. Provoking questions in this area include: "What else could account for this? Who would benefit if I thought this? What harm might occur if ___? How many other ways could someone look at this? What would __ (for example, my mother) say about this?" (Cardellichio & Field, 1997, p. 35).

Humans have a natural urge to complete things. This urge can be focused on extending student's thinking in many ways. Examples given by Cardellichio and Field (1997) include:

> Remove the conclusion from a short story and ask the students to create their own ending. Tell the students that chapter one is about the Revolutionary War and chapter three is about the Civil War. Ask what they expect to find in chapter two. Give the students the steps in a process or a solution (to a math problem, for example) with one or two steps missing. Ask what they think is missing. (p. 35-36)

Questions that can provoke this kind of thinking include: "What goes in the blank space? What is the missing piece or step? How would you end the story? Write the beginning of ___. What if __ did not happen?" (Cardellichio & Field, 1997, p. 36).

Finally, with the knowledge that current events in our daily lives are related in complex ways, our brain tries to simplify these experiences in order to make sense out of them. An exercise that encourages neural branching might include a question like: "What would happen if people stopped drinking Coca-Cola?" (Cardellichio & Field, 1997, p. 36). "The power of the web analysis to stimulate neural branching lies in moving beyond the obvious answers to uncover connections that we may not have realized previously" (Cardellichio & Field, 1997, p. 36). Such questions would be: "How extensive were the effects of ___? How many effects can you imagine from ___? Track the relationship of events following from ___. How is ___ connected to ___?"(Cardellichio & Field, 1997, p. 36).

Debra J. Prigge (2002) gives suggestions for six ways to increase memory and recall. First, recognize the importance of emotion. Use models, analogies, music, games, metaphors, drama and story telling, debates, visualizations, celebrations, classroom rituals and self-reflection to engage emotions in learning.

Secondly, create sensory associations. Students remember best by what they experience from hearing, feeling, seeing, smelling, tasting and touching. An example for sensory visualizations might be a way to help students remember their states and capitals. "Imagine a washing machine. Open the lid and you see that it is full of agitating, aromatic lemons." The washing machine represents the state of Washington; the lemons represents the capital, Olympia" (Prigge, 2002, p. 239).

Next, make learning personally relevant to the students. Help your students by providing "connections" through personal stories or analogies. These guided sharing of their experiences can help find personal meaning in their learning. (Prigge, 2002)

Use creative repetition for drill and practice. Try using brain-friendly drills that involve "creative repetition" so that the practice does not become dull. Games, music, rap songs, cooperative learning groups can help add to the creativeness (Prigge, 2002).

Don't forget to remember the importance of first and last. "The brain remembers best what is presented at the beginning and the end of a lesson" (Prigge, 2002, p. 240). Therefore, it is important to create powerful introductions and wrap-ups to each lesson to obtain optimal learning.

Finally, teach specific recall techniques. Providing students with tools such as associations, mnemonics, linking information, and creating personal recall techniques can contribute to the improvement of memory and recall (Prigge, 2002).

Incorporating movement into lessons can be interesting and amusing for both the teacher and students. "Yet physical activity is essential to promoting the normal growth of mental function, to generating positive emotions, and in learning and remembering cognitive material" (Sousa, 2001, p. 240). Sousa suggests several practices that can be incorporated into the classroom routine to help increase the amount of learning that can be retained by students. For example, to energize the sluggish times of the school day, such as early mornings or the middle of the day, why not try: measuring length of the room by hand spans, find and touch seven objects in the room that are the same color or move to four different sources of information that you can find in this room (Sousa, 2001).

Acting out concepts can provide an opportunity for movement. The following strategies "uses the body in a physical way to learn and remember a difficult concept" (Sousa, 2001, p. 240). Take for example, the concept of learning the continents. Sousa (2001) suggests trying this: "Stand in front of a world map. Say the continent and point to the assigned body part.

North America = left hand   Europe = forehead

Asia = right hand   Africa = waist

South America = left knee   Australia = right knee

Antarctica = a point on the floor between the feet" (p. 240). Sousa (2001) suggests there should be time set aside for practicing the above activity. After a period of time, the map could be removed and the activity repeated without the visual aide. Sousa (2001) also challenges the educator to expand on this idea and to think of a difficult concept that could be acted out.

Teach a move-around system that requires students to focus on the memory cue word given and then get up, from their seats, and move. For example, Jensen (2000) says: "Stand in the room where we first learned about X" (p. 37). Provide activities where the hemispheres of the brain are asked to "communicate" with each other in an activity requiring the left arm to cross over to pat the right shoulder or to pat your head and rub your belly. An added suggestive twist might be to march in place while patting opposite knees, elbows, shoulders or heels (Jensen, 2000).

Another example that would include the opportunity for movement might be directed towards a physical education teacher. Science concepts can be reinforced by giving students the chance to experience the structure and movement of atoms. With the use of hula-hoops, to imitate the action of the atoms when cooled, frozen, or heated (Caulfield, Kidd & Kocher, 2000).

Allow for role-playing on a regular basis. Two examples given by Sousa are to play charades to act out major points in a unit or develop and act out commercials advertising to review material already learned (Sousa, 2001).

Another area that “can promote student focus and productivity at all grade levels” (Sousa, 2001, p. 234) is music. To ensure the choice of music being played is actually enhancing the learning process rather than interfering, a few suggestions are given. These guidelines include: consideration of when to play the music, awareness of the music’s beats per minute, to determine if familiar or unfamiliar music should be used, if the use music should have lyrics or not, and finally, student input.

Music can be played at different times during the learning process. Sousa cautions educators when choosing the appropriate music selection for the particular activity. Music played at the beginning of class should set the emotional mood. As students are moving about the classroom, an upbeat tune can be used. When students are working on tasks, either independently or in small groups, choose music that facilitates the learning objective. To have students leave on a positive note, play an upbeat tune at the end of the class (Sousa, 2001).

The number of beats per minute in the music is very important. A person’s heat rate, blood pressure and emotional mood are influenced based upon the music’s beats. To meet the range of students in a working situation, try for music that plays about 60 beats per minute. This is the average heart rate. If you want to calm down a noisy group, music at 40 to 50 beats per minute, should be played. However, if you wish to get students excited, 80 to 90 beats per minute, would be the choice of music (Sousa, 2001).

Should familiar or unfamiliar music be played? The answer lies with the objective of the music. “Familiar music is fine when setting a mood. However, when working on a specific assignment, you may wish to use music that is unfamiliar” (Sousa, 2001, p. 335). Sousa cautions the selection of nature sounds as background music. This selection can be the source to more discussion rather than focusing on the assignment

(Sousa, 2001).

Music with lyrics is suggested at the beginning or the end of the class since the main purpose is to set the mood. For the most part, if student are working independently, lyrics may become a distraction. Students may begin to listen to sing along with the words or others might engage in conversation over the words. In both cases, students are off task (Sousa, 2001).

Finally, student input can be helpful in maintaining a positive classroom environment. Caution is given to emphasize that their music can be brought to class as long as it meets the set criteria. Providing an explanation for this rule can help students understand the reasons behind the set criteria (Sousa, 2001).

Sousa provides suggestions for music from teachers who have tried these titles and have found success in using them. For beginning and end of the class: "Vivalid – *The Four Seasons*, Kenny G – Any selection, Bach – *Brandenburg Concertos*, Yanni – Most selections, The Beach Boys, and Chopin – Most selections" (Sousa, 2001, p. 235). For "fast-paced activity: Rock, Disco, Reggae, Hits from the '50s and '60s and Marches" (Sousa, 2001, p. 236). Background music for processing or reflection activities include: Beethoven – *Moonlight Sonata*, Pachebel – *Canon in D major,* Mozart – Piano concertos, Enya (New Age) – Most selections, Ray Lynch (New Age) – Any selection; George Winston – *Seasons*, and Gary Lamb (Original) – Any selection" (Sousa, 2001, p. 236).

Many math objectives are difficult for younger students to grasp. Take for example, ratio. Westerwater and Wolfe (2000) identified a lesson that increases the likelihood that students will understand this concept if the topic is introduced something like this. With a can of frozen juice in hand, ask students whether they have ever mixed juice from a concentrate. After several positive responses, ask for directions as to how to mix the juice. Once the directions of adding three cans of water are discussed, then the introduction of ratio can be explored. With the increased understanding of the material, the better retention students will have.

Another difficulty arises in the subject of math, making meaning out of very large numbers. By creating a visual, the possibility of comprehension to such a number may not be so distant. Take for example trying to imagine how much $1 million, $1 billion or even $1 trillion really is. To create a way to connect these large numbers with something you already know, try imagining a 4-inch stack of new $1 thousand bills tightly wrapped. That stack would equal $1 million. Now take the stack and add more to equal the length of a city block, then you have $1 billion. To make $1 trillion, you would need the 4-inch stack of thousands to stretch 63 miles (Westwater & Wolfe, 2000).

In science, to demonstrate how sound travels faster through a solid than a gas, select several students. Spread the students, who have become “molecules”, far apart. This represents the form of gas. Ask a student to make noise and then touch another student who then passes the noise on to another student. Compare the results of this activity with one in which the students touch one another with the sound as they are in a molecule format for a solid, that is close together (Westwater & Wolfe, 2000).

Skepticism / Caution

In the scientific and educational fields, there are also some individuals that are skeptical or want to caution educators about implementation of brain-based learning techniques into the classroom. Patricia Wolfe and Ron Brandt (1998) caution, “Brain research does not – and may never – tell us specifically what we should do in a classroom. At this point it does not “prove” that a particular strategy will increase student understanding. That is currently the purpose of neuroscience research. Its purpose is to learn how the brain functions" (p. 9-10). As an educator, if an understanding of the brain and how it processes is not developed, the field will be susceptible to pseudoscientific fads, inappropriate generalizations and ambiguous programs (Wolfe & Brandt, 1998).

Roberts (2002) cautions, "much of the current research is new, and steps from research to application are inherently complex and difficult" (p. 282). Roberts also points out that although this may cause some concerns, "if nothing else, the sheer volume of new information about how the brain functions and learns forces us to question what we truly "know" about learning and educational practice" (p. 282).

Caine & Caine (1991) recommend that teachers and educators should not make changes to their schools and classrooms until their own thinking about teaching and the human brain has been looked at. This is suggested to reduce the chance of discouragement if someone would want to try to implement a specific technique that they may have found. Instead, they "suggest that teachers first acknowledge the interactive processes of immersion, relaxed alertness, and active processing in their personal lives" (Caine & Caine, 1991, p. 176). Addressing the suggestion can be made by finding "new ways to reflect on and process your own experience" (Caine & Caine, 1991, p. 176). Caine and Caine (1991) give an example of searching for different ways to see something in a different perspective, such as upside down. Secondly, "explore what interests you" (Caine & Caine, 1991, p. 176). Immerse yourself in your interest. When you feel comfortable with the new findings, find the time in your classroom when it would be appropriate to introduce the new interest and as Caine and Caine (1991) say, "let new ideas and connections unfold" (p. 176).

The success of brain-based teaching strategies, with the brain in mind, depends on the educator's objective of the lesson and the implementation of the activity. Students' background and enthusiasm for learning will also play into the success of the strategy being incorporated into the classroom. Therefore, researchers, educators and students will all play a vital role in the success of brain-based teaching strategies.

CHAPTER THREE

Summary, Conclusion, and Recommendations

Introduction

This chapter reviews the purpose of the study and summarizes the information found in the Review of Literature chapter. A critique of the findings and a conclusion is drawn also based on the results found in the Review of Literature chapter. The researcher will conclude with recommendations to educators and administrators.

Summary

The purpose of this study was to examine literature pertaining to the brain, the learning brain, factors affecting retention of learning, success stories involving brain-based learning, suggestions for optimal and skepticism/caution towards brain-based teaching and to assist upper elementary students achieve better academically.

Conclusion

The brain is complex. Scientists have only just begun to learn about the capabilities of this amazing organ. Despite the research of the brain, the need for additional research is necessary to help scientists gain a better understanding of the functions. As technology improves, the ability to explore and understand the process of the brain will become easier. Not only will this help in the scientific world, but in the educational world as well. The possibilities of creating lessons that allow the brain to obtain and synthesize as much of the related information possible would be an ideal situation. Until that "moment of discovery" in time comes, it is important for educators to ensure the understanding of concepts presented in the curriculum. Emotion and involvement play an important role in the learning process. Stimulation creates a "map", or direction, for the brain to draw upon when concepts are introduced. Research has also noted that if there is stress in the environment for which the student is trying to learn, the learning process will be made difficult.

Educators need to focus on the possibilities for making the curriculum meaningful. Enhancing the curriculum with the additional opportunities such as art, games, hands-on activities, music have been found to increase the learning process of students.

Many schools throughout the United States have found success in the implementation of brain-based learning techniques. The researcher reviewed several success stories from across the country. Each school reviewed had their own unique diversity for the students involved. With the cooperation of educators and specialists, working toward a common goal, there was success despite the diversity. Each success story reflected the dedication and commitment of all involved.

Even with the success of brain-based learning techniques, the researcher discovered specialists in this field also share caution as to what is educationally sound. Not all of the information available about brain-based teaching is proven effective. As with any new teaching concept presented to educators, knowledge of the pros and cons help to make the best decision.

The key to learning is by getting the brain's attention. By understanding the process, the way in which learning is presented can be more effective. Success of the importance for knowing more about the brain and how it learns was addressed in the previous chapter. The study also investigated teaching strategies for upper elementary teachers to utilize. These strategies create effective teaching strategies for optimal learning opportunities, from brain-based research, in the upper elementary classroom.

Recommendations

The result of this comprehensive review of literature has led the researcher to the following recommendations regarding the implementation of brain-based teaching strategies in the upper elementary classrooms.

For educators:

1. Before presenting brain-based teaching strategies into the classroom, it is recommended that an examination of how the educators' own brain learns.
2. Teachers need to be willing to try a variety of teaching strategies that include more involvement in the learning process. Look for activities that the educator feels comfortable presenting material in a different format. For example: include exploration with the use of manipulatives, in a math lesson, which would have normally been presented by a teacher directed demonstration on the board. Allow students to create questions for discussion, in a literature circle, verses predetermined questions.

For administrators:

1. With the need to structure curriculum around brain-based techniques, comes the need for more flexibility in the daily scheduling. Allowing time for educators to research and implement these new ideas involves additional preparation.
2. There is a need to restructure teacher inservice training. The focus of this time should be directed toward the need of the educator as it relates to their classroom environment.

3. Evaluate the daily schedule. Allow for additional times in which "specials teachers" can plan and help implement cross-curriculum from the classroom can enhance the learning process.

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