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# Designing a brain-based learning environment

Juntana Ginda Sperlich

# DESIGNING A BRAIN-BASED LEARNING ENVIRONMENT

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A Project

Presented to the

Faculty of

California State University,

San Bernardino

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In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

in

Interdisciplinary Studies:

Integrative Studies Option

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Dr. Sam Crowell

ABSTRACT

The term "brain-based" has been associated with good teaching strategies and is an area of interest for many teachers because there have been many recent discoveries on how the brain works and how to apply what is known about the brain to teaching. Teachers try many brain-based strategies in their classrooms thinking they are going to see great results in using these techniques.

The purpose of this project was to develop a teacher friendly guide that would help teachers not only apply brain-based strategies in the classroom, but also to see results from transforming their classrooms into brain-based learning environments. Merely applying a few brain-based strategies to lessons periodically cannot compete with the full benefits of changing the classroom environment to a brain-based environment.

To achieve that purpose, five steps were followed: literature was reviewed on how the brain works, strategies on teaching to how the brain learns, and what brain-based learning environments look like. Notes were then gathered from the research and a draft of the guidelines for designing a brain-based learning environment was created. Next, the draft was given to five experts for feedback. Patterns of the critiques on the draft were identified and

finally, based on the patterns found; the draft on "Guidelines for Designing a Brain-based Learning Environment" was rewritten.

The experts agreed that the guidelines are well organized and teachers will find it fairly easy to implement. It covers fourteen criteria, with several strategies under each section, for transforming a classroom into a brain-based learning environment. It also allows teachers to work at their own pace choosing strategies to implement in the classroom that would work best for the teacher. The set of guidelines, furthermore, provides a space for teachers to record the date of completion for each task implemented, so that they can monitor their growth.

ACKNOWLEDGMENTS

First of all, I wanted to thank my husband, Alex, for pushing me to complete this project; without you, I would probably still not be finished. I wanted to thank my boys, Isaac and Sebastian, though they are preschool-age, for the few occasions where they actually played quietly and allowed me to work on this project when I needed to. I also want to thank my daycare provider, Kristal Ellingwood for being available many times when the boys were not willing to play quietly.

I wanted to thank my colleagues, Carrie Miller, Jackie Irons, and Cathy Barker for taking the time to give me feedback on the "Guidelines for Designing a Brain-based Learning Environment", and being willing to try it out in their classrooms in the future. I would like to thank Dr. Bonnie Piller for her suggestions to make my own worksheets and have the guidelines published. I want to thank my fifth grade students, Denise Morales and Jorge Avina for their incredible artwork on the nervous system. I also want to thank Tim Thelander for helping me with the formatting of this project: you are a blessing.

Finally, I wanted to thank my professors in the Master of Arts in Education: Integrative Studies Option program. Thank you, Dr. Bob London, for taking the time to

read over my endless drafts of this project and allowing me to harass you when I didn't get feedback in a timely fashion. I also want to thank Dr. Sam Crowell, for encouraging me to join the program in the first place and for inspiring me to do research on brain-based learning. I cannot describe with words how you two have impacted my life, but know that the difference you have made will only lead to greater successes; not only for me, but also for the students I will have throughout my lifetime.

DEDICATION

"To God. With you, all things are possible."

"To my family: Alex, Isaac, and Sebastian Sperlich. I am blessed with you, indeed."

"To my student: Denise Morales. May your greatest dreams come true."

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# CHAPTER ONE

## INTRODUCTION

Teachers are experiencing an era in which they have to face the demands of teaching countless state standards and administering high stakes tests. Some teachers are forced to follow prescribed language arts and math programs, which claim to use brain-based strategies and claim to miraculously meet individual needs across all grade levels, but students aren't learning as much as teachers would like them to. In essence, teachers are being forced to use less effective strategies to achieve demanding objectives. It is possible to meet these high objectives at every grade level, but teachers need to be allowed to do what they know is best for their students. Teachers seem to always search for new teaching strategies that will meet the individual needs of their students, yet they already possess so many great strategies: guided practice, stretching breaks, the use of manipulatives, kinesthetic activities, and cooperative groups are still the norm in classrooms across the country. Summing up all the research I have collected on brain-based learning, I discovered that applying brain-based strategies to our classrooms is something good teachers have been doing all

along, but there are many more strategies than most implement. Applying even a fraction of these strategies would require a rigorous process of transformation for any teacher willing to commit. The purpose of this project is to create a set of guiding principles, based on research on the brain, which will help teachers transform their classrooms into a brain-based learning environment.

My interest in brain-based learning began with an introductory course in Psychobiology. In this class, I received instruction on how the nervous system worked. From there, I started coursework for the master's program in Education, with an emphasis in Integrative Studies and found myself intrigued by the tremendous amount of recent discoveries in brain research. I have eight years of experience in classrooms ranging from preschool to fifth grade and I wanted to know how to take that brain research and apply it in the classroom. In essence, I wanted to know how to transform my classroom into a brain-based learning environment.

My interest in brain-based instruction was further sparked with a review of literature on how the brain works, how teachers can use brain-based learning to help students learn, and what a brain-based classroom environment would look like. The research from Ornstein

and Thompson (1984) and Sylvester (1995) on how the brain works exposed physical characteristics of the brain; a description of each hemisphere of the brain and its functions; various parts of the brain and functions including the corpus callosum, brainstem, cerebellum, limbic system, hypothalamus, thalamus, amygdala, hippocampus, cerebral cortex and it's parts including the occipital lobe, temporal lobes, parietal lobes, and frontal lobes; the structure of neurons and how they work together to send messages across your body. Wolfe (2001) outlined the process of memory- how the brainstem, cerebellum, amygdala, and hippocampus work together to help us process information and form memories, and what kind of stimuli is needed to form those memories.

Research from Jensen (2000) on how to apply brain-based strategies to the classroom exposed the necessity for the strategies outlined in the following sentence. Teachers need to arrange the classroom for brain-based learning, set up a class schedule that optimizes on learning, and prepare students to learn before instruction ever began. Wolfe (2001) and Jensen (2000) maintain that teachers can use various strategies to grasp their students' attention and they must gain the attention of their students in order to help students

learn what they are trying to teach. Caine (1991) stated that teachers must eliminate threat to help students learn. Sousa (2001) pointed out several methods to increase memory in students and using transfer techniques help students cement new learning into long-term memory. Jensen (2000) further emphasized that students need time for non-conscious learning and teachers need to plan for down time to help students file information in meaningful ways. He furthermore asserted that providing enrichment activities will help students make greater neural connections and Sousa (2001) stated that asking questions using Bloom's Taxonomy provides enrichment. Jensen (2000) said teachers could watch students' eye movements to teach skills and include music in the classroom to help students retain what is taught. Sousa (2001) outlines several techniques teachers can use to teach to both halves of the brain. These studies and others increased my interest in transforming my classroom into a brain-based classroom environment.

Furthermore, the research on what a brain-based classroom environment would look like revealed a classroom similar to the following description by Stover (2001). In this enriched classroom, children learned by tapping into their interests and motivations, lessons were cut short

and the types of experiences the kids had were varied. It was a place where students engaged in developmentally appropriate activities. Stover (2001) further describes another school, in Billings, Montana, with a brain-based learning environment as a school that put more emphasis on varied learning strategies, as they created "learning stations" to provide different instructional settings and tools for children to work with. They enriched the environment and gave the kids more choices, so they would be more intrinsically motivated to learn. Diamond (2001) outlines a recipe for an enriched environment that can lead to children's academic success. She describes an enriched environment containing the following: a steady source of positive emotional support- love, encouragement, warmth and caring; a nutritious diet; a stimulation of all the senses to develop all areas of the cortex; an atmosphere free of undue pressure and stress, yet is pleasurably intense; a series of novel challenges; allowance for social interaction for most activities; promotion of the development for mental, physical, aesthetic, social and emotional skills; opportunity for the child to choose activities; activities that allow the child to assess the results of his/her efforts and to modify them; promotes exploration and the fun of learning;

and activities that allow the child to be an active participant rather than a passive observer.

The research I found in the literature review gave many suggestions on how to use brain-based learning in the classroom, but still wasn't organized well enough for easy application by elementary teachers. In fact, each author I reviewed suggested using several different strategies in the classroom, but if teachers randomly apply these suggestions, they are still not using brain-based learning to its fullest potential. Through the required coursework for the master's program in Interdisciplinary Studies and through my research on brain-based learning, I was able to try many brain-based activities in my classroom, such as rearranging the classroom to optimize learning, making models of atoms with candy, student designed projects exploring various Native American tribes, creating mind maps to help students consolidate literature, integrating ideas throughout curriculum, and so on. However, these activities were very isolated in nature and I knew that I would need to transform the whole classroom into a brain-based learning environment if I wanted my students to enjoy all the benefits of brain-based instruction. Stover (2001) and Diamond (2001) give detailed examples of what a brain-based learning environment should look like,

but there doesn't seem to be any research that helps teachers easily transform their classrooms into brain-based learning environments as described by Stover and Diamond.

The general purpose of this project is to help teachers transform their classrooms into brain-based learning environments. The research from the literature review suggested many strategies for implementing brain-based learning in the classroom. However, if a teacher chooses to implement only a handful of the suggested strategies, the teacher would not see as many results in the classroom, as he or she would if the whole classroom was transformed into a brain-based learning environment. To accomplish my purpose, I decided that I needed to take the research from the literature review and create a set of guiding principles, based on the research of the brain (specifically the section on how to use brain-based strategies to help students learn), which will aid teachers in planning and implementing brain-based strategies in the classroom. The general significance of this purpose is that the set of guidelines (or checklist of tasks) will help teachers plan a brain-based learning environment in the classroom. Furthermore, the guidelines would need to be organized so that they were easily

implemented and sensitive to different teachers' needs. The guidelines can be useful because teachers do not need to read the literature review before they start applying brain-based strategies in their classrooms.

Some general limitations of this project include the fact that there is no uniform way to implement strategies, there are too many brain-based strategies to implement, teachers would not have enough time to plan activities around implementing specific strategies, and the set of guidelines assumes some level of experience of the teacher and a strong commitment to the process of transformation into a brain-based learning environment. Of course, how teachers integrate the brain-based strategies in their classrooms will vary considerably among learning environments. I noticed immediately after completing the set of guidelines that it would be next to impossible to do each task because of the amount of planning and preparation it would involve. However, teachers do not need to apply every strategy in the checklist to see results.

The chapters to come will outline the process of taking research on the brain and creating a way to transform a classroom into a brain-based learning environment. Chapter II will expose the literature review

under the topics: how the brain works, strategies for using brain-based learning to help students learn, and what a brain-based classroom environment should look like. Chapter III will discuss the methodology to achieve the purpose of the study, including the following steps: the review of the literature on how the brain works and strategies on teaching to how the brain learns, gathering notes from the research and creating a draft of the guidelines for designing a brain-based learning environment, giving the draft to teachers and professors for feedback, looking for patterns in the feedback of my draft and finally, based on the patterns found, rewriting the draft of the set of guidelines for planning a brain-based environment. Chapter IV discusses the results of implementing the steps of the methodology including an outline of the fourteen guidelines for designing a brain-based classroom and how the patterns in the feedback were used to revise the set of guidelines for planning a brain-based environment. Chapter V will outline the conclusion of this project including a summary of the process, brief discussions of the set of guidelines themselves, and recommendations for future studies.

# CHAPTER TWO

# LITERATURE REVIEW

## How can I use Brain-Based Learning in my Classroom?

### An Exploration of the Art

After countless lessons observed in my classroom I could hear the echo of my intern supervisor saying, "Good teaching is good teaching." I always thought, "Yeah, yeah, yeah, why doesn't he give me some new fresh ideas, like something brain-based." Guided practice, stretching breaks, the use of manipulatives, kinesthetic activities, and cooperative groups are the norm in my classroom. Summing up all the research I have collected, I discovered that applying strategies consistent with what scientists have found in brain research to our classrooms is something good teachers have been doing all along, but there are so many more strategies than one could imagine. Applying even a fraction of these strategies would require a process of transformation for any teacher willing to participate. Before we delve into the strategies that apply brain research, we need to explore the systems of the brain and how they work together. Understanding how the brain works is critical for teaching in a brain-based environment. After we explore the brain and its functions,

we will look at several brain-based strategies to apply in our classroom. Finally, we will glance at what these strategies look like in the classroom.

## How Does the Brain Work?

At the size of two clenched fists and "weighing as much as a head of cabbage" (Ornstein and Thompson, 1984, p. 21), the organ we call the human brain is nothing short of amazing. The resting brain uses ten times the oxygen and glucose as the rest of the body. Furthermore, though the brain weighs less than 2.5% of our total body weight, it uses 20% of the body's energy consumption. According to Stover (2002), the human brain triples in size between birth to ages nine through eleven, a child's brain uses twice the energy as an adult brain, there is a huge increase in a child's synaptic connections up to age ten and an even greater increase when one is in a stimulating environment.

> The brain chiefly regulates the body- controlling temperature, blood flow, and digestion; monitoring every sensation, such as breath, heartbeat, blinking, and swallowing, and directing movement. Those things that are thought to make us most human- language, thinking, perception, intelligence, consciousness-

represent only a small fraction of the brain's functions. (Ornstein & Thompson, 1984, p. 38)

Various structures of the brain come in pairs- the right and left hemispheres being the major structures. The left hemisphere of the brain governs the right side of the body and the right hemisphere is in charge of the left side of the body.

The left hemisphere is responsible for language processing (what was said), while the right hemisphere processes the emotional context of speech (how it was said). In most people, speech is produced in the left hemisphere. Damage to the left hemisphere often leads to deficits if not destruction of language ability. The right hemisphere "decodes the external information, allowing us to create an overall understanding of what is said or what we read. It enables us to 'get' a joke or to respond appropriately to a comment" (Wolfe, 2001, p. 46). The left hemisphere is "designed to process information that must be processed sequentially" (Sylvester, 1995, p. 50).

> Because we code most of our information into differing sequences of letters and words, not into the letters themselves, our left hemisphere is generally the principal processor of spoken, written, and signed language. Because a word packs

> considerable information into a few relatively similar sounds or symbols, our comprehension of it requires close attention to subtle shifts in sound and line orientation that are characteristic of left hemisphere processing. (Sylvester, 1995, p. 50)

Children with normal language skills have larger left hemispheres because their left hemisphere is more active than the right. However children with a language disorder have a balanced brain. Both hemispheres interacting with each other is needed for an activity as complex as language. "Although each hemisphere is specialized to handle different tasks, the division between them is not absolute- they are in constant communication with each other. Rarely are one hemisphere completely idle and the other frantic with activity" (Ornstein and Thompson, 1984, p. 38).

The left hemisphere analyzes the individual foreground elements of our sensory field by meticulously examining the lower contrast details of the stimuli. The right hemisphere synthesizes the background by gathering little bits of high-contrast information from individual units in our sensory field. It gives us a quick, general sense of what's out there and how all those units are related (Sylvester, 1995). The left hemisphere examines

"the details of an individual tree, while the right hemisphere monitors the entire forest" (Sylvester, 1995, p. 50). The right hemisphere is known as the metaphoric mind because it only provides us with the broad concepts that can be experienced and interpreted in many ways.

The right hemisphere processes the negative aspects of emotion, while the left processes the positive aspects of emotion. "By processing related information from different perspectives, the hemispheres collaborate to produce something that becomes a unified mental experience" (Sylvester, 1995, p. 49).

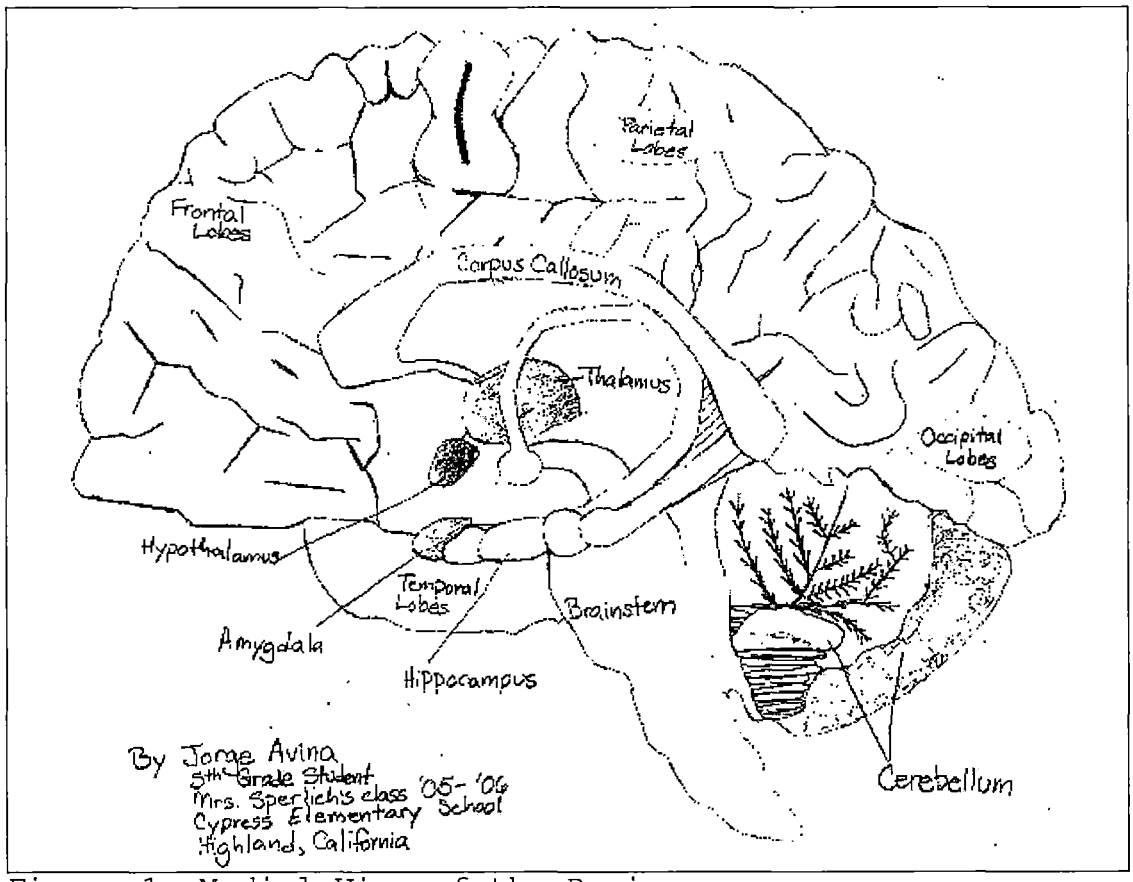


Figure 1. Medial View of the Brain

Joined by several bundles of fibers, the largest being 300 million axon, the corpus callosum is the bridge that connects both hemispheres of the cortex. The structures under cortex are responsible for alerting danger and opportunity, while the cortex decides the appropriate response. We'll explore the structures underneath the cortex first.

The brainstem controls our autonomic functions, such as breathing, heartbeat, and blood pressure. It does this

by a network of neurons called the reticular formation or RF. The reticular formation occupies the core of the brain stem. It also controls some eyeball movements, pupil constriction, stomach reflexes, facial expressions, salivation, and taste. The RF, neurons in the thalamus and other neurons from various sensory systems make up the reticular activating system or RAS. The RAS controls awareness levels and severe damage to the RAS can result in a coma. This system serves as an effective filter for thousands of stimuli constantly bombarding sensory receptors. It allows us to focus on relevant stimuli. "Like a telephone bell, the RAS alerts the cortex (the thinking area) in a general way about arriving information, such as 'visual stimulus on its way'" (Ornstein and Thompson, 1984, p. 25). The Pons or 'bridge', just below the midbrain relays information to and from the cerebellum. The final role of the brain stem is in the production of many of our brain's neurotransmitters, which hold the key to life itself.

The cerebellum is responsible for balance, the coordination of muscle function, body posture, position, and movement in space. During early childhood, when children learn basic movements, like walking and grasping, "The cerebellum stores these movement patterns in neural

networks and then, throughout life, calls upon them whenever they are needed. With proficiency, the cerebellum takes over much of the control, leaving the conscious mind free to do and think about other things" (Wolfe, 2001, p. 24).

The limbic system, made up of the hypothalamus and the thalamus, regulates perception and the body's vital functions. It plays a major role in storing memories of our life experiences. It is involved in emotional reactions having to do with survival, such as feeding, fighting, fleeing, and sexual reproduction. "Homeostatic mechanisms located in the limbic system regulate such functions as the maintenance of body temperature, blood pressure, heart rate, and levels of sugar in the blood" (Ornstein and Thompson, 1984, p. 27).

At the size of a pea and weighing four grams (Ornstein and Thompson, 1984), the hypothalamus is most important because it is the 'brain' of the brain. It is responsible for regulating eating, drinking, sleeping, waking, body temperature, chemical balances, heart rate, hormones, sex, and emotions. The hypothalamus is part of the autonomic system and along with the pituitary gland; it maintains the normal body state. It controls stimuli that underlie eating and drinking and helps regulate sex

drive, sleep, aggressive behavior, and pleasure. The hypothalamus also directs the master gland of the brain, the pituitary, which regulates body through hormones.

The thalamus helps initiate consciousness and makes preliminary classifications of external information. It controls the body's fight or flight response and almost all input, except olfactory, from sensory organs goes to the thalamus, which sorts the signals and sends them to receiving areas on the cortex.

The amygdala is also involved in the fight or flight response. It plays a major role in the control of emotion. All incoming sensory data, except smell, go first to the thalamus, which sorts the information and then sends it to the appropriate sensory-processing area of the cortex. At the same time, it sends the same information to the amygdala for evaluation. If the amygdala decides that stimuli is dangerous, it triggers the hypothalamus, which then sends messages to the body for action: heighten blood pressure, increased heart rate, and muscle tension (Wolfe, 2001). The amygdala also lays down unconscious memories and forms emotional memories that can trigger responses without the corresponding conscious recollections that tie responses to a particular event (Wolfe, 2001).

The hippocampus also plays a major role in storing memory. First it holds the memory of your immediate past, but eventually dispatches the memory to the cortex where it is stored in long-term memory (Wolfe, 2001). Once information is fully encoded into long-term memory, the hippocampus is no longer needed for the information to be retrieved.

Procedural memory does not require processing in the hippocampus (Wolfe, 2001). Also part of the limbic system, the basal ganglia is involved in bodily-kinesthetic intelligence and is closely interconnected with the cerebral cortex (Ornstein and Thompson, 1984).

Now let us explore the area of the brain "where decisions are made, the world is organized, our individual experiences are stored in memory, speech is produced and understood, paintings are seen, music is heard" (Ornstein and Thompson, 1984, p. 30)- the cerebral cortex. At one-eighth of an inch thickness, with six layers of cells, their dendrites, and some axons intricately folded, the cerebral cortex is "the executive branch of the brain, responsible for decision making and judgments on all information coming into it from the body and the outside world" (Ornstein and Thompson, 1984, p. 31). Compared with

any other animal, the human cerebral cortex is larger and more intricate.

Its functions sound simple, but combined with being able to do each task within a fraction of a second, one could only begin to ponder the complexity of this structure in the brain. "First, it receives information; it analyzes and compares this new information of prior experiences and knowledge, and makes a decision; it then sends its own messages and instructions out to the appropriate muscles and glands" (Ornstein and Thompson, 1984, p. 34). Also known as the neocortex, it is part of the brain that allows us to be aware, to recognize, and to talk about how we're thinking. "Most mental processes controlling and contributing to our conscious experience occur outside our conscious awareness. We are consciously aware of only a small part of what is going on inside our brain" (Wolfe, 2001, p. 31). The neocortex operates at the conscious level. "It is in the cortex that consciousness- our ability to be aware of what we are thinking, feeling, and doing- emerges" (Wolfe, 2001, p. 40).

Located at the back of the cerebral cortex the occipital lobe is devoted entirely to vision. Damage to this area can result in blindness even if the rest of the visual system is unaffected. First, visual stimuli are

related through the thalamus. When the visual stimuli first gets to the visual cortex it is processed in the primary visual perception area where millions of neurons are further sorted into areas designed to process various aspects of vision. Neurobiologists have spent the last two decades mapping the visual cortex into motion-sensitive cells, color-sensitive cells, and straight-line cells. There are also areas for general scanning, stereovision, depth, distance, and object detection. Second, once incoming information has been perceived or assembled in these areas, it travels to the visual association area, which compares the information with what you've seen before. The visual perception area allows you to perceive the actual object, and then the visual cortex communicates with other brain systems to determine what you have already stored visually. "Visual stimuli do not become meaningful until the sensory perceptions are matched with previously stored cognitive associations" (Wolfe, 2001, p. 34).

The temporal lobes, located on both sides of the brain just above the ears are composed of several subdivisions that cope with hearing, language, and some aspects of memory, particularly auditory. The lobes are mostly dedicated to processing auditory stimuli. Hearing

is the most important sense in humans. It allows us to communicate and gives us information necessary for survival. The temporal lobe uses two major regions to process hearing. "When the primary auditory region of the temporal lobe is stimulated, sensations of sound are produced. In addition, an auditory association area has links to the primary region and other parts of the brain and aids in the perception of auditory inputs, allowing us to recognize what we are hearing" (Wolfe, 2001,p. 34). Within these two regions, groups of neurons register a sound's loudness, pitch, or timbre. "When the temporal lobe is electrically stimulated, some people report the feeling of being in two places at once: the memory of an event and the present *coexist* in the person's consciousness" (Ornstein and Thompson, 1984, p. 36).

Where the left occipital, parietal, and temporal lobes meet, is a group of cells called Wernicke's Area. This is the enlarged area involved in speech and written language. It allows us to comprehend or interpret speech and to put words together in correct syntax when speaking. Located at the top of the brain almost enclosed by the occipital lobe and the temporal lobes are the parietal lobes. This is where we assemble our world. "It is probably here that letters come together as words, and

words get put together in thoughts" (Ornstein and Thompson, 1984, p. 36). Towards the front of the parietal lobe, sandwiched behind the motor cortex is a strip of cells called the somatosensory cortex. This strip of cells receives information about body position, muscles, touch, pressure from all over the body and environmental temperature, while the motor cortex controls the movements of the body. "Information about the status and condition of different parts of the body is represented in corresponding parts of the brain, although the area in the brain devoted to one part of the body or another is not in direct proportion to the physical area of the body. The reason for this is that the more the function is used, the more space is given to it in the brain" (Ornstein and Thompson, 1984, p. 37). The rear of the parietal lobes continuously analyzes and integrates all this information to give you a sense of spatial awareness. "The brain must know at all times where each part of the body is located and its relation to its surroundings" (Wolfe, 2001, p. 37). It maintains focus or spatial attention. When we focus on something in particular, or when our attention shifts from one location to another, activation of the parietal lobes can be seen through brain-imaging

techniques. As a stimulus becomes less meaningful, attention fades.

The frontal lobes, occupying the largest part of the cortex, have an especially rich connection with the limbic system, which makes the initial appraisal of whether an event is threatening or dangerous. The frontal lobes are primarily involved in planning, decision-making, and purposeful behavior. Our abilities to move parts of our body at will, think about the past, plan for the future, focus your attention, reflect, make decisions, solve problems, and engage in conversation are all due to our frontal lobes. They allow you to be consciously aware of all these thoughts and actions. "If destroyed or removed, a person becomes incapable of planning, carrying out, or comprehending a complex action or idea, and unable to adapt to new situations, such people are unable to focus attention and are extremely distracted by irrelevant stimuli" (Ornstein and Thompson, 1984, p. 36). This is the area that lights up more during silent reading, than reading aloud. The frontal lobes primarily are responsible for cognition and sensorimotor processing.

Toward the back of the frontal lobes is a strip of cells that stretches across the top of the brain above the ears. This strip is called the motor cortex, which is

where most neural activity directing muscular movement originates. "Similar to the somatosensory cortex, every part of your body, from your toes up to your lips, has a corresponding region in the motor cortex, but all parts of the body are not equally represented" (Wolfe, 2001, p. 40). Areas controlling fine motor movements are disproportionately large. Broca's Area, located in the left hemisphere of the motor cortex in most people, allows you to produce speech. Broca's Area is connected to Wernicke's Area by a bundle of nerve fibers. "This linkage is important because in order for speech to be uttered, its form and the appropriate words must first be assembled in Wernicke's Areas and then relayed to Broca's Area to be translated into the proper sound" (Wolfe, 2001, p. 40). The information is then passed to the motor cortex for vocal production. The motor cortex is the area of the brain that glows during a read aloud.

The prefrontal cortex is known as the association cortex. It is larger in humans than any other species. "It is here that information is synthesized from both the inner and outer sensory worlds, that associations between objects and their names are made, and that the highest forms of mental activities take place" (Wolfe, 2001, p. 42). The prefrontal cortex is critical for emotional

self-regulation. The orbitofrontal cortex has the responsibility for evaluating and regulating the emotional impulses emanating from the lower centers of the brain (Wolfe, 2001). No structure works alone in this complex system.

"The major portion of the brain's development occurs outside of the womb; it is exposed to and influenced by many different environments, experiences, and people" (Ornstein and Thompson, 1984, p. 39). Environmental conditions play a greater role in the development of the human brain than in any other primate. In fact, growth of the brain depends much on how adequately stimulating the early environment is. There are more connections and neurons in the brain of an infant than in an elderly adult. "Development seems to be more of a matter of 'pruning' those original connections than of making any new ones" (Ornstein and Thompson, 1984, p. 166).

We have just explored an overview of the brain: its structures and their functions. Now we must explore the most minuscule, yet highly complex cells in the brain that indeed, make the brain nothing short of amazing: the neuron. "The kind of creature we are, whether a simple reflex machine like the sea anemone or a being with the truly awesome power of the human mind, is determined by

the number of neurons and how they are put together" (Ornstein and Thompson, 1984, p. 73). "There are perhaps about one hundred billion neurons, or nerve cells, in the brain, and in a single human brain the number of possible interconnections between these cells *is greater than the number of atoms in the universe*" (Ornstein and Thompson, 1984, p. 21). Neurons cannot reproduce because if they were ever to divide and produce new neurons, the synaptic patterns and connections would be lost. Their job is to process information and convey it to other neurons in the brain to generate behavior and experience. "The neuron receives information at its dendrites, processes it in the cell body, and sends it out to other neurons and cells along its axon" (Ornstein and Thompson, 1984, p. 67). Neurons send and receive information across the synapse.

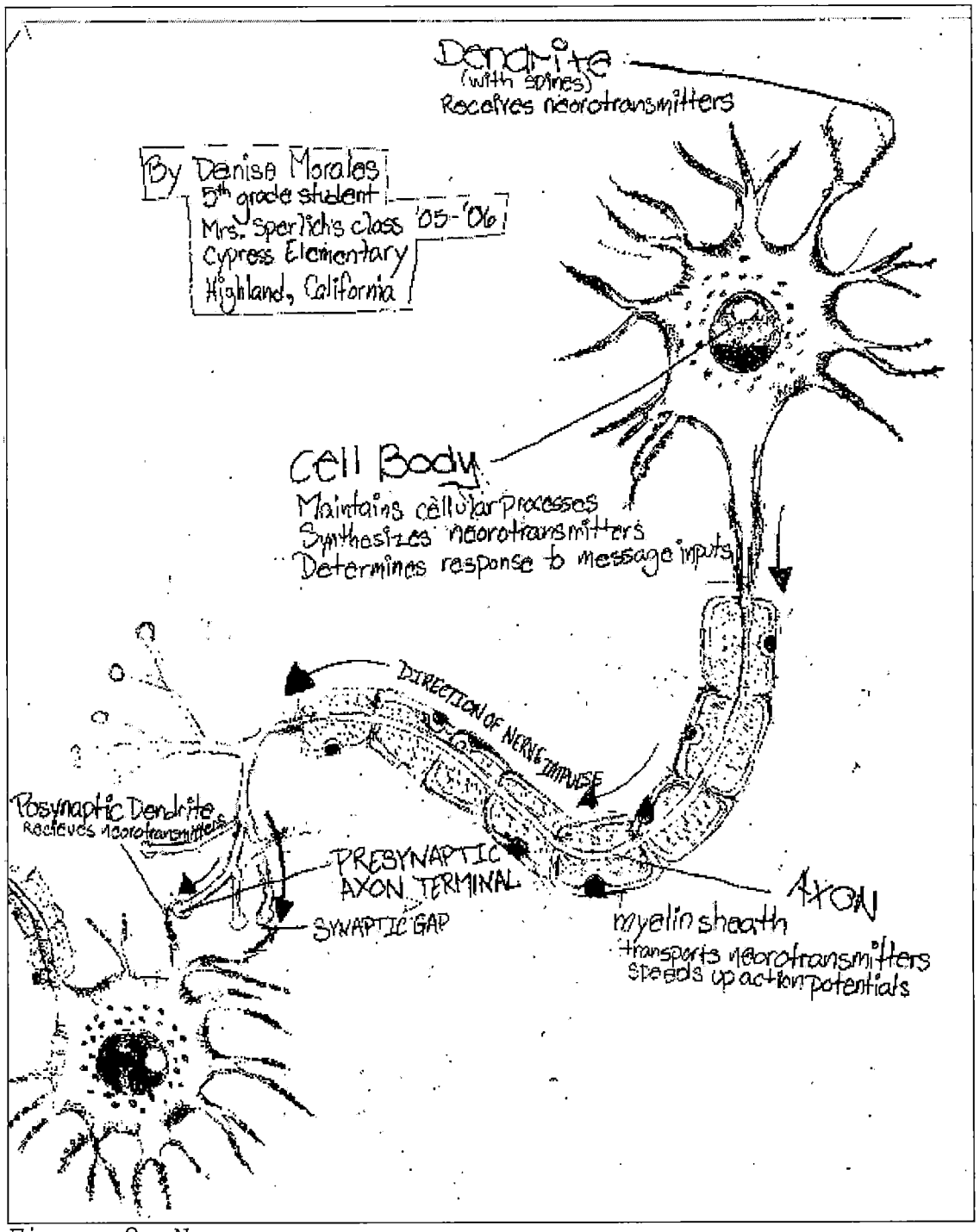


Figure 2. Neurons

A synapse is a connection where one neuron communicates with another. It is the most important part of the neuron. "A given neuron in the brain may have several thousand synaptic connections with other neurons, and in turn make synaptic connections to many other neurons" (Ornstein and Thompson, 1984, p. 68). The number of possible synaptic connections among nerve cells in a human brain is practically limitless.

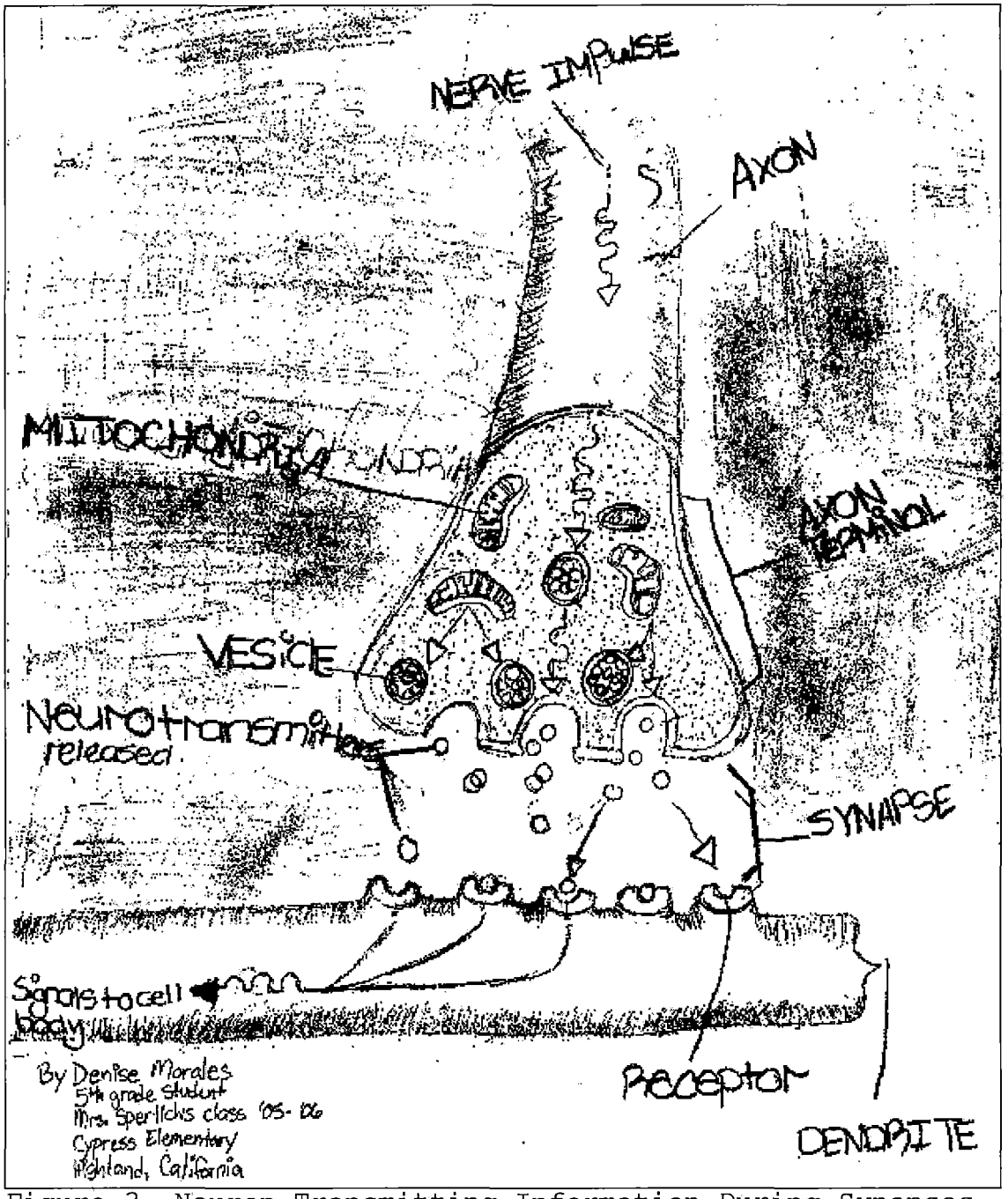


Figure 3. Neuron Transmitting Information During Synapses

Communication among neurons is done through nerve impulses, which are called action potentials. They develop

in the axon and then travel out the axon to the axon terminals that form synapses on other neurons. There it transmits information across the synapse to the target neuron. How fast the nerve impulse moves down the axon can range from one mile per hour to 150 miles per hour depending on the size of the axon and other properties (Ornstein and Thompson, 1984).

When the nerve impulse arrives, large openings develop in the terminal, and a hundred or so of the vesicles dump out a few thousand neurotransmitters. The amount of synaptic transmission can depend on the number of neurotransmitters released and the quantity of synapses on a neuron that are active at that moment (Ornstein and Thompson, 1984).

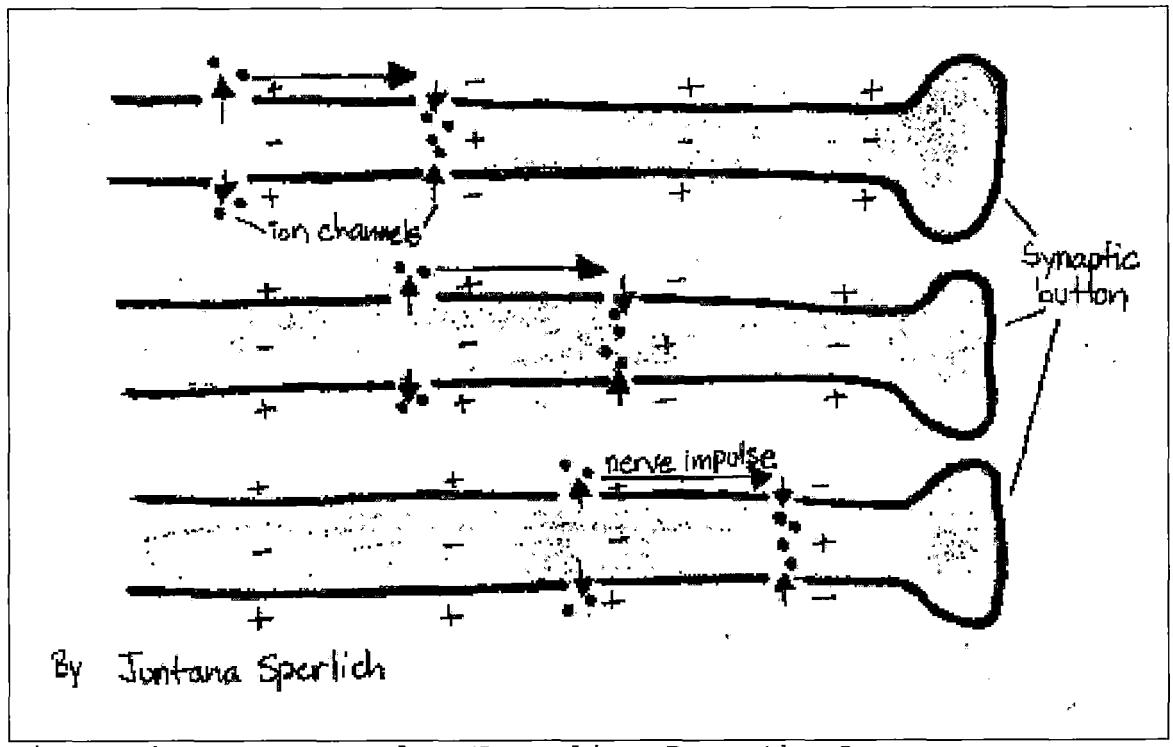


Figure 4. Nerve Impulse Traveling Down the Axon

The fluid outside of the action potential has quite a bit of sodium. An action potential is just movement of sodium molecules across the cell membrane from the outside to the inside through the little channels along the axon membrane. Sodium particles called ions have an electrical charge. The inside of the axon is negative compared to the outside with a voltage difference of nearly a tenth of a volt. "If we could hook up a few nerve cells together in the right way they would have as much voltage as a flashlight battery, even though the nerve cells are very tiny" (Ornstein and Thompson, 1984, p. 77). A neuron at

rest has almost all the sodium ions on the outside of the cell.

When the action potential develops at any point on the axon, the sodium channel gates in that spot open briefly and sodium ions rush in. A nerve impulse is a brief confined inrush of positively charged sodium ions. "When the nerve impulse occurs at one place on the axon membrane (and it occurs all the way around the axon membrane at that place), the closed gates on sodium channels, which are voltage-controlled just like electrical switches, pop open briefly and the nerve impulse moves to this next place, and so on all along the axon. This is how the nerve impulse travels along the axon" (Ornstein and Thompson, 1984, p. 77). The closed gates on the sodium channels pop open because the inside of the axon becomes slightly more positive than its normal resting value. The process of the action potential starts at the cell body when the membrane potential gets more positive charge inside than when at rest, which triggers the nearest sodium channel to pop open first.

Neurotransmitter and receptor molecules will either excite or inhibit the neural activity. Synaptic actions are graded from no action to a large action. "If enough of these synaptic excitations occur to reach threshold, the

sodium gates at the beginning of the axon are triggered to open and the nerve impulse develops" (Ornstein and Thompson, 1984, p. 79). The neuron decides to generate an all or nothing action potential and the whole process is repeated. If there is not enough synaptic excitation the neuron decides not to generate an action potential. Synaptic excitation and synaptic inhibition are the two basic synaptic actions on neurons.

Neurons talk to each other by releasing neurotransmitters at the synapses. The neurotransmitter is the ultimate unit of action in the nervous system. "Our 'gut feelings' are more than mere metaphor… the mental and the physical, the mind, the brain, and the body, are intrinsically linked by means of these chemicals" (Wolfe, 2001, p. 65). Neurotransmitters are made up of amino acids, which we get from the foods we eat. Sodium, chloride, potassium, and calcium are the only ions involved in neural activity. Each neurotransmitter has a particular shape that fits into the receptor molecules, much like a key fitting into a lock. Some receptor molecules open sodium channels causing the target cell to become excited and therefore initiating an action potential, while others open chloride channels, therefore

inhibiting an action potential (Ornstein and Thompson, 1984).

The second-messenger system can act on the DNA of the neuron to cause long-lasting or perhaps permanent changes. This only works if the first-messenger molecules (neurotransmitters) join with them or when drugs that mimic the first-messenger molecules combine with them. If the molecule fits, the receptor will attach it and be triggered into action. "This is the main reason why small amounts of drugs have powerful effects on the brain- they have shapes that resemble the shapes of normal neurotransmitters and fool the receptors into believing they are the real thing" (Ornstein and Thompson, 1984, p. 85). "The receptor molecule is the only lock that can be opened by the neurotransmitter that has the right shape, the key molecule" (Ornstein and Thompson, 1984, p. 94).

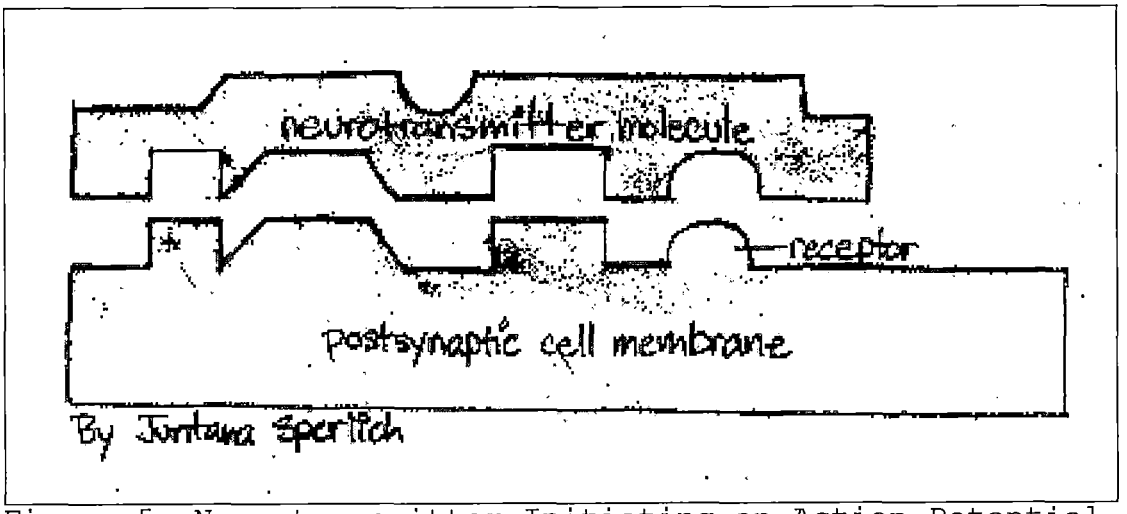


Figure 5. Neurotransmitter Initiating an Action Potential on a Receptor Molecule

Though we are born with all the neurons we will ever have in life, new synapses (connections among neurons) do grow and develop throughout life. Experience itself can cause new synapses to grow, therefore shaping the brain. "It is as if the forest of nerve cells became literally enriched, and the density of the branches increased; this is what produced a bigger brain" (Ornstein and Thompson, 1984, p. 167). The human brain is highly adaptive, as we continue to learn throughout our lives even well after the developmental stage for a particular type of learning has passed.

Though for the longest time, the connections and firing of neurons have been considered the biological basis for thought; we now believe that the brain is not

just the only source of thought, but rather the amplifier of it. "A thought is energy that causes the neurons in the brain to fire in a certain pattern" (Clark, 1986, p. 15).

We have just dissected the brain and examined its structures and their functions down to the tiniest cell in the brain. Now that we have a rough understanding of how the brain works, we will now look at a process of the brain that is the foundation of who we are and why we do what we do- memory. The brainstem, cerebellum, amygdala, and hippocampus play critical roles in processing information and forming memories, but we are not consciously aware of all this. "Memory is what enables us to learn by experience" (Wolfe, 2001, p. 74). It is essential to our survival. "Experience changes the way synaptic connections are made and increases the probability of firing in a predictable association with other neurons" (Wolfe, 2001, p. 76).

Memory begins with sensory input from the environment. Sensory memory takes in information from the senses, holds it for a fraction of a second until a decision is made about what to do with it and then either discards it, or sends it on for further processing. Note that "the brain is sometimes referred to as a sponge that soaks up information, but a better metaphor would be a

sieve: By some estimates, 99 percent of all sensory information is discarded almost immediately upon entering the brain" (Wolfe, 2001,p. 79). "All sensory data, except smells, travel first to the thalamus. From there the data are relayed to the specific portion of the cortex designated to process sight, sound, taste, or touch. As information travels from the sensory receptors to the site where it is processed, it is, in a sense, transformed. It changes from a photon of light or a sound wave into a percept. We do not 'see' the photon of light or the sound wave per se, we *perceive* a figure or a sound, and the perception is uniquely shaped by that perceiving mind at that moment" (Wolfe, 2001,p. 80).

Perception is the meaning we attach to information as it comes from our senses. "Our eyes may capture an image in much the same way as a camera, but what we see (or perceive) is influenced by the information we already have stored in our brains" (Wolfe, 2001, p. 80). Depending on our prior knowledge and what we see, meaning is assigned. "The brain checks the existing neural networks of information to see if the new information is something that activates a previously stored network" (Wolfe, 2001, p. 81). Matching new input to stored information is called pattern recognition and is critical for attention.

All humans have virtually perfect photographic memories, but it only lasts for one-tenth of a second. Even young children have photographic memory, but it is lost at the time they begin learning to read. Newly formed memories are delicate and easily disturbed, while older memories are almost impervious to anything short of brain damage. Bring to mind that memory is a process, not a thing. New memories need some time to wear in or consolidate into permanent memory traces. Extensive memorizing of material may actually decrease the ability to memorize additional information, but "rehearsing experiences or information strengthens or deepens the impressions, resulting in information that is more easily remembered" (Wolfe, 2001, p. 75).

In order for us to remember anything, we need to pay attention to it. Attention is selective. Here is how it works. The brain, through automatic mechanisms, constantly scans the environment. Recall that the RAS mostly filters thousands of stimuli and focuses on relevant data, discarding trivial information. Your brain unconsciously takes over the initial decision-making process for you. Novelty is a key component in the filtering process in that it is an innate attention-grabber. However, having novel experiences on a daily basis leads the brain to

habituation and it will eventually ignore the novel stimulus. Another attention-grabber is the intensity of the stimuli, be it loudness, brightness, and so on. Movement also influences attention. It is possible to influence what the brain pays attention to by using novelty, intensity, or movement, but in the classroom, none of these will prove useful over time because of habituation (Wolfe, 2001). This is the reason why flicking the lights to get the class' attention is not as effective later in the school year. The two factors that strongly influence whether the brain will attend to input and whether the attention will be sustained, are meaning and emotion (Wolfe, 2001).

The neural networks of the brain examine sensory stimuli as soon as they enter the brain to see if they form a familiar pattern. "If they do, a match occurs, and the brain determines that the new visual stimuli are familiar" (Wolfe, 2001, p. 84). Therefore the new information makes sense and has meaning. If there is no match, the brain attends to the meaningless information for a short time because it is novel, but if it makes no sense, the brain will probably cease to process it any further. Though for years it was thought that information was processed only from our senses to the associative

areas of the brain for interpretation and action, we now know that the brain continues to actively shape what is picked up by the senses almost from the beginning rather than by simply recording and processing information from the environment. "Every time we recall information from long-term storage into working memory, we relearn it" (Sousa, 2001, p. 125).

Quite often teachers go against the natural grain of our memory systems. They require long periods of sustained attention from students when teaching concepts the students know nothing about. "Sustained attention on something that you can't figure out that makes no sense is not only boring, it's almost impossible" (Wolfe, 2001, p. 84). The teachers get so frustrated when they ask these students to perform and the students have no clue where to begin, though the teacher just spent at least half an hour explaining how to do the task at hand. "You cannot reconstruct or reactivate a neural circuit or network if it was never activated in the first place" (Wolfe, 2001, p. 85). If our brains cannot find previously activated networks into which the new information can fit, we will most likely not attend to it and the information will be discarded as meaningless. If students are not paying

attention, they are not engaged; therefore they are not learning.

## How can Teachers use Brain-Based Learning to Help their Students Learn?

We have examined how the brain works in terms of survival and memory. Now we will dive into what is at the heart of all teaching- how we can help our students learn. We will then explore many strategies for brain-based learning. "Learning is the brain's primary function, its constant concern, and we become restless and frustrated if there is no learning to be done. We are all capable of huge and unsuspected learning accomplishments without effort" (Caine, 1991, p. 79). Assuming that learning takes place mainly by memorization of facts and skills is like looking at the moon and believing you have understood the whole solar system (Caine, 1991).

Biological rhythms greatly impact our ability to learn. Through the study of bio-cognitive cycles, we have found that one of our brain's major cycles is about ninety minutes. Overall intellectual performance peaks in the late afternoon and our comprehension increases as the day progresses, but our reading speed decreases. Short-term memory is best in the morning and least effective in the

afternoon, while long-term memory generally is best in the afternoon (Jensen, 2000).

Movements such as stretching or marching can help refocus students' attention and they should be encouraged to stand and stretch unobtrusively if they feel drowsy (Jensen, 2000). Exercises that encourage cross lateral movements of the limbs stimulate both sides of the brain and energize thinking. For example, to maintain attention, teachers should vary presentation and lecture times, while including sessions with activities that provide movement.

Researcher J. Oakhill of the University of Sussex found that in the morning we favor literal (facts, names, numbers, formulas, etc.) memory, while in the afternoon our brain is better at integrating new information with prior learning (Jensen, 2000). Tasks that require rote learning, spelling, problem-solving, test review, report writing, math, theory, and science are most efficiently learned between nine a.m. and noon, while movement-oriented tasks, paperwork, manipulatives, music, computer work, singing, and art are best learned between noon and two p.m. Between two and five p.m., it is best to study literature and history, and do sports, music, theater, and manual-dexterity tasks.

The brain's external to internal shift is regular and automatic. "This shift of focus seems to be a critical element in: 1) maintaining understanding; 2) updating long-term memories; and 3) strengthening our neural networks" (Jensen, 2000, p. 127). In other words, our brain needs time to go in and link up the present with the past and the future and without this time, learning drops dramatically. Teachers must pay attention to students and not assume that a student is goofing off, particularly when a good student is not paying attention. It could be that something has triggered their memory or shifted their focus inward (Jensen, 2000).

Learning occurs best when focused, relaxed from concentration, and then focused again. "Constant focused learning is increasingly inefficient. In fact, the whole notion of 'time on task' is in conflict both biologically and educationally with the way the brain naturally learns" (Jensen, 2000, p. 48). "Requiring learners to be attentive for a long-period of time is counterproductive, since much of what we learn cannot be processed consciously: It just happens too fast. Internal time is needed to process it and create meaning, as meaningfulness is a process generated within each individual. This 'down time' after each new learning experience will also reinforce the

'imprint' on our memory" (Jensen, 2000, p. 48). With young learners, content, lectures, and cognitive activities should be limited to periods of five to ten minutes each. With adolescents, these content sessions should be ten to fifteen minutes and adults should be no more than twenty-five minute sessions.

The use of novelty can have a great impact on getting the students attention. "Any stimuli introduced into our immediate environment, which is either new (novel) or of sufficiently strong emotional intensity (high contrast), will immediately gain our attention" (Jensen, 2000, p. 122). Jensen suggests that teachers hook students into learning by giving them more control, letting them create classroom rituals, projects, rules, procedures, and consequences. We should let students choose their curriculum and ensure the classroom climate reflects a sense of freedom, individual expression, and choice. Teachers need to capitalize on the brain's bias for high contrast by being outrageous, funny, or different. Lastly, teachers should encourage group work, as the novelty and variation of others increases learner momentum and relevance (Jensen, 2000).

Emotions play a major role in the learning process because "Emotion drives attention and attention drives

learning" (Wolfe, 2001, p. 86). It starts with the thalamus, which receives input and sends it to the appropriate part of the cortex for further processing. Simultaneously, the information is also sent to the amygdala, which determines the emotional relevance. Is this stimulus something I find objectionable or is it something I like? Meanwhile, the cortex processes the incoming stimuli rationally, so as to place it in a context that makes sense, and then it decides what to do with the information. Now the pathway from the thalamus to the amygdala is much shorter-only one synapse away, than the pathway from the thalamus to the cortex. The cortex gives us a more accurate representation of the stimulus, but it takes much longer. This is probably why we react to situations at first and then rationalize them. "The brain is biologically programmed to attend first to information that has strong emotional content" (Wolfe, 2001, p. 88). We are actually programmed to remember this information longer.

The brain, mind, body and emotions form a connected system. If we take emotion out of the mix, faulty cognition can occur. According to psychologist Jerry Levy, of the University of Chicago, the brain operates at its best when the emotional and cognitive systems are being

challenged. This allows physical and intuitive involvement and results in great motivation by the learner (Clark, 1986). Emotions or "arousal" are important in all mental functions and contribute greatly to attention, perception, memory, and problem solving. Without "arousal" we don't pay attention to details and fail to notice what is happening around us. Emotions not only occur in our brain, but also all over our bodies. "What we experience as an emotion or feeling is also a mechanism for activating a particular neuronal circuit- simultaneously throughout the brain and body- which generates a physiologically-based behavior" (Jensen, 2000, p. 199). A learner must also feel that something is true before they can actually believe it. "Once a learner has experienced learning in their preferred modality, the right number of times, and for the right length of time, they will feel that it is now true" (Jensen, 2000, p. 210).

Our logical side is responsible for setting a goal, while our emotional side provides the passion to persevere through difficult times. "Our emotions help us to focus our reason and logic" (Jensen, 2000, p. 199). The amygdale's main task is to bring emotional content to memory. Connected to the hippocampus, it does not process memory, but is the source of emotions that permeates

memory with meaning. Emotions bind the learning. They help us determine what is real, what we believe and what we feel. They activate long-term memory chemically through releasing neurotransmitters. Emotions help us make faster decisions by using non-conscious and "gut feelings". They help us make better quality decisions by engaging our values (Jensen, 2000). Jensen wrote in 2000 that we remember things that are mostly emotion-filled best because:

1. Emotional events receive superior processing.
2. The brain is over-stimulated when strong emotions are present.
3. Emotions give us a more stimulated and chemically charged brain, which helps us recall things better.
4. The more intense the amygdala arousal, the stronger the impression on the brain.

We need to help learners understand the importance of their own emotions in the learning process by: being a role model; having celebrations; giving opportunities for controversy through debates, dialogue, and game shows; physical rituals, like clapping patterns, chants, movements, or theme songs; and introspection through journals, small-group discussions, and reflection tasks

(Jensen, 2000). In classroom environments that have positive challenge and joy, the body releases endorphins, which are the neurotransmitters responsible for 'runner's high' (Jensen, 2000).

Things that are presented at the beginning of a lesson are the most memorable, followed by the things that are presented at the end, and lastly by the things that are presented in the middle (Jensen, 2000). This is because attentional bias occurs at the beginning and end of a lecture. At the beginning of a lecture, novelty is inherent and by the end there is an emotional release. Both foster chemical changes in the brain. Robert Glenn in 2002 suggested that teachers take advantage of the 'beginning and the end of the lesson' in executing the main points of the lesson and save the details and elaboration for the middle of the lesson, as the beginning and the end of a lesson are the times in which most of the learning occurs- while the middle is considered down time. "The primacy-recency effect describes the phenomenon whereby, during a learning episode, we tend to remember best that which comes first, second best that which comes last, and least that which comes just past the middle" (Sousa, 2001, p. 120). After getting the students focused, we can teach the new material first. We must avoid asking

students at the beginning of a lesson if they know anything about the topic being introduced. We also must use the beginning of the lesson strictly for teaching the new material, not for classroom management tasks, like collecting homework. We can use the middle of the lesson to have students practice the new learning or to discuss it by relating it to their past learnings. Since that last part of the lesson is our last opportunity to attach meaning to the new learning, we should do a closure activity then. Teachers need to try to package lesson objectives in teaching episodes of about twenty minutes.

To increase memory, storage, and retrieval, Jensen (2002) gives us a few ideas in the following list:

- Increase the use of storytelling, visualizations, and metaphors in your presentations.
- Attach a strong emotion to new learning with a purposely-designed intense activity.
- Review or repeat new learning within ten minutes; then after two days, and again after a week.
- Attach concrete reminders of the new learning, like an artifact.

- Attach an acrostic to new learning and other mnemonic devices.
- Put new learning on large, colorful posters and hang it up.
- Ask students to identify patterns and connect them with prior knowledge.
- Have students summarize new learning with a mind-map.
- Increase accountability with frequent reviews and "check-ups".
- Facilitate frequent group discussions on new material.
- Incorporate journal writing and other forms of personal reflection.

We as teachers need to make as many connections as possible; creating patterns when we can and linking prior knowledge with new information. "Our students are bringing a survival-oriented genetic blueprint to 'work' each day. It's up to us to create the conditions whereby their brain will 'choose' or 'select' the learning that will best enhance their chances of survival" (Jensen, 2000, p. 5). "Neurons that fire together, survive together, and wire together" (Wolfe, 2001, p. 76). We often prepare our

brains to pay attention to certain stimuli over others, such as looking for a friend in a crowd of people or, when directed by the teacher, to see a shape of a certain color among a large number of differed colored shapes. This is why we tell our students our learning objectives. "It allows the brain to anticipate the critical features or ideas and increase the likelihood that the brain will focus on the essential information" (Wolfe, 2001, p. 34).

The ability to retain information depends on an individual's exposure to new skills or knowledge, as well as interactive or project oriented lessons (Stover, 2001).

We need to put more emphasis on teaching to both halves of the brain since they work together most of the time. There is no such thing as right-brain learning or left-brain learning, only preferences where one hemisphere may be activated more than the other. Our brain is highly interactive, which makes us neither left-brain oriented or right-brain oriented, but whole brain oriented. The left-brain processes parts sequentially, while the right brain processes wholes randomly. Jerry Levy, PhD of the University of Chicago, found in 1985 that both sides of the brain are involved in almost every human activity, but the timing and degree of involvement are very important factors. "Content (the text in which the left hemisphere

excels) is important, but text without context (the specialty of the right hemisphere) is often meaningless. We need to teach content within a context that is meaningful to students, and that connects to their own lives and experiences. This is teaching to both halves of the brain. If we don't connect the curriculum to the learner's experience, much of the information gets lost, and we waste time having students engage in meaningless memorization rituals" (Wolfe, 2001, p. 48).

It is our primary responsibility, as teachers, to provide a psychological and physical climate in which to orchestrate learning. The graphic organizer below and the following paragraphs highlight what is needed to create such an environment.

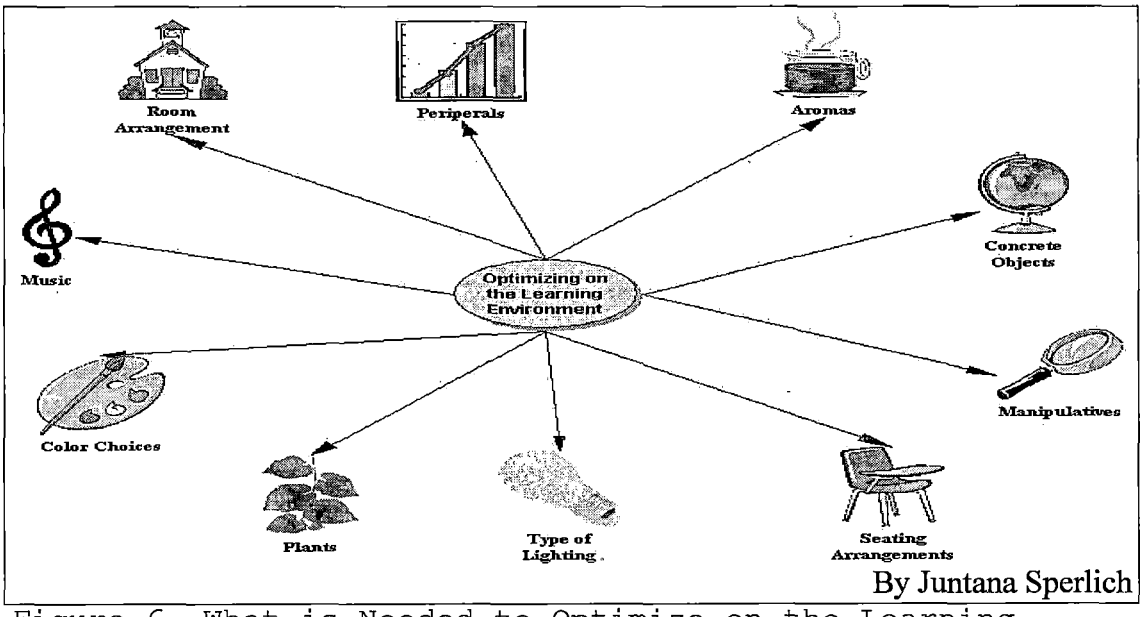



Figure 6. What is Needed to Optimize on the Learning Environment

Lights should be kept on to prevent the secretion of melatonin, which induces sleep. Soft, natural lighting is best for learning. Most teachers do not have a choice of what kind of lighting is in their classroom. Florescent lighting is actually the most detrimental to the learning environment. Teachers can bring in lamps with soft, natural lighting to soften the effects of florescent lighting.

Our eyes are capable of registering 36,000 visual messages per hour, and we take in 80 to 90 percent of all information through our eyes. We can attract the brain with movement, contrast and color changes. Jensen (2000)

suggests that we move around the room and increase and decrease our distance from our students. We can turn the lights off for a moment of group introspection, pass objects around for learners to touch and feel, color code boxes of materials for easy access and turn transparencies into colorful images.

Every color affects our body and brain differently. How it affects each person depends on one's personality. Bright colors, like red, orange, and yellow spark energy and creativity, but may increase aggressive and nervous behavior. Dark colors, like blue and green lower stress and increase feelings of peacefulness. Brown promotes a sense of security, relaxation, and reduces fatigue. In the classroom, some of our bulletin boards should be yellow, light orange, beige, or off-white, as these colors optimize learning by stimulating positive feelings (Jensen, 2000).

Concrete vivid images, such as high contrast, novel, symbols, icons, and other simple images are most influential. In the classroom, working models, project-based assignments, varied information mediums (videos, books, computers, cameras, etc.) and several art supplies make for productive learning and a happy brain. "Visuals are an important key to remembering content. Make

lectures or presentations more compelling to the brain with objects, photographs, graphics, charts, graphs, slides, video segments, bulletin board displays, and color" (Jensen, 2000, p. 59). "With direct instruction only, audience recall drops quickly, but with the addition of peripherals, effortless, subject-specific, longer-lasting recall is generated" (Jensen, 2000, p. 60). Enhance the visual environment of the classroom by adding interesting collections, photos, objects, and bulletin boards.

The Federal Clean Air Council found that plants raised indoor oxygen levels and increased productivity by ten percent (Jensen, 2000). "According to Dr. Wolverton, (of NASA) the best plants for optimal air cleansing and oxygen enhancing indoor learning environments are areca palms, lady palms, bamboo palms, rubber plants, gerbera daisies, yellow chrysanthemums, ficus benjamina, philodendrons, dracaena deremensis, and peace lilies" (Jensen, 2000, p. 66).

Some aromas can inspire individuals to set higher goals, take on greater challenges, and get along better with others, as well as enhance learning. The greatest learning effects came from a peppermint odor, according to several experiments on rats, (Jensen, 2000). "Alan Hirsch,

a Chicago neurologist, found that certain floral odors increase the ability to learn, create, and think" (Jensen, 2000, p. 67). "Research suggests that peppermint, basil, lemon, cinnamon, and rosemary enhance mental alertness, while lavender, chamomile, orange, and rose calm nerves and encourage relaxation," (Jensen, 2000, p. 67).

Besides creating an environment that optimizes brain-based learning, we need to consider some basic essentials the students need met before they even enter the classroom, like good nutrition, sleep, and so on. Teachers really have no control over these elements, but they can at least make the students and parents aware of these basic needs and help parents realize the importance of meeting these needs in order to help their students learn. The illustrations below suggest a complete list of essentials needed to prepare students to learn, plus some other necessities the teacher can help to provide, like teaching study skills and front loading the learner, in order to maximize learning for each student.

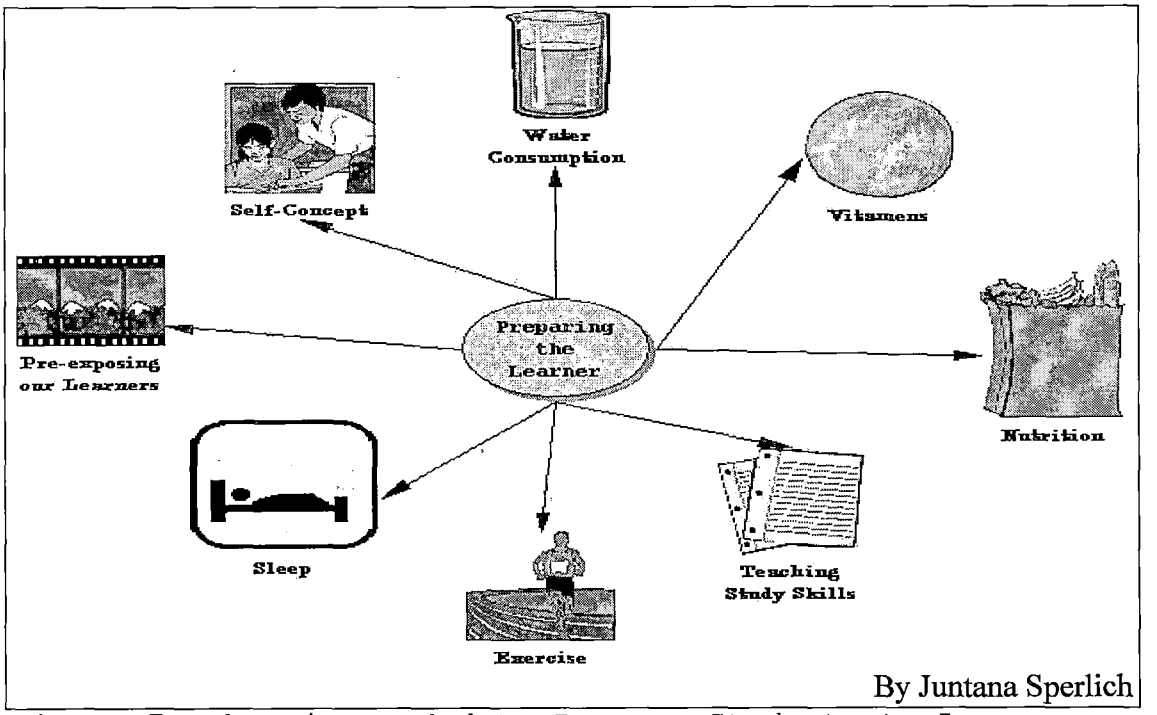


Figure 7. What is Needed to Prepare Students to Learn

Remind learners to drink water on their breaks and allow having water bottles. Students who are bored, listless, drowsy, and lacking concentration may be dehydrated, (Jensen, 2000).

Sleep is essential to learning. "The more complicated and complex the material, the more important sleep is to the learning of it" (Jensen, 2000, p. 51). Sleep actually provides the time for your brain to do its "housekeeping"- rearrange circuits, clean out unnecessary connections, and process emotional events.

Good nutrition promotes the healthy function of neurons. Your brain's most critical need is oxygen and

glucose, which comes from foods rich in nutrients. Second, your brain needs pure water everyday for optimal learning (Jensen, 2000). "The actual transmission of neurons is dependent upon the polarity of each cell and that's influenced by calcium, potassium, and water" (Jensen, 2000, p. 76). Dr. Wurtman of MIT says that proteins set the stage for learning and have positive and negative effects. Tyrosine, which is found in milk products, meats, fish, eggs, and tofu, actually enhances thinking, while tryptophan, found in poultry, has a calming effect on the brain. "Research supports the importance of taking a daily vitamin supplement in addition to eating your spinach, oranges, bran cereal, seafood, chicken, and vitamin-packed foods" (Jensen, 2000, p. 78). In one study, two groups of twelve to thirteen-year-olds participated in a series of visual acuity, reaction time, and intelligence tests. One group was given a vitamin supplement and the other a placebo and the group who took the vitamin supplement showed significant increases in all scores. Even minor vitamin deficiencies can impact learning performance. The graphic organizer below illustrates a variety of brain foods that not that only meet nutritional needs, but provide the essential vitamins needed to optimize learning for each student.

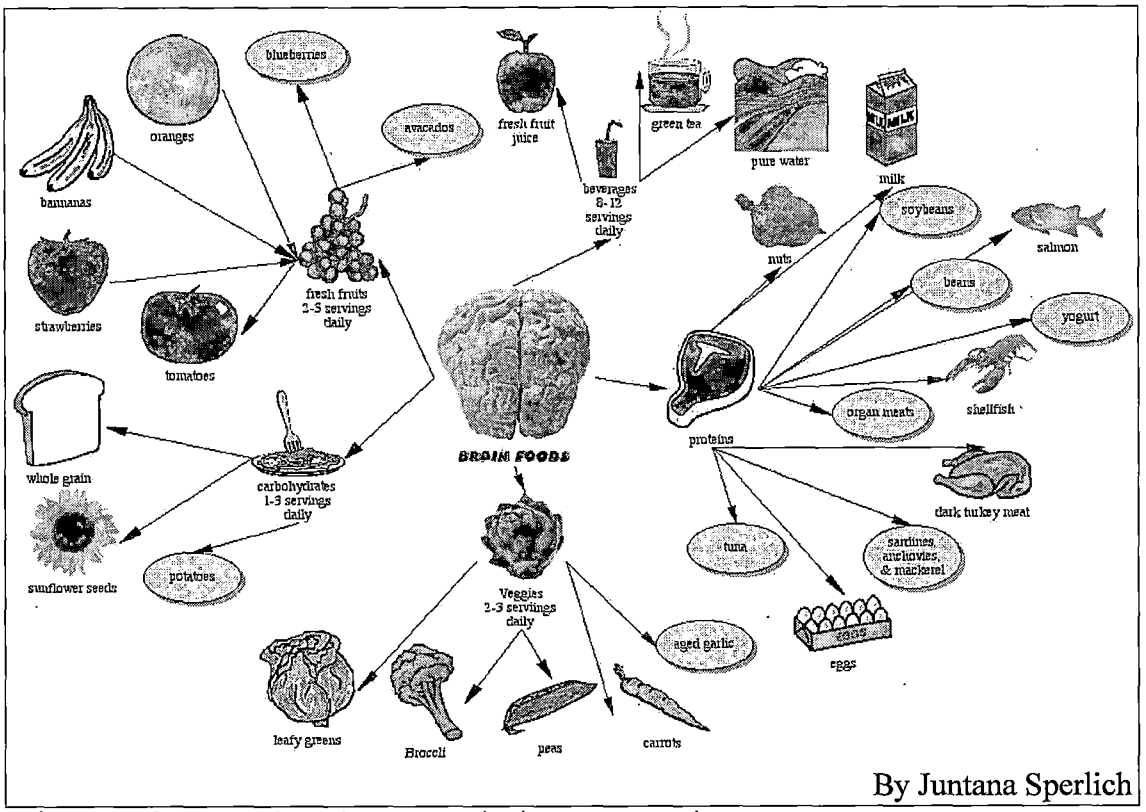



Figure 8. Foods that Optimize Learning

What students believe about themselves impacts their learning significantly. A positive attitude builds upon itself and ultimately increases learning, while a negative attitude can have fast descending effects that are crippling to the learner. Students who are labeled ADHD (Attention Deficit Hyperactivity Syndrome), SED (Severely Emotionally Disturbed), or LD (Learning Disabled), 'slow learners' or 'handicapped' in any other way are good candidates for self-esteem issues. "When authority figures of any kind make a statement about a child, the child is

apt to accept it as true, whether it's close to the truth or as far away from it as the moon" (Jensen, 2000, p. 74). Children are not developmentally ready for such reasoning until about ten or twelve, but by this time, they have already built up a whole set of capability beliefs that are shaping their future success. We need to be very cautious when we blurt out our frustrations toward children because they are likely to form capability beliefs based on our statements. To build and maintain a positive attitude in learners we should put up positive posters, give oral affirmations, and immediate hands-on learning successes (Jensen, 2000).

Students do not show up the first day equipped with study skills. They need to be taught *how* to learn. The essential components for study skills mastery include the following:

- Getting proper nutrition and sleep
- Setting goals and developing a purpose
- Browsing material to identify key concepts and build 'perceptual maps'
- Developing mind-maps that reflect their thoughts, questions, concerns, and connections to prior learning

- Reading with a highlighter marker and making notes in the margins
- Summarizing what they've learned, making reflections, and asking questions
- Applying their learning by making models and doing projects (Jensen, 2000).

"Among the many benefits of study-skills programs, they 1) help students to incorporate their preferred learning style; 2) improve student's confidence in learning; thus, improving self-esteem; and 3) encourage students to become more proactive- to take control of their learning" (Jensen, 2000, p. 81).

Pre-exposure to information, also called 'priming' makes subsequent learning proceed more quickly. The greater the amount of priming, the more the brain extracts and compartmentalizes the information (Jensen, 2000). Learning and recall also increases when a pattern or a graphic-organizer is provided prior to exposing learners to new material. "The brain's capacity to elicit patterns of meaning is one of the key principles of brain-based learning" (Jensen, 2000, p. 82).

We never actually cognitively comprehend something until we can create a model or metaphor that is derived from our inimitable personal world. "We are learning when

we can relate the knowledge from one area to another and then personalize it. Three essentials of higher brain functions are categorization, memory, and learning" (Jensen, 2000, p. 82). Learning depends on categorization and memory and memory depends on categorization.

Knowing facts may supply answers when we take tests, but it is pattern detection that aids learners in becoming thinking adults (Jensen, 2000). Before starting a unit, we need to discuss the topic orally with students, then represent our discussion in a mind-map, and post it. Then during the course of our studies, we should have students make maps, story boards, graphic organizers, paintings, models, etc. of the material. This creates meaning for the learner and gives students ownership over their learning. The important thing is getting students to relate the learning to their own personal lives, and increasing the context around it. "When prior learning is activated, the brain is much more likely to make connections to the new material, therefore increasing comprehension and meaning" (Jensen, 2000, p. 84).

Physical activity increases blood flow to the brain. Cross-lateral motions have dramatic effects on learning. Since the right side of the brain controls the left side of the body, such movements force the brain to talk to

itself and a brain that is fully engaged is far more efficient and effective (Jensen, 2000). Cross-lateral movements are particularly effective for those sleepy, overwhelmed, and frustrated students who may be having a learning block. This promotes better problem-solving and higher quality learning. "The body remembers as well as the mind: In many cases, it remembers better" (Jensen, 2000, p. 111).

Activating the vestibular system, by swinging, rolling, and jumping, helps us take in information from our environment. The part of our brain that processes movement is the same part of our brain that processes learning- the cerebellum. In fact, there have been over six dozen studies that suggest strong links between the cerebellum and memory, spatial perception, language, attention, emotion, nonverbal cues, and decision-making (Jensen, 2000).

Exercise fuels the brain with oxygen, and also triggers the release of neurotrophins, which enhance growth, impact mood, cement memory, and enhance connections between neurons (Jensen, 2000). Regular exercise may even stimulate the growth of new brain cells and prolong the survival of existing neurons. By physically challenging our bodies, our brains become more

adept at responding to mental challenges. We can maximize on the effects of movement on learning in the classroom by doing daily stretching sessions, walk and talks, dancing, role-playing, seat-changing, quick energizers, and movement games. "Brain-compatible learning means weaving math, movement, geography, social skills, role-playing, science, and physical education together" (Jensen, 2000, p. 167).

Under stress, the filing capacities of our brain are reduced and our short-term memory, along with our ability to form permanent new memories are restrained. "Distress not only interferes with health and physiological functioning, but also inhibits cognitive functioning. It impedes our capacity to think, solve problems, perceive patterns because of the inseparability of body, emotion, and intellect" (Caine, 1991,p. 67).

When we perceive threat, our brain tends to function at the hippocampal level, cutting off judgment at the frontal cortex level. Students with anxiety are more occupied with themselves than with the ability to learn, which inhibits their finding possibilities to help them solve their problems. A threat is anything that triggers a sense of helplessness and it varies from person to person. "Real learning involves challenge and excitement and the

ability to transform threat into challenge" (Caine, 1991,p. 74). In the classroom, rewards, grades and recognition contribute to the students' sense of identity. In the long run, these things become a potential threat in the students' attempt to maintain and enhance positive views of themselves.

There are three barriers to learning, which all intermingle. The first one is the critical/logical barrier, which causes us to feel threatened whenever we are asked to believe something that logically clashes with our prior belief. The second barrier is the intuitive/affective barrier, which goes up when we feel violated because an action was hurtful or emotionally inappropriate. These barriers particularly affect those who are labeled as 'different'. The last barrier is the moral/ethical barrier, which is activated when our beliefs about right and wrong are challenged and questioned. "Many of the demands that we impose on students, ranging from placing unreasonable time limits on learning and restraints on individual thinking to excessive competition and motivation by means of shame and guilt, will cause all but the most resilient of students to downshift. "When we respect their current views and provide them with the appropriate degree of safety and opportunity to creatively

explore, then we can take them beyond their immediate limitations" (Caine, 1991, p. 75).

Besides preparing our students for optimal learning, we have to keep in mind that while our brain is a sieve, which keeps what is significant, it is also a sponge to everything happening in the environment. "As early as two seconds prior to an actual activity or movement, our brain has already decided what body parts to activate and which side of the brain to use" (Jensen, 2000, p. 101). Ninety-nine percent of our learning is non-conscious. We are merely sponges, as we soak up visual cues, sounds, experiences, aromas, and feelings. In fact, simply absorbing an experience is valuable to our learning process as our brain expands its perceptual maps (Jensen, 2000). Dr. Lozanov, a Bulgarian researcher, reveals the power of non-conscious learning as follows:

- The mind has an enormous capacity of reception and teachers need to make the most of non-verbal messages.
- There is great value in visuals, stories, myths, metaphors, music, and movement, as our brain codes, symbolizes, generalizes, and multi-processes these things in ways beyond our comprehension.

- Our perceptions, biases and barriers must be dealt with before learning can be accelerated (Jensen, 2000).

"Your students are learning much more than you're teaching. How you treat them, what you say, how you say it, what you don't say, your sensitivity to their needs, your attitude about your own work, your feelings about your environment and life, how well you listen or don't - all these assorted impressions- influence your students, whether they and you realize it consciously or not" (Jensen, 2000, p. 104). Teachers can optimize on non-conscious learning by dong the following:

- posting affirming posters
- highlighting positive role models
- citing experts in a subject area
- incorporating videos, CDs, slides, and photographs on a topic
- telling stories about the success and perseverance of prior students
- opening a new subject with a celebration
- holding student discussions about fears, feelings and concerns about learning

- providing enough resources and letting students learn in their preferred style
- encouraging learners to find personal meaning in their projects
- always being receptive to questions or comments
- providing an atmosphere of physical and emotional safety where students feel accepted and respected (Jensen, 2000).

We take in so much information unconsciously that downtime is absolutely essential to process it all (Jensen, 2000). When students look as if they have stopped paying attention, it is a good idea to give them some time for reflection by doing a partner walk, music session, ball-toss, stretching, or mind-mapping time. This will help students make the information personally meaningful.

Humans have an innate need to seek meaning, but meaning does not always come automatically. As teachers, we need to understand that we are not just stuffing isolated facts into our students' brains, but we are helping them develop clusters of neurons that fire at the same time, resulting in even larger and more complex neural networks that reflect skills learned and ideas tied to purposes and meanings (Caine, 1999). We can facilitate

meaning-making by having a small group discussion with "what if" scenarios after new material has been presented. Teachers should encourage students to find personal meaning in their new learning and explain how the brain naturally prioritizes information moment by moment (Jensen, 2000). "During this necessary period of incubation, the brain filters out new incoming stimuli. It begins to sift through its full plate of information, looking for links, associations, uses, and procedures as it sorts and stores" (Jensen, 2000, p. 124). This association and consolidation process can only occur during downtime.

We also have the capacity not only to enrich our own minds, but also to enrich the minds of our students. "The human brain actually maintains an amazing plasticity throughout life. We can literally grow new neural connections with stimulation, even as we age. This fact means nearly any learner can increase their intelligence, without limits, using proper enrichment" (Jensen, 2000, p. 149). In Marion Diamond's experiments on rats, she found the number of connections increased by twenty-five percent when she had placed rats in an enriching environment. She summarizes her findings as follows: "With increasing amounts of environmental enrichment, we see

brains that are larger and heavier with increased dendritic branching. This means those nerve cells can communicate better with each other. With the enriched environment, we also get more support cells because the nerve cells are getting bigger. Not only that, but the junction between the cells, the synapse, also increases in dimension. These are highly sufficient effects of differential experience" (Jensen, 2000, p. 149). In addition to increased dendritic branching, synaptic plasticity was also evident. The synaptic growth varies depending on the complexity and type of activity one engages in. "This suggests that new experiences (like reading) can get wired into the malleable brain. In other words, as we vary the type of environment, the brain varies the way it develops" (Jensen, 2000, p. 150). In autopsy studies on graduate students, their brains had 40 percent more neural connections than those of high school dropouts. These graduate students also had twenty-five percent more overall brain growths. Now education alone was not the only differential, but the learning experiences of each student needed to be frequent and challenging for this growth to occur. "Cortical area growth does not have something to do with being smart, even though the internal efficiency of our wiring and

connections are more sufficient" (Jensen, 2000, p. 151). The illustrations below show how the brain changes during enrichment.

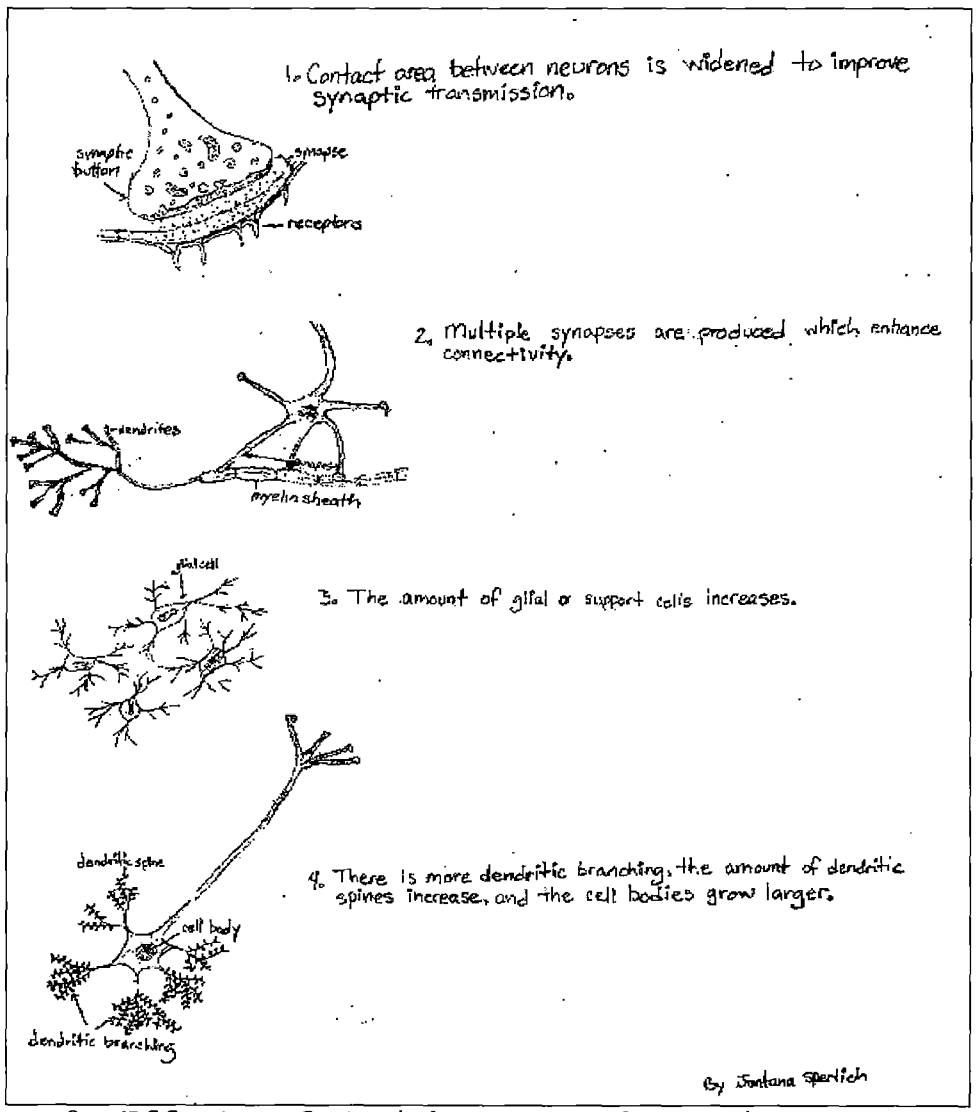



Figure 9. Effects of Enrichment on the Brain

Neurogenesis has been confirmed only in the hippocampus, an area essential for learning and memory.

Some studies have shown that enrichment of the brain leads to more spine growth on the dendrites, heavier cell bodies, longer dendrites, and more glial cell growth. "The process of learning can be changed by increasing the strength and the speed of transmission within the brain" (Clark, 1986, p. 19). Enriching the environment of the classroom brings about changes at the cellular level, not just in the children's behavior. "As children become more intelligent they also become biologically different from average learners as a result of using and developing the wondrous, complex structure with which they were born" (Clark, 1986, p. 20).

To enrich our brains, we must keep in mind that complex learning tasks are better than easy ones; more exercise is better than idleness. Challenging tasks are better than uncomplicated ones. Interaction is better than seclusion (Jensen, 2000). "The enrichment effect does not take months or years necessarily to show up. Significant 'structural modifications' in the dendritic fields of cortical neurons have been reported evident in just four days" (Jensen, 2000, p. 154). According to Jensen (2000), the five keys to enrichment are as follows:

1. The stimulus must be new
2. The stimulus must be challenging

3. The stimulus must be coherent and meaningful
4. The learning has to take place over time
5. There must be a way for the brain to learn from the challenging and novel stimuli, meaning feedback is needed.

The more consistent, specific, timely, and learner controlled the feedback, the better. The best form of feedback comes from other learners. Jensen (2000) suggests that students build a classroom model, play learning games, create a class video, or plan a community project to get indirect feedback from the interaction process.

The ability to bring together random bits of information to inform thinking, problem solving, and analysis is mainly what intelligence is. The brain relies on several circuits that tie together simultaneous stimuli to do this effectively. "When learners are provided with more consistent feedback and better quality feedback, they are better able to tie pieces of the learning puzzle together and integrate the information into higher quality relationships and patterns" (Jensen, 2000, p. 157). Teachers can maximize enrichment by doing the following:

1. Frequently commenting on previous learning
2. Encouraging peer teaching and interaction

3. Providing daily or weekly reviews (self, teacher, or peer generated)
4. Having teams keep progress charts for their group and post results
5. Encouraging students to keep a learning journal
6. Providing 'mock tests' that won't be applied to the grading scale
7. Having students pair up for test preparation
8. Having students correct their own homework, quizzes, tests, etc.
9. Having learners do a group presentation where they get some feedback (Jensen, 2000).

Brain-based learning isn't always about offering special projects or setting up the environment to orchestrate the optimal amount of learning. Our jobs require us to teach specific skills, like spelling, lecture on subjects, like history, and even teach problem-solving. The next few paragraphs offer a few strategies that help teachers meet these needs, while still offering a brain-based learning environment.

Teachers can help students learn tedious skills by paying attention to their eyes. Eye movements actually facilitate the processing and retrieval of information to and from the brain. Jensen (2000) gives us a few tips to

help hook the brain of a student having trouble in spelling through the following steps:

1. Access feeling with regard to the word: Start with eyes looking down.
2. Visualize the image of the word: Move eyes up and to the right.
3. Cement a word in auditory memory: Say the letters while looking to the right.
4. Cement a word kinesthetically: Trace the letters of the word with your fingers.
5. Recall a stored image of the word: Close eyes and look to the left.
6. Write out the correct spelling of a word on paper: Review it and look up to the left.
7. To cement the success: Look down to the right and celebrate the feelings of empowerment.

We can learn about our students' cognitive processing simply by asking questions and observing their eyes. Asking questions can elicit deeper thinking than merely providing answers because when we are asked a question that requires a yes or no answer, our brain actually continues, unconsciously, to process alternatives to the answer. Therefore, just asking questions generates sustained enriching brain activity. The better the quality

of a question, the more the brain is challenged to think (Jensen, 2000).

Sousa (2001) suggests that we ask questions using the old fashioned system of Bloom's Taxonomy. Though over 50 years old, the model of Bloom's Taxonomy is very brain-based. Each level (in ascending order: knowledge, comprehension, application, analysis, synthesis, and evaluation) is cumulative. One cannot answer questions from the higher levels (analysis, synthesis, and evaluation) without knowing the lower levels (knowledge, comprehension, and application). The three lower levels focus on convergent thinking, whereby the learner recalls and focuses what is known about a topic and uses it to solve problems through application. The upper three levels incorporate divergent thinking whereby the students take their learning to new levels of meaning and gain personal insights and discoveries. Attaining understanding at these levels is at the heart of brain-based learning. Sousa (2001) suggests posing questions at each level of Bloom's Taxonomy that begin with the following words: define (knowledge), summarize (comprehend), practice (application), contrast (analysis), infer (synthesis), and judge (evaluate).

Jensen (2000) suggests that we provide self-assessment opportunities to engage thinking skills. We should allow learners to share and shape their discoveries rather than always providing the right or wrong answers. The following are some alternatives to traditional question asking that Jensen (2000) suggests:

1. Have students generate the questions to be asked
2. Have students link their ideas to other subjects
3. Have students ask each other questions
4. Have students write up their own test questions
5. Have students relate ideas and questions to their own personal lives

Learners are more likely to integrate new learning and implement changes when lecture is followed by discussion (Jensen, 2000). "Brain-based learning advocates a brief lecture or presentation, a chunk of time for discussion, a reflection exercise, and a confirmation of the learning" (Jensen, 2000, p. 191). In simple terms, we share the information, problem solve, discover, discuss, and then confirm. Following this pattern helps students make the learning their own.

As mentioned earlier, a stimulus that brings forth emotion is remembered more easily than non-emotional stimuli. "Music elicits emotional responses, receptive or

aggressive states, and stimulates the limbic system" (Jensen, 2000, p. 245). The limbic system not only is involved in engaging musical and emotional responses, but also mediates long-term memory. This means that when information is given with music, there is a greater likelihood of it being encoded into long-term memory.

Music as a subject of study and as an accompaniment to the learning process is a valuable tool for the integration of thinking across both hemispheres of the brain (Jensen, 2000). Just consider this for a minute. Each of the countries leading in science and math has strong music and arts programs. In fact, the absence of art and music can retard brain development in children. Music actually primes the brain's neural pathways. Neural firing patterns are generally the same for music appreciation and abstract reasoning. Now here is where we need to be careful. Listening to music before testing is valuable, but listening during test taking would more than likely cause neural competition by interfering with the brain's natural firing patterns (Jensen, 2000).

You may be wondering what selections are most beneficial. Baroque on low in the background is great for writing focus and seatwork, as well as, review at the end of a learning session. Classical and romantic music, on

the other hand are better for introducing new information and storytelling. You can use a variety of other styles of music to set the mood or create an emotion to prime for learning (Jensen, 2000).

According to Jensen (2000), concert readings minimize time to teach and maximize time to learn. "Well-delivered concerts can open gateways to learning, reach the subconscious, create better understanding of subject matter, activate long-term memory, and reduce overall learning time" (Jensen, 2000, p. 252). First, you preview by laying out the "big picture" of a new unit in about three to seven minutes, accompanied by intriguing, attention-getting, dramatic music. Then you start the active concert by presenting the heart of the content (metaphors, readings, scripts, or text) in a dramatic way using an interplay of classical or romantic selections. Start with music only for the first thirty seconds, and then deliver your material just as the music gets quieter. Be sure to limit your instruction to five to fifteen minutes. Finally, you engage in passive review where you let the music and message carry a low-key review of the new material to the learner's unconscious minds, while students relax with their eyes closed. This session should

be accompanied with a Baroque selection and last only five to eight minutes.

Problem solving is to the brain what exercise is to the body (Jensen, 2000. "It creates a virtual explosion of activity, causing synapses to form, neurotransmitters to activate, and blood flow to increase. Especially good for the brain are challenging, novel, and complex tasks that require intense thinking and multi-tasking (doing more than one type of thinking at a time)" (Jensen, 2000, p. 191).

On the other extreme, boredom can do harm to the brain. "Withdrawal from the world and reduction of stimulation most certainly contribute to senility and depression, while activity and challenge promotes health and well being" (Jensen, 2000, p. 192).

In terms of sensory preferences and learning styles, Sousa (2001) suggests that teachers do the following: understand that students with different sensory preferences will behave differently during learning, recognize that we tend to teach according to our own sensory preferences, note the sensory preferences of our students through their behavior while we are teaching and don't take their behavior personally, just teach to those

various preferences and design lessons that include activities to meet the sensory preference of all learners.

Teachers can use humor to enhance classroom climate and promote retention (Sousa, 2001). Students increase retention up to fifty percent if they laugh while they learn; creating a positive emotional climate and helping students stay focused (Glenn, 2002). The physiological benefits of using humor are that it fuels more oxygen to the brain and laughter causes an endorphin surge, which creates a state of euphoria in the learner. The social and educational benefits include getting everyone's attention, creating a positive environment, increasing retention because of the high emotional content, and improving everyone's mental health by relieving stress (Sousa, 2001).

Brain-based learning entails recognizing the brain's rules for meaningful learning and coordinating teaching with those rules in mind (Caine, 1991). It relies on the fact that the other disciplines relate to each other and share common information that the brain can recognize and organize. This idea is at the heart of thematic teaching. "Brain-based learning is usually experienced as joyful, although the content is rigorous and intellectually challenging; and students experience a high degree of

self-motivation" (Caine, 1991, p. 8). According to Caine, (1991) and Crowell, (1998) we should keep the following Twelve Principles of Brain-based Learning in mind as we organize our classrooms into a brain-based environment.

1. The brain is a complex adaptive system. "Thoughts, emotions, imagination, predispositions, and physiology operate interactively as the entire system interacts with and exchanges information with its environment" (Crowell, 1998, p. 7).
2. The brain is a social brain. Learning is deeply influenced by the nature of our social relationships.
3. The search for meaning is innate. Making sense of our experiences is survival oriented. The classroom needs to provide stability and familiarity through routines and procedures, while offering lessons that are novel, discovery-based, and challenging to further embed meaning.
4. The search for meaning occurs through "patterning." "The brain is designed to perceive and generate patterns, and it resists having meaningless patterns imposed on it" (Caine,

1991, p. 81). Such patterns are isolated pieces of information that are unrelated to anything that makes sense to the students. Students will pattern, perceive and create meanings all the time; we just need to influence the direction. Teachers must present the information in a way that allows brains to extract patterns, rather than impose our patterns on students.

5. Emotions are critical to patterning. "What we learn is influenced and organized by emotions and mind sets based on expectancy, personal biases and prejudices, degree of self-esteem, and the need for social interaction" (Caine, 1991, p. 82). Teachers need to monitor the emotional climate in the classroom regularly and use effective communication strategies to allow for student and teacher reflection and metacognitive processes. The entire environment needs to be supportive and marked by mutual respect and acceptance.

6. Every brain simultaneously perceives and creates parts and wholes. The brain interacts constantly between hemispheres no matter what we are doing. One side may break down information into parts,

while the other side perceives and works with the whole or series of wholes. Teachers just need to build understanding and skills over time because learning is cumulative and developmental. Parts and wholes are conceptually interactive in that they derive meaning from and give meaning to each other.

7. Learning involves both focused attention and peripheral perception. "The brain responds to the entire sensory context in which teaching or communication occurs" (Caine, 1991, p. 83). Teachers need to organize materials that will be outside the focus of the learner's attention. Teachers need not only to use attention grabbing peripherals and music, but also they need to engage the interests of learners through their own enthusiasm about the content.
8. Learning always involves conscious and unconscious processes. "We learn much more than we ever consciously understand" (Caine, 1991, p. 84). Teachers need to offer opportunities for "active processing", in which students review how and what they learned so they can take

charge of their learning and development of personal meaning.

9. We have at least two different types of memory: A spatial memory system and a set of systems for rote learning. Our spatial system of memory does not need rehearsal and allows for instant memory of our experiences, but facts and skills that are isolated need much practice and rehearsal. Focusing on memorization does not facilitate the transfer of learning and interferes with subsequent development of understanding.
10. Learning is developmental. The brain is plastic, which means much of our neuronal connections are made by the experiences we have. There are sequential stages of development throughout childhood, including windows of opportunity where learning that occurs enhances further connections down the road. There is no limit to how much humans can learn.
11. Learning is enhanced by challenge and inhibited by threat. "The brain downshifts under perceived threat and learns optimally when appropriately challenged" (Caine, 1991, p. 86). Teachers should create a state of relaxed alertness in

students, where relaxation and an atmosphere of low threat and high challenge permeate the lesson and the teacher.

12. Each brain is uniquely organized. "Because learning actually changes the structure of the brain, the more we learn, the more unique we become" (Caine, 1991, p. 87). Teachers should allow students to express visual, tactile, emotional, and auditory preferences, as well as offer various choices that attract the interest of learners.

The brain will not develop to its potential without experiences. "While the basic structure of the brain is genetically programmed to develop, one awe-inspiring feature is that much of the electrical activity, the growth of dendritic branches on neurons, the synaptic connections between neurons, the formation of the myelin sheath that coats neurons and helps to accelerate the transmission of signals, and much more are all influenced by experience" (Caine, 1999, p. 183).

Multiple complex and concrete experiences are required for meaningful learning and teaching. This is accomplished through orchestrated immersion. Orchestrated immersion is taking the information off the page and

bringing it to life in the minds of the learner. "Orchestration involves the development of an approach to teaching that combines planning with opportunity of spontaneity- by both teacher and students" (Caine, 1991, p. 109). Teachers can help students create sophisticated mental maps when they present subject matter in the context of wholeness rather than isolated, meaningless pieces. Themes tend to facilitate this process by organizing seemingly fragmented topics into global relationships. Another way to orchestrate immersion is by offering projects to students. They need to be exposed to subject matter in many different ways. Projects offer challenging high interest opportunities for learners to connect content to the world. Providing multi-sensory representations is yet another form of orchestrated immersion. The key is to ensure that all senses be engaged in the design of experiences for students to have a deep and rich sensory experience of what is to be learned. Telling stories, exploring myths help tie content together and aids natural memory. Through integrating great literature into subject matter or engaging the learners' dreams, teachers can facilitate learning through orchestrated immersion. The classroom needs to possess a certain amount of orderliness and control in order to

facilitate orchestrated immersion. The teacher needs to ensure that projects are high interest, challenging, and extend the students' knowledge and understanding of the content. Teachers must not over-specify what students will be exposed to because what they emphasize shapes what students will be permitted to learn, which limits the learning process.

Now regarding storytelling and metaphors, teachers should keep in mind that electronic media affects the outcome of the growth of the cerebral cortex. Schwartz (1995) claims that new technologies are altering the structure and abilities of the human brain. Students are developing incredible capabilities in their right cerebral hemispheres, at the expense of their left hemisphere skills. The left cerebral cortex, which specializes in processing language and abstract functions like translating a story into a visual image in the mind, is being suppressed by the lack of stimulation due to video games, television, and so on. Such technology is helping to develop the right cerebral cortex, which specializes in processing visual imagery, such as video. In fact, the faster and more intense the picture, the more work and practice the right brain gets. These children can get so addicted to fast-action electronic displays, that they pay

more attention to videogames and electronic media than the never changing camera angle of a classroom or book. Sadly enough, children seem to have lost their imaginations.

Transfer helps students make connections between what they already know and what they will learn. "It is important to remember that the connections are of value only if they are relevant to the student's past, not the teacher's" (Sousa, 2001, p. 150). If students already have knowledge about what is to be learned, then teachers ought to take note and move on to something new. There is already enough repetition in today's curriculum. The following are strategies for connecting to past learnings that are novel and shift the task burden to the student: short stories about what students already know about a topic, interviews in the think-pair-share format, graphic organizers, mural or collages that communicate what students know, write a song that tells of their knowledge, build or draw a model that expresses what they know, or having students come up with their own ideas, like writing a poem, painting a picture, creating a quiz show, etc (Sousa, 2001).

Glenn (2002) suggests that teachers should avoid teaching similar concepts at the same time because the pathways to the cerebellum will get confounded. For

example, they're, there, and their: instead of teaching them in one lesson, separate them with time and teach the difference at the beginning of the lesson. Whenever two concepts have many more similarities than differences, there is a greater risk that the learner cannot tell them apart. What happens is the similarities overwhelm the differences, resulting in the learner attaching the same retrieval cues to both concepts. Teachers will have more success if they teach the first concept and make sure the students thoroughly understand it and practice it correctly. Then teach a related concept to give the first concept time to consolidate accurately into long-term memory. Then teach the second concept a few weeks later, so that the first concept acts for a positive transfer in learning the second concept. Another option is teaching the differences between the two concepts first. "Focusing on and practicing the differences gives learners the warnings and the cues they need to separate the two similar concepts and identify them correctly in the future" (Sousa, 2001, p. 151).

Teachers can identify the critical attributes of a concept for accurate transfer. Critical attributes are the characteristics that make one concept distinctive among all the others. First the teacher identifies the critical

attributes, and then the teacher gives simple examples that are accurate. Next the teacher gives complex examples and shows how the critical attributes apply. Then the teacher allows students to give examples and insures that the critical attributes apply to the examples given. Finally the teacher must help learners to recognize the limitations of the critical attributes, in other words, the exceptions to the rules of that particular concept.

According to Sousa (2001) in his technique called bridging, the teacher invokes transfer by helping students see the connection and abstraction from what the learner knows to other new learnings and contexts. This can be done when introducing a new topic by asking students to brainstorm ways this new learning can be applied to other situations. Bridging can be done after learning a topic by having students use an analogy to examine similarities and differences between one system and another. When problem solving, we can ask students to investigate ways of approaching the solutions and discuss the advantages and disadvantages of each. After applying their solutions, the students can discuss how well their approaches worked and how they might change their approaches next time to make their solution work.

Hugging is another strategy teachers can use to help the process of transfer. This is when you use similarity to make the new learning situation more like future situations to which transfer is desired. "Hugging means keeping the new instruction as close as possible to the environment and requirements that the students will encounter in the future" (Sousa, 2001, p. 159). You can carry out this strategy by using simulation games, such as debates, mock trials, and investigations. You can also have students do mental practice where a student cannot replicate an upcoming situation, but can practice what the situation would be like. The student can review potential variations of the situation and devise mental strategies for dealing with different scenarios. The final strategy is contingency learning in which the learner asks what other information or skill must be acquired to solve a problem and then learns it. All of Sousa's strategies are effective in helping students learn because they require a lot of responsibility on the behalf of the learner.

Closure is the process whereby the learner's short-term memory summarizes its perception of what has been learned. It is during this process that a student completes rehearsal and attaches meaning to the new learning, thereby increasing the chances that what is

learned will make its way into long-term memory. Teachers can initiate closure by saying, "I'm going to give you two minutes to think about three causes of …". During closure, the student mentally rehearses and summarizes concepts learned and decides whether they make sense and have meaning. You can use closure to begin a lesson, during a lesson, or at the end of a lesson (Sousa, 2001).

Often teachers need to reflect on their own teaching and find out what their students have retained. Teachers can test whether information is in long-term memory by giving a test 24 hours after the learning. They should test precisely what should have been retained and the test should come as a surprise to the learner. "Unannounced quizzes should help students assess what they have remembered, rather than be a classroom management device to get students back on task" (Sousa, 2001, p. 71).

Glenn (2002) suggests teachers use metaphors and mnemonic devices to help students learn, especially for boys since they tend to be more visually/spatially influenced, as opposed to girls being more verbally oriented. Teachers also need to give guided practice when teaching new skills. This is to emphasize correctness before letting students work independently. When they practice a skill incorrectly, it is more difficult to

unlearn the errors because the learning pathways have already been set. Finally, he suggests that students should do some of the teaching, as students learn most when they teach others. In fact, teaching others increases retention by 400 percent (Glenn, 2002).

## What does a Brain-Based Classroom Environment Look Like?

We have explored the anatomy of the brain and we have looked at several strategies (orchestrations really) of brain-based learning, but your question at this point may be, "Yes, but what does it look like?" Previously, when someone asked me about brain research strategies applied to the classroom I saw something similar to the first few paragraphs of Applying Brain Research in the Classroom is Not a No-Brainer by Stover (2001). I saw enriched classrooms where children learned by tapping into their interests and motivations, where lessons were cut short and the types of experiences the kids had were varied, a place where students engaged in developmentally appropriate activities. I saw these things, but I still had no idea how to set up such an environment in a society that seems to not care about individual interests and that seems to demand students to grow up too quickly. These situations seem to indicate the importance of maximizing

early education opportunities. Unfortunately, these indications cannot be addressed over the chorus of bellows emphasizing the need for each student to conform to state standards in a test crazed school system. One school decided to take a leap of faith and implemented the above brain research findings. In Billings, Montana, a school put more emphasis on varied learning strategies, as they created "learning stations" to provide different instructional settings and tools for children to work with. They enriched the environment and gave the kids more choices, so they would be more intrinsically motivated to learn. With the greater emphasis on early education, literacy, and new instructional techniques-along with a new class schedule and intensive staff development, the school has reached higher test scores (Stover, 2001).

Diamond (1996) further emphasizes the importance of an enriched environment and explains that the cerebral cortex deals with higher cognitive processing. "Our human cortex allows us to build cathedrals, compose symphonies, dream and plan for a better future, love, hate, and experience emotional pain because it is in the cortex that consciousness- our ability to be aware of what we are thinking, feeling, and doing, emerges" (Wolfe, 2001, p. 42). Now recall that though the neocortex is between

1.5 - 4.5 millimeters thick, nerve cells account for most of the thickness. The neocortex has the most rapid growth (up to sixteen percent increases) in the elementary schools years, though it continues to grow throughout a human's lifetime. The neurons within the cerebral cortex are not growing in number because at birth we have all the neurons we will ever have, but the neurons have dendrites, which are responsible for most of the postnatal neocortical growth and the network of neurons connecting become the hardware of intelligence. The dendrites are very responsive to input (stimulation)-increasing in number with use and decreasing with disuse. So in this case, if you use it you will not lose it. If you are exposed to a stimulating environment, your neural connections among dendrites will reach great depths, but if you do not exercise your brain, you will lose such connections previously made and lose depth. Providing children with challenging experiences through enriched educational environments will drastically benefit the growth of dendrites. A variety of enriching activities must be available to meet diverse needs, as no two brains are alike. Such activities may include interacting physically with objects, finding and processing information, or working with creative ideas. Regardless of

the form of enrichment, it is the challenge to the neurons that is important. Passive observation is not enough; students must be allowed to interact with their learning environments.

So how does our school system measure up to an enriched environment? To know we must ask ourselves what things an enriched environment may contain. Diamond (2001) outlines a recipe for an enriched environment that can lead to children's academic success. An enriched environment includes the following: a steady source of positive emotional support- love, encouragement, warmth and caring; a nutritious diet; a stimulation of all the senses to develop all areas of the cortex; an atmosphere free of undue pressure and stress, yet is pleasurably intense; a series of novel challenges; allowance for social interaction for most activities; promotion of the development for mental, physical, aesthetic, social and emotional skills; opportunity for the child to choose activities; activities that allow the child to assess the results of his/her efforts and to modify them; promotes exploration and the fun of learning; and activities that allow the child to be an active participant rather than a passive observer. On the other end of the spectrum, a non-enriched, impoverished environment, which causes

difficulties and a lack of success might include the following: a negative emotional climate; an unhealthy diet; sensory deprivation; high levels of stress; unchanging conditions; long periods of isolation from peers; a dull atmosphere lacking in fun; a passive involvement in activities; little personal choice of activities; little chance to evaluate results or effects and change to different activities; and development in a narrow range of interests. Sadly enough, the latter description resembles many of today's classrooms. Yet on the other side of the coin, you don't want your environment to be too enriched, as the brain needs time to transfer information into its association cortex. The cerebral cortex does not show as much growth with too much stimulation as it does with a moderate amount. Children need time to think about what is happening and what is coming next (Diamond, 2002).

Green (1999) states that when it comes down to it, individuals do not all learn the same way. When we ask students to receive information in a way, which is not consistent with their dominant learning modes, to perform under circumstances, which impede their learning, or to express their learning in a manner which does not allow them to use their strengths, synthetic stress, is created,

motivation is reduced, and performance results are decreased.

Strategies that meet the needs of these diverse learners include developing a learning profile for individual students and preparing for complex instruction, which involves providing a wide variety of instructional materials, resources, groupings, and assessment tools. There should be some classroom time devoted to social and emotional skill building, group problem solving, and team building to strengthen academic learning. Enriched learning environments should involve as many processing centers as possible because children need time and opportunities to make sense of their experiences by reflecting and finding connections in how things relate (Green, 1999). Such environments may include learning or interest centers that allow for student exploration and experimentation. The typical environment in a preschool or kindergarten classroom should be seen in higher grades. Direct teaching would have a small part of the total learning experience and assessments would include students evaluating their own learning process and progress.

For social development students should be given choices, encouraged to discuss their emotions and listen to others express their feelings. A variety of activities

that promote social interactions should be embedded in the curriculum. Students should be challenged to ask their own questions and research their own plausible answers (Green, 1999).

Teachers must help students understand the meaning of new information through storytelling, themes, and metaphors. Lessons must be exciting, meaningful and offer several choices. The classroom environment must foster mutual respect and acceptance. Teachers must engage students through their own enthusiasm about what is being learned (Green, 1999).

What makes an effective educator? Caine (1999) suggests the key is not simply to find a specific methodology or technique. "It is to grasp what actually happens in the brain during learning and to appreciate how all the different components of experience work together to help the brain do its job. That understanding enables us to select intelligently from all the methodologies at our disposal and to orchestrate them in a way that is appropriate for the situations in which we find ourselves" (Caine, 1991, p. 125). Caine (1999) furthers proposes educators to walk that fine line between exercising their power and empowering students. "We need to tap into students' intrinsic motivation and yet call for them to

work on and learn what society mandates. We need to assess their learning, but must also master the art of engaging them in authentic self-assessment. We have some time constraints, and yet we have to provide appropriate amounts of time for genuine work to be done and learning to occur. We need to provide feedback or make it available, and yet create conditions in which it is sage for students to take risks. All of these conditions are difficult but essential to implement" (p. 204).

# CHAPTER THREE

# METHODOLOGY

The purpose of this project is to create a set of guiding principles, based on research on the brain, which will help teachers plan and implement brain-based strategies in the classroom. To achieve that purpose, I followed the following five steps: I reviewed literature on how the brain works and strategies on teaching to how the brain learns, I then gathered the notes from the research and created a draft of the guidelines for designing brain-based learning curriculum, I gave the draft to three teachers and two professors for feedback, I then looked for patterns in their critiques on my draft and finally, based on the patterns found, I rewrote the draft. In the rest of this chapter I will outline the details of the methodology.

## Summary of the Literature Review and Guidelines for Planning a Brain-Based Environment

Based on the required coursework for the master's program in Interdisciplinary Studies: Integrative Studies Option in Education, along with my eight years of experience in classrooms ranging from preschool to fifth grade, I found myself intrigued by the tremendous amount

of recent discoveries in brain research and I wanted to know how to take that research and apply it in the classroom. In essence, I wanted to know how to use brain-based learning in my classroom. I began with a review of literature on how the brain works, how teachers can use brain-based learning to help students learn, and what a brain-based classroom environment would look like. I then took the research from the literature review and created a set of guidelines (I will also refer to it as a checklist of tasks) to help teachers plan a brain-based learning environment in the classroom. Encompassed within the series of guidelines are sets of checklists for each task under the following sections: setting up a brain-based environment, preparing the learner, setting up a schedule, how to hook our students, increasing memory, eliminating threat, non-conscious learning, planning down time, providing enrichment, teaching skills and eye movements, asking questions, including music, teaching to both halves of the brain, and using transfer to cement new learning into long-term memory. Teachers will need to read the literature review to give them some background information on how the brain works and how to essentially teach to the brains of their students. They then will go through each section of the guidelines for planning a

brain-based learning environment and choose various tasks that will work well for them and enter the date of completion of each task until they have completed several tasks in each section of the checklist. There are many tasks under each heading and teachers may become too overwhelmed if they try to complete each one, so I set objectives for teachers to accomplish at their own pace between two and five tasks for each section to encourage teachers to complete the entire set of guidelines. Completing a few tasks under each section can help transform the teachers' classrooms into brain-based learning environments. I felt that applying brain-based learning to the classroom would do the following: improve students' achievements in content areas, help students' interest in school to increase in that they will be more motivated and will enjoy school more, encourage students to work effectively with others and build an effective classroom community. In summary, I wanted to come up with an effective way for teachers to easily transform their classrooms into a brain-based environment.

## Developing a Draft of the Literature Review and Guidelines for Planning a Brain-Based Learning Environment

From the research gathered on how the brain works, strategies for using brain-based learning to help students learn, and what a brain-based classroom environment should look like, I then developed a draft of a set of guidelines for teachers to plan and implement a brain-based learning environment in their classrooms. While reading through the research in each book on how the brain works and brain-based learning, I highlighted significant information throughout. When finished with one book, I would read over highlighted areas and type the most pertinent information in one specific color associated with the author of that book and make certain that I typed the bibliography on the author using the same color of text. I would then read through the next book and use the same strategy of typing highlighted notes, but I would use a different color of text and affiliate that color with the author of the next book. I continued using this colored text strategy until I was finished with all the text resources for the literature review. Color coding the information from each resource helped me to remember who wrote what when I went to organize all the data into categories under how the brain works, using brain-based

learning in the classroom, and what a brain-based learning environment should look like.

A detailed description on how the literature review is organized is outlined in the sentences that follow. The section on how the brain works is organized in descending order by the subsequent topics: physical characteristics including size and structure; description of the hemispheres and functions of each; various parts and functions including the corpus callosum, brainstem, cerebellum, limbic system, hypothalamus, thalamus, amygdala, hippocampus, cerebral cortex and it's parts including the occipital lobe, temporal lobes, parietal lobes, and frontal lobes; neurons including parts and how they work together; and memory- how the brainstem, cerebellum, amygdala, and hippocampus work together to help us process information and form memories, and what kind of stimuli is needed to form those memories. The section on using brain-based learning to help students learn is organized under the following topics: biological rhythms and how they affect learning; techniques in gaining the students attention; how emotions impact the learning process; strategies to increase memory, teaching to both halves of the brain; how to set up the classroom to optimize on the learning environment; basic needs that

prepare students to learn; how patterns affect cognition; including exercise to help students learn; how stress and a threatening environment impact learning; optimizing on non-conscious learning; how to enrich the minds if our students; methods for teaching specific skills; what kinds of questions teachers should ask to optimize cognition; how to assess students and give lectures on new information using music; how problem solving tasks affect the brain; teaching to our students sensory preferences and learning styles; promoting retention of learning through laughter; the Twelve Principles of Brain-based Learning; how to provide meaningful learning to our students; how media affects learning; strategies that use transfer to assist students with making connections between what they already know and what they are learning; when to teach various concepts; and how to help students retain what they learn in the classroom. Finally the section on what a brain-based classroom environment looks like is organized by the description of three classrooms illustrated by D. Stover (2001), Marion Diamond (2001), and Fara Green (1999).

My next step was to develop a draft for guidelines in designing and implementing a brain-based classroom. I mostly used the research in the section of the literature

review on How to Use Brain-based Learning to Help my Students Learn. Based on the research from this section, I categorized the information under the following topics: setting up a brain-based environment, preparing the learner, setting up a schedule, how to hook our students, increasing memory, eliminating threat, non-conscious learning, planning down time, providing enrichment, teaching skills and eye movements, asking questions, including music, teaching to both halves of the brain, and using transfer to cement new learning into long-term memory. Each section has a summary of how to carry out the topic or the importance for applying the specific topic in the classroom and a checklist of tasks needed to accomplish the implementation of the topic with a set number of objectives necessary (between two and five choices from a list of between three and twenty tasks) to help the teacher transform the classroom into a brain-based learning environment. For example: the second section on Preparing the Learner summarizes what is needed to prepare students to learn, what the teacher can control and what is out of the teacher's hands, along with how to handle the uncontrollable things needed to prepare students to learn (i.e. parent letters emphasizing the need for enough sleep, good nutrition, vitamins, exercise,

and good self-concepts). There are also resources under this topic ranging from useful websites on exercise activities for the classroom and graphic organizers that assist teachers in helping students to create mind maps of their learning. In this section, the teacher is given a choice of doing a few or all the suggested strategies at his or her own pace, but the teacher must enter the date of application of each task. The entering of the date for each task is to help teachers be accountable in this process of using brain-based learning in the classroom and to help teachers monitor their growth more easily. Turning one's classroom into a brain-based learning environment can be an overwhelming job, therefore, I suggest that teachers follow the guidelines one section at a time and keep track of their growth, thereby seeing the fruits of their labor. There are fourteen sets of guidelines and completing the set number of objectives in each category should help teachers transform their classrooms into brain-based learning environments.

## Gathering Feedback on the Guidelines for Planning a Brain-Based Environment

Three teachers and two professors were asked to critique the original "Guidelines for Designing a Brain-based Learning Environment". I chose Ms. Jackie

Irons, who teaches second grade at Cypress Elementary in Highland because she has been a teacher for twenty years, has taught college classes on editing a thesis, and is very interested in applying brain-based strategies to the classroom. I gave the guidelines to Mrs. Carrie Miller, who also teaches second grade at Cypress Elementary and has been there for ten years, we are on the same track and work together often to meet the needs of our families at Cypress Elementary. The last teacher to critique the guidelines was Mrs. Cathy Barker, who has taught fourth grade in Colton and has worked on seemingly countless projects with me for our master's program. The first professor to critique the guidelines was Dr. Piller, a professor in the College of Education. I chose her because she inspired me to go beyond teaching students in the classroom. She was very interested in brain-based strategies to apply in the classroom and encouraged me to share my research with fellow colleagues. The final professor to critique the guidelines was Dr. London, a professor in the College of Education and coordinator of the masters program in Interdisciplinary Studies: Integrative Studies Option in Education. I wanted this professor's opinion on this set of guidelines because he and Dr. Crowell, who also teaches classes in the program,

have completely transformed my overall view of what the classroom is under high-stakes testing and rigorous standards that stress out teachers and students, as well as indicating what education can be if I take a little time here and there to let students create models of what is inside of them, integrate big and little ideas throughout all areas of curriculum, and give students the opportunity to develop and express their spirituality.

I gave each teacher and professor the draft of "Guidelines for Designing Brain-based Learning Environment". I then asked them to respond to three questions: What do you find useful about the guidelines, How can I improve the guidelines, and What do I need to add or take away from these guidelines to help a teacher implement these guidelines in the classroom. The teachers and professors gave me feedback in one of two ways: comments were either written on the guidelines themselves (the whole document was edited and suggestions were made) or they responded to my questions via email.

Identifying Patterns from the Data in the Feedback

The next step in the methodology process was to take the feedback from the three teachers and two professors and look for patterns. I read over comments and suggestions from each teacher and professor, then, I

transcribed suggestions made and categorized the summaries under the teacher or professor who made them. The comments were then saved for the results chapter of this project.

I narrowed down the suggestions to a paragraph on how the guidelines are useful and found patterns of about ten items that needed revision. Based on the patterns identified, I needed to develop guidelines to revise the original draft of "Guidelines for Designing a Brain-based Learning Environment". I then listed those guidelines in the results chapter of this project.

Revisions Based on the Feedback

Following the identified guidelines, I revised the original draft and created a final set of "Guidelines for Designing a Brain-based Learning Environment". I started the revision process with fixing minor editing errors and reformatting the whole set of guidelines. Then my fifth grade students and I made original illustrations where they were needed and I developed graphic organizers and original worksheets to accompany the set of guidelines.

# CHAPTER FOUR

# RESULTS

As previously stated, the purpose of this project was to create a set of guiding principles, based on the research of the brain, which will help teachers plan and implement brain-based strategies in the classroom. To achieve that purpose, I followed the following five steps: I reviewed literature on how the brain works and strategies on teaching to how the brain learns, I then gathered the notes from the research and created a draft of the guidelines for designing a brain-based learning environment, I gave the draft to three teachers and two professors for feedback, I then looked for patterns of their critiques on my draft and finally, based on the patterns found, I rewrote the draft. In the rest of this chapter I will report details about the research I gained from the literature review, how I used that research to create a set of guidelines for implementing brain-based learning in the classroom and the methodology for revising the original draft of the set guidelines.

## Results from the Literature Review

The research in the literature review was outlined and categorized under the following three topics: how the

brain works, how teachers can use brain-based learning to help students learn, and what a brain-based classroom environment would look like. Based on the research under the section on how teachers can use brain-based learning to help students learn, I then took the research from the literature review and created a set of guidelines (or a checklist of tasks) to help teachers plan a brain-based learning environment in the classroom. The essential guidelines for helping teachers transform their classrooms into brain-based learning environments are listed below.

1. Arrange the classroom for brain-based learning.
2. Prepare the students to learn before instruction begins.
3. Set up a schedule that optimizes on learning.
4. Teachers can use various strategies to grasp their students' attention and they must gain the attention of their students in order to help students learn what they are trying to teach.
5. There are several methods to increase memory in students.
6. Teachers must eliminate threat to help students learn.
7. Students need time for non-conscious learning.

8. Teachers need to make time for planning down time to help students file information in meaningful ways.
9. Providing enrichment activities will help students make greater neural connections.
10. Teachers can watch students' eye movements to teach skills.
11. Asking questions using Bloom's Taxonomy provides enrichment.
12. Including music in the classroom helps students retain what is taught.
13. There are several techniques teachers can use to teach to both halves of the brain.
14. Using transfer techniques help students cement new learning into long-term memory.

Each guideline has a checklist of tasks that require the teachers to read through each section and choose various tasks that will work well for them. When the teachers implement the task they are encouraged to enter the date of completion of the task until they have completed several tasks in each section of the checklist. There are set objectives for teachers to accomplish at their own pace between two and five tasks for each section to encourage teachers to complete the entire set of

guidelines. Completing a few tasks under each section should help teachers transform their classrooms into brain-based learning environments.

## Developing the Guidelines for Planning a Brain-Based Learning Environment

The Guidelines for Planning a Brain-based Learning Environment include explanations and sets of checklists for several tasks under the following sections: setting up a brain-based environment, preparing the learner, setting up a schedule, how to hook our students, increasing memory, eliminating threat, non-conscious learning, planning down time, providing enrichment, teaching skills and eye movements, asking questions, including music, teaching to both halves of the brain, and using transfer to cement new learning into long-term memory. Appendix A includes the original draft of the set of Guidelines for Planning a Brain-based Learning Environment.

## Evaluating the Results from the Feedback on the Guidelines for Planning a Brain-Based Learning Environment

Three teachers and two professors were asked to critique the original "Guidelines for Designing a Brain-Based Learning Environment". I chose Ms. Jackie Irons, a second grade teacher at Cypress Elementary in

Highland who has taught college classes on editing a thesis. Mrs. Carrie Miller, second grade teacher at Cypress Elementary, was chosen because she has ten years of experience in the classroom. Mrs. Cathy Barker, who has taught fourth grade in Colton, was chosen because she has worked closely with me on many projects for our masters program. I chose Dr. Piller to critique the guidelines because she is a professor in the School of Education at California State University in San Bernardino. I chose Dr. London, a professor in the School of Education at California State University in San Bernardino and coordinator of the masters program in Interdisciplinary Studies: Integrative Studies Option in Education because his suggestions would be just what I need to do to complete this project.

I gave each teacher and professor the draft of "Guidelines for Designing Brain-based Learning Environment". I then asked them to respond to three questions: What do you find useful about the guidelines, How can I improve the guidelines, and What do I need to add or take away from these guidelines to help a teacher implement these guidelines in the classroom. The teachers and professors gave me feedback in one of two ways: comments were either written on the guidelines themselves

(the whole document was edited and suggestions were made) or they responded to my questions via email.

In the following paragraphs, I will outline the feedback I received from the three teachers and two professors who critiqued the original draft of the "Guidelines for Designing Brain-based Learning Environment". Ms. Jackie Irons said the following: The whole checklist needs to be reformatted. First of all, the checklist needed page numbers. She also suggested that I replace all sentences containing the word "you" with "the educator" or "teacher". Mrs. Irons recommended that I reword the opening statement and a few other explanatory sentences throughout. She noted where she liked the explanations I gave and suggested other ways to state sentences throughout the checklist. Ms. Irons suggested that I put a bold title at the beginning of each checklist and separate the checklists from the explanatory paragraphs preceding them. Each checklist started with the word "I" and she recommended that I take this word off each item. She also suggested page breaks between subjects all the way through and she wanted to see an introduction to some of my graphic organizers. In terms of the things she likes about the checklist were its ease of use and the presence of the graphics and graphic organizers all

through the checklist. She said that the paragraph on Eliminating Threat was great and she liked the paragraph on Using Transfer to Cement New Learning.

Mrs. Miller thought that the checklist as a whole was very practical and easy to use. She thought that the suggestions for setting up a brain-based classroom were sensible. She said that the explanation for setting up centers was great. She liked the graphics and graphic organizers because they helped her understand the content better, particularly the graphic on Eye Movement and Thinking by Eric Jensen. Mrs. Miller thought that the extra worksheets on group activity evaluations were very useful. She said that the bullet notes on the Setting up a Schedule section were super

The next teacher to critique the checklist was Mrs. Cathy Barker, who stated that as a teacher she found the information very informative and helpful. She already knew what brain-based learning was and got opportunities to apply some activities in her classroom, but the examples and figures in the checklist made it clearer to her.

She believes that the checklist would be extremely helpful and efficient in the classroom. She said that when she does research to find information for the classroom sometimes she forgets some of the things that she wants to

implement. The checklist provides examples or suggestions and with many of them a place for a date to be entered to keep track of the process, not only to show evidence to her that it is working, but also to show any other teachers or administrators. Mrs. Barker said it could even be used to convince others to use some of these techniques. She loves how with all of the suggestions the checklist does not just leave teachers hanging, but it gives options and examples that any busy teacher would find most helpful.

She likes how the checklist gave reminders to help teachers keep in mind particular information on learning, such as when setting up a schedule and how the brain learns. Mrs. Barker said teachers often have a thousand things going on and it is easy to forget some of these things.

She really liked the cooperative group-learning guides. She used cooperative learning groups, but always had trouble setting up a form to help direct and track students in their learning process. She was glad they were included and wished she could have had access to it sooner. Mrs. Barker also thinks that the other forms that went with this guide are excellent for holding students

accountable for their learning, listening and participation.

She also loved the information on eye movement. She has never heard of it before and never really noticed it. She now notices her son Cameron doing it and she really thinks it is helpful in being able to relate to how a student is thinking. She says that the pictures can help a teacher understand the concept of eye movement and use it for the benefit of the students.

Mrs. Barker found it to be helpful that I did not assume what a teacher knows about learning. She said my explanations were thorough; for example, the details for using Blooms taxonomy strategies were great. The organization sheets on cognitive domain and action words helped her put into practice exactly what was suggested.

She found the information on how the brain works and brain hemispheric preference interesting. Mrs. Barker couldn't help but take the test to see where she fits in. She scored bilateral hemispheric balance, which was surprising to her. She noticed the suggestions on teaching to both sides of the brain, however she is still somewhat unclear on how a model focusing on one side or the other would look like. She said that one side of the brain is more creative and the other side is more analytical, but

in practice, possibly a chart or something to suggest what is good for the left, then the right, and then both sides of the brain would be more useful to her.

Dr. Piller, wrote, "You have superbly translated the research into usable tools with your checklists. The instructional worksheets show practical application." She recommended that I create original worksheets that were similar to what I have included from Sousa and other authors.

Dr. London, a professor in the School of Education agreed with the original format and said my suggestions were well organized and provided an in depth approach to implementing brain-based learning in the classroom. He highly recommended that I make the checklist more detailed in that I include one to two paragraphs of a rationale for most items on the checklist and an example of how to implement the checklist item in the classroom. He seemed to agree with Dr. Piller in making the additional worksheets original or asking permission from the author to include them in my checklist. Furthermore, he suggested that I make them more user friendly so that most teachers could look at a worksheet, without reading the rest of the checklist and be able to use the worksheet. Dr. London's final suggestion was to make my references consistent.

## Results from Identifying Patterns from the Data in the Feedback

Some significant patterns found are identified in the sentences that follow. The teachers and professors found the set of guidelines useful because it seemed very practical and easy to use. The explanations under each section were very informative and helpful. Suggestions present in the checklists were well organized and provide an in depth approach to implementing brain-based learning in the classroom. They approved of the presence of graphics and graphic organizers throughout the checklist because they helped them understand the content better. Suggestions for setting up a brain-based classroom were sensible and the explanation for setting up centers was great. Instructional worksheets show practical application and are excellent for holding students accountable for their learning, listening and participation. Bullet notes under various sections were helpful. Those who already knew what brain-based learning was and had opportunities to apply some activities to their classrooms found that the examples and figures in the checklist made it more clear. When teachers do research on how to apply brain-based learning to the classroom, sometimes they forget some of the guidelines that they want to implement

and the checklist provides suggestions on many of them with a place for a date to enter to keep track of the process and to show evidence that it is working. The suggestions in the checklist do not leave teachers hanging, but it gives options and examples that any busy teacher would find most helpful. The checklist gave reminders to help teachers keep in mind practical information on learning, such as setting up a schedule and how the brain learns.

Based on the patterns identified in the section on feedback from the teachers and professors on the draft of the "Guidelines for Designing a Brain-based Learning Environment", I have decided to implement the following guidelines in rewriting the draft.

1. The whole set of guidelines will be reformatted and in page numbers will be added.
2. The opening statement and a few other explanatory sentences throughout will be rephrased.
3. All sentences containing the word "you" will be replaced with the word "the educator" or "teacher".
4. Bold titles will be added to the beginning of each set of guidelines and the checklists will

be separated from the explanatory paragraphs preceding them.

5. Checklist items will not begin with the word "I".
6. Page breaks between subjects will appear all the way through and the introductions to some of the graphic organizers will be present.
7. References will be more consistent throughout.
8. Suggestions on teaching to both sides of the brain will be more clarified using Internet resources.
9. Original worksheets that are similar to what I included from Sousa (2001) and other authors will be created and made more users friendly.
10. Checklist items or tasks will be more detailed and an example of how to implement the checklist items in the classroom will be made clearer.

## Revisions made on the Draft of Guidelines for Planning a Brain-Based Learning Environment

This section outlines the major changes made on the draft of the "Guidelines for Designing a Brain-based Learning Environment". The whole set of guidelines was reformatted and page numbers were added. The opening statement and a few other explanatory sentences throughout

were rephrased. All sentences containing the word "you" were replaced with the word "the educator" or "teacher". Bold titles were added to the beginning of each set of guidelines and the checklists were separated from the explanatory paragraphs preceding them. Checklist items no longer begin with the word "I". Page breaks between subjects appear all the way through and the introductions to some of the graphic organizers are present. References are more consistent throughout. Suggestions on teaching to both sides of the brain were clarified using Internet resources. Original worksheets that are similar to what I included from Sousa (2001) and other authors were created and made more user friendly in that most teachers could look at a worksheet, without reading the rest of the guidelines and be able to use the worksheet. Checklist items or tasks are more detailed in that I added references from the literature review for the rationale of most items and examples of how to implement the checklist items in the classroom are made clearer. The final draft of the "Guidelines for Designing a Brain-based Learning Environment" can be found in Appendix B.

# CHAPTER FIVE

# CONCLUSION

As previously stated, the general purpose of this project was to help teachers easily transform their classrooms into brain-based learning environments. The specific purpose of this project was to create a set of guiding principles, based on the research of the brain, which would help teachers design a brain-based learning environment. In the rest of this chapter I will summarize how I accomplished my purpose, discuss the limitations and significance of the project, and make recommendations for future projects.

To achieve my purpose, I followed the following five steps: I reviewed literature on how the brain works, strategies on teaching to how the brain learns, and what brain-based learning environments look like. I then gathered the notes from the research, particularly the section on strategies on teaching to how the brain learns, and created a draft of the guidelines for designing a brain-based learning environment. Next, I gave the draft to three teachers and two professors for feedback. I then looked for patterns of the critiques on my draft and finally, based on the patterns found; I rewrote the draft

on the set of guidelines for designing a brain-based learning environment

The research in the literature review was outlined and categorized under the following three topics: how the brain works, how teachers can use brain-based learning to help students learn, and what a brain-based classroom environment would look like. Based on the research under the section on how teachers can use brain-based learning to help students learn, I was able to extract the following topics: biological rhythms and how they affect learning; techniques in gaining the students attention; how emotions impact the learning process; strategies to increase memory, teaching to both halves of the brain; how to set up the classroom to optimize on the learning environment; basic needs that prepare students to learn; how patterns affect cognition; including exercise to help students learn; how stress and a threatening environment impact learning; optimizing on non-conscious learning; how to enrich the minds if our students; methods for teaching specific skills; what kinds of questions teachers should ask to optimize cognition; how to assess students and give lectures on new information using music; how problem solving tasks affect the brain; teaching to our students sensory preferences and learning styles; promoting

retention of learning through laughter; the Twelve Principles of Brain-based Learning; how to provide meaningful learning to our students; how media affects learning; strategies that use transfer to assist students with making connections between what they already know and what they are learning; when to teach various concepts; and how to help students retain what they learn in the classroom. I then consolidated the previous topics from the literature review and created a set of guidelines to help teachers plan a brain-based learning environment in the classroom. The essential guidelines for helping teachers transform their classrooms into brain-based learning environments are listed below.

1. Arrange the classroom for brain-based learning.
2. Prepare the students to learn before instruction begins.
3. Set up a schedule that optimizes on learning.
4. Teachers can use various strategies to grasp their students' attention and they must gain the attention of their students in order to help students learn what they are trying to teach.
5. There are several methods to increase memory in students.

6. Teachers must eliminate threat to help students learn.
7. Students need time for non-conscious learning.
8. Teachers need to make time for planning down time to help students file information in meaningful ways.
9. Providing enrichment activities will help students make greater neural connections.
10. Teachers can watch students' eye movements to teach skills.
11. Asking questions using Bloom's Taxonomy provides enrichment.
12. Including music in the classroom helps students retain what is taught.
13. There are several techniques teachers can use to teach to both halves of the brain.
14. Using transfer techniques help students cement new learning into long-term memory.

Each guideline has a checklist of tasks that require the teachers to read through each section and choose various tasks that will be easy for them to implement in their classrooms. When the teachers complete the task they are encouraged to enter the date of completion of the task until they have completed several tasks in each section of

the checklist. There are set objectives for teachers to accomplish at their own pace for between two and five tasks for each section to encourage teachers to complete the entire set of guidelines. Completing a few tasks under each section will help teachers transform their classrooms into brain-based learning environments.

The draft of "Guidelines for Designing a Brain-based Learning Environment" that I developed was given to three teachers and two professors for feedback. Based on their feedback, I was able to draw conclusions on how useful the guidelines were and identify patterns for revisions that needed to be made. Based on the patterns identified, I revised the set of guidelines.

This project is significant because it developed a teacher friendly guide that would help teachers not only apply brain-based strategies in the classroom, but also to see results from transforming their classrooms into brain-based learning environments. Simply applying a few strategies that are brain-based to lessons every now and then is not enough to reap the full benefits of changing the environment in the classroom to a brain-based environment. Teachers willing to commit to this transformation process should see students' achievement in content areas improve, an increase in students' interest

in school in that they are more motivated and enjoy school more, and students working more effectively to build a positive classroom community.

The feedback from the three teachers and two professors indicates that the "Guidelines for Designing a Brain-based Learning Environment" is well organized and teachers will find it fairly easy to implement. It covers fourteen criteria, with several strategies under each section, for transforming a classroom into a brain-based learning environment. It also allows teachers to work at their own pace choosing strategies to implement in the classroom that would work best for the teacher. The set of guidelines, furthermore, provides a space for teachers to record the date of completion for each task implemented, so that they can monitor their growth.

The limitations of these guidelines include the following: the brain-based strategies are general and they need to be effectively tailored to suit the teacher implementing the task. The amount of suggestions for each criterion could be overwhelming and teachers may need to set aside some time for planning and implementing certain tasks. The "Guidelines for Designing a Brain-based Learning Environment" is quite an endeavor for one teacher to tackle on his or her own. It may be more effective for

the teacher to accept the challenge of this process in a collaborative group of teachers willing to work together through this process and discuss outcomes of implementing tasks.

When I began this project, just a few years ago, there was a decent selection of materials, research if you will, on how the brain learns and how to apply brain-based strategies in the classroom, but the research has already changed so much. One example is how colors affect our brains. In one study exposed by the Association of Alternative Medicine (2007) researchers found that red stimulates brain wave activity, increases heart rate, respirations and blood pressure. Orange is the color of joy and wisdom. It gives energy, stimulates appetite, and connects us to our emotional self. Yellow energizes, relieves depression, improves memory, and connects us to our mental self. Green has a calming effect and balances the nervous system. Blue is calming and connects us to holistic thought. Indigo is the color of intuition and connects us to our unconscious self. Violet is cleansing, strengthening, and awakening, and provides a peaceful environment. Jensen (2000) said bright colors, like red, orange, and yellow spark energy and creativity, but may increase aggressive and nervous behavior. Dark colors,

like blue and green lower stress and increase feelings of peacefulness. Brown promotes a sense of security, relaxation, and reduces fatigue. In the classroom, some of our bulletin boards should be yellow, light orange, beige, or off-white, as these colors optimize learning by stimulating positive feelings. I will have to do further research to find the most recent consensus, but I know teachers should have more color choices for their classroom bulletin boards than yellow, light orange, beige, or off-white.

I have noticed that most books I come across only offer isolated suggestions for applying brain-based learning to the classroom. There still does not seem to be any resources out there that help teachers actually transform their classrooms into brain-based learning environments. When I am finished updating the research where it is needed throughout each guideline, I plan to publish the literature review along with the set of guidelines for designing a brain-based learning environment. Right from the beginning of this project, I realized that it would be impossible for me to transform my classroom into a brain-based learning environment because there is no way I would find the time to apply even a fraction of the things on the checklist. Many items

require a lot of planning and preparation on behalf of the teacher. I tried to assist teachers with some tasks by including worksheets to facilitate project learning and graphic organizers to illustrate mind maps, but there is still much more that needs to be included to help teachers easily implement items on the checklist. I plan to facilitate the process of transforming one's classroom into a brain-based learning environment by creating compact disks with lesson plans and activities that comply with state standards for each grade level. Each compact disk will include colorful presentations of grade level vocabulary and ideas on how to turn reading selections into projects that help students consolidate literary skills needed to comprehend the selections, varying techniques and hands on lessons to help students learn specific math skills, ideas for projects in social studies, presentations on various standards in science, arts and movement activities integrated throughout each lesson, and internet resources that will help teachers meet the needs of each student in the classroom. Teachers will still have to assume a considerable amount of commitment in terms of arranging the classroom, preparing learners to learn before teaching begins, and setting up a schedule that optimizes learning in the classroom, but

they will not have to feel overwhelmed by all the other tasks needing to be implemented when all they will have to do is search for lessons and activities on the compact discs.

As if my work is not already cut out for me, I plan to start doing some research with some colleagues on how effective this project is and whether teachers can transform their classrooms into brain-based learning environments. From their feedback, I will find ways to make the set of guidelines more effective and do some research on how the new classroom environments impact test scores. Hopefully, all this project research will eventually lead into a dissertation for doctoral program. The possibilities are limitless, but I will start in my own classroom with my own timing and recruit teachers as I go along. My hope is that by the end of all this, there will be a relatively easy way to reap the fullest benefits of brain-based instruction using my set of guidelines for designing a brain-based learning environment.

# APPENDIX A

# ORIGINAL DRAFT OF "GUIDELINES FOR DESIGNING A BRAIN-BASED LEARNING ENVIRONMENT"

## Designing Brain-based Learning Environment

You now have all the information you could possibly want on how the brain works, how to apply brain-based strategies in your classroom, and what it looks like when one applies those strategies in their classroom. All this information is fine, but it may be more overwhelming now than ever when you take a look at your own classroom and try to plan the transformation into a brain-based learning environment. This section will help you with that process. You will be provided with a series of checklists and graphic organizers to help you set goals and take little steps into the transformation process of designing a brain-based classroom.

### Setting Up a Brain-Based Environment

The following checklist is meant to help you start the process of setting up a brain-based classroom. This process can be overwhelming if you plan on doing everything at once. Remember that designing a brain-based environment is a process, not an immaculate transformation overnight. Your best bet is to pick something off the checklist, apply it to your classroom, and then put the date of the application on the checklist next to the item chosen. This will help you to remember you are partaking in process of transformation and see your growth. Add something new to your classroom each week or two until you have filled out as much of the checklist as you want.

_____ Desks are arranged to maximize group work.

_____Concrete vivid images and peripherals can be seen from every position in the classroom.

_____White boards or chalkboards can be seen from every position in the classroom.

_____ Interest center/s are easily accessible and supplies are clearly labeled. *

_____Some bulletin boards are yellow, light orange, beige, or off-white.

_____There is a collection of interesting posters, photos, and objects around the room that enhance the visual environment.

_____There is one piece from each student displayed to promote positive feelings.

_____In a classroom with florescent lighting, there are some lamps with natural light bulbs positioned around the classroom.

_____There is 4 - 8 plants in the classroom. (See p. 31 for a list of plants to use.)

_____Aromas are present. (See p. 31 for a list of aromas to use.)

_____A CD/cassette player is present.

*You may use centers to reinforce skills taught in class. If this is the case, you may want one center per subject taught. You must provide enough materials for the amount of students you want to allow in that center. You will need to set up a schedule for when you want students to use the centers, how many students in each center, and how students will get from one center to the next (be it a rotation every 15 minutes or a checklist of centers you want students to visit). You will also want to design an accountability component where you check the work students completed in a center folder or you just have students write in a journal what they learned in each center that day. Remember, this is part of the consolidation process and it helps students transfer their learning to long-term memory. Be sure to teach students how to use each center and clean up the center for the next group of students. Setting up centers and maintaining the activities may be too overwhelming. The key to getting started is just setting up one center at a time, teaching the students how to use the center, and then setting up a new center each week until you and the students have a nice flow of activities.

*If the above stills seems too high maintenance for you than you may just want to set up an interest center where students explore a theme or concept. You can provide a list of activities students can do that go with the theme or provide materials for students to explore and experiment with their own ideas. Again, they will need to record their learnings in a journal to help them consolidate what they learned into long-term memory. You may want to set aside about 10 – 15 minutes each day for students to read and share their journal entries. This benefits the whole class by providing feedback for everyone.

Preparing the Learner

You set up your environment and now you've got to figure out what to do with this classroom full of students. First things first, you must prepare the learners for a brain-based environment. Now several things on this checklist are out of your hands. In other words, you really don't have control over the home environment of each student; however, you can write a parent letter emphasizing the importance of sleep, good nutrition, vitamins, exercise, and self-concept to the brain. You can even use the information on pages 32 and 33 to provide evidence for your cause. You will also need to emphasize the importance of sleep, good nutrition, vitamins, exercise, and self-concept to your students. You will be supporting the development of each student's self-concept and you will need to enlist the help of each student. This is a golden opportunity for you to set up a community in your classroom. Have students decide on the rules and consequences, if you are comfortable with the idea, as well as how to handle problems that may arise. Like the previous checklist, you may decide on doing only a few of these strategies or all of them. Just pick one, apply the strategy and then mark the date of application on the checklist so you can keep track of your growth.

_____Write and send a parent letter emphasizing the importance of sleep, good nutrition, vitamins, exercise, and self-concept to the brain.

_____Discuss with students the importance of sleep, good nutrition, vitamins, exercise, and self-concept to the brain.

_____Allow students to have water bottles on or around their desks and allow for water breaks if necessary.

_____Have students design rules, consequences, and rewards. (You can guide them to making up rules that you find necessary.)

_____Set up a time for class meetings, usually about 15 minutes, with a clipboard to list problems and a procedure for who will lead the meetings. (Be sure to have compliment circles on one student as often as possible until all students have been complimented).

_____Have students design some routines that promote self-concept of each student.

_____Teach the students study skills

____Setting goals and developing a purpose

____Browsing material to identify key concepts and building 'perceptual maps'

____Developing mind-maps that reflect their thoughts, questions, concerns, and connections to prior learning

____Reading with a highlighter and making notes in the margins

____Summarizing what they've learned, making reflections, and asking questions

____Applying their learning by making models and doing projects

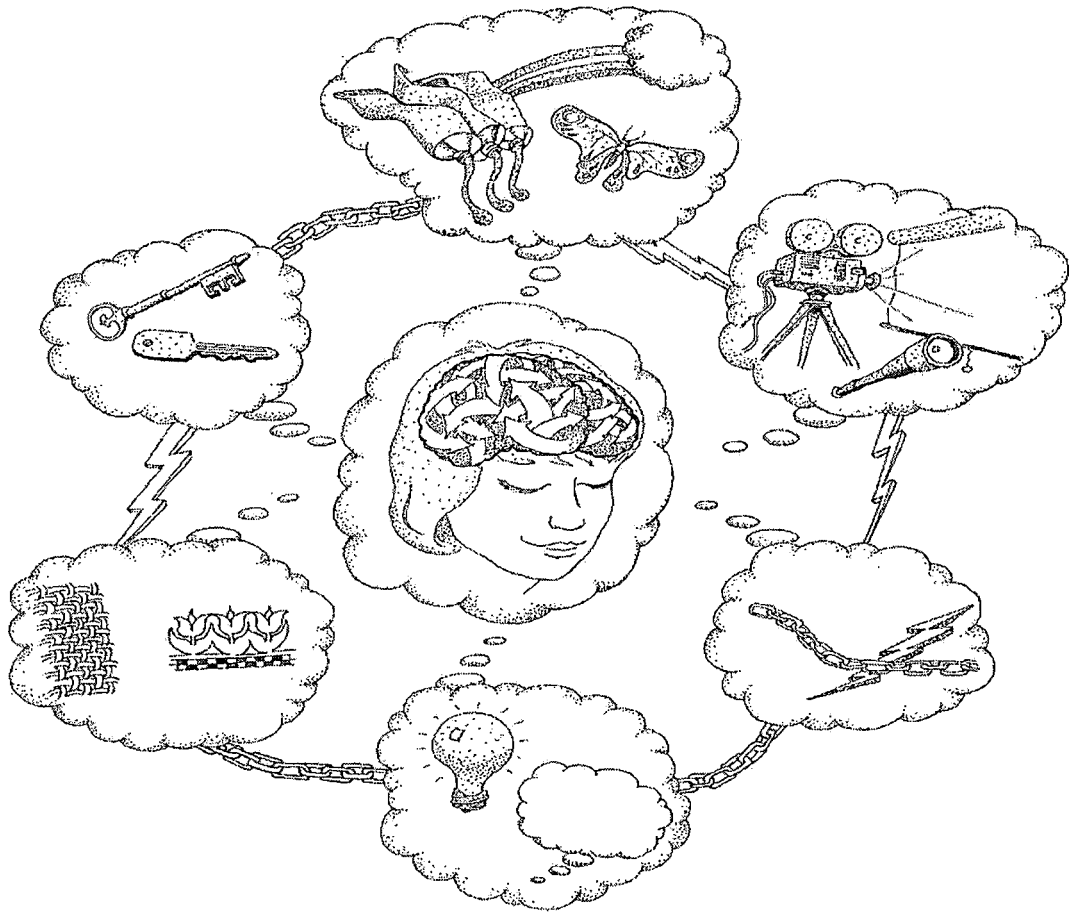
_____Mastering 'priming' or pre-exposing students to new material

____Using graphic organizers or mind-maps and posting them before starting a unit (see maps below for ideas)

____Having students make a model of their learning in a form of maps, storyboards, graphic organizers, paintings, etc. (Jensen, 2000)

_____Take short exercise breaks between lessons. (See p. 36 and 37 for ideas.)

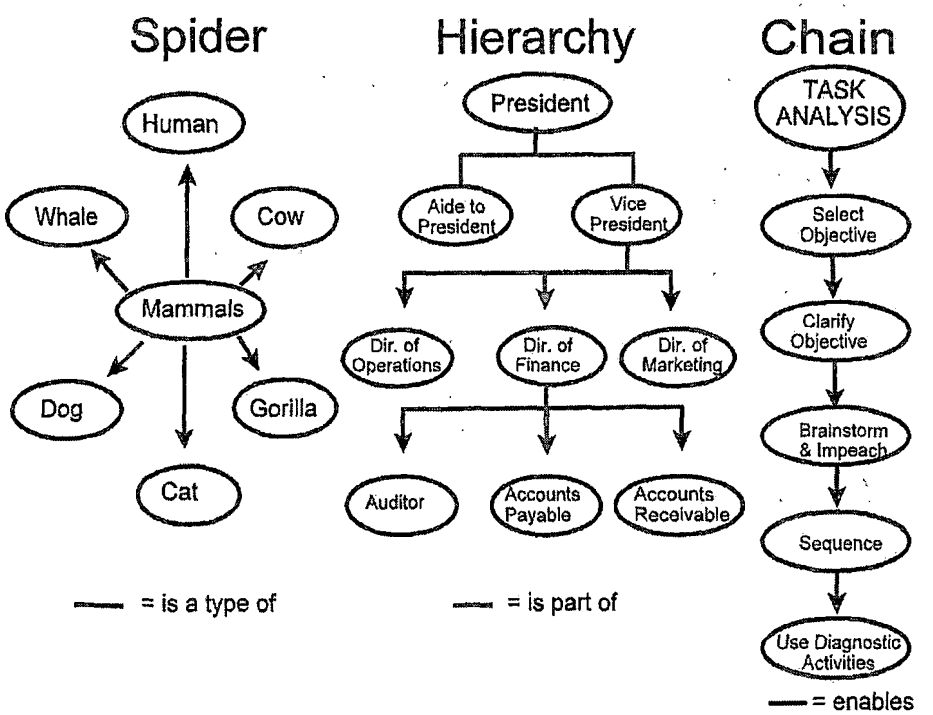
## Mind Map of a Mind Map



## Concept Mapping—General Guidelines—Continued

Concept mapping uses graphic diagrams to organize and represent the relationships between and among the components. These diagrams are also called *graphic* and *visual organizers*. Students should discuss these different types of relationships and give their own examples before attempting to select a concept map. There are dozens of possible organizers.[42] Below are three common types. In each, the relationship between items is written as a legend (for a few examples) or next to the line connecting the items (when there are many examples).

- **Spider maps** best illustrate classification, similarity, and difference relationships.
- **Hierarchy maps** illustrate defining and/or subsuming, equivalence, and quantity relationships.
- **Chain maps** illustrate time sequence, casual, and enabling relationships.

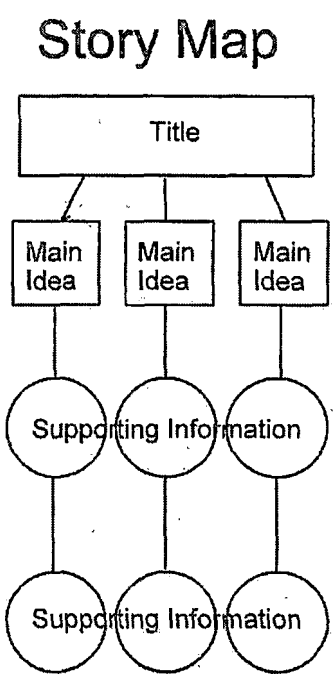


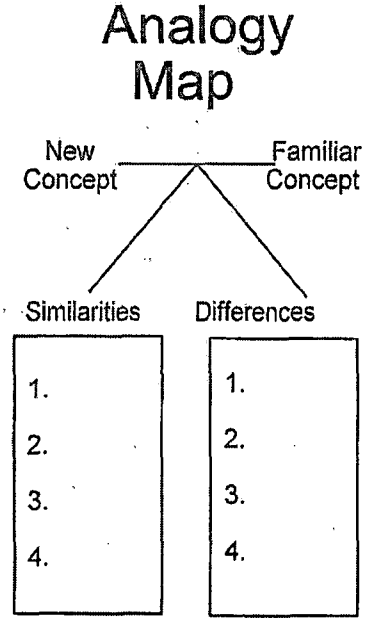

– Continued –

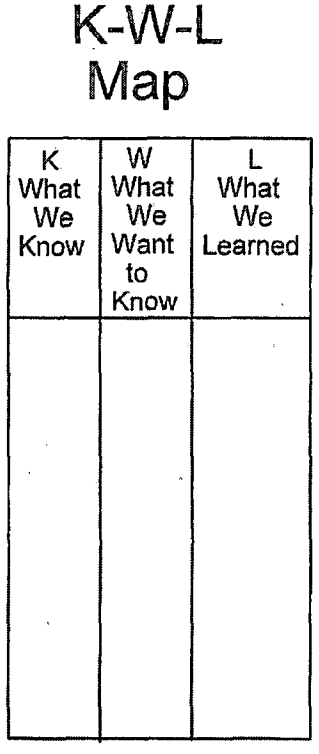
## Concept Mapping—General Guidelines—Continued

Below are three more types of concept maps.

- **Story maps** are useful for classifying main ideas with supporting events and information from the story.
- **Analogy maps** illustrate similarities and differences between new and familiar concepts.
- **K-W-L maps** illustrate the degree of new learning that will be needed. The "K" is for what we already *know*; "W" is for what we *want* to know; and "L" is for what we *learned*.



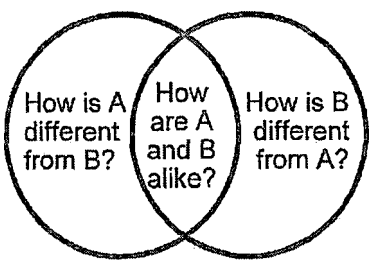




– Continued –

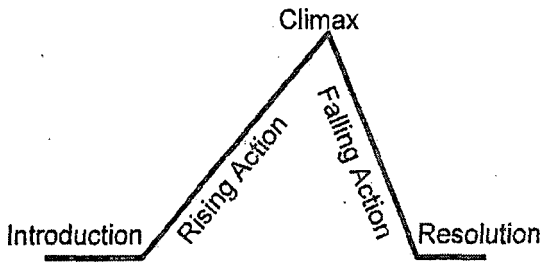
## Concept Mapping—General Guidelines—Continued

- **Venn diagrams** map the similarities and differences between two concepts.
- **Plot diagrams** are used to find the major parts of a novel.
- **A brace map** shows subsets of larger items.

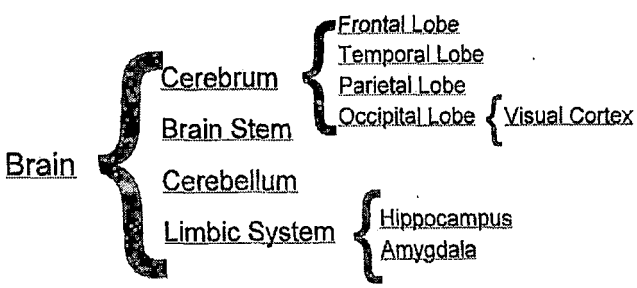
### Venn Diagram




### Plot Diagram




### A Brace Map




– Continued –

## Setting up a schedule

We must keep in mind the following about learning.

- Intellectual performance and comprehension increase as the day progresses.
- Short-term memory is best in the morning. Long-term memory is best in the afternoon.
- To maintain attention, vary presentation and lecture times, while changing up sessions with activities that provide movement.
- Students who do not looked focused may be consolidating information into long-term memory.
- With young learners, content, lectures, and cognitive activities need to be limited to 5 - 10 minutes each.
- With adolescents, these content sessions need to be limited to 10 - 15 minutes.
- With adults, these sessions must be no more than 25 minutes. (Jensen, 2000)

The following checklist gives you a rough time frame in which certain subjects are most effectively learned. Of course you will need to adjust this schedule to your school schedule.

_____ Between 9:00-12:00, I have planned rote learning tasks, spelling, problem-solving, test review, report writing, math, theory, or science activities.

_____ Between 12:00-2:00, I have planned movement-oriented tasks, paperwork, manipulatives, music, computer work, singing, or art.

_____ Between 2:00-5:00, I have planned to study literature or history, sports, music, theater, or manual-dexterity tasks. (Jensen, 2000)

How to Hook our Students

"In a classroom climate typified by positive challenge and joy, the body releases endorphins," (Jensen, 2000, p. 180). We need these endorphins present in our students in order to hook them into learning. The following is a checklist to help you develop some strategies to hook your students. Please enter the date of application next to the strategy.

_____I offer some lessons that are novel.

_____*I offer some lessons that are emotionally intense by being* outrageous, funny or different.

_____ I help learners understand the importance of their emotions in the learning process by...

____ Being a role model,

____Having celebrations;

____Giving opportunities for debates, dialogue, or game shows;

____Offering physical rituals, like clapping patterns, chants, movements, or theme songs.

____Offering time for introspection through journals, small-group discussions, or reflection tasks.

_____I have let my students create projects.

_____I have let my students choose their curriculum.

_____I often encourage group work. (See pages on group work for accountability pieces.) (Jensen, 2000)

# COOPERATIVE GROUP PLANNING GUIDE

Curriculum expectations: _____

Collaborative skill: _____

Before the lesson

Group Size | Materials

Room Arrangement | Time Frame

During the lesson

| Positive Interdependence | Academic Expectations | Task Directions | Collaborative Skill | Individual Accountability |
|---|---|---|---|---|
| ❑ Goal<br>❑ Incentive<br>❑ Resource<br>❑ Sequence<br>❑ Role<br>❑ Identity<br>❑ Outside Force<br>❑ Simulation<br>❑ Environment | | | | |

Monitoring students

❑ Teacher ❑ Student
❑ Formal ❑ Informal
❑ Checklist ❑ Notes

Closure

Collaborative skill: _____

Curriculum choice: _____

Adapted from *Cooperative Learning: Where Heart Meets Mind*, by Barrie Bennett, Carol Rolheiser-Bennet, and Laurie Stevahn. Toronto, Ontario: Educational Connections, 1991.

*Figure 4.3*

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# PROVIDING FEEDBACK FOR ANOTHER GROUP'S PRESENTATION

Topic: _____

Presenters: _____

| | Outstanding | | | | Needs More Work |
|---|---|---|---|---|---|
| General overview | 1 | 2 | 3 | 4 | 5 |
| Quality of materials | 1 | 2 | 3 | 4 | 5 |
| Creativity | 1 | 2 | 3 | 4 | 5 |
| Clarity of ideas | 1 | 2 | 3 | 4 | 5 |
| Presentation delivery | 1 | 2 | 3 | 4 | 5 |

| Positive Comments | Questions | Interesting Ideas |
|---|---|---|
| | | |

*Figure 5.6*

# GROUP REFLECTION

*As a group, fill in together.*

What roles did your group members take? _____

_____

_____

_____

_____

Describe the steps you took in organizing. _____

_____

_____

_____

_____

What went well? What did you learn? _____

_____

_____

_____

_____

If you were working together again, what changes would you make? _____

_____

_____

_____

_____

*Figure 5.7*

# HOW WELL DID WE WORK TOGETHER?

Team Name: _____

Members: _____

| Names | Targeted Skills | | |
|---|---|---|---|
| | Used Quiet Voices | Offered Ideas | Took Turns |
| | | | |
| | | | |
| | | | |
| | | | |

Suggestions for next time: _____

_____

_____

_____

_____

*Figure 5.2*

SkyLight Training and Publishing Inc.

# HOW DID I HELP MY GROUP?

My job for this assignment was _____

_____

_____

_____

I organized myself using these steps: _____

_____

_____

_____

_____

I helped the group by _____

_____

_____

_____

_____

Next time I will _____

_____

_____

_____

_____

*Figure 5.3*

SkyLight Training and Publishing Inc.

Increasing Memory

The following is a checklist to help us increase long-term memory of what we teach in our students. It is not necessary to apply all these strategies, but you should try to apply at least the first six strategies and then choose from the list of eleven strategies toward the end of the checklist. Again, just enter the date in which you applied the strategy on the checklist to see your growth.

_____I take advantage of the beginning and end of the lesson to execute the main points and I elaborate on the details in the middle of the lesson.

_____At the beginning of the lesson, once the students are focused, I avoid asking them if they know anything about the new topic.

_____I often use the middle of the lesson to deal with classroom management tasks (collecting homework, etc.), while students practice their new learning or discuss it by relating it to past learning.

_____I do a closure activity at the end to help students consolidate their new learning. (Sousa, 2001) (See p. 56 for more information)

_____I regularly tell my students my learning objectives.

_____I often try to connect curriculum to my students' experiences.

_____I offer opportunities to practice new skills through interactive or project-oriented lessons.

_____To increase memory, I have applied at least 5 of the following strategies.

____Increase the use of storytelling, visualizations, and metaphors in your presentations.

____Attach a strong emotion to new learning with a purposely-designed intense activity.

____Review or repeat new learning within ten minutes; then after two days, and again after a week.

____Attach concrete reminders of the new learning, like an artifact.

____Attach an acrostic to new learning and other mnemonic devices.

____Put new learning on large, colorful posters and hang it up.

____Ask students to identify patterns and connect them with prior knowledge.

____Have students summarize new learning with a mind-map.

____Increase accountability with frequent reviews and "check-ups".

____Facilitate frequent group discussions on new material.

____Incorporate journal writing and other forms of personal reflection. (Jensen, 2000)

Eliminating threat

Under stress, the filing capacities of our brain are reduced and our short-term memory, along with our ability to form permanent new memories are restrained. Teachers are inundated with stress with all the demands of today's politics that it is almost impossible for our students not to share some of the burdens of our stress. Nonetheless, we need to act like ducks on a stream- calm and collected on top, but paddling like crazy on the bottom. We must not let our students see our feet! The following is a checklist of some strategies to reduce threat from the classroom.

_____I try to limit the threat of rewards, grades, and recognition as they contribute to each student's identity and can pose a threat.

_____I try to help my students turn threats into challenges.

_____I try not to ask my students to believe something that logically clashes with their prior belief.

_____I try to prevent actions that are hurtful or emotionally inappropriate.

_____I try to be cognoscente of my students moral/ethical beliefs, so as to not to discredit or challenge their beliefs. (Caine, 1991)

Nonconscious Learning

Ninety-percent of our learning is nonconscious, therefore we need to realize that students are soaking up a lot more than what we are trying to teach them. We can try to optimize on nonconscious learning by applying at least five of the following strategies. Please mark the date of application next to the strategy to see your growth.

_____I hang up affirming posters.

_____I highlight positive role models.

_____I cite experts in a subject area.

_____I incorporate videos, CDs, slides, and photographs on a topic.

_____I tell stories about the success and perseverance of prior students.

_____I open a new subject with a celebration.

_____I hold student discussions about fears, feelings and concerns about learning.

_____I provide enough resources and letting students learn in their preferred style.

_____I encourage learners to find personal meaning in their projects.

_____I often am receptive to questions or comments.

_____I provide an atmosphere of physical and emotional safety where students feel accepted and respected. (Jensen, 2000)

Planning Down time

We have gone over countless strategies to get the information to stick on our students' brains, but we have to allow time for the glue to dry. This is where we need to plan down time to help our students consolidate the

information into meaningful files they can access at a later date. The following is a checklist of some strategies you can use to plan down time.

_____I facilitate small-group discussions with 'what-if' scenarios after new material is presented. (Caine, 1991)

_____I encourage my students to make mind maps of their new learning.

_____I encourage my students to find personal meaning in their new learning by journal writing.

_____I encourage my students to design creative projects that model their personal meaning from the new learning. (models, paintings, stories, poems, etc.)

Providing Enrichment

By providing an enriching environment we can actually help our students grow new neural connections. A few key things to keep in mind when providing enrichment are as follows. First the stimulus must be new, challenging, coherent and meaningful. Next the learning has to take place over time. Finally, there must be a way for the brain to learn from the challenging, novel stimuli- meaning feedback is needed. The following is a checklist of strategies teachers can use to maximize on enrichment.

_____I frequently comment on previous learning.

_____I encourage peer teaching and interaction.

_____I provide daily or weekly reviews. (self, teacher, or peer generated)

_____I have teams keep progress charts for their group and post results.

_____I encourage students to keep a learning journal.

_____I provide 'mock tests' that won't be applied to the grading scale.

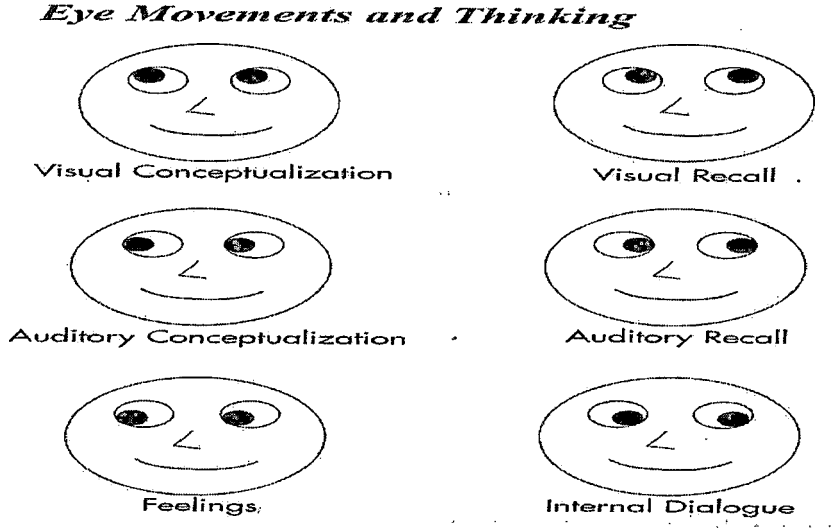
_____I have students pair up for test preparation.

_____I have students correct their own homework, quizzes, tests, etc.

_____I have learners do a group presentation where they get some feedback. (Jensen, 2000)

Teaching Skills and Eye movements

"Eye movements facilitate the processing and retrieval of information to and from the brain," (Jensen, 2000, p. 187). You can actually observe the thinking pattern of your students just by simply observing their eye movements in a non-stress situation. The following illustration lists six basic eye movements as they relate to thinking.




Copyright 2000 by Eric Jensen, Brain-Based Learning, p. 186

Teachers can use eye movement to teach basic skills, such as spelling. The following steps give you some ideas on how to help a student struggling with spelling.

1. Access feeling with regard to the word: Start with eyes looking down.
2. Visualize the image of the word: Move eyes up and to the right.
3. Cement a word in auditory memory: Say the letters while looking to the right.
4. Cement a word kinesthetically: Trace the letters of the word with your fingers.

5. Recall a stored image of the word: Close eyes and look to the left.
6. Write out the correct spelling of a word on paper: Review it and look up to the left.
7. To cement the success: Look down to the right and celebrate the feelings of empowerment. (Jensen, 2000)

"Cognitive activity occurring in one hemisphere triggers eye movements in the opposite hemisphere," (Jensen, 2000, p. 186). Teachers can really take advantage of the impact of eye movements on learning by trying some of the strategies on this next checklist.

_____When posting students' work on bulletin boards, put it low to access feelings, high to facilitate discussion, and overhead to help students store visual images in memory.

_____When presenting new material, stand to the right of the learners' viewpoint.

_____When doing a review, stand to the left of the learners' viewpoint.

_____Have students spread out during a test, so they won't have to worry about keeping their eyes on their own test and increasing stress levels.

Asking Questions

Jensen says that we can learn a lot about our students' cognitive processing simply by asking questions and then observing their eyes. In fact, asking questions generates sustained enriching brain activity because we continue to process the questions long after they have been posed. The following are a list of some alternatives to traditional questions that Jensen suggests you try. Just place a checkmark on the line next to strategies you applied.

____Have students generate the questions to be asked.

____Have students link their ideas to other subjects.

____Have students ask each other questions.

____Have students write up their own test questions.

____Have students relate ideas and questions to their own personal lives.

(Jensen, 2000)

You can also use the following charts on Bloom's Taxonomy to give your students opportunities to apply new learning through questioning. Why should we bother with such an outdated model such as Bloom's Taxonomy? Well the fact of the matter is that this model, though over 50 years old is very brain-based. Each level is cumulative. You cannot answer questions from the higher levels without knowing the lower levels. The three lower levels offer convergent thinking, whereby the learner recalls and focuses what is known about a topic and uses it to solve problems through application. The upper three levels incorporate divergent thinking whereby the students take their learning to new levels of meaning and gain personal insights and discoveries. Attaining understanding at these levels is at the heart of brain-based learning. The following is a checklist to help you apply some Bloom's Taxonomy questioning strategies. You don't have to do them all, but try to apply about three strategies. Please fill out the checklist below as you apply each strategy to watch yourself grow.

_____ I have used the Bloom's Taxonomy model in designing questions on a concept.

_____ I have designed at least two questions per level using the action words on p. 144 of the following page.

_____ I have designed group activities where students must answer questions together at each level of the Bloom's Taxonomy regarding a theme or concept.

_____ I have designed a test on a topic whereby students can choose which level of Bloom's Taxonomy questions to answer.

Note: the higher the level, the more points the questions are worth.

_____ I have allowed my students to design evaluations using Bloom's Taxonomy action words.

*Thinking Skills and Learning*

**Table 7.1 Bloom's Taxonomy of the Cognitive Domain[4]**

Below are the levels in decreasing order of complexity with terms and sample activities that illustrate the thought processes at each level.

| LEVEL | TERMS | SAMPLE ACTIVITIES |
|---|---|---|
| Evaluation | appraise | Which of the two main characters in the story would you rather have as a friend? Why? |
| | assess | Is violence ever justified in correcting injustices? Why or why not? |
| | judge | Which of the environments we've studied seems like the best place for you to live? Defend your answer. |
| Synthesis | imagine | Pretend you were a participant in the Boston Tea Party and write a diary entry that tells what happened. |
| | compose | Rewrite *Little Red Riding Hood* as a news story. |
| | design | Design a different way of solving this problem. |
| | infer | Formulate a hypothesis that might explain the results of these three experiments. |
| Analysis | analyze | Which events in the story are fantasy and which really happened? |
| | contrast | Compare and contrast the post–Civil War period with the post–Vietnam War period. |
| | distinguish | Sort this collection of rocks into three categories. |
| | deduce | Which of these words are Latin derivatives and which are Greek? |
| Application | practice | Use each vocabulary word in a sentence. |
| | calculate | Calculate the area of your classroom. |
| | apply | Think of three situations in which we would use this mathematics operation. |
| Comprehension | summarize | Summarize the paragraph in your own words. |
| | discuss | Why are symbols used on maps? |
| | explain | Write a paragraph explaining the duties of the mayor. |
| Knowledge | define | What is the definition of a verb? |
| | label | Label the three symbols on this map. |
| | recall | What are the three branches of government? |

# TAXONOMY OF THINKING SKILL ACTION WORDS

## Knowledge

Example: Locate the state capitals on the map of the United States.

| | |
|---|---|
| What | Name |
| Who | Recite |
| When | List |
| Where | Relate |
| Recall | Find |
| Locate | Identify |
| Repeat | Label |

## Comprehension

Example: Transpose Romeo and Juliet into a modern-day idiom.

| | |
|---|---|
| Reword | Reconstruct |
| Convert | Paraphrase |
| Outline | Transpose |
| Explain | Understand |
| Define | Conceive |
| Interpret | Calculate |

## Application

Example: Solve the problem of fastening two objects by studying the properties of burrs.

| | |
|---|---|
| Apply | Transform |
| Adapt | Employ |
| Transfer | Manipulate |
| Adopt | Utilize |
| Transcribe | Transplant |
| Solve | Relate |
| Use | Convert |

## Analysis

Example: Classify the following animals according to diet and determine their place in the food chain: shrimp, dolphin, worm, monkey, and rabbit.

| | |
|---|---|
| Break down | Analyze |
| Examine | Separate |
| Dissect | Investigate |
| Scrutinize | Compartmentalize |
| Inspect | Classify |
| Sort | Take apart |

## Synthesis

Example: Compound the following ingredients into a smooth paste: butter, flour, milk, and honey.

| | |
|---|---|
| Combine | Mix |
| Build | Compound |
| Originate | Structure |
| Regroup | Make |
| Conceive | Generate |
| Blend | Join |
| Develop | |

## Evaluation

Example: Determine the performance of the following mutual funds and select the top two: Fund A, Fund B, Fund AA, Fund BB, and Fund ABC.

| | |
|---|---|
| Assess | Assay |
| Judge | Decide |
| Weigh | Arbitrate |
| Rate | Grade |
| Determine | Appraise |
| Rank | Classify |

*Figure 6.4*

SkyLight Training and Publishing Inc.

Including Music

Why should we include music in our classrooms? The reason is that music elicits emotional response and it is the emotion that captivates attention and helps us encode whatever we are trying to teach into long-term memory. Media is a master at applying this strategy. Just ask yourself if you would have even remembered a catchy commercial if the music was missing. Would a scene from a scary movie have made such an impression on your memory if the music were absent? Likewise, we can use this strategy in our classrooms to imprint the new information longer. The following checklist suggests what kind of music to use when you want your students to learn about certain topics or practice certain skills. Again, you don't have to use them all, but try at least three strategies and examine your results.

_____ I try to teach a music lesson at least twice a month.

_____ My students listen to music before testing, but not during, so as not to interfere with the brain's neural firing patterns during the test.

_____I have used baroque music as a background for writing activities and seatwork.

_____I have used baroque music as a background for reviewing a learning session.

_____I have used classical or romantic music to introduce new information or for storytelling.

_____I have tried a concert reading to minimize time to teach and maximize time to learn.

1. Preview the 'big ideas' of a new unit in 3 –7 minutes by accompanying it with intriguing, attention-getting, dramatic music.
2. Present the heart of the content in a dramatic way using classical or romantic music in 5-15 minutes. (Let students listen to the music for

the first 30 seconds, and then deliver the material once the music gets quieter.)

3. Engage students in a passive review of 5-8 minutes, accompanied by baroque music, where you let the music and message carry a low-key review of the new material to the learner's unconscious minds, while students relax with their eyes closed.

Teaching to Both Halves of the Brain

We need to understand that students with different learning styles behave differently during learning. We also need to recognize that we teach according to our own learning style. We need take note of the learning styles of our students and not take their counterproductive behavior personally, but rather try to teach to those varied learning styles. The following is a checklist to help you apply strategies that foster teaching to varied learning styles. If you decide not to try them all, at least try the first three strategies and mark the date of application next to the strategy.

_____I have used the Testing Your Hemispheric Preference sheets below to assess what my preferred learning preference is.

_____I have given the Testing Your Hemispheric Preference sheets below to my students to assess what their individual learning preferences are.

_____I have helped my students develop their learning preferences by designing lessons that include activities to meet the preference of all learners. (See chart p. 194)

_____I have given my students the opportunity to design projects that accommodate their learning preferences.

**PRACTITIONER'S CORNER**

# Testing Your Hemispheric Preference

There are many instruments available to help individuals assess their hemispheric preference. The one below takes just a few minutes. The results are only an indication of your preference and are not conclusive. You should use additional instruments to collect more data before reaching any firm conclusion about your hemispheric preference.

**Directions**: From each pair below, circle A or B corresponding to the sentence that **best describes you.** Answer all questions. There are no right or wrong answers.

1. A. I prefer to find my own way of doing a new task.
   B. I prefer to be told the best way to do a new task.

2. A. I have to make my own plans.
   B. I can follow anyone's plans.

3. A. I am a very flexible and occasionally unpredictable person.
   B. I am a very stable and consistent person.

4. A. I keep everything in a particular place.
   B. Where I keep things depends on what I am doing.

5. A. I spread my work evenly over the time I have.
   B. I prefer to do my work at the last minute.

6. A. I know I am right because I have good reasons.
   B. I know when I am right, even without reasons.

7. A. I need a lot of variety and change in my life.
   B. I need a well-planned and orderly life.

8. A. I sometimes have too many ideas in a new situation.
   B. I sometimes don't have any ideas in a new situation.

– Continued –

## Testing Your Hemispheric Preference—Continued

9. A. I do easy things first and the important things last.
   B. I do the important things first and the easy things last.

10. A. I choose what I **know** is right when making a hard decision.
    B. I choose what I **feel** is right when making a hard decision.

11. A. I plan my time for doing my work.
    B. I don't think about the time when I work.

12. A. I usually have good self-discipline.
    B. I usually act on my feelings.

13. A. Other people don't understand how I organize things.
    B. Other people think I organize things well.

14. A. I agree with new ideas before other people do.
    B. I question new ideas more than other people do.

15. A. I tend to think more in **pictures.**
    B. I tend to think more in **words.**

16. A. I try to find the one best way to solve a problem.
    B. I try to find different ways to solve a problem.

17. A. I can usually **analyze** what is going to happen next.
    B. I can usually **sense** what is going to happen next.

18. A. I am not very imaginative in my work.
    B. I use my imagination in nearly everything I do.

19. A. I begin many jobs that I never finish.
    B. I finish a job before starting a new one.

– Continued –

## Testing Your Hemispheric Preference—Continued

20. A. I look for new ways to do old jobs.
    B. When one way works well, I don't change it.

21. A. It is fun to take risks.
    B. I have fun without taking risks.

**Scoring:**

Count the number of "A" responses to questions 1, 3, 7, 8, 9, 13, 14, 15, 19, 20, and 21. Place that number on the line to the right. A._____

Count the number of "B" responses to the remaining questions. Place that number on the line to the right. B._____

Total the "A" and "B" responses you counted. Total_____

The total indicates your hemispheric preference according to the following scale:

| | |
|---|---|
| 0–5 | Strong left hemisphere preference |
| 6–8 | Moderate left hemisphere preference |
| 9–12 | Bilateral hemisphere balance (little or no preference) |
| 13–15 | Moderate right hemisphere preference |
| 16–21 | Strong right hemisphere preference |

**Reflection:**

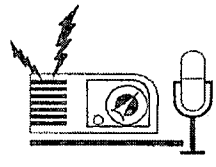
A. Did your score surprise you? Why or why not?

B. Describe here what your score may tell you about your teaching.

C. What implications do your answers in B above have for your students?

## Strategies for Teaching to the Whole Brain—Continued

Use the chart below to decide what types of classroom strategies would work best with students whose hemisphere and sensory preferences are as indicated. Use the **bridging** and **hugging** strategies you learned in Chapter 4 to help you with this.

| Modality | Left-Hemisphere Preference | Right-Hemisphere Preference |
|---|---|---|
| **Visually Preferred**  | | |
| **Kinesthetically Preferred**  | | |
| **Auditorily Preferred**  | | |

– Continued –

Using Transfer to Cement New Learning into Long-term Memory

Transfer helps students make connections between what *they* already know and what they will learn. Sousa suggests that we find out if students have knowledge about what is to be learned. If they do, we need to take note and move on to something new, as there is plenty of repetition in today's curriculum. Another thing to avoid is teaching similar concepts at the same time, such as latitude and longitude, or b, d, q, and p. What happens is the learner often cannot tell the differences between the two concepts because there are too many similarities. The following checklist suggests several strategies that promote transfer. Alas, I will ask that you just try five strategies and mark the date of application on the checklist to assess your growth.

___ I have asked my students to write a short story about what they already know about a topic.

___ My students have conducted interviews in the think-pair-share format.

___ I have asked my students to do graphic organizers, murals or collages that communicate what they know about a topic.

___ I have had some students write a song that tells their knowledge about a topic.

___ Some of my students have built a model or made a drawing that expresses what they know about a topic.

___ Some of my students have come up with their own ideas that show what they know about a topic, such as writing a poem, painting a picture, creating a quiz show, etc.

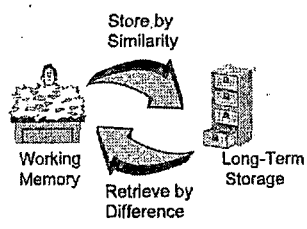
___ I have used the critical attributes page below to teach a concept.

___ I have used the bridging page below to invoke transfer. (See p. 55)

___ I have used the hugging page below to invoke transfer. (See p. 55)

## Identifying Critical Attributes for Accurate Transfer—Continued

**Identifying Unique and Unvarying Elements**




Identify a major concept and decide on its unique and unvarying elements (critical attributes).

Concept:_____

1. Its unique and unvarying elements (critical attributes) are

_____

_____

2. Simple examples are

_____

_____

3. Complex example(s) are

_____

_____

4. Student examples could be

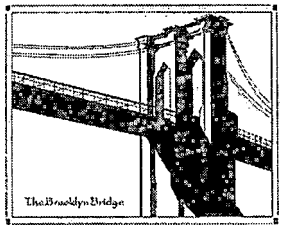
_____

_____

5. Limits of the unique and unvarying elements (if any) are

_____

## Teaching for Transfer: Bridging (Transfer of Past to Present)—Continued




**Bridging**: Invoking transfer by connecting what the learner knows to other new learning and contexts. Select a concept (e.g., energy, democracy, equilibrium, allegory) and use the strategies below to link that concept to the learner's past knowledge. Look at the **Practitioner's Corner** on concept mapping in Chapter 5, p. 196 for help with this task.

*Brainstorming* (applying new learning in other situations):

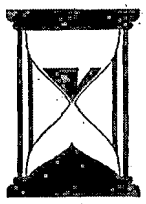
*Analogies* (examining similarities and differences):

The Analogy Map could help here (see p. 185).

*Metacognition* (solving problems by investigating advantages and disadvantages of alternative solutions):

| Advantages | Disadvantages |
|---|---|
| | |
| | |
| | |

## Teaching for Transfer: Hugging (Transfer of Present to Future)—Continued



**Hugging**: Invoking transfer by making the new learning situation more like future situations to which transfer is desired. Select a concept (or the same one you chose in Bridging) and use the strategies that follow to show how the concept can be useful in future circumstances.

*Simulation games* (practicing new roles in diverse situations):

Be prepared to present the simulation to the group.

*Mental practice* (devising mental strategies for dealing with different scenarios):

*Contingency learning* (secondary learnings needed to accomplish primary learning):

Congratulations, you have just completed the initial process of transforming your classroom into a brain-based learning environment. I say initial process because you will find yourself constantly changing as you get new students or you find some strategies just didn't work this year as they did last year. Though we know so much more about the brain now than we ever have, there continues to arise many discoveries that open doors for those of us in education. You may want to keep up with the findings, but in the meantime, I have provided a list of some useful websites that assist me with planning lessons in the classroom. Though you deserve a Golden Apple for your efforts, my hope is that you will find the real gold in your students' successes and their attitudes toward learning.

Useful Websites

1. Lesson Plans Page: http://www.lessonplanspage.com/
2. A to Z Teacher Stuff: http://www.atozteacherstuff.com/Lesson_Plans/lessonplans-gradelevels.shtml
3. Pro-Teacher: http://www.proteacher.com/
4. KidzOnline: http://www.kidzonline.org/LessonPlans/
5. Sites for Teachers: http://www.sitesforteachers.com/
6. Dana Alliance for Brain Initiatives: http://www.dana.org/

# APPENDIX B

# FINAL DRAFT OF "GUIDELINES FOR DESIGNING A BRAIN-BASED LEARNING ENVIRONMENT"

## Designing a Brain-based Learning Environment

Teachers now have much information on how the brain works, how to apply brain-based strategies in the classroom, and what it looks like when one applies those strategies in his or her classroom. All this information is fine, but it may be more overwhelming now than ever when a teacher takes a look at his or her own classroom and tries to plan the transformation into a brain-based learning environment. This section will help teachers with that process. It includes a series of checklists and graphic organizers to help teachers set goals and take little steps into the process of designing a brain-based classroom.

### Setting Up a Brain-Based Environment

The following checklist is meant to help teachers start the process of setting up a brain-based classroom. This process can be overwhelming if someone plans on doing everything at once. Remember that designing a brain-based environment is a process, not an immaculate transformation overnight. My suggestion is that the teacher choose one item at a time from the checklist, apply it to his or her classroom, and then put the date of the application on the checklist next to the item chosen. This will help teachers to remember they are partaking in a process of transformation and will allow them to see their growth. Teachers can add something new to the classroom each week or two until they have filled out as much of the checklist as they want.

___ Desks are arranged to maximize group work.

___ Concrete vivid images and peripherals can be seen from every position in the classroom.

___ White boards or chalkboards can be seen from every position in the classroom.

___ Interest center/s are easily accessible and supplies are clearly labeled. *

___ Some bulletin boards are yellow, light orange, beige, or off-white.

___ There is a collection of interesting posters, photos, and objects around the room that enhance the visual environment.

___ There is one piece from each student displayed to promote positive feelings.

___ In a classroom with florescent lighting, there are some lamps with natural light bulbs positioned around the classroom.

___ There are four to eight plants in the classroom. (See p. 31 for a list of plants to use.)

___ Aromas are present. (See p. 31 for a list of aromas to use.)

___ A CD/cassette player is present.

*Teachers may use centers to reinforce skills taught in class. If this is the case, they may want one center per subject taught. The teacher must provide enough materials for the amount of students he or she wants to allow in that center. The teacher will need to set up a schedule for when he or she wants students to use the centers, how many students in each center, and how students will get from one center to the next (be it a rotation every 15 minutes or a checklist of centers the teacher wants students to visit). Teachers will also want to design an accountability component where they check the work students completed in a center folder or they just have students write in a journal what they learned in each center that day. Remember, this is part of the consolidation process and it helps students transfer their learning to long-term memory. Be sure to teach students how to use each center and clean up the center for the next group of students. Setting up centers and maintaining the activities may be too overwhelming. The key to getting started is just setting up one center at a time, teaching the students how to use the center, and then setting up a new center each week until the teacher and the students can easily work with multiple centers. A

great resource if you have never created learning centers in your classroom are as follows:

1. **What Are the Other Kids Doing While You Teach Small Groups?**

   By Donna Marriott, Joel Kupperstein, Creative Teaching Press; Teacher edition (November 1997).

2. **Literature Circles,** by Marcia Huber, Creative Teaching Press, 2001

*If the above stills seems too high maintenance for teachers than they may just want to set up an interest center in which students explore a theme or concept. Teachers can provide a list of activities students can do that go with the theme or provide materials for students to explore and experiment with their own ideas. Again, students will need to record their learnings in a journal to help them consolidate what they learned into long-term memory. Teachers may want to set aside about 10 – 15 minutes each day for students to read and share their journal entries. This process benefits the whole class by providing feedback for everyone.

## Preparing the Learner

Now that the teacher has set up his or her environment, it is time to figure out what to do with the classroom full of students. First things first, the teacher must prepare the learners for a brain-based environment. Now several things on this checklist are out of the teacher's hands. In other words, the teacher really doesn't have control over the home environment of each student; however, he or she can write a letter to parents emphasizing the importance of sleep, good nutrition, vitamins, exercise, and self-concept to the brain. (A sample letter is provided in the appendix.) The teacher will also need to emphasize the importance of sleep, good nutrition, vitamins, exercise, and self-concept to his or her students. Teachers will be supporting the development of each student's self-concept and they will need to enlist the help of each student. This is a golden opportunity for the teacher to set up a

community in his or her classroom. The teacher can have students decide on the rules and consequences, if he or she is comfortable with the idea, as well as how to handle problems that may arise. Like the previous checklist, the teacher may decide on doing only a few of these strategies or all of them. The teacher can just pick one, apply the strategy and then mark the date of application on the checklist so he or she can keep track of his or her growth.

___ Write and send parents a letter emphasizing the importance of sleep, good nutrition, vitamins, exercise, and self-concept to the brain.

___ Discuss with students the importance of sleep, good nutrition, vitamins, exercise, and self-concept to the brain.

___ Allow students to have water bottles on or around their desks and allow for water breaks if necessary.

___ Have students design rules, consequences, and rewards. (You can guide them to making up rules that you find necessary.)

___ Set up a time for class meetings, usually about 15 minutes, with a clipboard to list problems and a procedure for who will lead the meetings. (Be sure to have compliment circles on one student as often as possible until all students have been complimented).

___ Have students design some routines that promote self-concept of each student.

___ Teach the students study skills

___ Setting goals and developing a purpose

___ Browsing material to identify key concepts and building 'perceptual maps'

___ Developing mind-maps that reflect their thoughts, questions, concerns, and connections to prior learning

___ Reading with a highlighter and making notes in the margins

___ Summarizing what they've learned, making reflections, and asking questions

___ Applying their learning by making models and doing projects

___ Mastering 'priming' or pre-exposing students to new material

___ Using graphic organizers or mind-maps and posting them before starting a unit (see maps below for ideas)

___ Having students make a model of their learning in a form of maps, story boards, graphic organizers, paintings, etc. (Jensen, 2000)

___ Take short exercise breaks between lessons.

(Visit some of the following websites for some useful ideas.)

π **Brain Gym® Exercises**

http://esl.about.com/library/lessons/blbraingym.htm

π **Classroom Movement Activity Ideas**

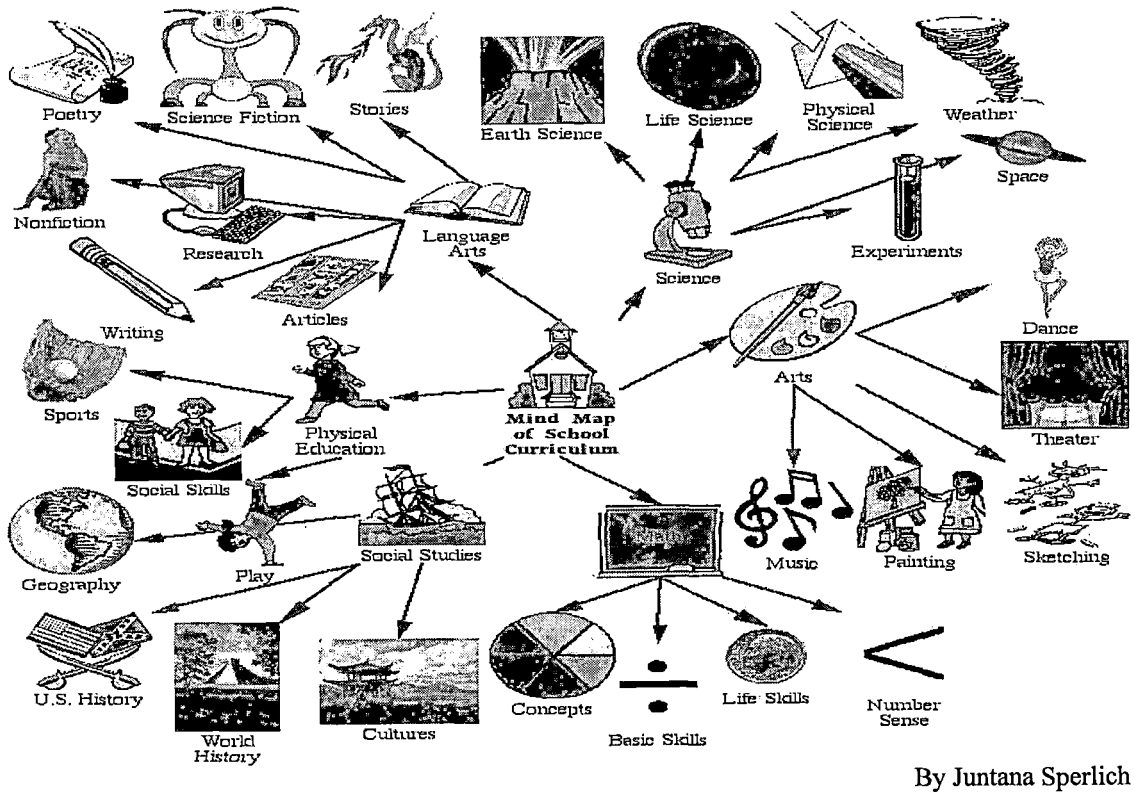
http://westlakees.wcpss.net/classroommovemenideas.htm

π **Responsive Classroom**

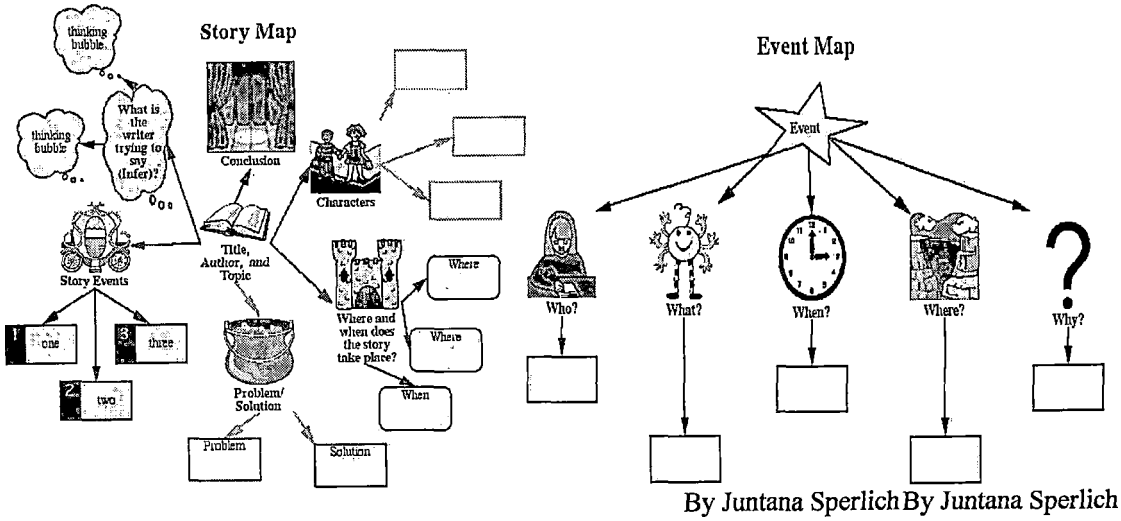
http://www.edina.k12.mn.us/concord/teacherlinks/rc.html

π **Fun and Easy Classroom Stretches**

http://ucce.ucdavis.edu/files/filelibrary/2372/20647.pdf




By Juntana Sperlich

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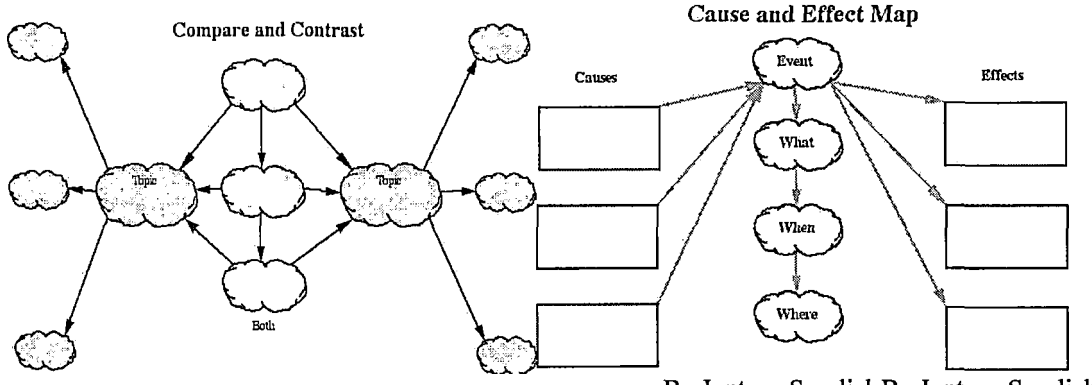
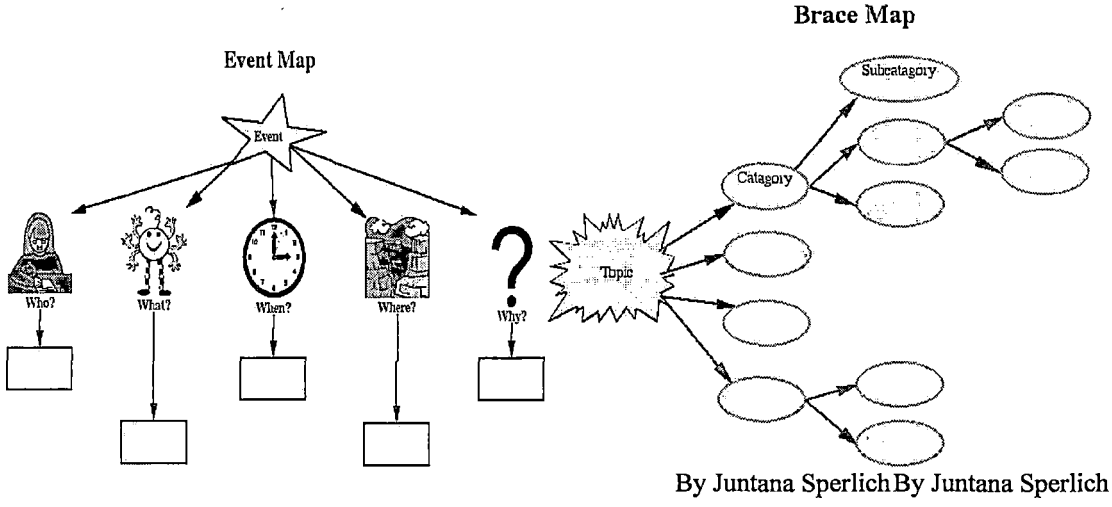
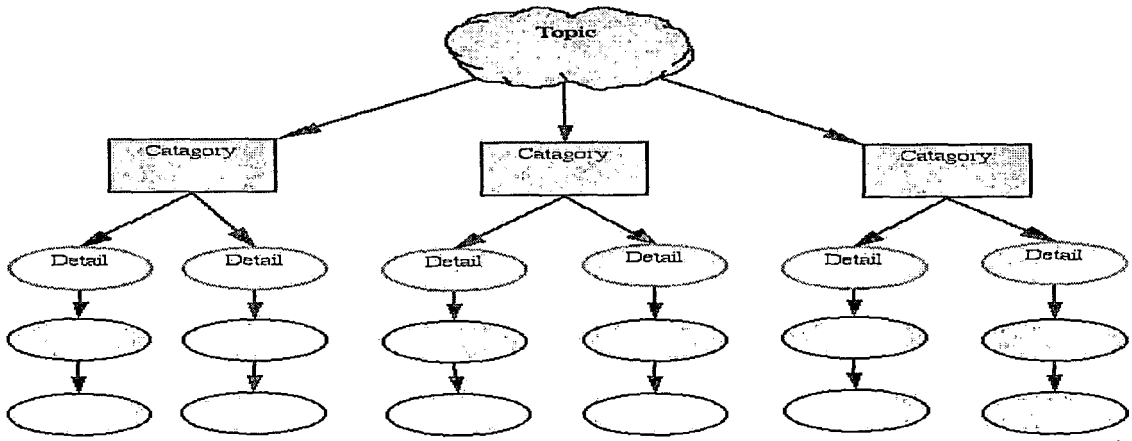

Compare and Contrast
Topic
Topic
Both
Cause and Effect Map
Causes
Event
What
When
Where
Effects
By Juntana SperlichBy Juntana Sperlich


Event Map
Event
Who?
What?
When?
Where?
Why?
Brace Map
Subcatagory
Catagory
Topic
By Juntana SperlichBy Juntana Sperlich

## Catagorizing Information

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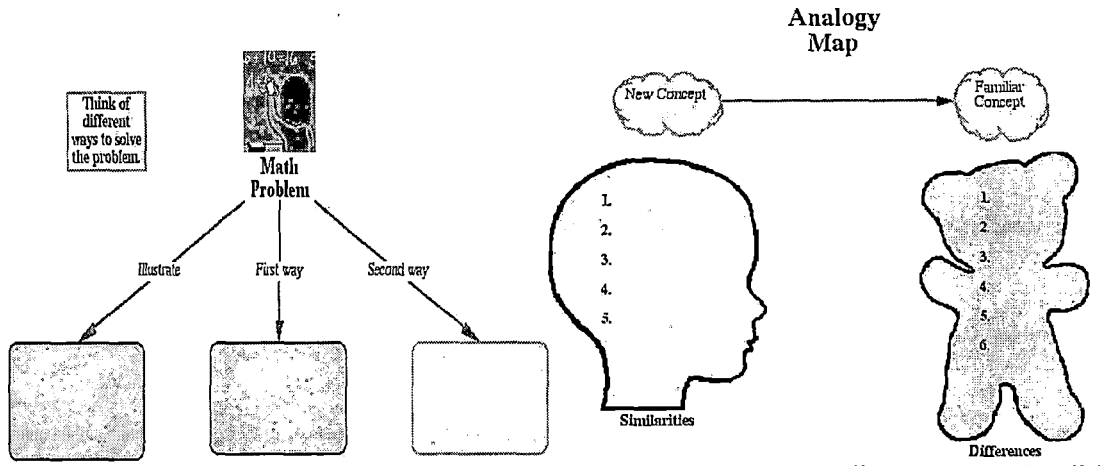



By Juntana Sperlich By Juntana Sperlich

## Setting up a schedule

Teachers must keep in mind the following about learning.

- Intellectual performance and comprehension increase as the day progresses.
- Short-term memory is best in the morning. Long-term memory is best in the afternoon.
- To maintain attention, vary presentation and lecture times, while changing up sessions with activities that provide movement.
- Students who do not looked focused may be consolidating information into long-term memory.
- With young learners, content, lectures, and cognitive activities need to be limited to 5 - 10 minutes each.
- With adolescents, these content sessions need to be limited to 10 - 15 minutes.
- With adults, these sessions must be no more than 25 minutes. (Jensen, 2000)

The following checklist gives teachers a rough time frame in which certain subjects are most effectively learned. Of course the teacher will need to adjust this schedule to his or her school schedule.

___ Between 9:00-12:00, I have planned rote learning tasks, spelling, problem-solving, test review, report writing, math, theory, or science activities.

___ Between 12:00-2:00, I have planned movement-oriented tasks, paperwork, manipulatives, music, computer work, singing, or art.

___ Between 2:00-5:00, I have planned to study literature or history, sports, music, theater, or manual-dexterity tasks. (Jensen, 2000)

## How to Hook our Students

"In a classroom climate typified by positive challenge and joy, the body releases endorphins," (Jensen, 2000, p. 180). We need these endorphins present in our students in order to hook them into learning. The following is a checklist to help teachers develop some strategies to hook their students. Please enter the date of application next to the strategy.

___ I offer some lessons that are novel.

___ I offer some lessons that are emotionally intense by being outrageous, funny or different.

___ I help learners understand the importance of their emotions in the learning process by...

___ Being a role model;

___ Having celebrations;

___ Giving opportunities for debates, dialogue, or game shows;

___ Offering physical rituals, like clapping patterns, chants, movements, or theme songs;

___ Offering time for introspection through journals, small-group discussions, or reflection tasks;

___ I have let my students create projects.

___ I have let my students choose their curriculum.

___ I often encourage group work. (Feel free to use the following pages on group work for accountability pieces.)

# Group Project Task List

## Group Name or Assignment

_____

_____

**Members of the Group**_____

**Name**_____
**Duties:**

1._____
2._____
3._____
4._____

**Name**_____
**Duties:**

1._____
2._____
3._____
4._____

**Name**_____
**Duties:**

1._____
2._____
3._____
4._____

**Name**_____
**Duties:**

1._____
2._____
3._____
4._____

# Project Check List

**Topic: Group Members:**

- π **Research** _____
- π **Summarize** _____
- π **Illustrate** _____
- π _____
- π **Research** _____
- π **Summarize** _____
- π **Illustrate** _____
- π _____
- π **Research** _____
- π **Summarize** _____
- π **Illustrate** _____
- π _____
- π **Research** _____
- π **Summarize** _____
- π **Illustrate** _____
- π _____
- π _____
- π _____
- π _____
- π **Create a Poster and/or Powerpoint Presentation on** _____
- π _____

# Group Presentation Critique

1. Topic_____

2. Group Members_____

3. Rating for each Category (1=needs work 2=okay 3=awesome)

| | | | |
|---|---|---|---|
| a. Visual Aids | 1 | 2 | 3 |
| b. Speeches | 1 | 2 | 3 |
| c. Creativity | 1 | 2 | 3 |
| d. Overall Presentation | 1 | 2 | 3 |

4. What did you like best of the presentation? Why?_____
_____

5. What would you recommend to improve the presentation?_____
_____

# Group Cooperation Reflection

**Topic: _____ Group Members:_____**

**Place the group members' names in the first column of boxes and place a check in the boxes next to each name where the student did the work in that category.**

| Names | Worked Cooperatively | Contributed Ideas | Did all Work Agreed Upon | (Teacher's Choice) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**Suggestions for next time:** _____
_____

## Increasing Memory

The following is a checklist to help teachers increase long-term memory of what they teach their students. It is not necessary to apply all these strategies, but the teacher should try to apply at least the first six strategies and then choose from the list of eleven strategies toward the end of the checklist. Again, just enter the date in which the teacher applied the strategy on the checklist to see his or her growth.

___ I take advantage of the beginning and end of the lesson to execute the main points and I elaborate on the details in the middle of the lesson.

___ At the beginning of the lesson, once the students are focused, I avoid asking them if they know anything about the new topic.

___ I often use the middle of the lesson to deal with classroom management tasks (collecting homework, etc.), while students practice their new learning or discuss it by relating it to past learning.

___ I do a closure activity at the end to help students consolidate their new learning. (Sousa, 2001) (See p. 56 and 57 for more information and ideas.)

___ I regularly tell my students my learning objectives.

___ I often try to connect curriculum to my students' experiences.

___ I offer opportunities to practice new skills through interactive or project-oriented lessons.

___ To increase memory, I have applied at least 5 of the following strategies.

___ Increase the use of storytelling, visualizations, and metaphors in your presentations.

___ Attach a strong emotion to new learning with a purposely designed intense activity.

___ Review or repeat new learning within ten minutes; then after two days, and again after a week.

___ Attach concrete reminders of the new learning, like an artifact.

___ Attach an acrostic to new learning and other mnemonic devices.

___ Put new learning on large, colorful posters and hang it up.

___ Ask students to identify patterns and connect them with prior knowledge.

___ Have students summarize new learning with a mind-map.

___ Increase accountability with frequent reviews.

___ Facilitate frequent group discussions on new material.

___ Incorporate journal writing and other forms of personal reflection, (Jensen, 2000).

**Eliminating threat**

Under stress, the filing capacities of our brain are reduced and our short-term memory, along with our ability to form permanent new memories are restrained. Teachers are inundated with stress with all the demands of today's politics that it is almost impossible for our students not to share some of the burdens of our stress. Nonetheless, we need to act like ducks on a stream- calm and collected on top, but paddling like crazy on the bottom. We must not let our students see our feet! The following is a checklist of some strategies to reduce threat from the classroom.

___ I try to limit the threat of rewards, grades, and recognition as they contribute to each student's identity and can pose a threat.

___ I try to help my students turn threats into challenges.

___ I try not to ask my students to believe something that logically clashes with their prior belief.

___ I try to prevent actions that are hurtful or emotionally inappropriate.

___ I try to be cognoscente of my students moral/ethical beliefs, so as to not to discredit or challenge their beliefs, (Caine, 1991).

## Non-conscious Learning

Ninety-percent of our learning is non-conscious, therefore we need to realize that students are soaking up a lot more than what we are trying to teach them. We can try to optimize on non-conscious learning by applying at least five of the following strategies. Please mark the date of application next to the strategy to see your growth.

___ I hang up affirming posters.

___ I highlight positive role models.

___ I cite experts in a subject area.

___ I incorporate videos, CDs, slides, and photographs on a topic.

___ I tell stories about the success and perseverance of prior students.

___ I open a new subject with a celebration.

___ I hold student discussions about fears, feelings and concerns about learning.

___ I provide enough resources and letting students learn in their preferred style.

___ I encourage learners to find personal meaning in their projects.

___ I often am receptive to questions or comments.

___ I provide an atmosphere of physical and emotional safety where students feel accepted and respected. (Jensen, 2000)

## Planning Down time

We have gone over countless strategies to get the information to stick on our students' brains, but we have to allow time for the glue to dry. This is where we need to plan down time to help our students consolidate the information into meaningful files they can access at a later date. The following is a checklist of some strategies teachers can use to plan down time.

___ I facilitate small-group discussions with 'what-if' scenarios after new material is presented. (Caine, 1991)

___ I encourage my students to make mind maps of their new learning.

___ I encourage my students to find personal meaning in their new learning by journal writing.

___ I encourage my students to design creative projects that model their personal meaning from the new learning. (models, paintings, stories, poems, etc.)

**Providing Enrichment**

By providing an enriching environment we can actually help our students grow new neural connections. A few key things to keep in mind when providing enrichment are as follows: first the stimulus must be new, challenging, coherent and meaningful. Next the learning has to take place over time. Finally, there must be a way for the brain to learn from the challenging, novel stimuli- meaning feedback is needed. The following is a checklist of strategies teachers can use to maximize enrichment.

___ I frequently comment on previous learning.

___ I encourage peer teaching and interaction.

___ I provide daily or weekly reviews (self, teacher, or peer generated).

___ I have teams keep progress charts for their group and post results.

___ I encourage students to keep a learning journal.

___ I provide 'mock tests' that won't be applied to the grading scale.

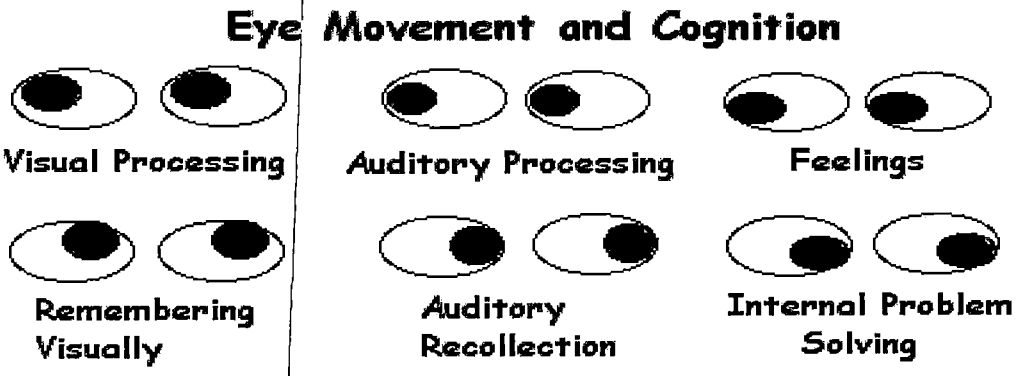
___ I have students pair up for test preparation.

___ I have students correct their own homework, quizzes, tests, etc.

___ I have learners do a group presentation where they get some feedback. (Jensen, 2000)

## Teaching Skills and Eye movements

"Eye movements facilitate the processing and retrieval of information to and from the brain" (Jensen, 2000, p. 187). Teachers can actually observe the thinking pattern of their students just by simply observing their eye movements in a non-stress situation. The following illustrations adapted from Jensen, (2000) lists six basic eye movements as they relate to thinking.




(Adapted by Juntana Sperlich from Jensen, 2000, p. 186)

Teachers can use eye movement to teach basic skills, such as spelling. The following steps give you some ideas on how to help a student struggling with spelling.

8. Access feeling with regard to the word: Start with eyes looking down.
9. Visualize the image of the word: Move eyes up and to the right.
10. Cement a word in auditory memory: Say the letters while looking to the right.
11. Cement a word kinesthetically: Trace the letters of the word with your fingers.
12. Recall a stored image of the word: Close eyes and look to the left.
13. Write out the correct spelling of a word on paper: Review it and look up to the left.
14. To cement the success: Look down to the right and celebrate the feelings of empowerment. (Jensen, 2000)

"Cognitive activity occurring in one hemisphere triggers eye movements in the opposite hemisphere" (Jensen, 2000, p. 186). Teachers can really take advantage of the impact of eye movements on learning by trying some of the strategies on this next checklist.

___ When posting students' work on bulletin boards, put it low to access feelings, high to facilitate discussion, and overhead to help students store visual images in memory.

___ When presenting new material, stand to the right of the learners' viewpoint.

___ When doing a review, stand to the left of the learners' viewpoint.

___ Have students spread out during a test, so they won't have to worry about keeping their eyes on their own test and increasing stress levels.

**Asking Questions**

Jensen (2000) says that we can learn a lot about our students' cognitive processing simply by asking questions and then observing their eyes. In fact, asking questions generates sustained enriching brain activity because we continue to process the questions long after they have been posed. The following are a list of some alternatives to traditional questions that Jensen suggests teachers try. Teachers can just place a checkmark on the line next to strategies you applied.

___ Have students generate the questions to be asked.

___ Have students link their ideas to other subjects.

___ Have students ask each other questions.

___ Have students write up their own test questions.

___ Have students relate ideas and questions to their own personal lives. (Jensen, 2000)

Teachers can also use the following charts on Bloom's Taxonomy to give their students opportunities to apply new learning through questioning. Why should we bother with such an outdated model such as Bloom's Taxonomy? Well the fact of the matter is that this model, though over 50 years old is very brain-based. Each level is cumulative. One cannot answer questions from the higher levels without knowing the lower levels. The three lower levels offer convergent thinking, whereby the learner recalls and focuses what is known about a topic and uses it to solve problems through application. The upper three levels incorporate divergent thinking whereby the students take their learning to new levels of meaning and gain personal insights and discoveries. Attaining understanding at these levels is at the heart of brain-based learning. The following is a checklist to help teachers apply some Bloom's Taxonomy questioning strategies. Teachers don't have to do them all, but they should try to apply about three strategies from the list. The teacher should fill out the checklist below as he or she applies each strategy to watch his or her class grow.

___ I have used the Bloom's Taxonomy model in designing questions on a concept.

___ I have designed at least two questions per level using the action words on the 'Posing Questions Using Bloom's Taxonomy' chart below.

___ I have designed group activities where students must answer questions together at each level of the Bloom's Taxonomy regarding a theme or concept.

___ I have designed a test on a topic whereby students can choose which level of Bloom's Taxonomy questions to answer. Note: the higher the level, the more points the questions are worth.

___ I have allowed my students to design evaluations using Bloom's Taxonomy action words.

# Posing Questions Using Bloom's Taxonomy

| Level | Questioning Words | | |
|---|---|---|---|
| **Evaluation** | ➢ appraise | ➢ determine | ➢ classify |
| | ➢ assess | ➢ rank | ➢ weigh |
| | ➢ judge | ➢ decide | ➢ rate |
| **Synthesis** | ➢ imagine | ➢ infer | ➢ blend |
| | ➢ compose | ➢ combine | ➢ generate |
| | ➢ design | ➢ regroup | ➢ build |
| **Analysis** | ➢ analyze | ➢ break down | ➢ investigate |
| | ➢ contrast | ➢ examine | ➢ sort |
| | ➢ distinguish | ➢ inspect | ➢ separate |
| **Application** | ➢ practice | ➢ adapt | ➢ transform |
| | ➢ calculate | ➢ transfer | ➢ relate |
| | ➢ apply | ➢ solve | ➢ use |
| **Comprehension** | ➢ summarize | ➢ outline | ➢ paraphrase |
| | ➢ discuss | ➢ interpret | ➢ calculate |
| | ➢ explain | ➢ reconstruct | ➢ convert |
| **Knowledge** | ➢ define | ➢ relate | ➢ locate |
| | ➢ label | ➢ find | ➢ list |
| | ➢ recall | ➢ repeat | ➢ identify |

(Adapted by Juntana Sperlich from Perry and Gregory, 1998, p. 144)

## Including Music

Why should we include music in our classrooms? The reason is that music elicits emotional response and it is the emotion that captivates attention and helps us encode whatever we are trying to teach into long-term memory. Media is a master at applying this strategy. Just ask yourself if you would have even remembered a catchy commercial if the music was missing. Would a scene from a scary movie have made such an impression on your memory if the music were absent? Likewise, we can use this strategy in our classrooms to imprint the new information longer. The following checklist suggests what kind of music to use when the teacher wants his or her students to learn about certain topics or practice certain skills. Again, the teacher doesn't have to use them all, but should try at least three strategies and examine his or her results.

___ I try to teach a music lesson at least twice a month.

___ My students listen to music before testing, but not during, so as not to interfere with the brain's neural firing patterns during the test.

___ I have used baroque music as a background for writing activities and seatwork.

___ I have used baroque music as a background for reviewing a learning session.

___ I have used classical or romantic music to introduce new information or for storytelling.

___ I have tried the following concert reading to minimize time to teach and maximize time to learn.

4. Preview the 'big ideas' of a new unit in 3 –7 minutes by accompanying it with intriguing, attention-getting, dramatic music.

5. Present the heart of the content in a dramatic way using classical or romantic music in 5-15 minutes. (Let students listen to the music for the first 30 seconds, and then deliver the material once the music gets quieter.)

a. *The Most Relaxing Classical Music in the Universe* (Classical), SLG, 2003.

b. *Classical Music for Dummies, Vol. 1* (Classical), Digital Music Group, Inc., 2006.

c. *The Most Uplifting Classics in the Universe* (Romantic), Denon Records, 2004.

6. Engage students in a passive review of 5-8 minutes, accompanied by baroque music, where you let the music and message carry a low-key review of the new material to the learner's unconscious minds, while students relax with their eyes closed.

    a. *Baroque Music for Dummies*, Digital Music Group, Inc., 2006.

    b. *The Best of Handel*, Universal International Music B.V., 1996

**Teaching to Both Halves of the Brain**

We need to understand that students with different learning styles behave differently during learning. We also need to recognize that we tend to teach according to our own learning style. We need take note of the learning styles of our students and not take their counterproductive behavior personally, but rather try to teach to those varied learning styles. The following is a checklist that includes a couple of great websites to visit to access your own hemispheric preference and learning style. There is also a website that helps teachers plan instruction for students with different learning styles. If the teacher decides not to try them all, he or she should at least try the first three strategies and mark the date of application next to the strategy.

___ I have visited the website below to assess what my hemispheric preference is.

- **Hemispheric Dominance Inventory Test**

  http://www.web-us.com/brain/braindominance.htm

___ I have explored the following website for some background information on each hemispheric preference and how to improve

study habits for those who are right brain dominant and for those who are left brain dominant.

- **Left Vs. Right: Which Side Are You On?**

  http://www.web-us.com/brain/LRBrain.html

___ I have asked my students to take the **Hemispheric Dominance Inventory Test** to assess what their individual hemispheric preferences are.

___ I have helped my students adjust their study habits to meet the needs of both sides of their brains.

___ I have visited the website below to assess what my dominant learning style is.

- **Multiple Intelligence Assessment**

http://www.berghuis.co.nz/abiator/lsi/lsiframe.html

___ I have explored **About Learning Styles Modalities** on the website for some background information on each learning style.

___ I have asked my students to take the **Multiple Intelligence Assessment** to investigate what their individual learning styles are.

___ I have helped my students develop their learning styles by designing lessons (or trying some from Lesson Tutor) that include activities to meet the preference of all learners.

- **Lesson Tutor**

  http://www.lessontutor.com/ltlist.html

___ I have given my students the opportunity to design projects that accommodate their learning preferences.

**Using Transfer to Cement New Learning into Long-term Memory**

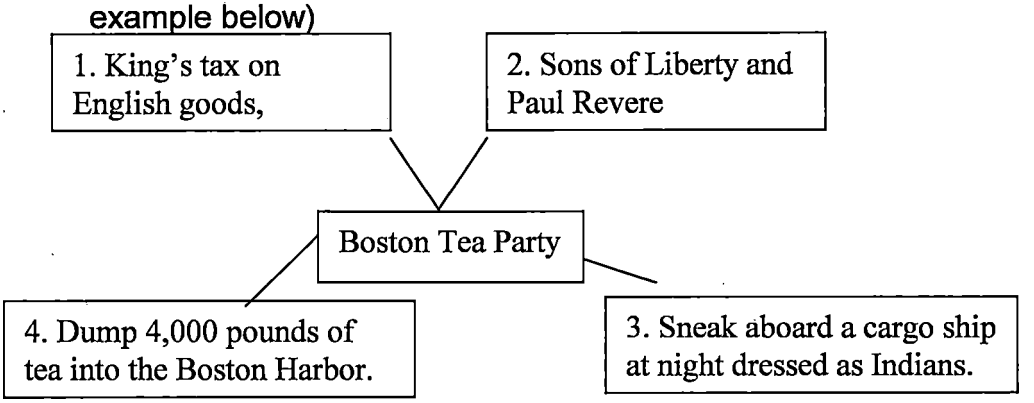
Transfer helps students make connections between what they already know and what they will learn. Sousa suggests that we find out if students have knowledge about what is to be learned. If they do, we need to take note

and move on to something new, as there is plenty of repetition in today's curriculum. Another approach to avoid is teaching similar concepts at the same time, such as latitude and longitude, or b, d, q, and p. What happens is the learner often cannot tell the differences between the two concepts because there are too many similarities. The following checklist suggests several strategies that promote transfer. Alas, just try five strategies and mark the date of application on the checklist to assess class growth.

___ I have asked my students to write a short story about what they already know about a topic. (Example: Write a short story about the events surrounding the Boston Tea Party.)

___ My students have conducted interviews in the think-pair-share format. (Example: What caused the Boston Tea Party? Think about the question on your own for one minute, partner up with a classmate, and then share your answers.)

___ I have asked my students to do graphic organizers, murals or collages that communicate what they know about a topic. (See example below)




___ I have had some students write a song or rap that tells their knowledge about a topic. (Example: "Now there's a little story, I'd like to tell about one brave brotha' you know so well. It all goes back, a couple hundreds of years. The brotha's name is Paul Revere..."

___ Some of my students have built a model or made a drawing that expresses what they know about a topic. (Example: Create a triorama depicting the story of the Boston Tea Party.)

___ Some of my students have come up with their own ideas that show what they know about a topic, such as writing a poem,

painting a picture, creating a quiz show or a Power point presentation, etc.

Congratulations, you have just completed the initial process of transforming your classroom into a brain-based learning environment. I say initial process because you will find yourself constantly changing as you get new students or you find some strategies just didn't work this year as they did last year. Though we know so much more about the brain now than we ever have, there continues to arise many discoveries that open doors for those of us in education. You may want to keep up with the findings, but in the meantime, I have provided a list of some useful websites that assist me with planning lessons in the classroom. Though you deserve a Golden Apple for your efforts, my hope is that you will find the real gold in your students' successes and their attitudes toward learning.

**Useful Websites**

For further resources on planning lessons that apply brain-based learning in the classroom, I have provided the following websites.

7. Lesson Plans Page: http://www.lessonplanspage.com/
8. A to Z Teacher Stuff: http://www.atozteacherstuff.com/Lesson_Plans/lessonplans-gradelevels.shtml
9. Pro-Teacher: http://www.proteacher.com/
10. KidzOnline: http://www.kidzonline.org/LessonPlans/
11. Sites for Teachers: http://www.sitesforteachers.com/
12. Dana Alliance for Brain Initiatives: http://www.dana.org/

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