Effect of educational neuroscience techniques in the university aural skills classroom

by

Staci Marie Horton

B.A., McPherson College, 2002
M.M., Kansas State University, 2011

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Curriculum and Instruction
College of Education

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2018

Abstract

The purpose of this study was to test student achievement in the course of one semester while enrolled in an Aural Skills music classroom. The research used the framework from Caine and Caine's 1991 Brain/Mind Learning Principles (later revised and republished in 2005 by Caine, Caine, McClintic and Klimek) and Jensen's Brain-Compatible Teaching theory (1997). The research was completed at a mid-American university. Treatment classrooms taught using strategies to implement novelty, student engagement, and scaffolding success techniques based on a subset of Caine's et al. Brain/Mind Learning Principles. The researcher used a quasi-experimental design with a treatment and control group, gathering quantitative pre-test/post-test data from student assessments before and after the implementation of the research-based brain-compatible strategies in the university Aural Skills classroom. The study followed four graduate teaching assistants who were new to collegiate teaching over the course of a semester; two were put in a training program and trained on how to create novelty, perpetuate student engagement, and build levels of success and two were left alone, to continue with a lecture style of teaching. At the end of the study, student test scores were examined to determine significance of the treatment. Results of this study are inconclusive, due to a methodology fail during the grading of the pre and post-tests. In the final chapter, preliminary findings indicate that academic gains were maintained within the control classes of Aural Skills I and III, and academic gains were maintained within the treatment class of Aural Skills II. The study is concluded with a discussion on methodological improvements necessary to provide reliable results within the bounds of educational research.

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Table of Contents

List of Figures

List of Tables

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In honor of Jesus, who started my final stretch of work with the reminder to never settle and stay caught in a terrible situation, but to break free and finally then, I can reflect the image of Jesus, instead of the image of self-doubt and guilt. And finally in deepest appreciation to my precious mother, who was willing to move into my house during her last days on earth, so I could continue this journey of research and teaching.

Dedication

In loving memory of my parents, Everett & Sandi Horton, who never lived to see me reach this final step, yet watch over me from heaven; to them I dedicate this work.

Preface

Researcher's Personal Background in Brain-compatible Teaching

"When positive habits are formed early, the job of teaching becomes significantly easier" (Jensen, 2008, p. xiv). My own teaching career is a testament to this statement. After four years of undergraduate instruction in the science of music education, I was faced with the final hurdle of student teaching before gaining my own classroom. Despite various courses on American education history, a reading strategies course, teaching special learners in the integrated classroom, and a pedagogical course within the music spectrum, I was faced with the untaught task of sharing my passion for music and music making with three hundred elementary students, as well as three hundred middle and high school students, in one semester of student teaching. Two weeks into student teaching, I was beginning to wonder if I could truly be an effective teacher. Students started the semester well-behaved, but as the cooperating teacher became less involved and I took on the leadership role, I began to notice a loss of student attention, and with the loss of attention their behavior began to change. My cooperating teacher spent countless hours after school each day offering ideas for the next day's lesson to make my presentations stronger, successful, and more engaging to the students. Yet still I wondered, what was the missing key that would make the students behave and stay engaged in my lessons? If my passion wasn't enough to make them excited about music making, what did I have to offer these students?

When I shared my concerns with my cooperating teacher regarding how I would succeed without her daily help, she offered me a chance to attend an upcoming professional development event. The seminar was called Quantum Learning and it was directly related to using and understanding the brain's natural learning styles and implementing these specific strategies into your classroom for student success. After attending one session, I was captivated. Finally, I had found the missing link to connect my enjoyment of making music to my students' own interests and we could begin to grow in learning together. The strategies provided an understanding of what triggers the brain's attention and what keeps students engaged and excited to learn new concepts.

During my student teaching, I attended a total of two sessions and my teaching improved dramatically. I was able to understand why there was such a need for manipulatives for the primary learners, and how the use of intrigue and mystery engaged my exploring middle level learners with the thrill of a challenge. I discovered that when I carefully broke down levels of hard work and effort and paired them with recognition and success, my high school students would be spurred to demand individual excellence from themselves within our rehearsals. This was why my cooperating teachers loved teaching. Once I discovered it, I wanted it for myself.

In my first teaching position, the elementary school where I was assigned began a five-session professional development seminar on Quantum Learning. I received the seminar's full body of knowledge, my own textbook and a mentor to check in on my progress of implementing brain-compatible teaching strategies in my classroom. My passion and drive for excellence in music turned into a deep desire to show all students how to be successful and excel in their own learning.

To this day I continue to teach with these guidelines and tips running in the back of my mind. I design projects, lessons and even lectures with student success at the forefront of my implementation strategies. And when faced with a research opportunity, I wanted to see if my experience could be used to help other teachers and students achieve success in the music classroom. What I learned is while I desire to be an effective teacher, academic research is a horse of a different color.

Chapter 1 - Introduction

In January 2014, Forbes magazine reported that England offered a 6 million pound research grant to reveal the truths and myths on brain-based teaching in England schools (Parnell, 2014). The grant would fund experimental studies to prove or disprove specific neuroscientific data that had been linked to success in the classroom. In Parnell's article Dr. Hilary Leevers, head of education and learning at the Wellcome Trust said, "It's really important that teachers start looking for stronger evidence in any activities they do, but particularly in those that say they're based upon neuroscience, because our scoping work really suggests that there's very little evidence currently for interventions based upon neuroscience having impact on educational outcomes." Howard-Jones, a leading expert on the role of neuroscience in educational practice and policy at the University of Bristol, states, "You can't go directly from brain scan to lesson plan" (Howard-Jones, 2011, 111). Before cutting edge research makes it into schools however, it needs to be rigorously tested (Parnell, 2014). Howard-Jones, (2011) states, "The last decade has seen something of a step change in efforts to bring cognitive neuroscience and education together in dialogue" (2011, 110). This 2014 research grant from England continues to demand experimental research that definitively provides statistically significant research based studies. The newly launched fund in the United Kingdom aims to connect neuroscientists, psychologists, educators and other stakeholders to projects like systematic testing of different school start times or lesson lengths to give strong evidential support for education tools or methodologies (Parnell, 2014).

Prior to this grant, the European Union, England and United States have all proposed research grants to support, encourage and increase the connection of neuroscience with medical science (DiSalvo, 2013). In 2012, three hundred experts in neuroscience, medicine and computing from the European Union collaborated to develop the "Human Brain Project" (HBP, 2012). The HBP Pilot report, published in 2012, reports the vision for brain research and its application (www.humanbrainproject.eu). DiSalvo reports, "China may be farther along than Europe or the U.S., with older initiatives such as "Brainnetome" (www.brainnetome.org/en), and long standing ties to the U.S.-based "Organization for Human Brain Mapping" (www.humanbrainmapping.org), which held its 2012 Annual Meeting in Beijing, China" (DiSalvo, 2013, 1).

The increased focus of the inclusion of neuroscientific strategies in the United States classroom began when medical science was increasingly able to study the human brain. With the advent of brain imaging techniques, scientists no longer have to rely on autopsies or injuries to view the brain. Early technologies such as X-Rays and CAT scans provided scientists' ability to see the shape and size of the brain. More recent technologies such as a PET scan, MRI, EEG, and fMRI provide a more in-depth look at the energy created by different areas of the brain during excitement and rest (Wolfe, 2010). It was in this same timeframe of brain scan developments that President George H. Bush proclaimed the 1990's as the "decade of the brain" to increase public awareness of the benefits derived from brain research. The Secretary's Commission on Achieving Necessary Skills Background 1992 Report [SCANS] proclaimed that America was facing an educational crisis as its schools were no longer adequately meeting the nation's students' educational needs (Brodnax, 2004). The 1990's fad of brain-based teaching strategies in the classroom was the collaboration of neuroscientific discoveries and their match to educational strategies used in the classroom (Slavkin, 2004). Brain-compatible methods of learning emphasize how the human brain receives, processes, interprets, connects, stores, and retrieves messages (Greenleaf, 2003). During the 1980's and 1990's, numerous authors (Anderson, 1993; Coleman, 1990; Fullan, 1993; Glasgow, 1997; Goodlad, 1983; Goodlad, Oakes, & Swartzbaugh, 1988; Glasser, 1993; Joyee & Showers, 1995; Maceaehein, 1994; Marzano, 1992; O'Neil, 1995; Schlecthy, 1990; Senge, 1990; Slavin, 1989; Senge, Kleiner, Roberts, Ross, & Smith, 1994; Theobald & Mills, 1995) have all written about the need for an educational restoration and the need to use instructional strategies that successfully educate all of our children and develop their capacity to be successful adults capable of meeting current and future challenges (Brodnax, 2004). In 1995, Robert Sylwester declared in his book *A Celebration of Neurons: An educator's guide to the human brain* that the profession of education is "now approaching a crossroads. We can continue to focus our energies on the careful observation of external behavior . . . or we can join the search of a scientific understanding of the brain mechanisms, processes, and malfunctions that affect the successful completion of complex learning tasks" (Sylwester, 1995, p. 5).

Researcher's Personal Interest in researching Brain-compatible Teaching

Based on my own success from implementing brain-compatible teaching in the music classroom, I was interested in sharing instructional techniques with future music teachers. When offered the opportunity for advanced studies in music education, I was ready and eager to thrive as the student in a classroom, yet I found little evidence of brain-based strategies and little use of learning styles. One professor even called them a fad or unnecessary trend in education. Once again, as experienced in my undergraduate courses, I sat through numerous lectures with little interaction between professor and student. I began to wonder if a brain-compatible training program would influence college instructors teaching. Then I began to wonder if implementing brain-based college instruction would influence college students' success in course like Aural Skills.

Rationale for Study

College students are faced with classes often taught by instructors who may not have been educated on brain-compatile strategies for learning and how to implement these strategies into their daily lessons to help students succeed. Eric Jensen (2008) begins his book, *Brain-based Learning: The New Paradigm of Teaching*, with this statement, "Everything you do uses your brain, and everything at school involves students' brains. It is the most relevant understanding for educators to have right now" (p. 3). Neuroscientific research provides the background for how a human brain learns and processes information. Educators should be aware of different instructional approaches that can stimulate various sensory mechanisms to activate the brain centers that control movement and influence emotion. The challenge for educators is to step away from a previous model of teaching and create a new mental model of education (Caine & Caine, 1997). "For education to function in this . . . way, new approaches to teaching are needed, and a clear developmental path must be laid down along which educators can walk together" (Caine, et all, 2005, p. 10).

Statement of the Problem

Today's colleges and universities need to be more effective in teaching undergraduate students (Rawlings, 2012). Training systems such as Kagen, Cooperative Learning seminars and Quantum Learning are three systems already developed and in use in K-12 schools across America (DePorter, 2009), but to what extent can brain-compatible strategies be effective for student achievement in higher education? Just as the UK has called for brain-compatible myths to be debunked, the U.S. universities and colleges can also begin the research required to understand and use the best practices available for our students' achievement.

At the time of this study there was a lack of quasi-experimental designed research studies exploring student achievement when using research-based brain-compatible strategies. Specifically, such research pertaining to university Aural Skills classrooms. Slavkin (2004) cites Prigge (2002) that all stakeholders who are involved in education profit from brain-compatible learning. Students, educators, parents, and administrators all reap the benefits of a curriculum that is designed to support student achievement based on the morphology of the human brain. This study offers music faculty and directors in schools of music a specified in-depth look at the results from the implementation of educational neuroscientific techniques on student achievement. Specifically, these results are derived from implementing research-based brain-compatible strategies to create novelty, enhance student engagement, and scaffold moments of success while learning in lesson designs during the course of a semester.

Purpose of Study

The purpose of this study was to test student achievement in a mid-American university's Aural Skills music classroom by implementing novelty, student engagement, and scaffolding success techniques based on a subset of Caine and Caine's 1991 twelve principles for natural brain learning, later revised and republished in 2005 by Caine, Caine, McClintic and Klimek. The researcher used an quasi-experimental design, establishing a selected control and treatment group; both groups taking a pre-implementation test and a post-implementation test and using quantitative analysis to garner results on student achievement in the university Aural Skills classroom. To verify implementation [and non-implementation] of techniques the researcher administered pre- and post-test observations with the graduate teaching assistants. Prior to implementation, the researcher researched and prepared key strategies that support the brain's natural response of learning from Caine, Caine, McClintic and Klimek (2005) principles and then modeled and described the strategies to graduate teaching assistants who were new to collegiate instruction. The significance for selecting these graduate teaching assistants, those who are still within the ten-year collegiate teaching experience window, is supported by Jensen's statement, "When positive habits are formed early, the job of teaching becomes significantly easier" (Jensen, 2008, p. xiv). The graduate teaching assitants were observed repeatedly to oversee the successful use of new strategies in their classrooms and determine that the control group remains pure. The researcher also gathered additional data via a mid-term grade check to record the continual effects of novelty, student engagement and student success in the lessons on student achievement.

Research Questions

The focus of this study is to determine the results of implementing research-based strategies on student achievement in a university Aural Skills music classroom. The research-based strategies specifically addressed the use of novelty, student engagement, and scaffolding moments of student success within a lesson. Throughout the course of this quasi-experimental design study using pre-test/post-test data, the research questions guiding the course of this design study were:

1. What are the effects of research-based brain-compatible teaching strategies that promote novelty, student engagement, and scaffolding success on student achievement during one semester in a university Aural Skills classroom?
2. Is there a difference in student achievement over a period of a semester with continual enhancement of novelty, student engagement, and scaffolding success strategies?

Null Hypotheses

H_o: The implementation of brain-compatible strategies had no effect on the student achievement results in the university Aural Skills classroom.

H_o: There is no difference in student achievement over a semester with the continual enhancement of novelty, student engagement, and scaffolding success strategies.

Significance of the Study

This study provides an opportunity to explore the influence that brain-based strategies may have on student achievement. Previous research studies done in an Aural Skills undergraduate classroom have not focused on the influence of brain-based strategies on student achievement. This study begins to develop an initial piece of a larger picture toward the ideal 21st century classroom.

Limitations of the Study

Classrooms that are using novelty and creating activities to increase student engagement are fluid, interactive, and often loud in nature; this creates potential limitations for this study, requiring the researcher to find additional means to record observations, such as a recording device and field notes.

Additional limitations that pertain to this study also include the impact of the researcher on the subject's teaching during observations. When the researcher comes to observe the implementation of the researched-based brain-compatible strategies, it can be assumed that the graduate teaching assistants will take extra care to demonstrate the strategies learned from the training sessions. This may affect the amount of strategies used in a single class period. To address this limitation the researcher used repeated observations and analysis of multiple student test results to gain a more realistic view of the data.

One possible limitation is researcher bias stemming from a strong belief as to the positive influence of brain-compatible strategies toward student achievement.

Delimitations of the Study

A true experimental design is a quantitative approach in which the researcher obtains data from both a treatment and control group, randomly selected (Campbell & Stanley, 1963). Explanatory research is a qualitative design that allows the researcher the opportunity to seek out co-varying relationships through detailed, in-depth data collection (Creswell, 2008). As this research study followed an quasi-experimental design, the researcher selected this particular level of Aural Skills because of the graduate teaching assistants: 1) all taught the same level of Aural Skills courses in the same music program, 2) two graduate teaching assistants had a music education degree and completed one semester of student teaching in a public school while the other two subjects had a music performance degree and had not taught classes at any level prior to this teaching assignment. Two of the participants were randomly selected for training in the research-based brain-compatible strategies and two did not receive training. Participants were also queried for their qualifications to participate in this study. They must have fewer than ten years of collegiate teaching experience which will indicate low levels of college teaching experience beyond "on the job" discoveries, as well as having a spring semester Aural Skills course to teach.

Definition of Terms

The following terms are defined as they are related in the context of this dissertation proposal:

1. Brain-compatible teaching: It is a set of principles and a base of knowledge and skills upon which we can make better decisions about the learning process (Caine, 1995; Jensen, 2008). Thinking about the learning process by taking a holistic approach, looking at teaching developmentally and socio-culturally.
2. Brain-compatible educator: Draws on cognitive neuroscience, psychological, and educational research in a continual search to provide the best possible instructional environment for students (Radin 2005).
3. Educational neuroscience: Robert Sylwester (2012) states that the terms brain-based and brain-compatible have negative baggage from the early 1980's of inappropriately speculative claims and encourages all researchers to use the term educational neuroscience.
4. Novelty: Changes occurring in the environment that stimulate the brain (Sousa, 2011). Novelty stimulates a questioning response in the brain causing it to seek for more information. For example, when a huge box is beautifully wrapped and placed in the front of the room, questions such as 'What is in this box?', or 'What is going to happen next?', start forming in the brain.
5. Scaffolding success moments in teaching: Using strategies to help students find the right answer, rather than only correcting them when wrong; this is done in order to create a supportive learning environment that results in improved student performance (Sousa, 2011).
6. Engagement: Occurs when students make a psychological investment in learning (Newmann, 1992). There are three levels of engagement; they include: cognitive (beliefs and values), behavioral (habits and skills), and emotional (motivation and feelings) engagement (Jones, 2008).
7. Aural Skills class: The purpose of this course is for undergraduate music students to learn, identify and sing major, minor and modal scales, intervals, rhythms and meter to promote their aural ability to listen to music and correctly identify all components required to notate the music correctly. The college catalog's course description for Aural

Skills II states: Development of Aural Skills through sight singing, rhythmic training, and ear training; melodic, rhythmic, and harmonic dictation to reinforce concepts in Music Theory II.

8. Graduate Teaching Assistants: For the purpose of this study, this will refer to the instructors with less than ten years of collegiate teaching experience, specifically the graduate teaching assistants (GTA) who participated in this study.

Summary

Chapter One introduced the proposed research to study the effect of research-based neuroscientific strategies on student achievement in an Aural Skills course. The chapter included a rationale for the study; statement of the problem; purpose of the study and research questions posed; significance, limitations, and delimitations of the study and a definition of terms.

Chapter Two provides the theoretical perspectives that will serve as a framework for this study, discussing the twelve principles of brain/mind learning as provided Caine, Caine, McClintic and Klimek (2005) and the brain-compatible approach to learning as provided by Jensen (1997). Chapter Two provides relevant literature related to neuroscience, educational psychology, and relevant brain-compatible strategies that shape novelty, enhance student engagement and how to scaffold moments of success in every learning experience.

Chapter Three describes the proposed research methodology, including research questions and corresponding null hypotheses, research design, strengths and weakness of chosen design, sample frame and setting of proposed study, sampling procedures and techniques, the timeline, the pilot study of the training program, the procedures, and the training program measures.

Chapter Four presents the data gathered from the study, the description of the sample, missing data and the affects on the results, the overview of the statistical procedures, assumptions of *t*-test analysis and the data collected for the research questions, both comparatively and within-groups, and the responses to the hypothesis.

Chapter Five proposes the results of this study, based on the data gathered, summarizes conclussions, proposes suggesstions for future study and suggestions for additional research.

Chapter 2 - Review of Literature

Introduction

The human brain is always learning (Caine & Caine, 1991, Jensen, 2008; Sousa, 2011; Spitzer, 2006). Pat Wolfe stated, "The more we understand the brain, the better we'll be able to design instruction to match how it learns best" (Wolfe, 2010, p. 49). Duman's research (2010) provided "a meta-analysis conducted on learning styles, 42 different studies were reviewed and the review reveled that coherence between learning activities and learning styles enhances academic achievement (Hein & Budny 2000; Bayraktar, 2000; Sünbül, 2004)" (Duman, 2010, p. 2083). This study's framework was guided by the revised edition of Caine, Caine, McClintic and Klimek (2005) *Twelve Brain/Mind Learning Principles in Action: The Fieldbook for Making Connections, Teaching, and the Human Brain*. While the study focused primarily on the five specific principles, Principle 3: The search for meaning is innate; Principle 5: Emotions are critical to patterning; Principle 10: Learning is developmental; Principle 11: Complex learning is enhanced by challenge and inhibited by threat associated with helplessness; and Principle 12: Each brain is uniquely organized, all are presented in this initial review. The other framework used in this study is the Brain-Compatible Approach to Learning (Jensen, 1997) that guided the researcher's training on how lesson implementation of research-based neuroscientific strategies could work in the classroom.

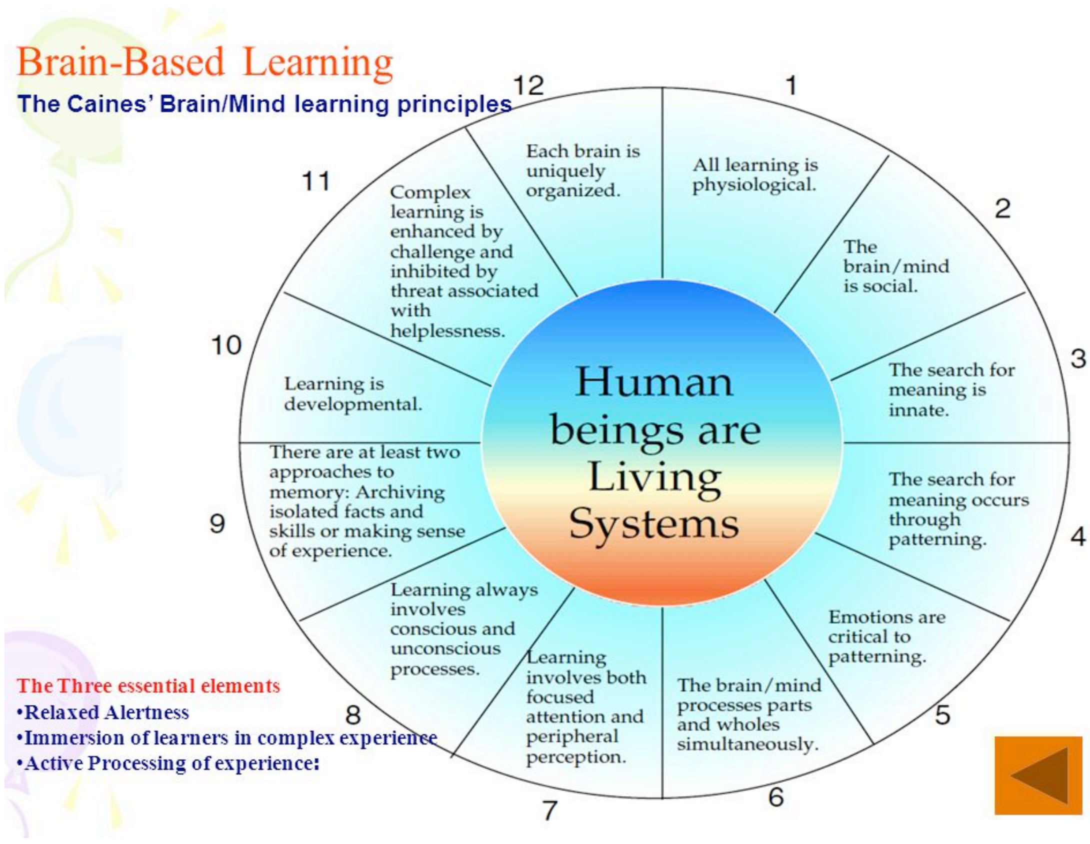
Overview of the 12 Brain/Mind Learning Principles Framework

Caine & Caine's twelve principles of brain-compatible teaching, originally published in (1991), revised in 2000, then revised and republished in 2005 by Caine, Caine, McClintic and Klimek's book *Twelve Brain/Mind Learning Principles in Action: The Fieldbook for Making Connections, Teaching, and the Human Brain* combines neuroscientific research with empirically tested classroom data to provide the framework for understanding brain-based teaching and how it can apply to education today. Principles three, five, ten, eleven and twelve specifically informed this study as will be described below. The Twelve Brain/Mind Learning Principles are presented to provide an overview of the framework that influenced this study.

Twelve Brain/Mind Learning Principles

Caine defines "brain-based teaching and learning as taking a holistic approach, looking at teaching developmentally, socioculturally and in other broad ways" (Caine, 1995, p. 44). Jensen defines "brain-based as a way of thinking about the learning process. It is a set of principles and a base of knowledge and skills upon which we can make better decisions about the learning process" (Jensen, 2008, p. xiii). "The objective of brain-based learning is to move from memorizing information to meaningful learning" (Caine & Caine, 1990, p. 69). In their book *Making connections: Teaching and the human brain* Caine & Caine (1991) provide twelve original principles for brain-based learning as a general theoretical foundation to apply to education. The following principles and their definitions (See Figure 2.1) from Caine & Caine's book support the development of the theoretical framework for this research.

Figure 2.1 The Brain/Mind Learning Principles Wheel



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Principle One: All learning is physiological

The brain never stops performing many functions simultaneously (Ornstein & Thompson, 1984). The brain must process many events simultaneously occurring in a day, from the correct tension in your muscles to hold your head up, to the coordination of finger muscles, eye movements and cognition to think and accurately type a sentence. Learning is as natural as breathing, and it is possible to either inhibit or facilitate learning. Anything that affects our physiological functioning affects our capacity to learn (Caine, 1991). The brain is a constant processor of stimuli, sending and receiving messages that control the entire body's response. While good teaching should "orchestrate" all the dimensions of parallel processing based on theories and methodologies that make orchestration possible (Caine, 1991), early educators need a frame of reference that enables them to select from the vast array of methods and approaches that are available.

Principle Two: The brain/mind is social

"All students learn more effectively when their social nature and need for relationships are engaged and honored" (Caine, et al., 2005, 49). All human beings are born with a biological need to relate to others (Diamond & Hobson, 1998). "In absence of healthy emotional and social interactions and modeling by healthy adults on a consistent basis, children will largely 'become' whatever their environment models" (Caine, et al., 2005, 51). Teachers have the opportunity to play a large role in facilitating a positive and safe environment for socialization through the use of groups, teams, role play, class discussion, and encouraging students to take an active role in determining class expectations and rules.

Principle Three: The search for meaning is innate

This principle was used to inform the integration of novelty in the lesson design to enhance student achievement. The search for meaning (making sense of our experiences) is survival-oriented and fundamental to the human brain. At the center of meaning is a sense of relatedness. The brain needs and automatically registers the familiar while simultaneously searching for and responding to novel stimuli (O'Keefe & Nadel, 1978). "All learners are trying to make sense out of what is happening all the time" (Jensen, 1997, p. 36). When students finally make sense of new ideas, new situations, and/or new skills, the old connects with the new and there is a resonance. They get it "in their belly" is a phrase to describe this moment of learning

(Caine, et al., 2005). The search for meaning cannot be stopped, only channeled and focused. Brain-compatible education provides stability and familiarity. At the same time, it should be able to satisfy the brain's enormous curiosity and hunger for novelty, discovery, and challenge (Caine, 1991). As experiences are evaluated as "good," "bad," or "neutral," meaning is created; "these emotional activations pervade all mental functions and literally create meaning in life" (Siegel, 1999, p. 159). Students can learn more effectively when their interests and ideas are engaged and honored (Caine, et al., 2005). The use of novelty within lesson design increases the brain's interest in the subject that is being taught. Students are surprised and alerted when the world does not act as they expected it to act (Caine, et al., 2005). The brain's continual search for meaning provides a window of opportunity for the educator to affect the learning potential in a learner by prolonging the lessons through the use of novelty.

Principle Four: The search for meaning occurs through patterning.

The brain is constantly seeking meaning, integrating information into categories connected to previous knowledge (Caine, 1995). "Our brain's quest for meaning causes us to seek whatever pattern we can from the information we absorb" (Jensen 1997, p. 38). Due to this fact, the brain doesn't naturally learn things that are illogical or have no meaning; brain-compatible learning stresses the importance of patterning. When the brain's natural capacity to integrate information is acknowledged and invoked via teaching, vast amounts of initially unrelated or seemingly random information and activities can converge and be assimilated (Caine, 1991). In order for information to be considered relevant, it must relate to something the learner already knows. The more relevance there is the greater the meaning (Jensen, 1997, p. 38). The educator should present information in a way that doesn't impose patterns, but rather allows the brain to extract patterns. For teaching to be effective in patterning, a learner must be able to create meaningful and personally relevant patterns from the data.

Principle Five: Emotions are critical to patterning

This principle was used to examine how to scaffold moments of success in the lesson design to enhance student achievement. What we learn is influenced and organized by emotions and mindsets involving expectancy, personal biases and prejudices, self-esteem, and the need for social interaction. Emotions are also crucial to memory because they facilitate the storage and recall of information (Rosenfield, 1988). All students can learn more effectively when appropriate emotions are elicited by their experiences (Caine, et al., 2005). Educators should create an emotional climate in their classroom that is both supportive and marked by mutual respect and acceptance (Caine, 1991). "When the learner's emotions are engaged, the brain codes the content by triggering the release of chemicals that single out and mark the experience as important and meaningful" (Jensen, 1997, p. 38). Student and teacher reflection and metacognitive (thinking about thinking) approaches should be encouraged. A student's moments of success within each lesson allows for the brain to release positive neurotransmitters, such as serotonin and dopamine, reinforcing that learning is a positive act and not a stressor. The optimal state of mind for meaningful learning rests on an emotional foundation, and the best foundation includes competence and confidence (Caine, et al., 2005).

Principle Six: The brain/mind processes parts and wholes simultaneously

In a healthy person, the two hemispheres of the brain are inextricably interactive, irrespective of whether a person is dealing with words, mathematics, music, or art (Hand, 1984; Hart, 1975). When facilitating this natural response, educators realize one area of the brain will reduce information into parts and another area will simultaneously perceive and work with the information as a whole. Educators who understand that the brain has separate but simultaneous tendencies typically organize information by presenting chunks of information over time allowing the learning to be cumulative and developmental (Caine, 1991). Educators facilitate this concept when they share the big picture with students, yet teach each concept in small, manageable bites.

Principle Seven: Learning involves both focused attention and peripheral perception

The brain directly absorbs the information of which it is aware and to which it is paying attention. It also directly absorbs information and signals that lie beyond the immediate focus of attention. This means that the brain responds to the entire sensory context in which teaching or communication occurs (O'Keefe & Nadel, 1978). "Our brain's ability to focus and maintain its attention is a basic element to learning and memory . . ." (Sylwester, 1995, p. 78). Attention generally begins as a passive process scanning the environment with sensory receptors to gather data and determine importance. As such, the educator should also organize all information materials that are outside of the focus of the learner's attention. Peripherals, for example, visuals such as charts, illustrations, set designs, and art provide data for the brain to absorb during passive attention. Music has also become very important as a means to enhance and influence a more natural acquisition of information (Caine, 1991). Understanding that the learner's brain is seeking engagement, educators can design their environment to provide a rich and colorful area for continual peripheral learning.

Principle Eight: Learning always involves conscious and unconscious processes

We learn much more than we ever consciously understand. Most of the signals that we peripherally perceive enter the brain without our awareness (Caine, 1991). Thus, we remember what we experience in a situation, not just what we are told. Teaching should be designed in such a way as to help students benefit maximally from unconscious processing. Active processing allows students to review how and what they learned so they can begin to take charge of learning by developing their own personal meanings. Through the educator's act of elaborative rehearsal of procedures and theories through the use of metaphors and analogies, students can reorganize the material in personal, meaningful, and valuable ways. For example, encouraging a student to give feedback offers the student a chance to verbalize what conscious learning has occurred, leaving room for the unconscious to be explored.

Principle Nine: Original - We have two types of memory: a spatial memory system and a set of systems for rote learning; Revised – There are at least two approaches to memory: archiving isolated facts and skills or making sense of experience

The system that drives the search for meaning and is motivated by novelty is our spatial memory. This system is always engaged and is inexhaustible. It is enriched over time as we increase our understanding of natural categories and procedures. The more information and skills are separated from prior knowledge and actual experience, the more our brains depend on rote memory and repetition for learning (Caine, 1991). A blend of novelty and repetition in teaching provide the ideal blend for a learning brain.

Principle Ten: Learning is developmental

This principle was used to reinforce the awareness of student learning differences to enhance student achievement. All learning builds on previous learning (Caine, et al., 2005). Embedding is an important element all brain-compatible strategies have in common. A student's success depends on making use of all the senses through immersing the learning in a multitude of complex and interactive experiences. For example, when specific items are given meaning within ordinary experiences, the brain is embedding the knowledge within its own filing system (Caine, 1991). All students can learn more effectively if individual differences in maturation and development are taken into consideration (Caine et al., 2005). For example, when a concept is learned through multiple interactive and novel activities, such as classroom demonstrations, projects, field trips, performances, stories, metaphor, drama and so on, the brain can surround the concept with memories from the event. Later when recall is required, the concept can quickly be found.

Traditionally American schools have held an instructionist model in which a teacher or lecturer 'transmits' information to students. In contrast, psychologist Lev Vygotsky's (1978) sociocultural learning theory promotes learning contexts in which students play an active role in learning. Vygotsky theorized that in all student-teacher interactions there is a zone of proximal development. The zone of proximal development is the distance between a student's ability to perform a task under adult guidance and/or with peer collaboration and the student's ability to solve the problem independently. According to Vygotsky, learning occurs in this zone. Roles of the teacher and student are therefore shifted, in order to construct the meaning and learning, the student seeks and discovers new information and the teacher collaborates. In other words, learning becomes reciprocal for the students and teacher.

Principle Eleven: Complex learning is enhanced by challenge and inhibited by threat associated with helplessness

This principle was used to explain the importance of scaffolding moments of success in every lesson to enhance student achievement. Stress is defined by the activation of the stress response, which releases specific hormones into the body and the brain (Caine, et al., 2005). The hippocampus, a part of the limbic system, appears to function particularly as a relay center for the rest of the brain and is most sensitive to stress (Jacobs & Nadel, 1985). The body releases cortisol in direct response to certain types of stress; and chronic stress is associated with high levels of cortisol in the body (Caine & Caine, 1995). Moderate amounts of these "stress" hormones can actually help learning, but large amounts of cortisol can affect the brain, body and immune system negatively (Sapolosky, 1998). When signals are relayed to the brain indicating negative stress, the brain short circuits executive functions in the prefrontal cortex and becomes less flexible by reverting to automatic and often primitive routine behaviors, which is not conducive to learning new concepts and lessons (Jacobs & Nadel, 1985). Educators should strive to create a state of relaxed alertness in students, one that is low in stress and high in challenge (Caine, 1991). All students can learn more effectively in a supportive, empowering yet challenging environment (Caine, et al., 2005). Building, or scaffolding, moments of student success within the lesson allow the brain to remain calm and release positive neurotransmitters, such as dopamine or serotonin, that maintain a zero/low stress learning environment.

Principle Twelve: Each brain is uniquely organized.

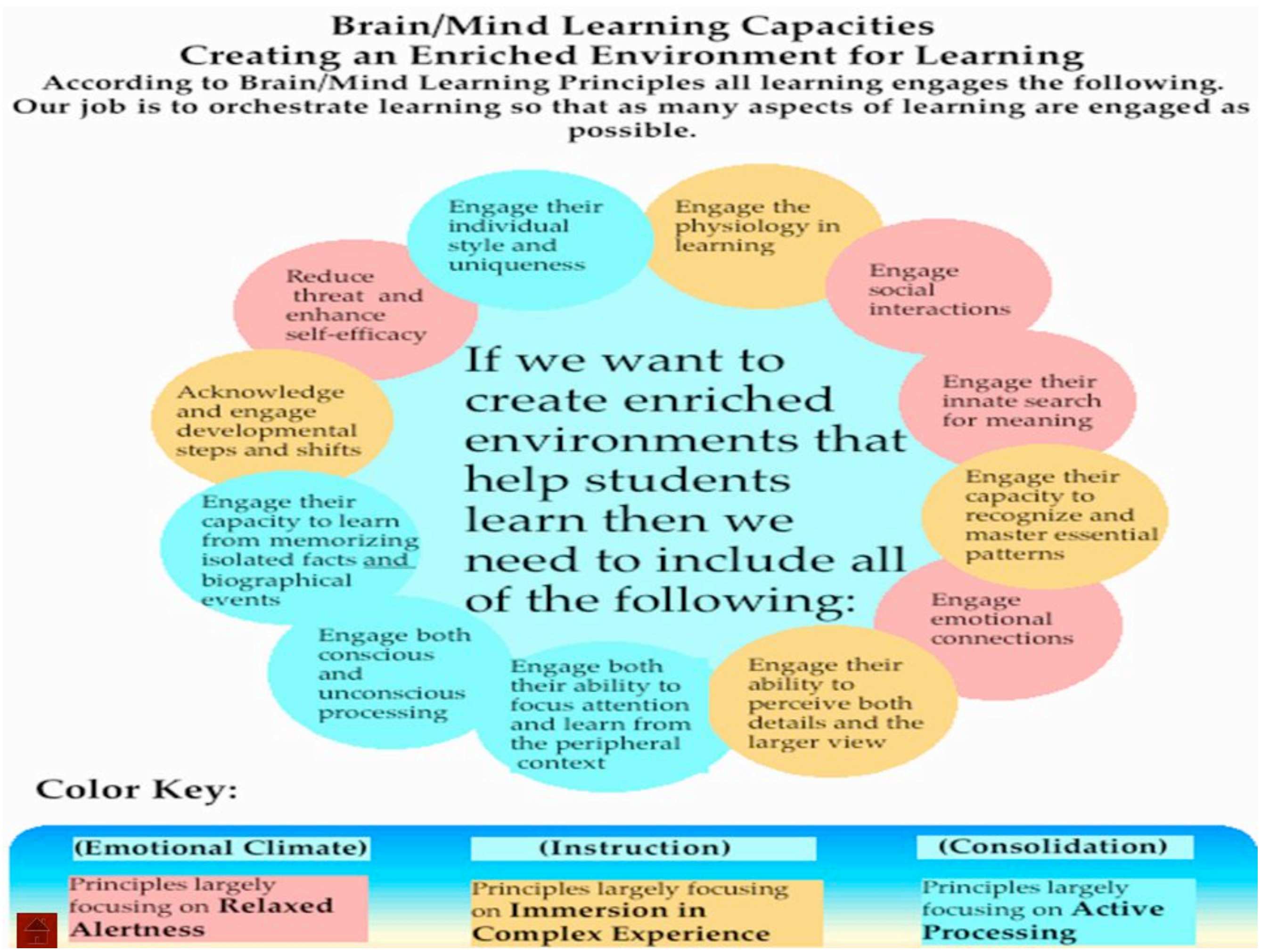
This principle was used to summarize that because every brain is different, a variety of techniques could be used in the lesson design to enhance student achievement. The brain is malleable and has plasticity. This means each brain has the ability to continually change during a lifetime in subtle ways as a result of different experiences (Sousa, 2011). Learning actually changes the structure of the brain; the more we learn, the more unique we become (Caine, 1991). Although all humans have the same set of systems, they are integrated differently in each and every brain based on our personal experiences. The challenge and reward of using brain-compatible strategies in the classroom is that there is a revolving door of options and procedures that will work for a lesson and a class of students. The opportunities continually expand with each new discovery in the neurosciences.

Brain-compatible Teaching

The second framework that influenced this study was Brain-compatible teaching, presented by Jensen (1997). The use of novelty, enhancing student engagement and scaffolding moments of success in the lesson design to support student achievement are found in the theory of brain-compatible teaching. Robert Cloniger (1987) explains that three neural systems run our lives, 1) the cortex's quest for novelty; 2) the mid-brain's hunt for pleasure; and 3) the lower-brain's desire to avoid harm. This analysis provides a perfect summary of our daily lives – try new things, seek pleasure and avoid getting hurt. Jensen (1997) supports that we can use these "rules of the brain to get students' attention when it's appropriate" (Jensen, 1997, 28). Novelty gets our attention; and challenges maintain it. Brain-compatible educators use these principles to create an "attentional state" (Jensen 1997) or enrolling mind-set. Creating novelty within the lessons and infusing academic challenge into a safe learning environment melds to increase student engagement during a lesson. These three areas support each other to assist not only the educator in providing attentive students, but it also supports the learner to maximize the incoming data to be stored in short-term, working and long-term memory.

> Brain-compatible teaching includes: 1) strategically attracting the learner's attention with novelty, emotions, relevance or curiosity; then 2) allowing the appropriate amount of time for the learner to absorb the material in the differentiated learning-style for the student; and 3) providing the necessary time and conducive setting for integration, meaning and memory to occur. . . . Giving the students more control and allowing them to choose complex, interesting, life-like projects will focus their attention on their learning instead of on their daydreams (Jensen, 1997, p. 28).

Figure 2.2 Brain/Mind Learning Capacities



Novelty

"Brain-compatible teaching requires the opportunity of greater choices for learners and more diversity in instructional methods" (Jensen, 1997, p. 7). Novelty instantly gets attention and engages the learner to make sense of something (Caine, et al., 2005). "Psychologists have known for some time that if we experience a novel situation within a familiar context, we will more easily store this event in memory. But only recently have studies of the brain begun to explain how this process happens and to suggest new ways of teaching that could improve learning and memory" (Fenker & Schütze, 20008, p. 1). "Research by K.H. Pribram (1975) and D. McGuiness (1976) found that norepinephrine, a neurotransmitter linked with attention, novelty and arousal, is found in great concentrations in the right hemisphere . . ." (Jensen, 1997). "One of the most important brain regions involved in discovering, processing and storing new sensory impressions is the hippocampus, located in the temporal lobe of the cerebral cortex. Novel stimuli tend to activate the hippocampus more than familiar stimuli do, which is why the hippocampus serves as the brain's "novelty detector" (Fenker & Schütze, 2008, p. 1). Bunzeck and Düzel's (2006) research at the University of Magdeburg's Institute for Cognitive Neurology considered how the major "novelty center" of the brain--called the substantia nigra/ventral tegmental area (SN/VTA)--might be activated by the unexpectedness of a stimulus. The hippocampus receives stimuli and compares it to prior knowledge, if disequilibrium occurs, the neurotransmitter dopamine is released to the substantia nigra (SN) and ventral tegmental area (VTA) in the midbrain. From there nerve fibers extend back to the hippocampus and trigger the release of more dopamine, in a cycle called the hippocampal-SN/VTA loop. (Fenker & Schütze, 2008) "Novelty results in the arousal of emotional states of either suspician, intrigue, surprise, curiosity, suspense, confusion or anticipation, hope, security, fun, acceptance, self-confidence" (Jensen 1997, p. 26). The influence of this for educators is that students attention is geared to respond to change, novelty, or the shock effect. Jensen reports that "Any stimuli introduced into our immediate environment which is either new (novel) or of sufficiently strong emotional intensity (constraining) will immediately get our attention" (Jensen, 1997, p. 27).

Enthusiasm is generated when students are presented with real-life experiences and are challenged to find creative ways to explore or connect with the new and novel information (Caine, et al., 2005). A great way to introduce novelty is to present students with a puzzle or model of something new to them during the presentation of the content or review sessions. "The novelty and variation generated by other learners may also provide much of the attentional bias needed" (Jensen, 1997, p. 27) for student engagement.

Games range along a continuum of novelty and they can be more complex and incorporate many elements of the curriculum to be remembered. Games provide the option to be teacher-directed or, even better, they can become student-directed and intrinsically motivational. Fun is experienced when creative games are used that also result in successful memorization (Caine, et al., 2005) .

To feed a brain's voracious appetite for patterns, emotions, sounds, sights, novelty, and sensory stimulation, educators should offer students a greater variety in lesson designs, environments, and in offering student-choice during the school year. Take learners outside, teach the class in a new environment, allow students to watch a video on the content, invite guest speakers, play music in the background, fill the room with poster peripherals, integrate manipulatives and learning stations, have a box of props for students to use, create teams for assignments – these are all ideas suggested by Jensen (1997) to keep a learner's brain thriving on feedback and stimulating experiences.

The strategy of only using novelty to engage a students' attention is a short-term benefit. The use of novelty in an educational context must be balanced with ritual and predictability. It is undesireable for students' attention to be continually focused outward, because it doesn't allow their brains to process information internally. Students need time to gather data, practice, reflect, review and share what they have learned. Jensen contends that the more predictable the learning environment, the more room there is for novelty, because any change will be noted by the brain as new incoming stimuli (Jensen, 1997).

Engagement

To learn in a structured environment, we are often required to "pay attention" for long stretches of time. Expecting extended classroom attention is problematic and even inappropriate; this is due to the human brain's inability to filter all incoming stimuli, rather it sorts out which is less critical to the body's survival (Jensen, 1997). The part of the brain that integrates all incoming sensory information to determine what is vital and what is non-necessary is the reticular formation near the top of the brain stem. It rests at the base of the limbic system and regulates our general level of attention, focus cycle and internal-external shifts in awareness (Jensen, 1997). Christenson, S. L., Reschly, A.L., & Wylie, C. A. (2012) book, *The Handbook of*

Research on Student Engagement compiled multiple articles regarding student engagement and its role in student achievement. One such article in the handbook is Student Engagement: What is it? Why Does it Matter? by Finn and Zimmer (2012) which reviews student engagement in a 13-year longitudinal study that revealed student engagement is considered both essential for learning and modifiable through school practices and policies. “It is fundamentally important for the learner to build confidence for accummulating experiences in order to increase student engagement” (Hye Yu, J., Chae, S., Chung, Y.-S., 2018, 241).

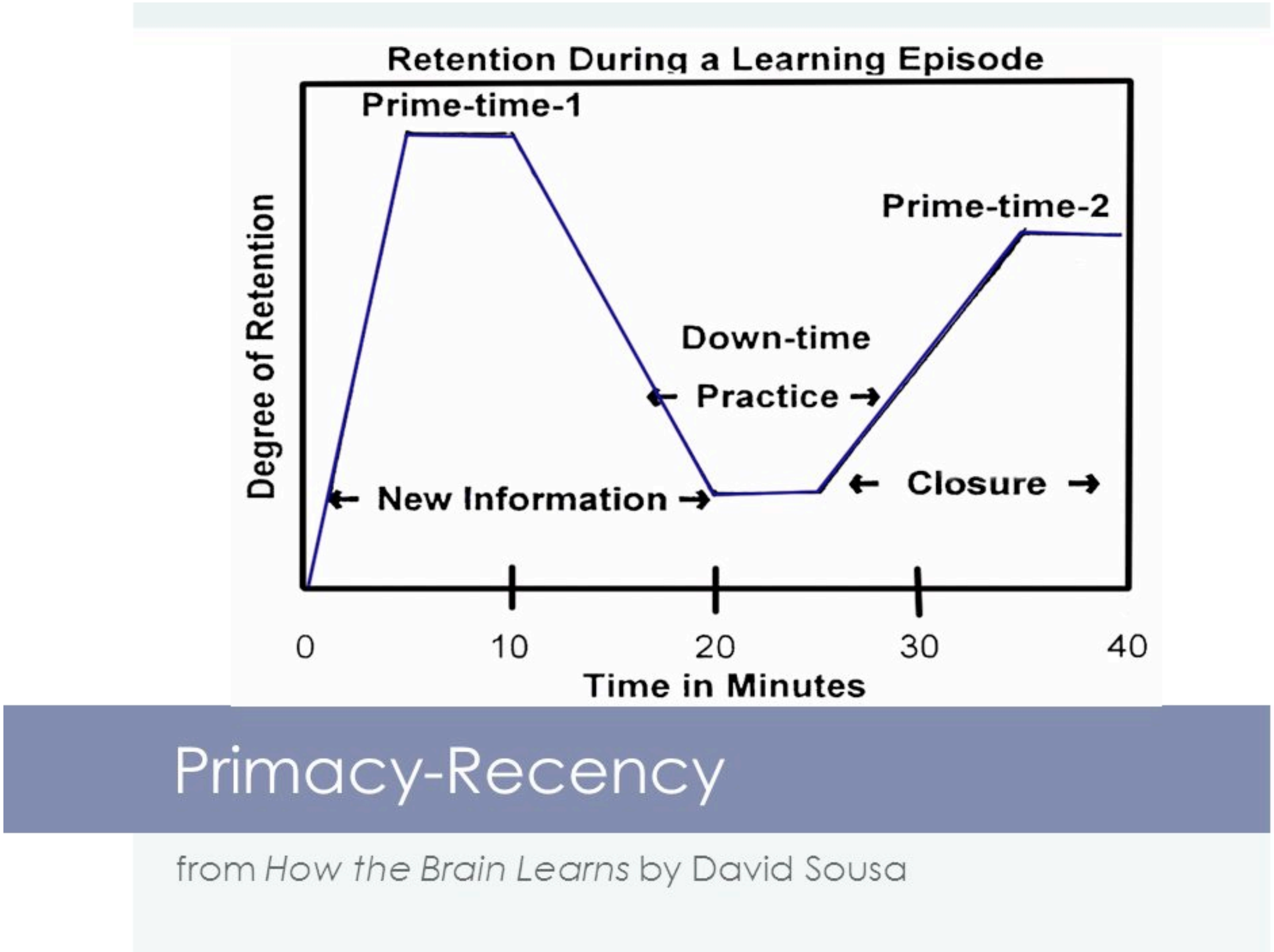
The prior fad of right brain or left brain tendencies is over. “We should be promoting ‘whole-brain thinking’, rather then right or left-brained strategies; learners should be provided with global overviews followed by sequenced steps. Alternate between the big picture and the details to ensure that both types of learning and presenting are represented.” (Jensen, 1997, p. 19) “The more effectively we deal with the whole learner, the more successful we will be in teaching.” (p. 21) Jensen suggests, deal with the learner’s feelings and physical condition as well as their cognitive aspects (1997).

> The learner’s brain must construct meaning on its own, brain-compatible educators provide their students with the resources to construct their own way of understanding the material, engaging them to connect the successful meaning in a safe, secure learning environment to students’ positive empowerment of success in the classroom. Resulting in greater self-confidence and intrinsic motivation for future learning. (Jensen, 1997, p. 32)

David Sousa in his fourth edition of “How the Brain Learns” (2011) reminds educators that “The old adage, ‘practice makes perfect’ is rarely true. It is very possible to practice the same skill repeatedly with no increase in achievement or accuracy of application” (Sousa, 2011, p. 104). If a learner consistently practices a skill incorrectly, the process of unlearning and then relearning skills correctly is very challenging. Consequently, educators want to ensure that students practice the new skill correctly from the beginning. Madeline Hunter’s 2004 book *Mastery Teaching* supports educators using different types of practice over time. The continual and correct rehearsal is called “distributed practice or spacing effect” by Sousa (2011) which supports repeated practice through increasingly longer amounts of time. Jerome Bruner (1971) called it spiral curriculum, whereby critical information and skills are reviewed at regular intervals within and over several grade levels. When educators support this practice in the classroom daily, they demonstrate a part of educational neuroscience that encourages the educators to build on students' schema at of beginning each lesson. While continual, correct repetition may increase a student's skills, the implications of retention affect how long the knowledge for the needed skills will last (Sousa, 2011). The learning episode begins when the student focuses on the educator with intent to learn. This is called "prime-time" (p. 96). Since any information presented during the first prime-time will be what students remember, it is critical that educators only share correct and valuable information during this prime-time. (See Figure 2.3) Sousa reinforces this to educators, "When you have the students' focus, teach the new information. Don't let prime-time get contaminated with wrong information" (p. 96).

The first prime-time of a forty minute class is right at the start of class through the first thirteen to fifteen minutes. Twenty minutes into the class, the student's brain has transitioned from prime-time, (high intensity to learn) to down-time (low intensity to learn). During down-time, Sousa encourages educators to have students practice the new skills and information taught during the first twenty minutes of class. Student can lead practice groups, create team responses, write short notation exercises during this down-time. While this may seem counterintuitive to teaching, allowing students to practice and teach others throughout your lesson reinforces each student's individual understanding and provides everyone with a chance to practice the new skill. Sousa (2011) reminds, "Whoever explains, learns!" (p. 101). Sufficient down-time or skill reinforcement is ten minutes and the final twenty minutes of class are another prime-time for teaching. During this second most powerful learning time, educators can have students determine meaning and build a new level of understanding (Sousa, 2011). The educator should plan their use of the final fifteen minutes of class carefully. A word of caution from Sousa (2011) to educators, "As the lesson time lengthens, the percentage of down-time increases faster than the prime-time. The information is entering working memory faster than it can be sorted or checked, and it accumulates. This cluttering interferes with the sorting and chunking processes and reduces the learner's ability to attach sense and meaning, thereby decreasing retention" (p. 97).

Figure 2.3 Primacy-Recency



Scaffolding Levels of Success in the Classroom

"We can take advantage of the brain's quest for novelty by eliciting states of curiosity, oddity-interest, suspense, awe, confusion, surprise and the 'ah-ha!' We can successfully answer the brain's hunt for pleasure by creating states of anticipation, hope, security, fun, self-confidence, acceptance, success and satisfaction within our lesson's challenges and demonstrations, but the third category, the brain's desire to avoid harm is trickier" (Jensen, 1997, p. 29). Brain-compatible educators know to start with getting students' attention, but also know to avoid embarrassment, hurt, anxiety, fear or ridicule as a means of novelty. Rather than avoid emotions in learning, educators should be prepared to deal with them. We can allow negative emotions to be processed and positive emotions to tag learning as fun. “This time of de-stressing allows the brain to stop the release of cortisol, and begin to release dopamine, increasing the enjoyment of learning. Learners need to be able to express negative feelings before being asked to learn” (Jensen, 1997, p. 31).

Leslie Hart (1983) calls the results of negative stress in the classroom downshifting (Caine & Caine, 1994). “We define downshifting as a psychophysiological response to perceived threat accompanied by a sense of helplessness and lack of self-efficacy” (Caine & Caine, 1994, p. 69). The brain is typically curious and absorbent of new information, but it closes down to survival mode when it perceives a threat that triggers a sense of helplessness. This emotional state causes all higher-order cognitive functions of the brain to shut down and prevents students from constructing meaning from new content or creating solutions for new challenges (Caine & Caine, 1994). Downshifting, in large part, is the reason students fail to apply the higher levels of Bloom’s taxonomy (Bloom, Englehart, Furst, Hill & Krathwohl, 1956). Principle eleven of Caine’s (et al. 2005) brain/mind learning principles states that “complex learning is enhanced by challenge and inhibited by threat associated with helplessness” (Caine, et all 2005). Students under threat downshift, making learning new information difficult, if not impossible, until the threat is removed. Therefore, brain-compatible educators must keep the recognition of the role of emotions as a top priority.

Educators who align their teaching with the research gathered from educational neuroscience know they must provide ample time for student understanding, processing, elaboration and verification of complex content during a lesson to expand knowledge beyond a surface level. During these processes, students will undergo a period of “unknowing” which causes the brain to seek new information and engage in complex forms of learning. This time of learning feels risky to students. In order to support the new learning the educator should establish an environment that allows for safe risk-taking (Caine & Caine, 1994). When students feel safe and happy in the learning environment, their cortisol levels remain low and the increased levels of dopamine cement the idea that learning new material is both exciting and adventurous. This relaxed alertness induces the brain to pay attention for long periods of time, to think systematically and creatively within the flow of learning, and to work cooperatively. Relaxed alertness thereby, creates a high level of successful learning in the lesson (Jensen, 2008).

Framework for Brain-Compatible Learning Approach

"The dance between letting go of old beliefs and taking on a new way of thinking and perceiving is delicate and complex" (Caine, 1995, p. 47). Applying research-based brain-compatible strategies to teaching demands a revising of old teaching methods in all areas of an educator's lesson plan. "It's a continual search for deeper meanings within simple systems that will stimulate imaginative educators to create new forms of enriched social environments within electronic classroom walls" (Sylwester, 1995, p. 141). In addition to Caine's (et al. 2005) brain/mind learning principles, the Brain-Compatible Approach to Learning (Jensen, 1997) is the other theoretical model selected that guided the researcher's training on how lesson implementation of research-based neuroscientific strategies could work in the classroom. This approach was used to guide the participants' reflections on educator and student success through interview questions. Brain-compatible teaching is essential for optimal learning; educators at all levels, preschool through higher education, need this component to round out their conceptual framework. If pre-service educators are expected to learn about recent developments in neuroscience and cognitive science, then their educators—university faculty—should understand these topics in depth (Smilkstein 2003). University professors should lead the way in role modeling best instructional practices, not only for graduate teaching assistant preparation programs, but also throughout the university. Learning about how the brain learns is one of the first steps in becoming an articulate professional educator (Radin, 2005).

The brain-compatible approach to learning is a system-wide method based on current neuroscientific research that suggests how our brains naturally learn best (Jensen, 1997). Our brain does whatever it has to do in order to survive, both biologically and functionally. The brain is at its peak when learning what it needs to learn, yet very little learning goes on when learners are in poor learning states (Jensen 1997).

Authors T. Kenyon (1994), M. and I. Csikszentmihalyi (1990), G. and R. N. Caine (1990) E. Jensen (1997) and J. Singer (1977) all concur that optimal learning takes place when the following conditions are met: High Challenge, Low Stress and Immersed flow state. High Challenge occurs when the learner is intrinsically motivated, when the content is not too easy or too hard, and when it is based on the learner's own relevant choice. Low Stress occurs when the learner is in general relaxation and maintaining alpha brain wave state. Immersed flow state occurs when the learner's attention is on learning and doing, not on feeling self-conscious or on being evaluated. M. Csikszentmihalyi (1990) says that optimal learning requires a state of consciousness known as flow, an uninterrupted state in which one loses oneself in the performance. This time of peak concentration and attention is characterized by a timeless, pleasure-producing experience where creativity and learning can be maximized during the brain's focused concentration on the task or skill. While it is challenging to force oneself into a state of flow, an educator can optimize the environment to increase the likelihood a student working in an Immersed flow state by starting with an easy task and upgrading to High Challenge (Csikszentmihalyi 1990 & Jensen 1997). This further supports Vygotsky's views of Constructivism and that learning is achieved when the challenge is within the Zone of Proximal Development.

Table 2.1

Summary of Brain-Compatible Learning Strategies

Not Brain-Compatible	Yes: Brain-Compatible
Low emotional impact	Appropriately high emotional arousal
Fragmented, sequential only	Global, unified, holistic, thematic
Concern with being "on task"	Alternating focus-diffusion learning
Standard boring illustrations	Colorful abundant memory maps
Suppressing learner energy	Utilizing and expressing energy
Lecture, more didactic	Multiple intelligences served
Emphasis on content only	Emphasis on context, meaning & value
Resigned to the learner's state	Positively conditions the learner & states
Mistakes recognized directly	Mistakes note indirectly or re-framed
Learner associated with failure	Use of alter-ego, other fun characters
Emphasis on quiet learning	Often rich with talking, music, activities
Assessment by standardized tests	Feedback quality & quantity is increased
Belief that learning is difficult	Attitude is: it's easy, fun & creative
Create tension & stress to learn	Keeps stress low and enjoyment high
Learning as only mental/cognitive	Learning also emotive, action, movement
Central focused stimuli	Use of significant peripheral stimuli
Extended presenter lecture time	Alternate focus & diffusion activities
Assumes authority from role	Creates constant respect & credibility

Not Brain-Compatible	Yes: Brain-Compatible
Finish when times up	Finish with celebration
Subtle or obvious threats, helplessness	Remove threats: focus on support
Focus on learning in the classroom	Real world, simulations, trips
Institutional boring rituals	Positive, purposeful rituals
Infer, threaten, demand	Suggest, ask & tell, suggest, ask & tell
Watered down micro-chunk curriculum	Year-long, real-life thematic curriculum
Insistent focus on conscious learning	Use of strong non-conscious learning
Minimal open and closing time	Longer open & close, shorter middle
Delayed, indefinite & vague feedback	Immediate, positive & dramatic feedback
Teach for the test, with stress	Learn for the joy of learning & real-life
Sit at desks and limit interactions	Mobility, face each other, partners, groups
Abrupt exposure to content	Purposeful & consistent pre-exposure
Introduce topic, forget it	Multiple exposure & activation at 1-3 days
Outcome-based learning	Learning is often a by-product of play
Constant use of negatives; "don'ts"	Use of totally positive language
Artificial, contrived textbook learning	Using real-life problems in the real world
Use of bribes, rewards, gimmicks	Intrinsic motivation elicited
Starve the brain for stimulation	Enriched: music, sights, aromas, movement
Disciplined, orderly, quiet, repressive	Expressive, changing, noisy
Single topic only by teacher choice	Learner input on topics, directions & depth
Standardized "objective" assessment	Multiple brain-based assessment strategies

Research on Brain Processing

Humans are preconditioned to learn and seek methods for survival by gathering data and information from their environment (Caine & Caine, 1991; Sousa, 2011). During the implementation of the pilot study, the instructors used during the pilot requested additional information regarding the brain processes to better understand the construct of creating novelty, student engagement and scaffolding success in teaching. The following sections of this chapter provide the research that supports this additional information.

The Brain's Processing Power

The human brain weighs about 1.4 kg, which is only about 2% of our body weight; however, it uses more than 20% of the energy that we supply with food. The brain processes information gathered from the senses and other neurons day and night. Neurons, found primarily in the brain and in the spinal cord, also known as the central nervous system, number approximately 100 billion neurons (Wolfe, 2010). Unlike other cells in the body, a neuron has tens of thousands of branches emerging from its core, called dendrites. The dendrites receive electrical impulses from other neurons and transmit them along a long fiber, called the axon. A layer called the myelin sheath surrounds each axon (Sousa, 2011). The job of the dendrites is to receive information from other cells and the main job of the axon is to send information to other cells (Wolfe, 2010). When a neuron receives an electrical impulse from a nearby dendrite, the electrochemical process travels through the myelin sheath. This impulse can move through the entire length of an adult's body in two tenths of a second (Sousa, 2011). Between each axon and dendrite is a small gap called a synapse. Neurons communicate electrochemically by passing messages at the synaptic junction between axon terminals and spines on dendrites or cell bodies (Wolfe, 2010). When a neuron transmits an electrochemical impulse through the axon to the synapse, the activity releases chemicals stored in the brain called neurotransmitters, which either excite or inhibit the neighboring neuron (Sousa, 2011). Each neuron has up to 10 thousand connections, of which less than 10 connections are back to the same neuron. As such each neuron is connected with thousands of different neurons (Spitzer, 2006, p. 50).

Figure 2.4 The Neuron

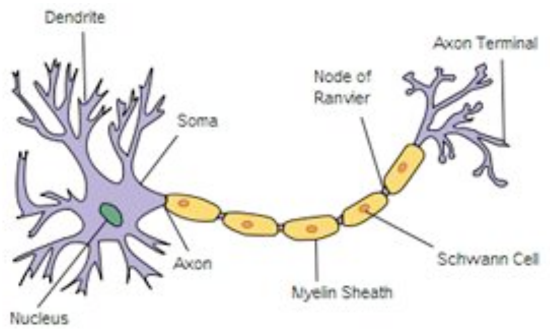


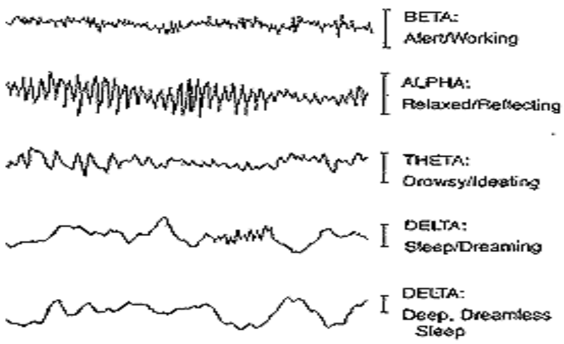
Figure reprinted from: www.wikipedia.com

This means that it is possible to have up to one quadrillion synaptic connections in one brain. Learning occurs by changing the synapses so that the influence of one neuron upon another neuron changes (Sousa, 2011, p. 22). All these billions of synapses allow the brain to continually process incoming sensory data, retrieve decades of stored memories, maintain facial recognition, learn languages, communicate verbally and non-verbally, maintain reflexive moment, and store new information in creative ways. (See Figure 2.4)

Brain Waves

The brain is an electromechanical organ, full of electrical synapsis between neurons that share information at a rapid pace. A fully functioning brain can generate 10 watts of electrical power, and if all 10 billion interconnected nerve cells discharged at one time that a single electrode placed on the human scalp would record about five millionths to 50 millionths of a volt (Herrmann, 1997). Electrical activity emanating from the brain is in the form of brainwaves, there are four categories of these brainwaves, ranging from the most activity to the least activity (Herrmann, 1997). When the brain is aroused and actively engaged in mental activities, such as an active thinking, problem-solving or debate, it generates beta waves. The beta waves range from 13 to 40 Hertz cycles/second. The alpha wave ranges from 7-13 Hertz/second, and is refered to as a state of ‘relaxed alertness’. This state indicates the body is relaxed and feeling no threat and yet, the brain is still at a higher frequency for alertness (Herrmann, 1997). One of the benefits of alpha state is that it promotes a positive attitiude about learning (DePorter, et. al, 1999). Theta waves are associate with sleep, deep relaxation and visualization at the 4-7 Hertz/second frequency. During the theta state, tasks become so automatic that you can mentally disengage from them. The ideation that can take place during the theta state is often free flow and occurs without censorship or guilt. It is typically a very positive mental state (Herrmann, 1997). Finally, Delta waves are at 1.5-4 Hertz/second, it occurs most often during deep sleep, such as a time of rapid eye movement (aka REM) (Brainandhealth.com, 1).

Figure 2.5 Brainwaves



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Neurotransmitters

Neurotransmitters are chemical molecules that tag a neuron's message to neighboring neurons. Neurotransmitters carry out various communication functions at the synapse. The shape of the neurotransmitter interacts with the shape of the receptor. If it's a good match, the neurotransmitter transmits its message into the receiving neuron (Sylwester, 1995). The brain's neurotransmitters are classified either functionally, chemically or both. The function of the neurotransmitter is to send either an inhibitory or an excitatory response from the first neuron to the receiving neuron at the juncture of the synaptic gap. "An excitatory message helps to increase the subsequent communicative actions of the postsynaptic neuron [receiving neuron], and an inhibitory message helps to reduce them" (Sylwester, 1995, p. 36). In a typical chemical synapse between two neurons, the neuron from which the nerve impulse arrives is called the presynaptic neuron. The neuron to which the neurotransmitters (chemical messengers) bind is called the postsynaptic neuron (Sylwester, 2005). The presynaptic neuron has a terminal button that contains the mitochondria—where cellular energy is produced—and vesicles that transport the neurotransmitters from the cell body where they are produced to the synaptic area. When the synaptic energy is released, the neurotransmitters are discharged into the gap and bind to member receptors in the postsynaptic neuron. The neurotransmitters that are not connected to a receptor are reabsorbed by the presynaptic neuron.

Neural activity in our brain is much more inhibitory than excitatory. We focus our attention on one task, limit our activity to one task, and ignore most of our memories, unless required (Sylwester, 2005). Persons with ADD or ADHD demonstrate a principally excitatory brain that continually attends to everything, seeks to carry out all possible actions, and has continual open access to all prior experiences. The results of this clinically diagnosed excitatory brain is to provide an inhibitory drug that responds as an inhibiting neurotransmitter in the brain and stops the neuron messages from being sent with excitatory neurotransmitters (Sylwester, 1995). Neurotransmitters are categorized by molecular structures [amino acids, monoamines, & peptides] or by response task [inhibit or excite] (Sylwester, 1995, Appendix A) (Boeree, 2009).

Inhibitory Neurotransmitters

Serotonin contributes to various functions, such as regulating body temperature, sleep, mood, appetite, and pain.

GABA (Gamma-aminobutyric acid) contributes to motor control, vision, regulates anixety by serving as a brake to the excitatory neurotransmitters. “It is estimated that as many as one-third of all synapses in the cortex are GABA synapses” (Sylwester, 2005, p. 71).

Glycine is found in combination with GABA as a major neurotransmitter in the brain and spinal cord.

Dopamine is synthesized at the base of the cortex and is released into the limbic system and frontal lobe (Wolfe, 2010). This neurotransmitter is most associated with reward in the brain. “Low levels of dopamine are associated with Parkinson’s disease, and high levels are associated with some forms of schizophreniz” (Sylwester, 2005, p. 58).

Endorphin is short for “endogenous morphine;” it is involved with the pain reduction and pleasure responses in the brain. Opioid drugs, such as heroin, mimic the response of endorphin by slowing the heart-rate, respiration and metabolism.

Excitatory Neurotransmitters

Dopamine is both an excitatory and inhibitory neurotransmitter, it supports focus and motivation when used as an excitatory neurotransmitter.

Norepinephrine (also called noradrenaline) is the primary neurotransmitter in the sympathetic nervous system, it supports energy and attentiveness, as well as maintaining the sleep cycle, dreaming and learning. Norepinephrine causes the adrenal gland to respond with a rush of adrenaline when our body is on high alert by increasing our heart rate and blood pressure and activating stress-related fight or flight responses.

Epinephrine is the name of adrenaline when it is a neurotransmitter. It also responds to the body's fight or flight behaviors and boosts our heart rate and blood pressure when stressed. Long term stress or insomnia cause epinephrine levels to be depleted resulting in fatigue and lack of focus.

Glutamate is the most commonly found neurotransmitter in the central nervous system and supports the brain's long-term memory and filing system. It also supports vision, learning and is surprisingly toxic to neurons. Excessive amounts of this neurotransmitter will kill neurons that are responsible for memory, learning and clarity in vision.

Asparte is an excitatory neurotransmitter that closely resembles glutamate, with similar supportive structures and destructive tendencies.

Acetylcholine is primarily associated with controlling conscious movement. Operating all voluntary and many involuntary muscles, it supports wakefulness, attentiveness, anger, aggression, sexuality and thirst responses in the brain.

Peptides

Peptides are either digestive products or hormones. Many peptides have been found to operate in the brain, as well as the body, and are called neuropeptides (Wolfe, 2010). They are neither inhibitory or excitatory, they act as modulators within the body and the brain to trigger responses.

Endorphine was discovered by scientists in 1975, when Hughes and Kosterlitz were searching for an internally produced chemical that would fit into the existing opiate receptor cells. What they found was a natural substance that acts much like morphine in blocking pain and producing euphoria. Originally called *enkephalin*, endorphine uses the same receptor site that was triggered when the drug morphine was used (Wolfe, 2010). Endorphine levels rise in the brain during prolonged, sustained exercise, through acupuncture, meditation and with positive social contact (Sylwester, 2005).

Substance P is present in many sensory neurons and pain messages to the brain. It also helps to initiate and regulate emotions.

Vasopressin is a peptide that is ruled by the pituitary gland. It helps to regulate water retention and blood pressure, as well as enhancing memory formations. Vasopressin is found to be higher in males and the peptide oxytocin higher in females. Both peptides enhance social and bonding behaviors, such as parent/child and husband/wife relationships.

Cortisol is a slow release, slow decaying hormonal peptide that is secreted by the adrenal gland into the bloodstream during high stress situations. Cortisol supports the fast responding neurotransmitter epinephrine during a fight or flight reaction by increasing heart rate and blood pressure, releasing blood clotting elements into the bloodstream, requiring muscles to be tensed and ready to flee, increasing sensatory input, and causing memory systems to retrieve any knowledge relevant for survival from prior situations. High cortisol levels also suppress the digestive and immune system for it views these as a non-essential system when fleeing or fighting. While low levels of cortisol support the body's wakefulness and attention, constant high stress situations demand cortisol to be continually added to an already stressed physical body. Additionally, cortisol can be destructive on the brain, as high levels of cortisol cause damage to the hippocampus, causing memory loss and cognitive decline.

The preceding explanation of the role of neurotransmitters in the brain was given in order that when subsequent instruction about scaffolding success occurred in the training, the graduate teaching assistants would know that positive, safe, and successful moments in teaching happened because they had learned how to trigger appropriate neurotransmitters or inhibit inappropriate neurotransmitters.

Parts of the Brain

The introduction of the parts of the brain relates to the study because it provided a foundation for recognizing the areas of the brain and their varied functions. This foundation increased the graduate teaching assistants' awareness of the need for specific methods to employ in their classrooms in order to promote and enhance student achievement.

At the base of the brain where the spinal cord begins is the brainstem. The primary purpose of this area is to ensure the body's survival through automatic functions that are not under conscious control, but are essential to survival. Examples of these functions include heart rate, respiration, and blood pressure (Wolfe, 2010). Severe damage to the brainstem is life threatening as this portion of the brain keeps life-support systems functioning, and no other portion of the brain monitors these functions.

Resting above the brainstem at the back of the brain is the cerebellum, also known as the little brain (Wolfe, 2010). This portion of the brain is highly active from birth to age two, learning the coordinated movements needed to activate every muscle to perform walking, running, lifting a fork, and even the skills required for writing. When the cerebellum receives information that the motor cortex has begun to initiate a movement, it computes the contribution that various muscles will have to make to perform that movement and sends the appropriate messages to those muscles in about 1/50th of a second (Wolfe, 2010). When proficiency in the movement is reached, the cerebellum takes over much of the control, leaving the conscious mind free to do and think about other things.

Lobes of the Brain

Occipital Lobes

Located at the lower central back of the brain are the occipital lobes, the primary brain center for processing visual stimuli. It is split into many subdivisions, each providing analysis of visual data coming into the brain, determining if what you are seeing is, for example, an apple or an apple tree. Visual stimuli do not become meaningful until the sensory perceptions are matched with previously stored cognitive associations. This is why preparing students by telling them the objective of an activity is usually desirable. It allows the brain to anticipate critical features or ideas, and it increases the likelihood that the brain will focus on essential information (Wolfe, 2010). This tendency can also work in the educator's favor, for when a novel object is introduced, the brain's occipital lobe is on high alert, taking in new data at a rapid rate for coding and comprehension.

Figure 2.6 Regions of the Human Brain

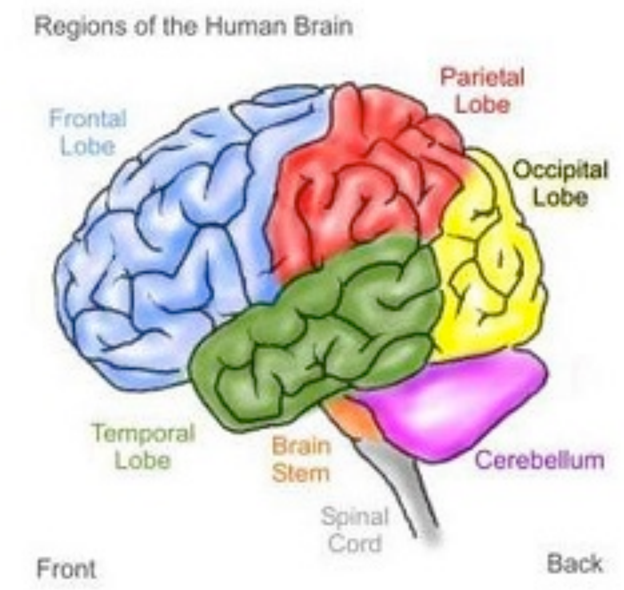

Figure reprinted from: www.researchgate.net

Temporal Lobes

The temporal lobes are located just above the ears and below the frontal lobes in the brain. The primary function of these lobes is to process auditory stimuli to cope with language, hearing and some aspects of auditory memories. Hearing allows humans to communicate vocally with one another, to give and receive information that is vital for our survival.

Parietal Lobes

The parietal lobes are located between the occipital and frontal lobes and above the temporal lobes. Split into two portions, the anterior lobe receives sensory stimuli such as temperature, pain, pressure and positions of the body and the posterior lobe determines spatial awareness (Wolfe, 2010). The parietal lobes also receive the sensory input from touch and maintains focus on a task or tactile event (Wolfe, 2010). It supports the brain in tasks, such as recognition, manipulation, physical orientation, articulation, etc.

Frontal Lobes

The frontal lobes occupy the largest part of the cortex and perform the most complex functions (Wolfe, 2010). Frontal lobes play an especially important role in that they control, fixate, and shift conscious attention – thus determining how the current situation relates to our previous experience (Sylwester, 1995). The ability to move parts of our body at will, think about the past, plan for the future, focus attention, reflect, make decisions, solve problems, and engage in conversation are possible because of a highly developed frontal lobe. The prefrontal cortex, located in the front of the frontal lobes, has been called the "silent area," meaning it is free from processing sensory data and governing data. The prefrontal cortex works as the association cortex; where information is synthesized and association between objects and their names are made. The prefrontal cortex handles the highest forms of mental activities (Wolfe, 2010). Simulations from the outside environment (received by our sensory receptors and are quickly sent through the thalamus and amygdala) which cause stress or fright, trigger the hippocampus to interrupt the prefrontal signal, and the body responds automatically with a rapid fight or flight reaction. So when students are stressed, their prefrontal/association cortex, is not used to process data. In other words, when students are stressed, they do not make rational decisions, but rather respond with emotions. Research findings have implicated a part of the prefrontal cortex as critical for emotional self-regulation (Siegel, 1999). Only after a person responds to and controls the stress, causing cortisol levels to drop, is the prefrontal cortex allowed to analyze the reason for the stress and subsequent emotional response. The orbito-frontal cortex, an area within the prefrontal cortex that is located near the eye socket, appears to be responsible for evaluating and regulating the emotional impulses emanating from the lower centers of the brain (Wolfe, 2010). Therefore in support of student achievement, educators need to be attentive to the emotional environment of their classrooms—keeping them low stress, full of motivation to succeed and celebrating moments of success within each lesson. Such an environment keeps cortisol levels low and the prefrontal cortex active.

The previous information guided preparation of graduate teaching assistants' training to increase the awareness of the need for specific methods to employ in their classrooms in order to promote and enhance student achievement.

Relevance to Student Achievement

Educators need to see that learning is not a process that the brain needs to manage. According to Spitzer (2006), learning occurs automatically whenever the brain is perceiving, thinking or feeling. Learning that focuses predominately on facts and information must transition into more sophisticated learning that requires the use of that information for relevant goals and purposes (Caine, et al., 2005). "Educators have to understand how to create classrooms and learning that engage the whole brain, from facts, skills and procedures to executive functions. These are not separate in the brain, neither should they be separate in education" (Caine, et al., 2005, p. 9). An internet search engine will scan the internet instantaneously on any subject, almost any fact a student needs for class can be found on the web. Educators must come to terms with the fact that this is the information age and students can find information everywhere. Eric Jensen (2008) concurs in his book, *Brain-based Learning: The New Paradigm of Teaching*, with this statement. "Everything you do uses your brain, and everything at school involves students' brains. It is the most relevant understanding for educators to have right now" (Jensen, 2008, p. 3).

Personal Learning Preferences Affect Student Achievement

In this study graduate teaching assistants were to provide hands-on, real-life experiences in order to 1) engage the students' interest and 2) enable them to apply the experience to the content of the lessons. The experience was to support the students to develop multiple ways to make sense of what is being taught rather than memorization of facts alone in an effort to support student achievement. Slavkin (2004), Jensen (2008) and Sousa (2011) are quick to point out that a main feature of successful brain-compatible teaching or educational neuroscience (Sylwester 2012) is that students need educational experiences that relate to how their individual brains learn as well as understanding the differences in personal learning styles. Student performance can be strengthend by organizing appropriate instruction to provide more effective learning (Sims & Simes, 1995).

"Brain-based education focuses on each student's differences in thinking" (Slavkin, 2004, p. 40). "Different teaching styles are required for different learning objectives (Gagne, Briggs & Wagner, 1992)." (Duman, 2010, p. 2083). Hower Gardner, known for his Multiple Intelligence theory (1993) reinforces the belief that teaching should be performed by considering the style differences of students. No single learning-teaching theory is adequate on its own (Duman, 2010). Teaching students requires instructors to synthesize brain-based learning and learning styles together and use this combination in experimental classroom environments (Duman, 2010).

The following educational neuroscientific strategies were used in the training session for the two selected graduate teaching assistants in this study.

Modalities

The use of visual, auditory, and kinesthetic modality tests (aka VAK), allow students the opportunity to understand how their brains tap into leaning new content and how the brain retrieves stored data. Individuals not only have a preferred modality, they also have preferred combinations of modalities which afford them specific natural gifts and challenges (Markova, 1992). Researchers are uncertain exactly how or when a modality becomes embedded; however, some speculate that it is internalized between the ages of three and six (Jensen, 2000). Two selected graduate teaching assistants completed a short modality assessment and were provided techniques to integrate this strategy in their teaching to enhance student understanding of the Aural Skills content and support student achievement.

Multiple Intelligence Theory

Introducing the selected graduate teaching assistants to Howard Gardner's multiple intelligences (1993), allows for a symbiotic relationship to develop between teaching and testing. The Multiple Intelligence theory conceives of intelligence as a combination of inheritable potentials and skills that can be developed in diverse ways through relevant experiences (Gardner, 1983). Educators allow their students to express what they have learned in different ways and students are expected to produce results based on their own research in student-developed presentations. Gardner's Multiple Intelligence original proposal from 1990, stems from empirical evidence to include seven intelligences. His next publication added an eighth intelligence in 1993. The eight identified intelligences are as follows (Gardner 1999):

Linguistic: The ability to analyze oral information and to use appropriate language; these students enjoy activities that involve speaking and writing.

Logical-Mathematical: The ability to develop equations and proofs, make calculations and solve abstract problems; these students enjoy activities involving cause and effect, manipulating numbers, quantities and operations.

Spatial-Visual: The ability to recognize and manipulate large-scale and fine-grained spatial images; these students enjoy the opportunity to internalize the spatial world in one's mind.

Bodily-Kinesthetic: The ability to use one's own body to create products or solve problems; these students like to participate in any activity where they are given a chance to move around.

Naturalistic: The ability to identify and distinguish patterns among different types of plants, animals, weather formations, and/or rocks that are found in the natural world; these students like to check for similarities and differences in nature and code them.

Interpersonal: The ability to recognize and understand other people's moods, desires, motivations, and intentions; these students are comfortable working in groups and are often voted the leader of the group.

Intrapersonal: The ability to recognize and understand his/her own moods, desires, motivations and intentions; these students have a talent for understanding one's own internal struggles and successes.

Musical: The ability to hear, produce, remember and make meaning of different patterns of sounds; these students have a talent for mimicry, learning a foreign language and participating in musical ensembles.

Similar to exploring the three modalities which affect a student's intake of information, the Multiple Intelligence theory was explored by two graduate teaching assistants with the researcher. The graduate teaching assistants completed a short "'How are you smart?' chart" assessment and discussed techniques to integrate this theory in their teaching to enhance student interactions with the Aural Skills content and support student achievement.

Success Model

Difficult content compounded with the individual's degree of personal risk to tackle a new concept could be enough to make a student hold back or freeze up (Jensen, 1994). Educator's seeking feedback from their students may, unintentionally, cause students more stress by the frequent use of questioning and quizzes. The success model reminds educators to set the student up for success by introducing the concept in three ways, 1) multi-sensory, 2) with information broken down or chunked into three or four categories at a time, and 3) with frequent review opportunities (DePorter, Reardono, Singer-Nourie, 1999). Additionally when seeking student feedback to determine their understanding of the content, the success model reminds educators to evaluate in three ways, 1) do a quick check with the large group or whole class for understanding, 2) have small groups, teams or partners work together to strengthen understanding, and 3) finish with the individual in a one on one setting such as a homework assignment, quiz or test. The researcher presented this model to two graduate teaching assistants to assist them in planning their interaction with the students regarding assessment planning and providing feedback to students.

Attention & Active Engagement

Attention has always been a central concern for educators. The focus and engagement of our students is critical to their success in assessments and exams. Robert Sylwester's text, *A Celebration of Neurons: An Educator's Guide to the Human Brain* states, "Our brain's ability to focus and maintain its attention on objects and events is critical to learning and memory, and attention is the basic element in classroom motivation and management." He defines an effective attentional system as one that is able to complete the following:

- quickly identify and focus on the most important items in a complex environment,
- sustain attention on its focus while monitoring related information and ignoring other stimuli,
- access memories that aren't currently active, but that could be relevant to the current focus, and
- shift attention quickly when important new information arrives (1995).

Active engagement in students arrives as sensory information moves through the brainstem into two attentional processing systems; 1) the fast emotional system, and 2) the slower analytic system that processes stimuli from the sensory receptors through the thalamus, sensory lobes and to the frontal lobes for evaluation and response (Sylwester, 1995). The brain is naturally curious and inquisitive. When we seek out specific information, our attention system primes itself in anticipation by increasing our response levels within the frontal and prefrontal cortex. Sylwester suggests that the best vehicles for priming a student's interest are storytelling, candid conversations, debates, role playing, simulations, songs, games, films and novels. He advises, "We must constantly help students test their memories in real and metaphoric life settings that encourage stimulating interaction, or else all our efforts to create the memories are for naught" (Sylwester, 1995, p. 103). The integration of novelty, surprises, gaming activities, and new locations for class were added to the two graduate teaching assistant's lessons who were integrating these strategies in the study.

Summary

The brain is an intricate and powerful organ. It sustains life in our physical bodies and through research in neuroscience educators can sustain active learning for all students in their classrooms. Building upon the theoretical models of Caine, Caine, McClintic & Klimek's 12 Brain/Mind Learning principles (2005) and Jensen's Brain-Compatible approach to teaching (1997), the framework for this study has been established. This chapter presented relevant brain-compatible strategies that shape novelty, enhance student engagement and how to scaffold moments of success in every learning experience and also explored relevant literature related to educational psychology and relevance to student achievement.

Chapter 3 - Methodology & Research Design

Introduction

The objective of brain-compatible learning is to move from simply expecting the student to memorize information to creating meaningful learning experiences that affect the student both cognitively and emotionally (Caine & Caine, 1990). This quasi-experimental design used brain-compatible strategies to create novelty, enhance student engagement and scaffold moments of success to determine the effect on student achievement in the university Aural Skills classroom. Throughout the course of this quasi-experimental study the researcher analyzed pre-implementation and post-implementation mean test scores for quantitative analysis to determine effect on student achievement. The researcher conducted the research in a mid-American university with a student population of 20,000-25,000 and student to teacher ratio of 25:1 or lower and within the global student population, the study narrowed the focus to the music department's Aural Skills course student population of 75-85 and a student to teacher ratio of 18:1. There were three Aural Skills courses taught that semester, Aural Skills I, II, and III. Each course was broken down into two sections and each section was taught by one graduate teaching assistant.

This chapter presents a description of the methodology process as follows: 1) the research questions and corresponding null hypotheses, 2) research design, 3) strengths and weakness of chosen design, 4) sample frame and setting of the study, 5) sampling procedures and techniques, 6) the timeline*,* 7) the pilot study of the training program, 9) procedures, a) test data anaylsis, b) training program, 10) measures, and 11) chapter summary. Throughout this report, the term participant refers to the graduate teaching assistant and the term subject refers to the students in their courses.

Research Questions & Null Hypotheses

The focus of this study was to explore the causal effect on student achievement using research-based neuroscientific teaching strategies specifically novelty, engagement, and scaffolding success in a university Aural Skills classroom. The following research questions guided this study:

1. What are the effects of research-based brain-compatible teaching strategies that promote novelty, student engagement, and scaffolding success on student achievement during one semester in a university Aural Skills classroom?

The researcher states the following null hypothesis:

H_o: The implementation of brain-compatible strategies had no effect on the student achievement results in the university Aural Skills classroom.

The other research question and related null hypothesis that provided additional framework for this proposed study was:

2. Is there a difference in student achievement over a period of a semester with continual enhancement of novelty, student engagement, and scaffolding success strategies?

The researcher states the following null hypothesis:

H_o: There is no difference in student achievement over a semester with the continual enhancement of novelty, student engagement, and scaffolding success strategies.

Research Design

Experimental design was used to compare student achievement between the control and treatment groups to indicate if specific instructional activities provided for the experimental group impacted student achievement (Campbell & Stanley, 1963). In educational research, as in this study, the researcher is interested in generalizing the findings to a setting in which testing is a regular phenomenon. If the researcher uses regular classroom examinations for data gathering, it can be maintained that assessments themselves are not the initiator of achievement differences. Classroom observations were completed to ensure that no undesirable interaction of control and the treatment groups would be present (Campbell & Stanley, 1963).

Table 3.1

Research Design

Classroom	Course	Data Pt. 1	Intervention	Data Pt. 2	Data Pt. 3
Classroom A	Aural Skills I	Pre-Test	Treatment	Test	Post-test
Classroom B	Aural Skills I	Pre-Test	Control	Test	Post-test
Classroom C	Aural Skills II	Pre-Test	Treatment	Test	Post-test
Classroom D	Aural Skills II	Pre-Test	Control	Test	Post-test
Classroom E	Aural Skills III	Pre-Test	Treatment	Test	Post-test
Classroom F	Aural Skills III	Pre-Test	Control	Test	Post-test

Subject Selection and Informed Consent

The researcher sent an email asking the Aural Skills supervisor to indicate his/her willingness to allow the research to be conducted in the specified courses. The introductory email included the following information: content area of training, the facilitator's credentials, the IRB contact information, the qualifications for the study and how this study was seeking interested participants. Once the email requesting permission had been sent, the researcher established a two-week waiting period for a reply from the supervisor. As the response was slow, a follow-up appointment was made to request permission in person. After receiving the supervisor's email requesting more information, an appointment was made to share the purpose of the study, the risks and benefits, the subjects involved in this study. The supervisor was given a supervisor's consent form (APPENDIX A) to sign and show a willingness to allow the researcher to approach the graduate teaching assistants via email and determine if they would be interested in participating in the study. Upon determined interest and willingness to participate in the study, graduate teaching assistants were given a participant consent form to sign (APPENDIX B), this form explained the purpose of the study, the data collection procedures, a timeline of the study, and risks, if any. After reviewing the provided information, the course graduate teaching assistants were free to decline to participate in the study or drop out at any time. Prior to this study, two of the graduate teaching assistants had already taught the Aural Skills I course for three semesters, while the other two of the graduate teaching assistants had only taught Aural Skills II course for one semester prior to the study. This was the first semester that two of the graduate teaching assistants had ever taught Aural Skills III. However, none of the graduate teaching assistants had ten or more years of collegiate teaching experience, as the study requires. The graduate teaching assistants were assigned the following course teaching load for the Spring 2014 semester.

Graduate teaching assistants who choose to join the study signed the consent form and were given a copy for their personal records. Additionally, they were asked to provide their school email to assist the researcher in communication when scheduling observations and subsequent training. The graduate teaching assistants received a card with the researcher's contact information and those selected for the treatment group were given the date of the upcoming training weekend.

Following the four graduate teaching assistants' informed consent, the researcher attended each graduate teaching assistant's Aural Skills classes to enlighten students that a study was to be conducted in the courses and their own compliance was entirely voluntary. Following the presentation detailing the study, the researcher distributed a Student Informed Consent form (APPENDIX C) to all students in the class, leaving extras with the subject/graduate teaching assistant for any students who were absent. The researcher indicated to students that by signing the form they consented to have his/her student exams and scores recorded for the study, if they chose not to participate, the individual only needed to return the consent form blank and their scores would not be included. The researcher left the room after distributing the consent form, so as to not pressure students, and the graduate teaching assistants returned the signed forms to the researcher after the day's class period was over.

Pilot Study of Training Program

The researcher piloted the training program in January 2014 with select music faculty at a small mid-western college. The study included presentations on the implementation of novelty, enhancing student engagement and methods to scaffold success moments in every lesson. Upon completion of the pilot study training program, the following changes to the training program were suggested: (a) prior to discussing novelty, engagement and scaffolding success in the classroom, an introductory session is needed to cover how the brain learns and codes new information, and (b) the trainer must create additional time within the training to implement participant collaboration, storytelling, and debriefing, this will allow the subjects' cortisol levels and stress response to remain low during the fast pace of the training weekend. These suggestions were implemented in the offical training of the two graduate students in the final study.

Sample Frame & Setting of the Study

In an ideal experiment, the researcher forms at least one control group and one experimental group (Bausell, 1994) [also known as a treatment group]. The researcher used convenience sampling to select the four Aural Skills classes from the same university for this study, two of which were randomly selected for the control group and two for the treatment group. These classes are designed and taught by graduate teaching assistants. The graduate teaching assistants were guided by the Aural Skills supervisor's written curricular course goals and a scheduled test framework. All graduate teaching assistants leading a course were expected to teach the same curriculum, however, each individual graduate teaching assistant could determine how the goals would be addressed and met within each specific lesson. This freedom in lesson design allowed the opportunity to maintain a control group class whose graduate teaching assistant(s) could teach the lessons without interference, while allowing the treatment graduate teaching assistant(s) the opportunity to implement the brain-compatible techniques within his/her lesson plan designs. All subjects were observed three times in the study via a classroom observation visit.

Table 3.2

Graduate Teaching Assistant's assigned teaching load

Classroom	Course	Graduate Teaching Assistant #
Classroom A	Aural Skills I	Graduate Teaching Assistant 1
Classroom B	Aural Skills I	Graduate Teaching Assistant 2
Classroom C	Aural Skills II	Graduate Teaching Assistant 3
Classroom D	Aural Skill II	Graduate Teaching Assistant 4
Classroom E	Aural Skills III	Graduate Teaching Assistant 1
Classroom F	Aural Skills III	Graduate Teaching Assistant 2

Procedures

Of the 83 student consent forms distributed, 79 agreed to participate, n=79. All four graduate teaching assistants indicated an interest in discovering and creating brain-compatible lessons for their classes, however only two of the four were in the training program. The treatment group's training program that provided information and brain-compatible teaching strategies was completed over a weekend early in the spring 2014 semester. This allowed for all graduate teaching assistants to be on campus and for all four of them to have received the instructional content and teaching assignments from the Aural Skills supervisor. The graduate teaching assistants of the treatment group were sent an email with the date of the training session and the researcher answered additional questions. During the training weekend, the researcher taught the graduate teaching assistants of the Classrooms A, C and E the strategies that support how the brain learns. The researcher and graduate students together brainstormed ideas on how to create methods for implementing novelty in the class, enhance student engagement and scaffold student success into their upcoming lessons.

Description of the Training Session

The training program provided strategies for graduate teaching assistants 1 and 3 implementing the use of novelty, enhancing student engagement and scaffolding moments of success in every lesson to facilitate student achievement. The researcher used the revised twelve brain/mind learning principles by Caine, Caine, McCintic & Klimek from the book, *Twelve Brain/Mind Learning Principles in Action: The Fieldbook for Making Connections, Teaching and the Human Brain* (2005) and Jensen's book, *Completing the Puzzle: The Brain-Compatible Approach for Learning* (1997) for the framework of the training. From the Caine, et. al (2005) text, the researcher selected five principles to design the training implementation program. The five specific principles selected were:

- Principle 3: The search for meaning is innate;
- Principle 5: Emotions are critical to patterning;
- Principle 10: Learning is developmental;
- Principle 11: Complex learning is enhanced by challenge and inhibited by threat associated with helplessness; and
- Principle 12: Each brain is uniquely organized.

First, the researcher used Principles 10 and 12 and taught how each subject's brain learns and dialoged why educators should know this information prior to teaching. This section was added after the feedback from the pilot study of the training revealed this information was needed. Aligning with Principle 3, the researcher presented how the search for meaning is enhanced when implementing novelty in the classroom by using a novel experience or environment. This was experienced by the researcher's use of novelty in the training and reinforced with dialog. The graduate teaching assistants created ways to implement this principle into their Aural Skills lesson plans. The experiential learning moment is based on the neuroscientific research that supports the brain learns best through experimental moments (Caine & Caine, 1991). Graduate teaching assistants were encouraged to implement games, stories, activities requiring movement and surprises as a way to create novelty in the classroom. As the Aural Skills classes are traditionally recitation based, the researcher engaged graduate teaching assistants 1 and 3 in a discussion concerning the lack of student engagement in collegiate lecture-style classes. Graduate teaching assistants were encouraged to design an engaging introduction and increase the use of active discussion techniques, and visual aides. Ideas on how to provide more laboratory experiences were shared, such as board work or piano playing and increased collaboration between subjects were explored. The researcher demonstrated how to scaffold moments of success within a lesson, enabling the student to use prior knowledge (schema) and tag it to new levels of incoming knowledge. Incorporating Principle 5 and 11 into the third session, the techniques for scaffolding success were revealed. Scaffolding success is finding the "ah-ha!" moments in teaching which cause subjects' stress levels and cortisol levels to decrease. The decrease in stress hormones allows the frontal lobe to freely process new information, and to associate the new learning as positive, due to the increase of dopamine and serotonin in the brain (Sousa, 2011). In the same manner, scaffolding success allows the brain to release positive neurotransmitters, such as serotonin and dopamine, to tag incoming knowledge as safe and allow to collate the new knowledge with prior knowledge creating deeper levels of enjoyment and mastery within the lesson. To facilitate the graduate teaching assistants' grasp of scaffolding success with students, the researcher implemented moments of scaffolded success during the training program and then drew the graduate teaching assistants' attention back to the fun moments, recognizing them as memorable and pleasant. Graduate teaching assistants who were teaching the treatment subjects were expected to incorporate scaffolding success moments through an increase in peer-lead review, class discussions and by providing subjects multiple critical thinking opportunities during each class. Additionally, graduate teaching assistants were to provide feedback to subjects through discussion and review how answers were found. Caine et. al (2005)'s Principle 1 states the brain is a parallel processor. From this principle, the researcher conducted a final debriefing activity for the graduate teaching assistants to dialogue and share their understanding of how to use these five selected principles in the university Aural Skills classroom. The graduate teaching assistants then created lessons for the next class period to immediately implement the strategies discussed. Slides from the training session are found in Appendix D.

After the training session, the researcher scheduled two post-training observations with each graduate teaching assistant in charge of the treatment classrooms implementing the brain-compatible strategies. To assist the graduate teaching assistants implementing the treatment, the researcher listened and advised each one regarding concerns of strategy implementation and/or regarding empirical evidence experienced in their classroom. The researcher also conducted two observations in the control classrooms to validate the lack of cross contamination of the specific brain-based techniques being used in the control subjects' classrooms. Field notes were taken at all observations.

Data Collection

The testing schedule for the Aural Skills courses consisted of three main assessments in the semester. This allowed the researcher to use 1) the first exam as a pre-test providing baseline data, 2) the second exam as the mid-term providing the researcher the opportunity to see the potential initial effects of the implementation in the treatment classrooms, and 3) the final exam as a post-test providing data and analysis. Each test that was given to the Aural Skills subjects was jointly designed by the graduate teaching assistants and assessed content mastery and was aligned to goals set by the supervisor at the beginning of each semester. Graduate teaching assistants met a week before each test was given to design the test for all subjects in the study. Each written test had four areas of assessment, interval identification, harmonic dictation, melodic dictation, and rhythmic dictation. The grading of the tests was completed by the graduate teaching assistants with paper copies of results returned to the subjects and test scores recorded in a gradebook. Graduate teaching assistants compiled the final raw scores to determine class mean in an excel document, excluding non-subject scores (students who did not return a signed consent form). The graduate teaching assistants replaced all subject names with an identification number for the researcher's ability to track individual subject's scores across the scope of the study. At the end of the semester, all excel documents were emailed to the researcher for data analysis with a copy of each test and key. The subject's composite scores were analyzed to determine the statistical significance, if any, of the effect on student achievement resulting from the use and continued use of brain-compatible techniques in the university Aural Skills classroom. Upon completion of descriptive tests, a paired samples *t* test was conducted to determine the significance between control group's composite test scores, pre-test/mid-term/post-test, as well as between the treatment group's composite pre-test/mid-term/post-test scores.

Because a pre-test/post-test control group study requires unbiased pre-test data, training did not begin until three weeks into the spring semester and after the course's first assessment, which was used as the baseline pre-test data.

After the subjects took a pre-test, the training intervention was administered to the graduate teaching assistants who were teaching the treatment classes. The strategies were implemented with the course material in the next instructional sequence. The subjects completed a mid-term and a post-test. The Classroom's composite test scores from the post-test was used to record student achievement.

Data Analysis

The data was used to determine the statistical significance, if any, of the effects of research-based brain-compatible teaching strategies that promote novelty, student engagement, and scaffolding success on student achievement during one semester in a university Aural Skills classroom.

Measures

The following analyses were conducted: (a) Anderson-Darling Normality test; (b) Levene's homogeneity of variance test; (c) a *t* test for dependent samples in order to determine significant difference between the mean of the control and treatment groups; (d) a paired samples *t* test between control group's three test scores; (e) a paired samples *t* test between the treatment group's three test scores; (f) observations and field notes were gathered to provide a baseline for comparison of pre and post data of the treatment classrooms using the training strategies. After establishing normalcy with an Anderson-Darling Normality test, a *t* test for dependent samples was run in order to determine significant difference between the mean of the control and treatment groups.

The graduate teaching assistants in the treatment classrooms continued their use of brain-compatible strategies in the university Aural Skills classroom throughout the remainder of the semester and subject's Aural Skills test scores were analyzed. The researcher used a paired samples *t* tests to track student achievement within groups. This measure supported the researcher's statistical data with the long-term effects on the implementation that occurred. The final form of statistical assessment for the second research questions was used on the pre-implementation/post-implementation test scores gathered from each subject in the study. This data was used to determine the statistical significance, if any, of the effects of the teaching strategies on student achievement during one semester in a university Aural Skills classroom. The use of descriptive statistics provided 1) normality scores via the Anderson-Darling Normality test, 2) Levene's homogeneity of variance test, and 3) standard deviations of test scores from each Aural Skills class. A paired samples *t* test was conducted to determine the significance between control group's three test scores, pre-test/mid-term/post-test, as well between the treatment group's pre-test/mid-term/post-test scores.

Assumptions of *t* test Analyses

Andy Field, author of *Discovering Statistics Using SPSS* (3rd ed) restates the importance of checking the following assumptions before running the *t* test analyses. "Both the independent *t*-test and the dependent *t*-test are parametric tests based on the normal distribution. Therefore they assume:

- The sampling distribution is normally distributed. In the dependent *t*-test this means that the sampling distribution of the differences between scores should be normal, not the scores themselves.
- Data are measured at least at the interval level.

Additional Assumptions for the Independent t-test

- Variances in these populations are roughly equal (homogeneity of variance)
- Scores are independent because they come from different people." (2009)

Strengths and Weakness

The purpose of an experimental design is to employ a method to describe the relationship between variables or to predict an outcome (Campbell & Stanley, 1963). This study used *t* tests to analyze pre-test and post-test scores to determine significance and paired sample *t* test for between groups significance between the pre-test, mid-term and post-test scores. Campbell and Stanley (1963) argue that experimental pre-test/post-test designs are the top recommended designs in the methodological literature. The internal threats of history, maturation, testing, instrumentation, statistical regression, selection, mortality and interaction of selection and maturation are all controlled in this design. Due to the nature of the control/treatment Aural Skills courses occurring at the same time and days for both groups, intersession history was also controlled as required for this design (Campbell & Stanley, 1963). Maturation and testing were controlled because both groups had the same assessment given on the same day and time. Instrumentation was controlled as the assessments were jointly planned by all graduate teaching assistants in order to insure content and assessments were equal. "Regression is controlled as far as mean differences are concerned," affirm Campbell & Stanley (1963, p. 15) because "no matter how extreme the group is on pretest scores," if both treatment and control groups are randomly assigned they all have equal opportunity to be from the same extreme pool. Selection was ruled out as a internal validity threat since placement in the course section was randomized. To address mortality issues, if a student was absent the day of a test in either the control or treatment group, or test results were inflated with extra credit scores (as was the case in this study) the researcher randomly selected and removed a student's score from the opposite group.

Campbell and Stanley's introduction to *Experimental and Quasi-experimental Designs in Research* (1963) suggest that if the experiment uses regular classroom examinations as data (as this study did) then no undesirable interaction of testing and the treatment would be present. The researcher used normal testing procedures from three levels of Aural Skills courses, Aural Skills I, II and III, to counteract this external threat to the validity. Additionally, the researcher suggests other universities replicate this study (see final discussion chapter).

Summary

This chapter presented a description of the methodology used in this quasi-experimental design study. These include: the research questions and corresponding null hypotheses, the selected research design, strengths and weakness of chosen design, the sample framework and setting of the study, the sampling procedures and techniques, the timeline for the study, the pilot study of training program and subsequent changes made to training program, the study's procedures, the test data analysis, and a desciption of the graduate teaching assistants training program.

Chapter 4 - Presentation of Data Results

The research topic for this dissertation was the effect of implementing brain-compatible teaching strategies in the university Aural Skills classroom on student achievement, specifically the use of creating novelty, enhancing student engagement, and scaffolding success moments. The research question was: "What are the effects of research-based brain-compatible teaching strategies that promote novelty, student engagement, and scaffolding success on student achievement during one semester in a university Aural Skills classroom?" The framework of this study was to use Caine, Caine, McClintic and Klimek (2005) brain/mind learning principles and Jensen's (1997) Brain-compatible Approach to Learning in Aural Skills classes.

A second research question used to observe longitudinal effects was: "Is there a difference in student achievement over a period of a semester with continual enhancement of novelty, student engagement, and scaffolding success strategies?" The analysis of the within groups test scores provided data for this question. This chapter includes the description of the sample, missing data and its effect, overview of statistical procedures, assumptions, research question one and two results and a summary.

Descriptives

Students in this study were enrolled in either Aural Skills I, II or III. There were 79 total subjects in the study, and four participant graduate teaching assistants who were providing the instruction in the classes. The gender of the students was not collected in the data. Total class sizes in Aural Skills I was thirty-three, with fifteen subjects in Graduate Teaching Assistant's 1 class and eighteen subjects in Graduate Teaching Assistant's 2. Total class size in Aural Skills II was twenty-one, with nine subjects in Graduate Teaching Assistant's 3 class and twelve subjects in Graduate Teaching Assistant's 4. Total class size in Aural Skills III was twenty-eight, with fifteen subjects in Graduate Teaching Assistant's 1 class and thirteen subjects in Graduate Teaching Assistant's 2.

Missing Data

After entering data into the computer for analysis, the researcher determined if there were errors in the data or missing data. D. George and P. Mallery (2001) stipulate the research must atone how missing data and errors were handled for an accurate interpretation of the results.

Errors can occur when subjects score outside the range for variables, for example, scoring a zero, there are missing scores, or students were absent during a testing day. Upon review of test data, the most glaring event that resulted in missing data was the control graduate teaching assistants added extra credit points to their subjects' test scores, perhaps due to compensatory rivalry. This was not a stipulation allowed in the methodology and has caused a methodology fail in the overall research project. Due to the discovery of score inflation in the control classrooms, the researcher requested that all subject tests be regathered even those that had already been distributed back to the control classes to determine which points were given for extra credit and which were not. The subjects' tests had the names removed prior to the researcher's review of the primary documents and upon review, all test scores that did not have an accurate reading without the inflation of extra credit points were removed from the data sets. As the IRB consent form stipulates subject's confidentiality, the researcher was unable to personally ask the control subjects to resubmit the primary documents of the tests. Therefore, the researcher could only use the documents gathered by the graduate teaching assistants and could not ask individual subjects to resubmit their tests for score verification. The Aural Skills III control class only returned four primary documents for test 1 (pre-test) and eight primary documents for test 2 (mid-term), causing the sample size for the *t*-tests to appear skewed from the normality test. The Aural Skills II control class only returned four primary documents for test 1 (pre-test) and five primary documents for test 2 (mid-term), also causing the sample size for the *t* test to appear skewed from normality test. After realizing that the control graduate teaching assistants were inflating their subjects' scores in a potential compensatory rivalry, the post-test data was cleaned of all extra credit scores by the researcher. The researcher gathered all final test copies, with names removed, and removed all the inflated points given to the control subjects before the tests were returned to them.

Effect of Missing Data on Results

In respect to the use of a *t* test for data analysis, Northwestern's online Statguide confirms that if the number of paired differences is small, it may be difficult to detect assumption violations. With small samples, violation assumptions such as nonnormality are difficult to detect even when they are present. Also, with small sample size(s) there is less resistance to outliers, and less protection against violation of assumptions (PROPHET StatGuide, 1996, para. 20). Also even if none of the test assumptions are violated, a *t* test with small sample sizes may not have sufficient power to detect a significant departure from 0 of the mean of the paired differences, even if this is in fact the case. Therefore, if a statistical significance test with small sample sizes produces a surprisingly non-significant p-value, then a lack of power may be the reason. “A test's power is the probability of correctly rejecting the null hypothesis when it is false. The test's power is influenced by the choice of significance level for the test, the size of the effect being measured, and the amount of data available.” (Ellis, 2010, p. 52) Lastly, the overuse of the same form of analysis causes the strength of the *t* test to weaken.

Six missing values, comprised from scores with inflated extra credit points, were identified in the Aural Skills I pre-test. These missing values constituted 35% of the data set, therefore the mean scores of all other subjects for the affected variable replaced these six missing values. Two missing values, comprised from scores with inflated extra credit points, were identified in the Aural Skills I mid-term. These missing values constituted 11.7% of the data set, therefore; the mean scores of all other subjects for the affected variable replaced these two missing values. All values were viable in the post-test mean scores data.

Eight missing values, comprised from scores with inflated extra credit points, were identified in the Aural Skills II pre-test. These missing values constituted 66.6% of the data set, therefore; the mean scores of all other subjects for the affected variable replaced these eight missing values. Seven missing values, comprised from scores with inflated extra credit points, were identified in the Aural Skills II mid-term. These missing values constituted 58% of the data set, therefore; the mean scores of all other subjects for the affected variable replaced these seven missing values strongly weakening the implication of the p-value’s significance and power. All values were acceptable in the post-test mean scores data.

Nine missing values, comprised from scores inflated with extra credit points, were identified in the Aural Skills III pre-test. These missing values constituted 69% of the data set, therefore; the mean scores of all other subjects for the affected variable replaced these nine missing values. Five missing values, comprised from scores inflated with extra credit points, were identified in the Aural Skills III mid-term. These missing values constituted 38% of the data set, therefore; the mean scores of all other subjects for the affected variable replaced these five missing values. All values were viable in the post-test mean scores data.

Overview of Statistical Procedures

Setting a significance level provides a reflection of the maximum risk acceptable in any observed difference that is due to chance. Cresswell (2008) states that in the field of education the significance level is set at .05. This significance level is indicated in the p-value which is the probability (p) that a result could have been produced by chance if the null hypothesis were true. This means that five out of one hundred times (an extremely low probability value) a dependant variable will actually be observed if the null hypothesis is true. When the critical region (area on the normal curve for low probability values if the null hypothesis is true) for rejection of the null hypothesis is divided into two areas at the tails of the sampling distribution, the result is a two-tailed test of significance (Vogt, 1999). In case of this study, the dependent variable is the student achievement score.

In order to provide a detailed understanding of the methodology used with gathering assessment data, the researcher adhered to the following steps. During the first six weeks of the semester, the graduate teaching assistants were encouraged to teach their courses with no change in manner from previous semesters. The researcher observed one session taught by each graduate teaching assistant to gather baseline observation data. The first assessment of the semester was distributed, and scores were submitted to the researcher to use as pre-test data with the following results (See Table 4). Throughout the analysis of the Classroom averages, the subjects test scores were figured by taking the number of points earned divided by the total number of points in the pre-test and recording the number as a percent out of one hundrend. The Standard Deviation spread is always based on the mean percentage, not number of points earned.

Table 4.1

Test 1 (Pre-Test)

Classroom	Course	Average Percent	Standard Deviation
Classroom A	Aural Skills I	90.2	0.06876
Classroom B	Aural Skills I	93.5	0.07301
Classroom C	Aural Skills II	88.3	0.04655
Classroom D	Aural Skills II	81.6	0.20686
Classroom E	Aural Skills III	85.9	0.07485
Classroom F	Aural Skills III	86.5	0.09434

After the first assessment was given by all graduate teaching assistants to the subjects, the researcher met with graduate teaching assistants 1 and 3 to inform them that they were selected, via a coin toss, to be the treatment graduate teaching assistants in the study, both attended the training weekend sessions. Graduate teaching assistants 2 and 4 were instructed to continue teaching in a similar manner as before to maintain a viable control group. The window for initial implementation was short for graduate teaching assistants 1 and 3, as the next assessment was only four weeks away from the first test of the semester. However, the treatment subjects began receiving the brain-based strategies promptly and the researcher observed all graduate teaching assistants teaching their respective courses before the second assessment of the semester (See Table 5).

Table 4.2

Test 2 (Mid-Term)

Classroom	Course	Average Percent	Standard Deviation
Classroom A	Aural Skills I	84.5	0.08268
Classroom B	Aural Skills I	95.5	0.06023
Classroom C	Aural Skills II	89.5	0.04187
Classroom D	Aural Skills II	79.6	0.13361
Classroom E	Aural Skills III	89.5	0.05524
Classroom F	Aural Skills III	93.0	0.06789

The final assessment of the study was also used as post-test data from the semester. Graduate teaching assistants 1 and 3 now had eight weeks to implement the brain-based strategies and the researcher had observed all four graduate teaching assistants teaching their respective courses before the final assessment. The subjects' scores were again aggregated and compared (See Table 6).

The collected data from the overarching research question and second question are provided in this chapter. The first two research questions were answered using quantitative analysis.

Table 4.3

Test 3 (Post-Test)

Classroom	Course	Average Percent	Standard Deviation
Classroom A	Aural Skills I	82.6	0.10540
Classroom B	Aural Skills I	88.2	0.11525
Classroom C	Aural Skills II	84.8	0.10402
Classroom D	Aural Skills II	80.5	0.08319
Classroom E	Aural Skills III	83.0	0.09541
Classroom F	Aural Skills III	92.8	0.10772

Research Question 1

What are the effects of research-based brain-compatible teaching strategies that promote novelty, student engagement, and scaffolding success on student achievement during one semester in a university Aural Skills classroom?

Following the quasi-experimental design with a pre-test/post-test, the current chapter first presents the results of statistical analyses carried out by the researcher using the collected quantitative data. Subsequent to the careful collection and coding of data, and the entry into minitab, pre-test mean scores were calculated for the dependent variable of student achievement on the pre-tests. Classroom A represents the Aural Skills I treatment classroom and Classroom B represents the control classroom. Descriptive statistics related to mean and the additional key factor of standard deviation are included in table 7. Using two-tailed *t* test the averages of the final percentages were examined from the pre-test, mid-term and post-test.

A Levene's test run on the viable pre-test data found that the assumption of homogeneity of variance was met, p = .76; therefore a two-tailed independent samples *t* test based on equal variances was carried out. No significant testing difference in student achievement averages were found in the pre-test $t(17) = -0.90$, $p = 0.38$, ($p < .05$), 95%CI (-0.125236, 0.050283). The results from the pre-test suggest that subjects in the treatment group ($M = .9025$; $SD = 0.068$) scored lower than the subjects in the control group ($M = .935$; $SD = 0.07301$). The size of the effect ($r = 0.213$), as indicated by Cohen's (1988, 1992) coefficient *r* was found to be slightly above the convention for a small effect ($r = .10$); therefore only 1% of the total variance is explained from this significance statistic. It is important to note Cohen's coefficient *r* the effect size, while showing small to medium effects are in correlation with the small sample size. This is not a true indication of the results from the complete sample population, for the test was only run on non-inflated data.

A Levene's test on the viable mid-term data from the control and treatment classrooms found that the assumption of homogeneity of variance was met, p = .343; therefore a two-tailed independent samples *t* test based on equal variances was carried out. A significant testing difference in student achievement averages were found in the mid-term $t(28) = 4.14$, $p = 0.001$, ($p < .05$), 95%CI (0.055346, 0.163554). The results from the mid-term suggest that subjects in the treatment group ($M = .8457$; $SD = 0.0827$) scored a lower mean then the subjects in the control group ($M = .9551$; $SD = 0.0602$). The size of the effect ($r = 0.616$), as indicated by Cohen's (1988, 1992) coefficient *r* was found to be slightly above the convention for a large effect ($r = .50$); therefore 25% of the total variance is explained from this significance statistic. A Levene's test run on all post-test data found that the assumption of homogeneity of variance was met, p = .76; therefore a two-tailed independent samples *t* test based on equal variances was carried out. No significant testing difference in student achievement averages were found in the post-test $t(30) = 1.42$, $p = 0.165$, ($p < .05$), 95%CI (-0.024543, 0.137148). The results suggest that subjects in the treatment group ($M = .827$; $SD = 0.105$) scored slightly lower in mean scores then the subjects in the control group ($M = .883$; $SD = 0.115$). The size of the effect ($r = 0.250$), as indicated by Cohen's (1988, 1992) coefficient *r* was found to be slightly above the convention for a small effect ($r = .10$); therefore only 1% of the total variance is explained from this significance statistic (See Table 7).

Classroom C represents the Aural Skills II treatment classroom and Classroom D represents the control classroom. Descriptive statistics related to mean and the additional key factor of standard deviation are included in table 8. Using two-tailed *t* test the averages of the final percentages were examined from the pre-test, mid-term and post-test.

Table 4.4

t-test Results for Aural Skills I

Classrooms A vs. B	Mean	Standard Deviation	Standard Error of Mean	P-Value
Pre-Test A	90.25%	0.0688	0.018	0.380
Pre-Test B	93.5%	0.07301	0.047	
Mid-Term A	84.57%	0.0602	0.021	0.001
Mid-Term B	95.51%	0.0827	0.016	
Post-Test A	82.7%	0.105	0.028	0.165
Post-Test B	88.3%	0.115	0.027	

[1.] Classroom A is Treatment Classroom & Classroom B is the Control Classroom.

To find the assumption of homogeneity of variance, a Levene's test from viable pre-test data was run and revealed homogeneity was not met, p = .006; therefore a two-tailed independent samples *t*-test based on unequal variances was carried out. A significant testing difference in student achievement averages were found in the pre-test $t(3) = 0.65$, $p = 0.006$, ($p < .05$), 95%CI (-0.265115, 0.400582). These results suggest that subjects in the treatment group scores are significantly higher than the subjects in the control group.

Again, a Levene's test on the viable mid-term data found that the assumption of homogeneity of variance was not met, p = .006; therefore a two-tailed independent samples *t* test based on unequal variances was carried out. No significant testing difference in subjects' achievement averages were found in the mid-term $t(4) = 1.61$, $p = 0.127$, ($p < .05$), 95%CI (-0.071563, 0.269154). These results suggest that subjects in the treatment group scored slightly higher in mean scores then the subjects in the control group.

On the final data point, a Levene's test found that the assumption of homogeneity of variance was met, p = .406; therefore a two-tailed independent samples *t* test based on equal variances was carried out. No significant testing difference in student achievement averages were found in the post-test $t(19) = 1.05$, $p = 0.305$, (p < .05), 95%CI (-0.042425, 0.128383). These results suggest that subjects in the treatment group scored slightly higher in distribution with the subjects in the control group (See Table 8).

Table 4.5

t-test Results for Aural Skills II

Classrooms C vs. D	Mean	Standard Deviation	Standard Error of Mean	P-Value
Pre-Test C	88.3%	0.04655	0.016	0.006
Pre-Test D	81.6%	0.20686	0.10	
Mid-Term C	89.5	0.04187	0.014	0.127
Mid-Term D	79.6	0.13361	0.060	
Post-Test C	84.8%	0.104	0.035	0.305
Post-Test D	80.53%	0.0832	0.024	

[1.] Classroom C is Treatment Classroom & Classroom D is the Control Classroom.

The size of the effect in the Aural Skills II pre-test (*r* = 0.351), as indicated by Cohen's (1988, 1992) coefficient *r* was found to be at the convention for a medium effect (*r* = .30); the mid-term data shows an effect (*r* = 0.627), which is slightly above the convention for a large effect (*r* = .50); and the post-test data (*r* = 0.234), which is slightly above the convention for a small effect (*r* = .10). Therefore 9% of the total variance is explained from this significance statistic for the pre-test in correlation with the small sample size, 25% for the mid-term in correlation with the small sample size only 1% of the total variance is explained from this significance statistic on the post-test from the full sample size.

Classroom E represents the Aural Skills III treatment classroom and classroom F represents the control classroom. Descriptive statistics related to mean and the additional key factor of standard deviation are included in table nine. Using two-tailed *t* test the averages of the final percentages were examined from the pre-test, mid-term and post-test.

A Levene's test from viable data found that the assumption of homogeneity of variance was met, p = .739, p = .584, p = .629; respectively; therefore two-tailed independent samples *t* tests based on equal variances was carried out for the pre-test, mid-term and post-test. Regarding the pre-test, no significant testing difference in subject achievement averages were found $t(16) = -0.12$, $p = 0.906$, ($p < .05$), 95%CI (-0.100147, 0.089433). The results from the pre-test suggest that subjects in the treatment group scored slightly lower than the subjects in the control group. A propos the mid-term test, no significant testing difference in subject achievement averages were found $t(20) = -1.32$, $p = 0.202$, ($p < .05$), 95%CI (-0.090489, 0.020394). These results suggest that subjects in the treatment group scored lower in mean scores than the subjects in the control group. In contrast a significant testing difference in student achievement averages were found in the post-test $t(25) = -2.51$, $p = 0.019$, ($p < .05$), 95%CI (-0.178713, -0.017672). The results from the post-test suggest that subjects in the treatment group scored a lower mean than the subjects in the control group.

Table 4.6

t-test Results for Aural Skills III

Classrooms E vs. F	Mean	Standard Deviation	Standard Error of Mean	P-Value
Pre-Test E	85.9%	0.0748	0.020	0.906
Pre-Test F	86.5%	0.0943	0.047	
Mid-Term E	89.5%	0.0552	0.015	0.202
Mid-Term F	93%	0.0679	0.024	
Post-Test E	83%	0.0954	0.025	0.019
Post-Test F	92.8%	0.108	0.030	

[1.] Classroom E is Treatment Classroom & Classroom F is the Control Classroom.

Pursuant to the research question 1, the null hypothesis that follows was tested:
H_o: The implementation of brain-compatible strategies had no effect on the student achievement results in the university Aural Skills classroom.

Based on statistical analysis the null hypothesis was maintained for Aural Skills Classes I and II and could be rejected for Aural Skills Class III in that a significant difference was found between the dependent variable (student achievement), the percentage of the pre-test scores and the percentages of the post-test scores in Aural Skills III. However, due to the small sampling size, the researcher believes a complete rejection of the null hypothesis is premature. A more robust sample size is needed.

Research Question 2

Is there a difference in student achievement over a period of a semester with continual enhancement of novelty, student engagement, and scaffolding success strategies?

Subsequent to the careful collection and coding of data, and the entry into minitab, normality was calculated for the within groups variables of pre-test, mid-term and post-test, as well as Cohen's coefficient to determine effect size. These statistics related to student achievement and additional key factors which influence significance are included in tables 10-17.

Aural Skills I – Treatment Subject's Within Group Testing

Aural Skills I (aka Classroom A) was taught by graduate teaching assistant 1, who instructed the treatment subjects. In many statistical tests, such as the *t* test, the assumption is made that the sampling distribution is normally distributed and if this assumption is not met, then the logic behind the hypothesis testing is flawed. When Classroom A's assumptions were checked for normalcy with the Anderson-Darling Normality Test, the following results were noted that the mid-term scores $D(14) = 0.071$, $p < .05$, and the post-test scores, $D(14) = 0.621$, $p < .05$, were significantly normal. The pre-test score $D(14) = 0.012$, $p < .05$, was non-normally distributed. The pre-test needed outliers removed.

Table 4.7

Anderson-Darling Normality Test

	P-Value
Pre-Test	0.012
Mid-Term	0.071
Post-Test	0.621

Data Transformations of Pre-Test Scores

Using dependent samples *t* test the combinations of the treatment subject's variable student achievement scores were examined. A two-tailed paired sample *t* test found significant difference between the pre-test ($M = .902$, $SD = 0.68$) to the mid-term ($M = .845$, $SD = 0.082$) for Classroom A's achievement scores, $t(15) = 4.31$, $p = 0.001$, ($p < .05$), $r = .76$. The coefficient *r* was found to be slightly above the convention for a large effect ($r = .50$); therefore 25% of the total variance is explained from this significance statistic (See Table 11).

Table 4.8

Treatment Subjects in Aural Skills I: Paired t test Pre-Test, Mid-term

Classroom A's Within Group Analysis	n	Mean	Standard Deviation	P-Value
Pre-Test	15	90.2%	0.068757	0.001
Mid-Term	15	84.5%	0.082683	

A two-tailed paired sample *t* test found no significant difference between the mid-term to the post-test for Classroom A's achievement, $t(14) = 0.63$, $p = 0.504$, ($p < .05$), $r = .18$. The coefficient *r* was found to be slightly above the convention for a small effect ($r = .10$); therefore 1% of the total variance is explained from this significance statistic (See Table 12).

Table 4.9

Treatment Subjects in Aural Skills I: Paired t test Mid-term, Post-Test

Classroom A's Within Group Analysis	n	Mean	Standard Deviation	P-Value
Mid-Term	14	84.5%	0.082683	0.504
Post-Test*	14	82.6%	0.105401	

*For the post-test data the zero outlier was removed.

A two-tailed paired sample *t* test found significant difference between the pre-test and the post-test for Classroom A's achievement, $t(14) = 2.33$, $p = 0.036$, ($p < .05$), $r = .56$. The coefficient *r* was found to be slightly above the convention for a large effect ($r = .50$); therefore 25% of the total variance is explained from this significance statistic (See Table 13).

Table 4.10

Treatment Subjects in Aural Skills I: Paired t test Pre-Test, Post-Test

Classroom A's Within Group Analysis	n	Mean	Standard Deviation	P-Value
Pre-Test	14	90.2%	0.068757	0.036
Post-Test	14	82.6%	0.105401	

Pursuant to the research question two, the null hypothesis that follows was tested:

H_o: There is no difference in student achievement over a semester with the continual enhancement of novelty, student engagement, and scaffolding success strategies.

Based on statistical analysis the null hypothesis could be rejected in the Aural Skills I class that significant difference was found between continual implementation of brain-compatible strategies, comparing the percentage of the pre-test scores to mid-term scores, and the pre-test scores to the post-test scores. However, due to the small sampling size, the researcher believes a complete rejection of the null hypothesis is premature. A more robust sample size is needed. The mean scores between the pre-test to mid-term and pre-test to post-test decreased, indicating that student achievement in the classroom is slipping, rather then growing. Regarding the mid-term to post-test, the mean scores also decreased however the null is retained as it is showing no significant difference was found between the mid-term scores to the post-test scores of the treatment subjects.

Aural Skills III – Treatment Subjects' Within Group Testing

Aural Skills III (aka Classroom E) was also taught by gradaute teacher 1. When Classroom E's assumptions were checked for normalcy with the Anderson-Darling Normality Test, the following results were noted that none of the test scores were normally distributed. The pre-test scores $D(13) = 0.478$, $p < .05$, the mid-term scores $D(13) = 0.437$, $p < .05$, and the post-test scores, $D(13) = 0.622$, $p < .05$, were all significantly normal.

Table 4.11

Anderson-Darling Normality Test

	P-Value
Pre-Test	0.478
Mid-Term	0.437
Post-Test	0.622

Subsequent to the careful collection and coding of data, and the entry into minitab, normality was calculated for the within groups variables of pre-test, mid-term and post-test, as well as Cohen's coefficient to determine effect size. A two-tailed paired sample *t* test found significant difference between the pre-test to the mid-term for Classroom E's achievement scores, $t(13) = -2.90$, $p = 0.013$, ($p < .05$), $r = .62$. The coefficient r was found to be slightly above the convention for a large effect ($r = .50$); therefore 25% of the total variance is explained from this significance statistic. Upon analysis of the mid-term to post-test student achievment scores, a two-tailed paired sample t test found significant difference between the mid-term to the post-test for Classroom E's achievement scores, $t(13) = 3.97$, $p = 0.002$, ($p < .05$), $r = .74$. The coefficient r was found to be above the convention for a large effect ($r = .50$); therefore 25% of the total variance is explained from this significance statistic. Conversely, a two-tailed paired sample t test found no significant difference between the pre-test to the post-test for Classroom E's achievement scores, $t(13) = 1.89$, $p = 0.082$, ($p < .05$), $r = .46$. The coefficient r was found to be slightly above the convention for a medium effect ($r = .30$); therefore 9% of the total variance is explained from this significance statistic. These statistics related to student achievement and additional key factors which influence significance are included in tables 15-17.

Table 4.12

Treatment Subjects in Aural Skills III: Paired t test Pre-Test, Mid-Term

Classroom E's Within Group Analysis	n	Mean	Standard Deviation	P-Value
Pre-Test	14	85.9%	0.074845	0.013
Mid-Term	14	89.57%	0.055237	

Table 4.13

Treatment Subjects in Aural Skills III: Paired t test Mid-Term, Post-Test

Classroom E's Within Group Analysis	n	Mean	Standard Deviation	P-Value
Mid-Term	14	89.57%	0.055237	0.002
Post-Test	14	83%	0.095405	

Table 4.14

Treatment Subjects in Aural Skills III: Paired t-test Pre-Test, Post-Test

Classroom E's Within Group Analysis	n	Mean	Standard Deviation	P-Value
Pre-Test	14	85.9%	0.074845	0.082
Post-Test	14	83%	0.095405	

Pursuant to the research question two, the null hypothesis that follows was tested:

H_o: There is no difference in student achievement over a semester with the continual enhancement of novelty, student engagement, and scaffolding success strategies.

Based on statistical analysis the null hypothesis was could be rejected in the Aural Skills III class that significant difference was found between continual implementation of brain-compatible training, comparing the percentage of the pre-test scores to mid-term scores, and the mid-term to the post-test scores, however due to the small sampling size, this is a premature rejection of the null. Especially as the mean scores between the pre-test to mid-term and mid-term to post-test actually decreased. Regarding the pre-test to post-test, the mean scores also decreased; however the null could be retained showing no significant difference was found between the pre-test scores to the post-test scores of the treatment class.

Aural Skills II – Treatment Subject's Within Group Testing

Aural Skills II (aka Classroom C) was taught by graduate teaching assistant 3 who also received the training. When Classroom C's assumptions were checked for normalcy with the Anderson-Darling Normality Test, the following results were noted that the pre-test scores $D(8) = 0.818$, $p < .05$, and post-test scores $D(8) = 0.512$, $p < .05$, were normally distributed. The mid-term score, $D(8) = 0.014$, $p < .05$, was significantly non-normal. The mid-term scores needed outliers removed (See Table 18).

Table 4.15

Anderson-Darling Normality Test

	P-Value
Pre-Test	0.818
Mid-Term	0.014
Post-Test	0.512

Data Transformation and Analysis of Mid-Term for Classroom C

Using dependent samples *t* test the combinations of the treatment subjects' variable (student achievement) scores were examined. Normality was calculated for the within groups variables of pre-test, mid-term and post-test, as well as Cohen's coefficient to determine effect size. A two-tailed paired sample *t* test found no significant difference between the pre-test to the mid-term for Classroom C's achievement scores, $t(8) = -0.64$, $p = 0.538$, ($p < .05$), $r = .22$. The coefficient *r* was found to be slightly above the convention for a small effect ($r = .10$); therefore only 1% of the total variance is explained from this significance statistic. A two-tailed paired sample *t* test also found no significant difference between the mid-term to the post-test for Classroom C's student achievement scores, $t(8) = 1.60$, $p = 0.149$, ($p < .05$), $r = .49$. The coefficient *r* was found to be slightly above the convention for a medium effect ($r = .30$); therefore 9% of the total variance is explained from this significance statistic. Not unlike the two previous data points, a two-tailed paired sample *t* test found no significant difference between the pre-test to the post-test for Classroom C's student achievement scores, $t(8) = 1.46$, $p = 0.182$, ($p < .05$), $r = .45$. Again, the coefficient *r* was found to be slightly above the convention for a medium effect. These statistics related to student achievement and additional key factors which influence significance are included in tables 19-21.

Table 4.16

Treatment Subjects in Aural Skills II: Paired t test Pre-Test, Mid-term

Classroom C Within Group Analysis	n	Mean	Standard Deviation	P-Value
Pre-Test	9	88.3%	0.046547	0.538
Mid-Term	9	89.5%	0.041866	

Table 4.17

Treatment Subjects in Aural Skills II: Paired t test Mid-term, Post-Test

Classroom C Within Group Analysis	n	Mean	Standard Deviation	P-Value
Mid-Term	9	89.5%	0.041866	0.149
Post-Test	9	84.8%	0.104021	

Table 4.18

Treatment Subjects in Aural Skills II: Paired t test Pre-Test, Post-Test

Classroom C Within Group Analysis	n	Mean	Standard Deviation	P-Value
Pre-Test	9	88.3%	0.046547	0.182
Post-Test	9	84.8%	0.104021	

Pursuant to the research question two, the null hypothesis that follows was tested: H_o: There is no difference in student achievement over a semester with the continual enhancement of novelty, student engagement, and scaffolding success strategies.

Based on statistical analysis the null hypothesis was maintained in the Aural Skills II class that no significant difference was found between continual implementation of brain-compatible strategies, comparing the percentage of the pre-test scores to mid-term scores, the mid-term to the post-test scores and the pre-test scores to the post-test scores of the treatment class.

Observation Notes

The researcher's observational data noted the following information in the classrooms. Before training, all subjects were observed to being taught in a standard lecture manner. After the training, graduate teaching assistants 1 and 3 made all subjects responsible for their own learning. The researcher observed the graduate teaching assistants 1 and 3 calling on a variety of subjects, warning them to look at the problem and ask a neighbor for help, if needed, because anyone could be called to answer. Additional changes observed, post-training were when graduate teaching assistant 1 stopped demonstrating all the problems on the whiteboard and instead had the subjects go to the whiteboard and work in teams to solve problems. Graduate teaching assistant 1 also created games for review day capitalizing on the subjects' competitive drives to succeed and increased subject buy-in with an environmental change, by meeting at a near-by donut shop. Graduate teaching assistant 3 added the use of 30-second games and singing activities to the lessons and subjects acted more confident for the pressure of sight-singing during testing. Graduate teaching assistant 2 and 4 continued with lecture style of teaching throughout the semester. The researcher did observe graduate teaching assistant 2 increased the use of drill and practice at the end of the semester to prepare for the final assessment. And observed graduate teaching assistant 4 continued to use teacher-lead lessons, by completing the interval notation on the board while students passively watched and also continued to lecture for the entire class period.

Chapter 5 - Conclusions

A central focus of this research was to determine if the use of brain-compatible strategies used in the Aural Skills classroom affected student achievement. The research specifically intentified strategies that promote creating novelty, enhancing student engagement and scaffolding moments student success during lessons. The preliminary results of the study reveal a lack of effect on student achievement in this context. The researcher supports the findings as valuable for "Negative results do not make . . . the results less significant . . . . It means that the direction of . . . research should not be determined by the pressure to win the 'significance lottery,' but rather systematic, hypothesis-driven attempts to fill holes in our knowledge" (Matosin, et. al, 2014, p. 173).

The first part of this chapter addresses the data, based on the subjects' test results, which was affected by the implementation or lack of implementation of brain compatible teaching in the classrooms. It will discuss and interpret the identified factors affecting the study and relating them to previous research, state suggestions for a future study and how the study could be improved.

Research Question 1: What are the effects of research-based brain-compatible teaching strategies that promote novelty, student engagement, and scaffolding success on student achievement during one semester in a university Aural Skills classroom?

Based on statistical analysis the null hypothesis was maintained for Aural Skills Class I as the results suggest that the subjects in the treatment group score slightly lower in mean scores then the subjects in the control group. Additionally, the null hypothesis was maintained for Aural Skills Class II (Classrooms C & D) even though the results suggest that subjects in the treatment group scored slightly higher in distribution with the subjects in the control group. However, there was no statistical significance found between the pre and post-tests. The hypothesis could be rejected for Aural Skills Class III (Classrooms E & F) in that a significant difference was found between the dependent variable (student achievement) in the percentage of the pre-test scores and the percentages of the post-test scores, yet the results suggest that subjects in the treatment group scored a lower mean than the subjects in the control group. However, due to the small sampling size, the researcher believes a complete rejection of the null hypothesis is premature. A more robust sample size is needed.

Research Question 2: Is there a difference in student achievement over a period of a semester with continual enhancement of novelty, student engagement, and scaffolding success strategies?

Based on statistical analysis the null hypothesis could be rejected in the Aural Skills I (Classrooms A & B) that significant difference was found between continual implementation of brain-compatible training, comparing the percentage of the pre-test scores to mid-term scores, and the pre-test scores to the post-test scores; however the null is retained showing no significant difference was found between the pre-test scores to the mid-term scores of the treatment's class. Based on statistical analysis the null hypothesis was maintained in the Aural Skills II (Classrooms C & D) that no significant difference was found between continual implementation of brain-compatible strategies, comparing the percentage of the pre-test scores to mid-term scores, the mid-term to the post-test scores and the pre-test scores to the post-test scores of the treatment's class. Based on statistical analysis the null hypothesis could be rejected in the Aural Skills III (Classrooms E & F) that significant difference was found between continual implementation of brain-compatible training, comparing the the percentage of the pre-test scores to mid-term scores, and the mid-term to the post-test scores; however the null is retained showing no significant difference was found between the pre-test scores to the post-test scores of the treatment's class.

Results

This study was to test if the implementation of select brain-compatible strategies would indeed impact student achievement. Student achievement is delineated by the use of the treatment/control group approach with the treatment being the implementation of research-based brain-compatible instructional strategies in the university Aural Skills classroom. The pre-test/post-test results were analyzed between classes, or within groups to determine significance.

Aural Skills I Results: The difference between the 2 pre-tests indicate no significance difference, meaning that they are both equally distributed in high and low learners. The missing data, due to pulling scores that were inflated with additional points, did affect the pre-test results by 33% and there was a low variance noted from Cohen's coefficient *r*, less then 1%. So both classes could be determined as equally divided. The mid-term scores from test two was taken within the initial four weeks after graduate teaching assistant 1 received training. The mean scores from the mid-term were higher in comparison to graduate teaching assistant 2's class, indicating that the novelty of this teaching style did produce initial student achievement. The statistical significance of p = 0.001 supports this statement. The missing data was low, only 11% of the total scores would show effect from them, and there was a high coefficient r, indicating 25% of the variance in these scores is explained from the significance statistic. However, the spread of mean scores between the control classroom and the treatment classroom was growing, so while the treatment classroom (A) was improving, the control classroom (B) was improving at a faster rate without the influence of the techniques. The long-term effects on the Aural Skills I student achievement are not shown with statistical significance, $p = 0.165$, yet the mean score gap between the two classrooms did decrease. So while the control classroom consistantly outscored the treatment classroom in the study, the treatment classroom (A) did begin to narrow the gap in scores, ending in a more similar mean spread as seen at the beginning of the semester. The researcher proposes the following items may have impacted the treatment classroom's overall acheivement. During the course of the semester, the exams were increased in difficulty level, the decreased use of brain-compatible teaching strategies and a gradual slide back to typical teaching of lecture and recitation or possibly as the subjects became more comfortable with novelty strategies used, it lost the power of enhancing student engagement. Additionally, the researcher did observe that graduate teaching assistant 2 conducted a drill & practice review session with Classroom B, training subjects to know exactly what would be on the final test, whereas graduate teaching assistant 1's review session of games and student-led question & answer activities in a new environment with Classroom A didn't accurately reflect the upcoming demands of the paper-pencil test.

> Many learners may actually know the material they are being tested on, but may not demonstrate it well during exam time. If they study under low stress, yet take an exam under high stress, their brain will not retrieve as much as if they study and take the exam both under moderate stress. Since its unlikely that an exam would be a low-stress experience, studying in that state is less useful. Role playing is most productive when the same physiological, emotional and mental states are rehearsed that will be in effect during the real situation. (Jensen, 1997, p. 42)

For example, graduate teaching assistant 2 lead a vigorous drill and practice style review in the classroom prior to the post-test, with the teacher asking the questions in a manner similar to the next day's test. While graduate teaching assistant 1 selected a novel location, a local donut shop, for the drill and practice session. This environment did not match the upcoming final exam's classroom environment.

Aural Skills II results: A Levene's test from viable pre-test data found that the assumption of homogeneity of variance was not met, p = .006; therefore a two-tailed independent samples *t*-test based on unequal variances was carried out. The difference between the two pre-tests indicate a significant difference of unequal variances, meaning that the two classrooms were not equally distributed in high and low learners. These results suggest that subjects in the treatment group scored significantly higher than the subjects in the control group. Therefore, the scores in the treatment classroom started higher then the control classroom and they maintained higher scores throughout the semester, the unequal distribution of the students in the data sets adds an additional variable to the study that was not addressed in the research. The missing data had a medium effect on the pre-test results about 32% and there was a small variance noted from Cohen's coefficient *r,* less than 9%.

The mid-term scores from test two was taken within the initial four weeks after graduate teaching assistant 3 received training. The mean scores for Classroom C's class were higher in comparison to Classroom D's, indicating that the novelty of this teaching style may have produced initial student achievement. However, the statistical significance of $p = 0.127$ does not support significance to this claim. The researcher noted the subjects in Classroom C started the testing period with a higher mean average and they maintained the advantage throughout the semester. However, it is important to note the missing data had a high effect on the mid-term results, 62% and there was a large variance noted from Cohen's coefficient *r* of 25%.

Tsang (2009) states that:

> "many clinical trials, for instance, have low statistical power to detect differences in adverse effects of treatments, since such effects are rare and the number of affected patients is very small. Different retrospective analyses can yield substantially different information. The appropriate approach, therefore, depends upon the goal of the analysis. Often the goal is simply to quantify our uncertainty in the findings of a study, in which case calculating a confidence interval about the observed effect size is the most straightforward approach. Sometimes the goal is to evaluate the ability of the study to detect a biologically meaningful pattern, for example to determine whether the study

meets a pre-specified target or to make comparisons between a number of different studies. In these cases calculating retrospective power (or detectable effect size) can be useful, depending upon how the analysis is done." (p. 610)

Aural Skills III results had no statistical significance at any level of testing. This may be resulting from a number of factors, (1) this was graduate teaching assistant 1's first semester to teach the course, (2) graduate teaching assistant 2's vigorous review session prior to the post-test, and (3) the effect of the missing data on the significance testing. This Aural Skills Class III results revealed that a significant difference was found in student achievement, although the mean percentage of the available pre-test scores and the mean percentages of the post-test scores in Aural Skills III leaned toward Classroom F's favor.

Conclusions

"Learning begins with defining vocabulary, mastering facts, skills and procedures using memorization and repetition. This kind of learning has a quality to it that provides a comforting degree of certainty." (Caine & Caine, 2005, p. 9) Subjects in the beginning level of Aural Skills needed to develop a solid foundation of the mastery of intervals, sight singing skills and dictation, these basic skills were more suited for rote teaching and mastery style tests. The results in this study's research support the use of paper-pencil tests for the Aural Skills I students, and the 30-second daily practice drills for the Aural Skills II students when determining effect. "In part, the brain does learn this way." (Caine & Caine, 2005, p. 9)

The researcher affirms that the generalizations from this study are specific to the setting of a pre-determined mid-American university's music department and shouldn't be assumed to other studies. The addition of extra credit points to the control subjects' test scores resulted in the study's methodology fail and minimizes the overall results of this study. It is important to note that retrospective analyses are no substitute for the proper planning of research (Cohen 1990). Only in the planning stages is it reasonable to change the sampling design, the α-level, or even to completely re-think the goals of the study. As such, the researcher did not change the research question to better reflect the data so the results would be viewed as positive. "Science is, by its nature, a collaborative discipline, and one of the principal reasons why we should report negative results is so our colleagues do not waste their time and resources repeating our findings" (Matosin, et. al, 2014, p. 172).

These results support the discussion provided in Gözüyesi and Dikici's research (2014) that indicates brain-compatible education can cause student achievement, yet the specific effects do not show statisical significance. "Negative findings are a valuable component of scientific literature because they force us to critically evaluate and validate our current thinking, and fundamentally move us towards unabridged science" (Matosin, et. al, 2014, p. 171). Goodchild van Hilten's 2015 blog affirms, "The academic community has developed a culture that overwhelmingly supports statistically significant, 'positive' results. Researchers themselves strive for these results and rush to publish them, leaving the 'failed' attempts in the dust" (https://www.elsevier.com/). By reporting these results, including the methodology fail, the body of knowledge toward the use of brain-based strategies in the classroom to support student achievement is enlarged.

The researcher notes the overuse of *t* tests in the study, and that the concern for a Type I error is quite high. However, as most of the current *t* tests p values are so far from .05 the odds of an ANOVA producing significant results are quite low. Conservation studies are, by their nature, often characterized by small sample sizes and high sampling variation. The appropriate use of power analysis and confidence interval estimation allows us to obtain the most information from our limited resources and to make an honest assessment of what our results do and do not tell us. Using standardized effect size measures avoids the need to specify the sampling variance, so the only information needed from the study is the sample size and α-level. The major disadvantage is that it is much harder to assess the biological significance of a standardized measurement.

Suggestions for Future Study

This research study is subject to a number of delimitations that were imposed by the research design and time constraints. From a quantitative perspective it is important to note that a lack of reliability existed from the use of graduate teaching assistant created tests for all three testing situations. The graduate teaching assistants, while jointly creating the tests, did not have the tests reviewed by the researcher or a team of experts to ensure that the instruments were both valid and reliable.

A major limitation to the study was the testing data received from the graduate teaching assistants was initially inflated by the control group and many scores had to be removed from the final analysis. The researcher should have ensured multiple graders complete the grading of each test, to achieve reliability in the test results. These areas of weakness that would need to be addressed before replications of this study would take place.

1. Lack of reliability with the use of graduate teaching assistant created tests
2. Low validity research of the tests
3. Methodology fail from the lack of control of the control teacher's giving extra credit points to subjects' scores.

Suggestions for Additional Research

"Applications to educational policy and practice will come later, after the kind of study that leads to greater understanding." (Sylwester, 1995, p. 23) Additionally, "negative results are just as useful as positive findings" (Farnelli, 2010, p. 5). In pursuit of additional reflection of this quasi-experimental design study, the researcher recommends nine areas of additional research.

1. Replicate the study in another university Aural Skills classroom, and focus the results on only one area of change, such as only novelty.
2. Replicate the study using the same pre- and post-test instead of two different exams.
3. Use a standardized exam to remove test validity and reliablity concerns.
4. Replicate the study in a larger or smaller university classroom that does not teach music, perhaps in a history classroom
5. Try the study again in an Aural Skills classroom yet use trained educators who have taught the course for more then five years.
6. Replicate the study in another university classroom, and limit the data to one Aural Skills course, not 3 to determine hypothesis more clearly, in a practical action approach where a likely cause and effect is established, but nothing is proven.
7. Include mentoring during the study to ensure that the treatment subjects don't exhaust all their initial novelty ideas, then stop implementing additional brain-compatible strategies in their teaching.
8. Use two forms of assessment within the study, standardized and authentic.
9. Replicate the study again with more information provided from the student responses. The researcher recommends extreme care be taken to remove compensatory rivalry.

Summary

Robert Sylwester writes, “Educators who are willing to study the new cognitive science developments, and then to imaginatively explore and experiment in their search for appropriate educational applications, will have to work out the specifics in the years ahead. If our profession doesn’t do it, nothing will happen. Things will remain as they are.” (Sylwester, 1995, p. 141) The purpose of this study was to test student achievement in the course of one semester while enrolled in an Aural Skills music classroom following the two frameworks Brain/Mind Learning Principles (2005 by Caine, Caine, McClintic and Klimek) and Jensen’s Brain-Compatible Teaching theory (1997). The researcher used a quasi-experimental design with a treatment and control group, gathering quantitative pre-test/post-test data from student assessments before and after the implementation of the strategies. Two graduate teaching assistants were put in a training program and trained on how to create novelty, perpetuate student engagement, and build levels of success and two graduate teaching assistants were left to continue with a lecture style of teaching. At the end of the study, the subjects’ composite test scores were examined to determine statisitcal significance of the treatment. The final results of this study are inconclusive, due to a methodology fail during the grading of the pre and post-tests. Preliminary findings indicate that academic gains were maintained within the control classes of Aural Skills I and III, and academic gains were maintained within the treatment class of Aural Skills II. The observation notes indicate to the value of drill and practice sessions that closely mimic the actual testing situation are valuable to students. The study is concluded with a discussion on methodological improvements necessary to provide reliable results within the bounds of educational research.

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Appendix A - Supervisor Letter of Consent

KANSAS STATE UNIVERSITY

INFORMED CONSENT

PROJECT TITLE: The Effects of Educational Neuroscience in the University Aural Skills classroom

APPROVAL DATE OF PROJECT*:* 2/01/2014 **EXPIRATION DATE OF PROJECT**: 5/16/2014

PRINCIPAL INVESTIGATOR: Dr. Jana Fallin

CO-INVESTIGATOR(S): Staci Horton

CONTACT NAME AND PHONE FOR ANY PROBLEMS/QUESTIONS: Dr. Fallin – jfallin@ksu.edu

PURPOSE OF THE RESEARCH: Upon your approval, your Aural Skills graduate teaching assistants (GTAs) will be invited to participate in a research study. The purpose of this study is to explore how experiencing brain-compatible teaching strategies in the university Aural Skills classroom effects student achievement.

PROCEDURES & LENGTH OF STUDY TO BE USED: For this study, your GTA's will be asked to take part in the following activities:

1. Interviews: They will be asked to participate in two interviews, each lasting about 1 hour - once in February, and once in March, each to be conducted in person.
2. Observations: The researcher would like to observe the GTAs three times in their classroom, observing instructional techniques only (not collecting data from students). Each observation will last for fifty minutes with the taking of minimal field notes.
3. Training Session: Your GTAs will be asked to participate in a training session. This session will provide techniques and discussion on brain-compatible teaching strategies that they can incorporate into their collegiate teaching.
4. Document review: The researcher would like to review classroom documents, such as lesson plans, instructional handouts, and test scores, no copies will be made of the documents; however,

the researcher will take notes on them. The researcher does not wish to collect any student documents.

There will be four participants in this study.

RISKS OR DISCOMFORTS ANTICIPATED: There are no foreseeable risks associated with this study.

BENEFITS ANTICIPATED: The benefits of participating in the study are both professional and personal. The research should add to the knowledge base about how to implement brain-compatible teaching for learning. The teachers who participate will have an opportunity to reflect on their practices, have professional dialogue about an important development in teaching and receive feedback about their attempts to use this new method.

EXTENT OF CONFIDENTIALITY: The methods for preserving confidentiality include: transcribing the tapes and destroying them by the end of August, 2014; keeping the tapes, transcripts, and documents in a safe and locked area for my eyes only. Data will be recorded with each teacher identified by a number code. There will be no link back to the teachers. The code will be destroyed by the end of August of 2014. Reports will be written in aggregate terms and with some individual responses described. The descriptions of the school and geographical area will be very broad, for example, a school in the Midwest. Subjects will not be identified in the report. In the report, the existing documents will not have identifiers attached.

The researcher has a security code on email that gives only the researcher access to it. Any email communication will be printed and deleted immediately. The printed copies will be used for research purposes only.

Interview transcripts, collected teacher documents and printed emails will be destroyed by the end of August 2014.

CONTACT NAME AND PHONE FOR ANY PROBLEMS/QUESTIONS: If you have questions at any time about the study or the procedures, you may contact the principal researcher, Dr. Jana Fallin at 785-532-7828, or by email at jfallin@ksu.edu.

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact the office for the University Research Compliance Office (URCO) Fairchild Hall, 785-532-3224 or by e-mail at comply@ksu.edu.

TERMS OF PARTICIPATION: I understand this project is research, and that my GTA's participation is completely voluntary. I also understand that if they decide to participate in this study, they may withdraw their consent at any time, and stop participating at any time without explanation, penalty, or loss of benefits, or academic standing to which they may otherwise be entitled.

I verify that my signature below indicates that I have read and understand this consent form, and willingly agree to allow my GTA's participate in this study under the terms described, and that my signature acknowledges that I have received a signed and dated copy of this consent form.

Supervisor's signature____

Investigator's signature______________________________________

Consent form date: January 10, 2014

Appendix B - Participant Letter of Consent

KANSAS STATE UNIVERSITY

INFORMED CONSENT

PROJECT TITLE: The Effects of Educational Neuroscience in the University Aural Skills classroom

APPROVAL DATE OF PROJECT*:* 2/01/2014 **EXPIRATION DATE OF PROJECT**: 5/16/2014

PRINCIPAL INVESTIGATOR: Dr. Jana Fallin

CO-INVESTIGATOR(S): Staci Horton

CONTACT NAME AND PHONE FOR ANY PROBLEMS/QUESTIONS: Dr. Fallin – jfallin@ksu.edu

PURPOSE OF THE RESEARCH: You are invited to participate in a research study. The purpose of this study is to explore how experiencing brain-compatible instructional strategies in the university Aural Skills classroom effects student achievement. The project is required for the completion of the doctorate of philosophy in curriculum and instruction with an emphasis on Music Education. All results will remain anonymous.

PROCEDURES & LENGTH OF STUDY TO BE USED: For this study, you will be asked to take part in the following activities:

1. Interviews: You will be asked to participate in two interviews, each lasting about 1 hour - once in February, and once in March, each to be conducted in person.
2. Observations: The researcher would like to observe you three times in your classroom, observing instructional techniques only (not collecting data from students). Each observation will last for fifty minutes with the taking of minimal field notes.
3. Training Session: You will be asked to participate in a training session. This session will provide techniques and discussion on brain-compatible teaching strategies that you can incorporate into your collegiate teaching.
4. Document review: The researcher would like to review classroom documents, such as lesson plans, instructional handouts, and test scores, no copies will be made of the documents; however,

the researcher will take notes on them. The researcher does not wish to collect any student documents.

There will be four participants in this study.

RISKS OR DISCOMFORTS ANTICIPATED: There are no foreseeable risks associated with this study.

BENEFITS ANTICIPATED: The benefits of participating in the study are both professional and personal. The research should add to the knowledge base about how to implement brain-compatible teaching for learning. The teachers who participate will have an opportunity to reflect on their practices, have professional dialogue about an important development in teaching and receive feedback about their attempts to use this new method.

EXTENT OF CONFIDENTIALITY: The methods for preserving confidentiality include: transcribing the tapes and destroying them by the end of August, 2014; keeping the tapes, transcripts, and documents in a safe and locked area for my eyes only. Data will be recorded with each teacher identified by a number code. There will be no link back to the teachers. The code will be destroyed by the end of August of 2014. Reports will be written in aggregate terms and with some individual responses described. The descriptions of the school and geographical area will be very broad, for example, a school in the Midwest. Subjects will not be identified in the report. In the report, the existing documents will not have identifiers attached.

The researcher has a security code on email that gives only the researcher access to it. Any email communication will be printed and deleted immediately. The printed copies will be used for research purposes only.

Interview transcripts, collected teacher documents and printed emails will be destroyed by the end of August 2014.

CONTACT NAME AND PHONE FOR ANY PROBLEMS/QUESTIONS: If you have questions at any time about the study or the procedures, you may contact the principal researcher, Dr. Jana Fallin at 785-532-7828, or by email at jfallin@ksu.edu.

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact the office for the University Research Compliance Office (URCO) Fairchild Hall, 785-532-3224 or by e-mail at comply@ksu.edu.

TERMS OF PARTICIPATION: I understand this project is research, and that my participation is completely voluntary. I also understand that if I decide to participate in this study, I may withdraw my consent at any time, and stop participating at any time without explanation, penalty, or loss of benefits, or academic standing to which I may otherwise be entitled.

I verify that my signature below indicates that I have read and understand this consent form, and willingly agree to participate in this study under the terms described, and that my signature acknowledges that I have received a signed and dated copy of this consent form.

Subject's signature_____________________________________

Investigator's signature__________________________________

Consent form date: ____________, 2014

Appendix C - Student Letter of Consent

KANSAS STATE UNIVERSITY

INFORMED CONSENT

PROJECT TITLE: The Effects of Educational Neuroscience in the University Aural Skills classroom

APPROVAL DATE OF PROJECT*:* 2/01/2014 **EXPIRATION DATE OF PROJECT**: 5/16/2014

PRINCIPAL INVESTIGATOR: Dr. Jana Fallin

CO-INVESTIGATOR(S): Staci Horton

CONTACT NAME AND PHONE FOR ANY PROBLEMS/QUESTIONS: Dr. Fallin – jfallin@ksu.edu

PURPOSE OF THE RESEARCH: You are invited to participate in a research study. The purpose of this study is to explore how experiencing brain-compatible instructional strategies in the university Aural Skills classroom effects student achievement. The project is required for the completion of the doctorate of philosophy in curriculum and instruction with an emphasis on Music Education. All results will remain anonymous.

PROCEDURES & LENGTH OF STUDY TO BE USED: For this study, you will be asked to take part in the following activities:

1. Observations: The researcher would like to observe your class three times, observing instructional techniques only (not collecting data from students). Each observation will last for fifty minutes with the taking of minimal field notes.
2. Document review: The researcher would like to review classroom documents, such as lesson plans, instructional handouts, and test scores, no copies will be made of the documents; however, the researcher will take notes on them. The researcher does not wish to collect any student documents.

There will be approximately 65 students total in the classes.

RISKS OR DISCOMFORTS ANTICIPATED: There are no foreseeable risks associated with this study.

BENEFITS ANTICIPATED: The benefits of participating in the study are both professional and personal. The research should add to the knowledge base about how to implement brain-compatible teaching for learning. The teachers who participate will have an opportunity to reflect on their practices, have professional dialogue about an important development in teaching and receive feedback about their attempts to use this new method.

EXTENT OF CONFIDENTIALITY: The methods for preserving confidentiality include: transcribing the tapes and destroying them by the end of August, 2014; keeping the tapes, transcripts, and documents in a safe and locked area for my eyes only. Data will be recorded with each teacher identified by a number code. There will be no link back to the teachers. The code will be destroyed by the end of August of 2014. Reports will be written in aggregate terms and with some individual responses described. The descriptions of the school and geographical area will be very broad, for example, a school in the Midwest. Subjects will not be identified in the report. In the report, the existing documents will not have identifiers attached.

CONTACT NAME AND PHONE FOR ANY PROBLEMS/QUESTIONS: If you have questions at any time about the study or the procedures, you may contact the principal researcher, Dr. Jana Fallin at 785-532-7828, or by email at jfallin@ksu.edu.

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact the office for the University Research Compliance Office (URCO) Fairchild Hall, 785-532-3224 or by e-mail at comply@ksu.edu.

TERMS OF PARTICIPATION: I understand this project is research, and that my participation is completely voluntary. I also understand that if I decide to participate in this study, I may withdraw my consent at any time, and stop participating at any time without explanation, penalty, or loss of benefits, or academic standing to which I may otherwise be entitled.

I verify that my signature below indicates that I have read and understand this consent form, and willingly agree to participate in this study under the terms described, and that my signature acknowledges that I have received a signed and dated copy of this consent form.

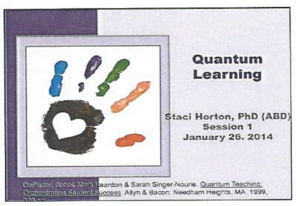
Student's signature____

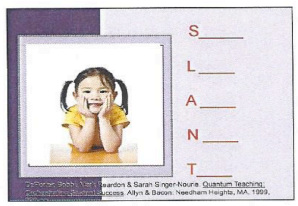
Investigator's signature_____________________________________

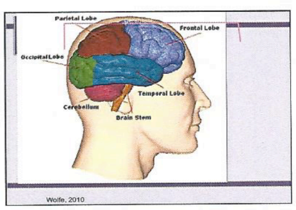
Consent form date: _____________, 2014

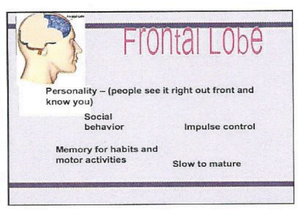
Appendix D - Powerpoint Slides from Training Session

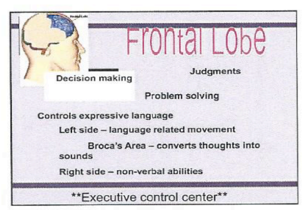
Session 1 – January 2014

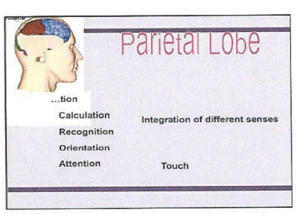


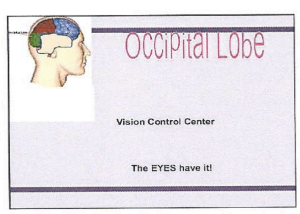


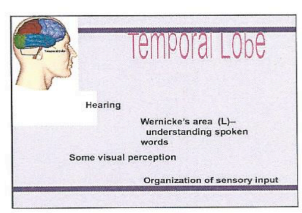


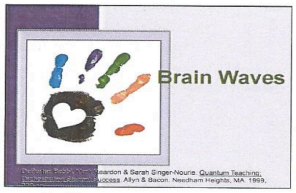








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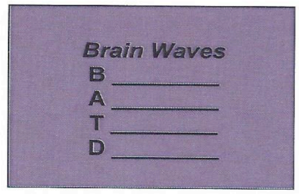
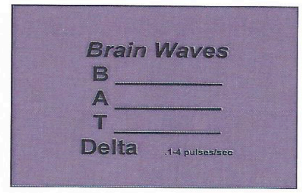
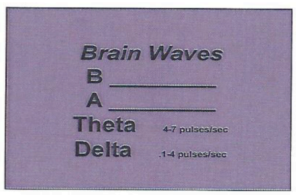
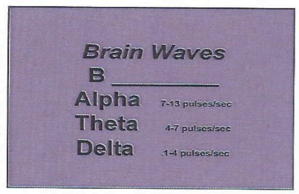
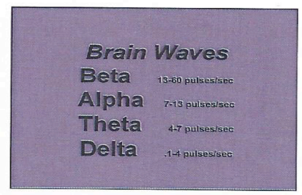
Success. Allyn & Bacon. Needham Heights, MA. 1999,

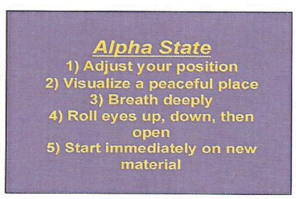

Brain Waves
B ________
A ________
T ________
D ________

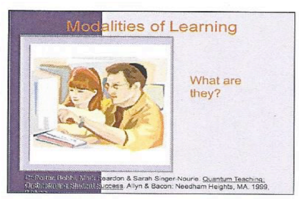

Brain Waves
B ________
A ________
T ________
Delta .1-4 pulses/sec

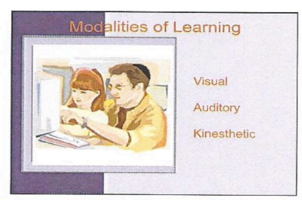

Brain Waves
B ________
A ________
Theta 4-7 pulses/sec
Delta .1-4 pulses/sec

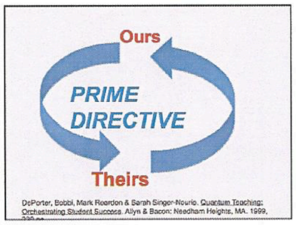

Brain Waves
B ________
Alpha 7-13 pulses/sec
Theta 4-7 pulses/sec
Delta .1-4 pulses/sec

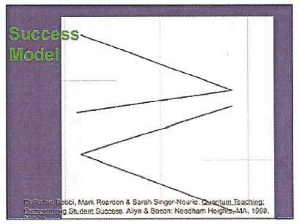

Brain Waves
Beta 13-60 pulses/sec
Alpha 7-13 pulses/sec
Theta 4-7 pulses/sec
Delta .1-4 pulses/sec

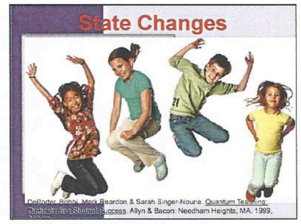

Alpha State
1) Adjust your position
2) Visualize a peaceful place
3) Breath deeply
4) Roll eyes up, down, then open
5) Start immediately on new material

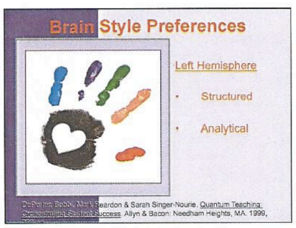

Modalities of Learning
What are they?
Reardon & Sarah Singer-Nourie. Quantum Teaching:
Success. Allyn & Bacon. Needham Heights, MA. 1999,

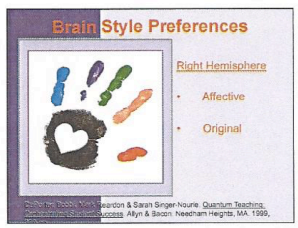

Modalities of Learning
Visual
Auditory
Kinesthetic


Ours
PRIME DIRECTIVE
Theirs
DePorter, Bobbi, Mark Reardon & Sarah Singer-Nourie. Quantum Teaching: Orchestrating Student Success. Allyn & Bacon: Needham Heights, MA. 1999,


Success Model


State Changes


Brain Style Preferences
Left Hemisphere
Structured
Analytical


Brain Style Preferences
Right Hemisphere
Affective
Original


Lesson Plan Design
E
E
L
D
R
C


Lesson Plan Design
Enroll
E
L
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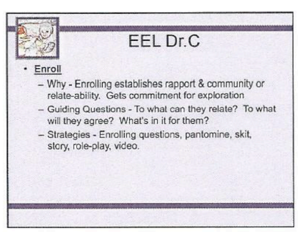
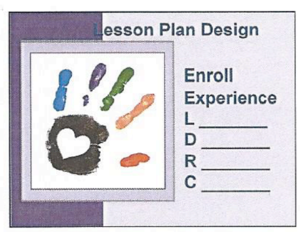
C


EEL Dr.C
Enroll
– Why - Enrolling establishes rapport & community or relate-ability. Gets commitment for exploration
– Guiding Questions - To what can they relate? To what will they agree? What's in it for them?
– Strategies - Enrolling questions, pantomine, skit, story, role-play, video.


Lesson Plan Design
Enroll
Experience
L
D
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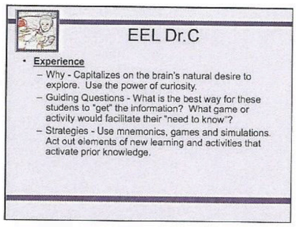
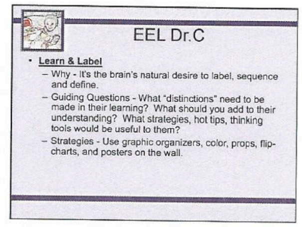
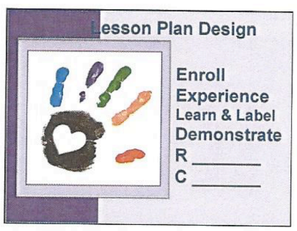
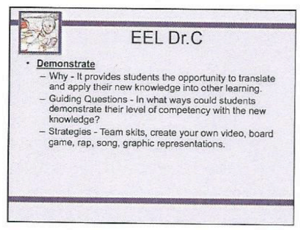

EEL Dr.C
Experience
– Why - Capitalizes on the brain's natural desire to explore. Use the power of curiosity.
– Guiding Questions - What is the best way for these studens to "get" the information? What game or activity would facilitate their "need to know"?
– Strategies - Use mnemonics, games and simulations. Act out elements of new learning and activities that activate prior knowledge.

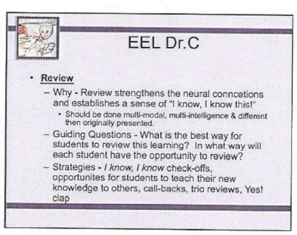

Lesson Plan Design
Enroll
Experience
Learn &
Label
D ______
R ______
C ______


EEL Dr.C
Learn & Label
– Why - It's the brain's natural desire to label, sequence and define.
– Guiding Questions - What "distinctions" need to be made in their learning? What should you add to their understanding? What strategies, hot tips, thinking tools would be useful to them?
– Strategies - Use graphic organizers, color, props, flip-charts, and posters on the wall.

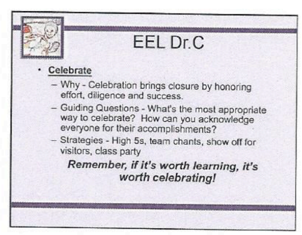

Lesson Plan Design
Enroll
Experience
Learn & Label
Demonstrate
R ______
C ______

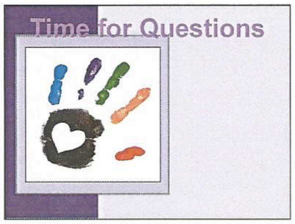

EEL Dr.C
Demonstrate
– Why - It provides students the opportunity to translate and apply their new knowledge into other learning.
– Guiding Questions - In what ways could students demonstrate their level of competency with the new knowledge?
– Strategies - Team skits, create your own video, board game, rap, song, graphic representations.


Lesson Plan Design
Enroll
Experience
Learn & Label
Demonstrate
Review
C ______


EEL Dr.C
Review
– Why - Review strengthens the neural conncetions and establishes a sense of "I know, I know this!"
• Should be done multi-modal, multi-intelligence & different then originally presented.
– Guiding Questions - What is the best way for students to review this learning? In what way will each student have the opportunity to review?
– Strategies - I know, I know check-offs, opportunites for students to teach their new knowledge to others, call-backs, trio reviews, Yes! clap


Lesson Plan Design
Enroll
Experience
Learn & Label
Demonstrate
Review
Celebrate ☺


EEL Dr.C
Celebrate
– Why - Celebration brings closure by honoring effort, diligence and success.
– Guiding Questions - What's the most appropriate way to celebrate? How can you acknowledge everyone for their accomplishments?
– Strategies - High 5s, team chants, show off for visitors, class party
Remember, if it's worth learning, it's worth celebrating!


Time for Questions


Thank you for your participation!
Have a great day!
Staci Horton, MM

Session 2 – January 2014

Multiple Intelligences

HOW ARE YOU SMART?
SESSION 2

PRESENTATION BY STACI HORTON

Dr. Howard Gardner

- Developmental Psychologist
- Professor of Cognition and Education at the Harvard Graduate School of Education at Harvard University
- His book *Frames of Mind: The Theory of Multiple Intelligences* was published in 1983.
- Introduced the thought that not only do human beings have several different ways of learning and processing information, but these methods are relatively independent of one another.

Multiple Intelligences

How are you smart?	Dr. Gardner's Terms
• Picture Smart	• Visual-Spatial
• Word Smart	• Linguistic
• People Smart	• Interpersonal
• Music Smart	• Musical
• Nature Smart	• Naturalistic
• Body Smart	• Body-Kinesthetic
• Self Smart	• Intrapersonal
• Number Smart	• Logical
Acronym:	SLIM-N-BIL(E)

Spatial-Visual

Skills	Careers Involving Spatial-Visual Skills
• Thinks in color and 3D	• Visual artists
• Perceives patterns	• Mechanics
• Takes things apart and puts them back together	• Pilots & Sailors
• Active Imaginations	• Engineers
• Drawing, doodling, painting, sculpting	• Architects
• Excels at mazes	• Surgeons
	• Graphic artists

Who were/are some famous people with the Spatial-Visual Intelligence?

- Matt Groening
- Steven Spielberg
- Leonardo da Vinci
- Picasso
- Galileo Galilei

Ways to enhance Spatial-Visual Skills

- Play games like Pictionary
- Do jigsaw puzzles
- Redecorate your room
- Add one more item to a full refrigerator
- Use mind maps to remember important concepts

Linguistic-Verbal

Skills	Careers Involving Linguistic-Verbal Skills
• Enjoys reading and writing	• Journalists
• Excellent debater & public speaker	• Therapists
• Good at creating puns and rhymes	• Secretaries
• Acquires foreign languages easily	• Politicians & Public speakers
• Storytelling	• Speech Pathologists
	• Lawyers

Who were/are some famous people with the Linguistic-Verbal Intelligence?

- Barbara Walters
- Shakespeare
- John F. Kennedy
- J.K. Rowling

Ways to enhance Linguistic-Verbal skills

- Play games like Scrabble
- Do crossword puzzles
- Play listening games
- Write reviews on a variety of subjects
- Learn new a few new words each week
- Journaling

Interpersonal

Skills	Careers Involving Interpersonal Skills
• Good leader of peers • Mediates conflict • Organizer of people • Good communicator • Effective working on a team	• Teachers • Anthropologists • Sales People • Business Administrators • Travel Agents • Bartenders

Who were/are some famous people with the Interpersonal Intelligence?

- Oprah Winfrey
- Martin Luther King, Jr.
- Pope Francis
- Dr. Oz

Ways to enhance Interpersonal Skills

- Interact with new people often
- Go on a group retreat
- Check out an internet discussion board
- Watch how people interact in the mall
- Conduct interviews

Musical-Rhythmic

Skills	Careers Involving Musical-Rhythmic Skills
• Hums, whistles, makes music with body • Sense of rhythm, tone, pitch • Able to discern musical patterns • Performs &/or Composes music	• Music Teachers • Composers • Musicians • DJ • Sound Technicians • Music Critics

Who were/are some famous people with the Musical-Rhythmic Intelligence?

- Mozart
- Glenn Miller
- Madonna
- Bach
- Debussy

Ways to enhance Musical-Rhythmic Skills

- Sing in the shower or car
- Listen to a variety of radio stations (not talk radio)
- Take a music lesson or join a choir/band
- Connect music to a lesson – e.g. popular songs during the Civil Rights movement
- Play "Name that Tune"
- Play "Stomp" by creating your own sounds on household items

Naturalistic

Skills	Careers Involving Naturalistic Skills
• Categorization • Perceives patterns • Looks for ways to group items • Spot-the-difference puzzle skills • Able to distinguish between different items in a group	• Scientists • Pilots & Sailors • Surgeons • Cartoonists • Interior Decorators • Artists • Organizers • Librarians

Who were/are some famous people with the Naturalistic Intelligence?

- Charles Darwin
- Steve Irwin
- Chef Emeril

Ways to enhance Naturalistic Skills

- File books according to type
- Visit the planetarium or aquarium
- File CDs in a specific order
- Look for patterns in the stars at night
- Categorize your movies

Body-Kinesthetic

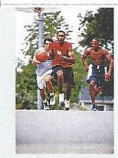
Skills	Careers Involving Body-Kinesthetic Skills
• Learns through movement • Athletic Ability • Gives physical performances • Understands graphic images • Talented mimicker or impressionist	• Dancers • Surgeons • Professional Athletes • Actors • Farmers

Who were/are some famous people with the Body-Kinesthetic Intelligence?

- Michael Jordan
- Will Ferrell
- Gretchen Bleiler
- Steve Martin

Ways to enhance Body-Kinesthetic Skills

- Walk on curbs to improve balance
- Take dancing lessons
- Play Charades an other role-playing activities
- Exercise
- Learn a craft - like woodworking
- Play video games that require fast reflexes



Intrapersonal

Skills	Careers Involving Intrapersonal Skills
• Strong, distinctive personalities • Deep awareness of inner thoughts • Excellent focus and concentration • Independent • Knows personal gifts and limits • Self-Disciplined • Understands inner processes of others	• Psychologists • Therapists • Explorers • Entrepreneurs • Ministers

Who were/are some famous people with the Intrapersonal Intelligence?

- Gandhi
- The Dalai Lama
- Joel Osteen
- Billy Graham
- Friedrich Nietzsche

Ways to enhance Intrapersonal Skills

- Learn to meditate
- Write your autobiography
- Keep a journal
- Set goals for yourself
- Establish your "quiet corner" in your home
- Work on projects individually

Logical-Mathematical

Skills	Careers Involving Logical-Mathematical Skills
• Skilled problem-solver • Questions natural events • Uses abstract symbols • Pattern games • Curious about how things work	• Technicians • Computer Programmers • Engineers • Economists • Computer Analysts • Math Teachers

Who were/are some famous people with the Logical-Mathematical Intelligence?

- Bill Gates
- Steve Jobs
- Albert Einstein
- Gen. Patton

Ways to enhance Logical-Mathematical Skills

- Do logic puzzles
- Tutor someone in math
- Visit a laboratory at the local hospital or college
- Practice doing simple calculations in your head
- Look for patterns in poetry

Existential

Skills	Careers Involving Existential Skills
• Sees the big picture • Interested in questions about life, death, and beyond • Able to look beyond the senses to explain phenomena • Likes to Be Outside • Strong interest in society and those around them	• Philosophers • Theologians • Life Coaches • Cosmologists

Who were/are some famous people with the Existential Intelligence?

- Socrates
- Buddha
- Wayne Dyer
- St. Augustine

Ways to enhance Existential Skills

- Find connections between your world and the real world
- Seek to see the "big picture"
- Look at a topic from a different point of view
- Summarize information learned in a lesson
- Teach others

- Painting by Warner

CHECK OUT THIS ONLINE QUIZ: HTTP://PSYCHOLOGY.ABOUT.COM/LIBRARY/QUIZ/BL-MI-QUIZ.HTM

Interested in discovering your highest Multiple Intelligence?

12 Brain/Mind Learning Principles

RENATE NUMMELA CAINE
GEOFFREY CAINE
KARL KLIMEK
& MCCLINTIC
2005

The brain is a parallel processor

- Thoughts, intuitions, pre-dispositions, and emotions operate simultaneously and interact with other modes of information. Good teaching takes this into consideration.
- That's why we talk about the teacher as being the "Orchestrator of Learning."
- The brain is a complex, dynamic system

Learning engages the entire brain

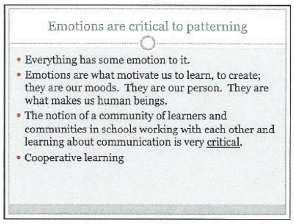
- This means that the physical health of a child – the amount of sleep, the nutrition – affects the brain, as do moods. We are physiologically programmed, and we have cycles that have to be honored.
- Fatigue will affect the brain's memory.
- The brain is a social brain.

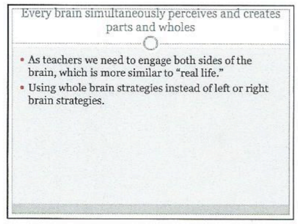
The search for meaning is innate.

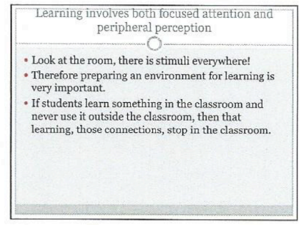
- We are naturally programmed to search for meaning. The principle is survival oriented.
- Provisions must be made to satisfy the hunger for novelty, discovery, and challenge. At the same time lessons need to be exciting and meaningful and offer students an abundance of choices.
- We want to know what things mean to us. A student will always ask, "What's in it for me?"
- Give them time and opportunities to make sense of their experiences with a chance to reflect and see how things relate.

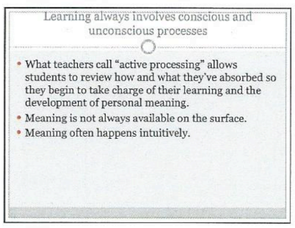
The search for meaning occurs through "patterning."

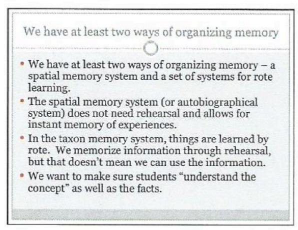
- The brain resists having meaningless patterns imposed upon it.
- Meaningless: isolated and unrelated pieces of information
- Patterning is everywhere.
- The ideas behind thematic teaching and integrated curriculum are based on this principle of looking for patterns and seeing interrelated patterns in learning.

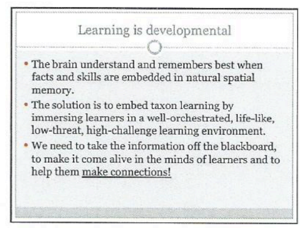

Emotions are critical to patterning
Everything has some emotion to it.
Emotions are what motivate us to learn, to create; they are our moods. They are our person. They are what makes us human beings.
The notion of a community of learners and communities in schools working with each other and learning about communication is very critical.
Cooperative learning

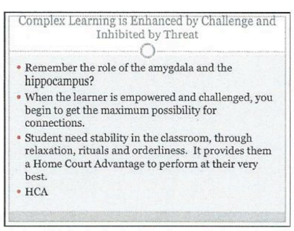

Every brain simultaneously perceives and creates parts and wholes
As teachers we need to engage both sides of the brain, which is more similar to "real life."
Using whole brain strategies instead of left or right brain strategies.

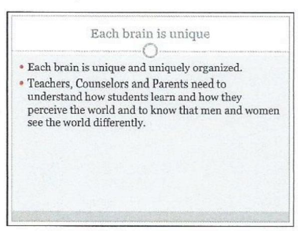

Learning involves both focused attention and peripheral perception
Look at the room, there is stimuli everywhere!
Therefore preparing an environment for learning is very important.
If students learn something in the classroom and never use it outside the classroom, then that learning, those connections, stop in the classroom.


Learning always involves conscious and unconscious processes
What teachers call "active processing" allows students to review how and what they've absorbed so they begin to take charge of their learning and the development of personal meaning.
Meaning is not always available on the surface.
Meaning often happens intuitively.

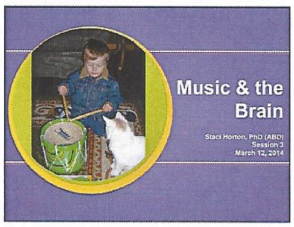

We have at least two ways of organizing memory
We have at least two ways of organizing memory – a spatial memory system and a set of systems for rote learning.
The spatial memory system (or autobiographical system) does not need rehearsal and allows for instant memory of experiences.
In the taxon memory system, things are learned by rote. We memorize information through rehearsal, but that doesn't mean we can use the information.
We want to make sure students "understand the concept" as well as the facts.

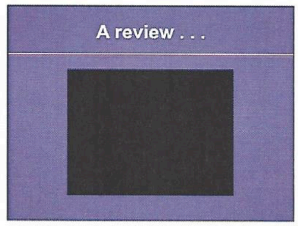

Learning is developmental
The brain understand and remembers best when facts and skills are embedded in natural spatial memory.
The solution is to embed taxon learning by immersing learners in a well-orchestrated, life-like, low-threat, high-challenge learning environment.
We need to take the information off the blackboard, to make it come alive in the minds of learners and to help them make connections!

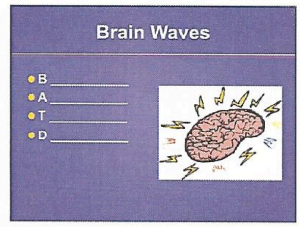

Complex Learning is Enhanced by Challenge and Inhibited by Threat
Remember the role of the amygdala and the hippocampus?
When the learner is empowered and challenged, you begin to get the maximum possibility for connections.
Student need stability in the classroom, through relaxation, rituals and orderliness. It provides them a Home Court Advantage to perform at their very best.
HCA

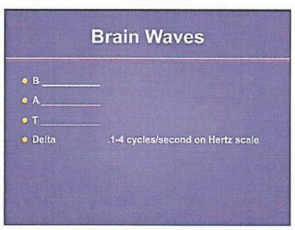

Each brain is unique
Each brain is unique and uniquely organized.
Teachers, Counselors and Parents need to understand how students learn and how they perceive the world and to know that men and women see the world differently.

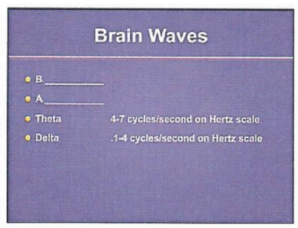
Session 3 – January 2014

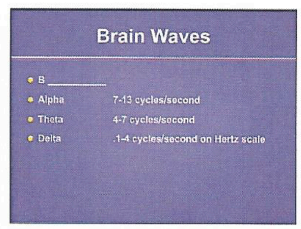


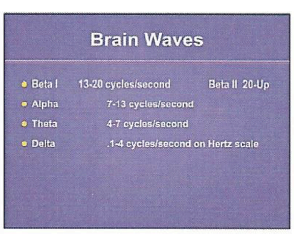


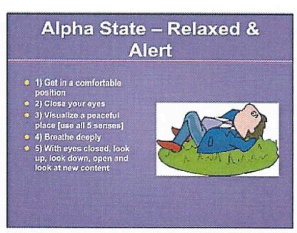


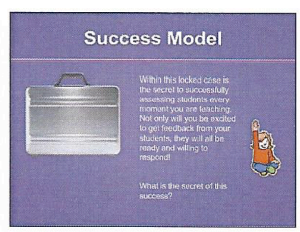


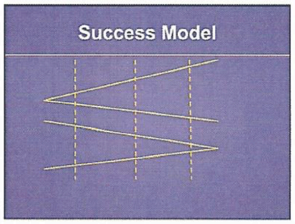


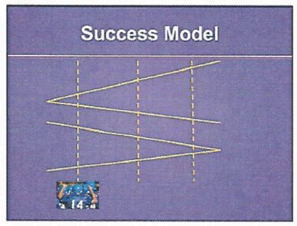


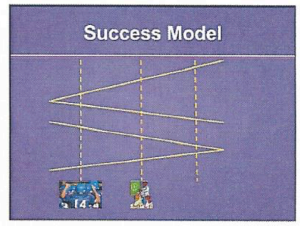


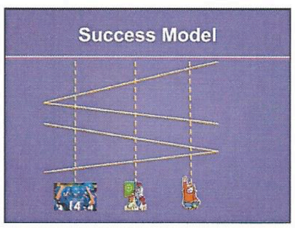





Success Model


Success Model


Success Model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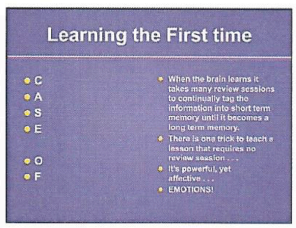
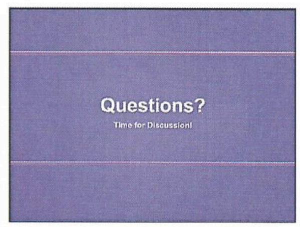
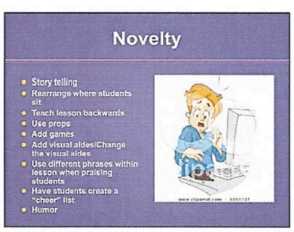
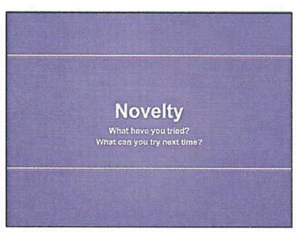
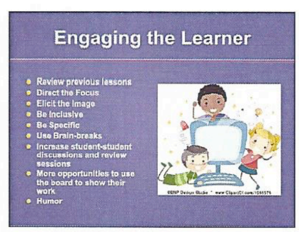
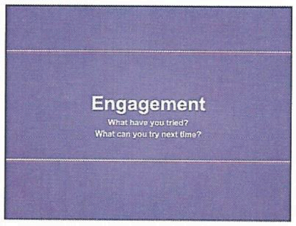

Learning the First time
C
A
S
E
O
F
When the brain learns it takes many review sessions to continually tag the information into short term memory until it becomes a long term memory.
There is one trick to teach a lesson that requires no review session . . .
It's powerful, yet affective . . .
EMOTIONS!

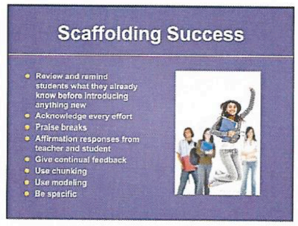

Questions?
Time for Discussion!

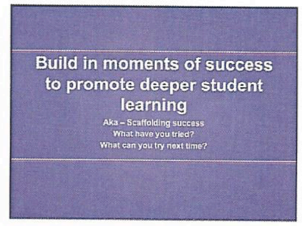

Novelty
Story telling
Rearrange where students sit
Teach lesson backwards
Use props
Add games
Add visual aides/Change the visual aides
Use different phrases within lesson when praising students
Have students create a "cheer" list
Humor


Novelty
What have you tried?
What can you try next time?


Engaging the Learner
Review previous lessons
Direct the Focus
Elicit the Image
Be Inclusive
Be Specific
Use Brain-breaks
Increase student-student discussions and review sessions
More opportunities to use the board to show their work
Humor


Engagement
What have you tried?
What can you try next time?


Scaffolding Success
Review and remind students what they already know before introducing anything new
Acknowledge every effort
Praise breaks
Affirmation responses from teacher and student
Give continual feedback
Use chunking
Use modeling
Be specific


Build in moments of success to promote deeper student learning
Aka – Scaffolding success
What have you tried?
What can you try next time?


'Til next time . . .
Thanks for your participation!