LET THEM MOVE:

KINESTHETIC LEARNING AND COGNITION

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ABSTRACT

This paper investigated the question: what effects kinesthetic learning opportunities, within the school's content curricula, have on the cognitive performances of Kindergarten through third grade children? A critical examination of the research literature concerning brain functions, physiology, and learning styles in their relation to educational practices will aide the inquiry. Both the content matter and context in which it is learned are important factors in a child's education. The critical review of research studies showed that some students benefit significantly from kinesthetic learning opportunities and therefore, it is important to include them in a well-balanced curriculum. Kinesthetic learning opportunities are one means of meeting the needs of the diversity that exists among learners in our public school classrooms.

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CHAPTER 1: INTRODUCTION

This paper will investigate the question: what effects kinesthetic learning opportunities, within the school's content curricula, have on the cognitive performances of kindergarten through third grade children? A critical examination of the research literature concerning brain functions, physiology, and learning styles in their relation to educational practices will aide the inquiry. Both the content matter and context in which it is learned are important factors in a child's education. I believe that an individual's ability to remember, analyze, and synthesize new information impacts academic success. It is part of a teacher's responsibility to plan and implement learning opportunities that will engage and benefit all students. When a teacher strives to know and understand her students' unique ways of learning it may increase both engagement and cognitive growth. Many young children learn by doing. Can offering the opportunity within the classroom to explore new concepts with their bodies and minds help students learn? Learning contexts which offer multiple sensory experiences, especially kinesthetic senses, could be one way to include diverse learners. Many questions, and a plethora of answers, float around the field of education. Can some students learn best when physically engaged with their curriculum? I believe that an inquiry into this question is pertinent for my future teaching career. Therefore, this paper will investigate the effects that incorporating kinesthetic methods of learning has on knowledge, analysis, and synthesis of new information.

The first chapter offers the relevance of this question to me as a teacher and to the teaching profession, the rationale for and against including kinesthetic learning opportunities, and a brief definition of terms. These issues will be viewed from three perspectives; brain research, physiology, and cognitive development as they pertain to classroom instruction and practices. Chapter Two will shed some light on the historical background of educational psychology, physical education, and cognitive development. In Chapter Three the current research on these three perspectives will be critically examined. Finally, Chapter Four offers conclusions and areas for future study.

Statement of Purpose

Determining what effects the use of kinesthetic learning opportunities has on the cognitive performances of primary students is important to me in my future teaching because I believe it is essential for some learners to simultaneously engage their bodies and their minds. I will examine whether kinesthetic learning opportunities should be a part of a broad curriculum which incorporates a variety of learning experiences. I envision having a classroom that utilizes kinesthetic, auditory, visual, musical, logical, and linguistic learning experiences. Not only to reach students who prefer to process information in these manners, but also those who will grow further by learning to process information in a multitude of manners.

I wish to test my assumptions about the benefits of kinesthetic approaches to learning and teaching. Currently, I consider learning a process of the mind, the body, and the connection therein. This process is unique to each learner. Not only is each learning process unique, but the learners themselves are representative of a multitude of social and cultural contexts. Students from various ethnic backgrounds show proclivities to different learning contexts (Allen & Butler, 1996; Boykin & Cunningham, 2001). Our public school classrooms are diversifying in student ethnicity, race, socio-economic status, primary language, generation since immigration, cultural community, and religion. The

2000 report of the U.S. Census Bureau predicts that by the year 2040 more than 50 percent of the school-age children will be from ethnic minority groups (as cited in Spring, 2006). It is our responsibility as teachers and school personnel to respond to these changes.

Rationale

Today's students are increasingly less active during out of school times than students of past generations. More children are watching more hours of television daily. In 2004, The Henry J. Kaiser Family Foundation published a report on media influence in children's lives. They found that eight to eighteen year-olds spend nearly six and a half hours per day using media, during which time they are exposed to more than eight and a half hours per day of media messages because a quarter of a young person's day is spent using two or more media simultaneously (Foehr et al., 2005). Children need to be offered opportunities to be physically active during the school hours. Physical education classes are one source for this; recess is another. Children can increase their physical skills, social skills, and emotional skills during physical education (P.E.) and recess. Yet, in many schools, P.E. teachers have been relegated to itinerant status and physical education is only offered once a week, if at all. Recess has taken the same hit. A recent survey showed that as much as forty percent of elementary schools have abolished recess (Zygmunt-Fillwalk & Bilello, 2005). Today's children are more sedentary, more obese, and less likely to have access to recess and physical education during school hours. Therefore, with the traditional arenas for physical activity diminishing, can classroom teachers help students fulfill their physical and cognitive growth needs by offering a wide range of learning contexts that include movement and other kinesthetic senses?

I believe it is time to investigate whether incorporating movement within content curriculum could partially satisfy a child's need for physical activity. This is not a new topic in the education field; it is one that is worthy of being revisited. Child development, psychological, and educational theorists have espoused the benefits of experiential learning for children. Maria Montessori theorized, based upon qualitative experimentation, that children need to be presented with authentic materials from which they will develop intellect on their own, naturally. She stated, in reference to the child's intellectual development, "the sole [educational] problem is that of offering the child the necessary nourishment" (Montessori, 1965/1917, p. 70). John Dewey argued that education must be one of quality experiences offered and guided by the teacher (Dewey, 1938). Furthermore, educative experiences consist of experimental, hands-on exploration of everyday subjects such as history, math, and science. In addition, Jean Piaget determined that learning is dependent upon interacting directly with one's environment. One of the stages of child development in particular was devoted to concrete operations. This occurs from the ages of seven through eleven years old (Singer & Revenson, 1996). Concrete operations are those tangible manifestations of abstract thoughts. For example, a child will learn about an apple by holding it and through examining it with his other senses. If one were to verbally describe an apple, this child would not actually learn about the myriad characteristics of that apple.

Researchers have discovered that the brain responds to the motions of the body and vice versa (Pellegrini et al., 1995; Hogervorst et al., 1996; Tomporowski et al., 2005). Modern theorists also support the connection between the mind and body. David Kolb (1984) derived his theory of experiential learning from knowledge of how the brain functions. He defined learning as “the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience” (Kolb, 1984, p. 41). Howard Gardner (1983) explained his theory of multiple intelligences (MI) as opposed to one static intelligence; Intelligence Quotient (IQ). He proposed that people have a mixture of kinesthetic, linguistic, mathematical, musical, spatial, interpersonal, and intrapersonal ways of processing new information. Dunn & Dunn (1985) developed a learning style model that includes 21 different learning preferences separated into the stimuli categories of environmental, emotional, physiological, psychological, and sociological. It is the physiological and environmental categories that pertain to the types of kinesthetic learning this paper explores. Kinesthetic learning contexts are one approach students can utilize to process new information. Finally, Eric Jensen (1998) proclaimed that educators need to teach with the brain in mind. It is essential to understand the development of the brain and how it processes information in order to provide learning content and contexts that will be absorbed by the brain, thereby expanding cognitive abilities.

Not all theorists, scientists, and educatory agree on the connection between the brain and classroom practices. One neuroscientist expressed caution in making the direct connection between neuroscience and education. Usha Goswami (2006) urged educators to realize that there is a gap between neuroscience and classroom practices. Neuroscientists can not simply tell teachers what works best for children. Goswami addresses several “neuromyths” that are circulating among the brain-based learning industry. She detailed a few neuromyths that have spurred on the brain-based learning industry. One of which was teaching to the left or right brained learner; a myth caused by an over-simplification of hemispheric specialization. Goswami contends that neuroscience can inform education to improve the learning situations of many students, but the communication should be directly between the scientists and the educators. She claimed that, despite misinformation between the two fields, teachers can help students learn better as they get more information about how the brain works. She stated that any program which changes behavior will result in remapping of the neural networks; it will change the brain.

Meanwhile, the brain-based theorists and educators have taken the available information and created specialized programs for elementary students to improve their capacity for learning. They clearly see a connection between the brain’s functions and learning (Caine & Caine, 2000, 1998a, 1998b, 1997, 1995, 1990; Dennison, 1981; Gilbert, 1977; Hannaford, 1995; Jensen, 1988; Ratey, 2001; Wolfe, 2000; & Zull, 2002). These researchers and authors represent two theory models, brain-based learning and Educational Kinesiology (EduK). These theories provide a foundation for exploring the question of what effects do using kinesthetic learning opportunities have upon cognitive development. The inclusion of multiple teaching methods and learning experiences in public school classrooms can meet the varied needs of the diverse student population. Yet, there will be little research reviewed in Chapter Three on brain-based learning. This is due to the fact that there are very few qualitative or quantitative research studies published in peer-reviewed scholarly journals. Indeed, several international educational foundations exist which do not have this level of research supporting their theories and practices. Educational Kinesiology (EduK), developed by Paul Dennison, is one of these. Dennison’s specialized series of patterned movements, called Brain Gym, are used in many schools throughout the nation as a means to improve cognitive skills (Dennison, 2006).

The lack of scientifically-based research on brain-based learning and Brain Gym have led some professionals in the fields of education, neuroscience, and educational psychology to argue against the claims made by these theorists and organizations (Kratzig & Arbuthnott, 2006). One of these critics will be examined in depth in Chapter Three.

Limitations

The scope of this paper will include: research on the brain and its functions, kinesthetic learning opportunities within literacy, mathematics, and science; the impact of exercise on simple cognitive tasks; and classroom practices and their relationship to cognitive performances. Those content curricula which will be highlighted are reading, writing, reading comprehension, science, and mathematics. The cognitive skills involved that will be addressed are memory, analysis, and synthesis. Finally, the testing procedures covered will consist of physical skills and academic achievement scores.

Definitions of Terms

- Cognitive performance is the measurable or observable outcome of the cognitive process. The areas of cognition that will be examined in this paper are knowledge, analysis, and synthesis. These areas of cognition are also referred to as critical thinking.
- Kinesthetic learning opportunities include tactile and movement sensory stimuli.
- Learning experience is the lesson, prepared or natural, that provides an individual with the opportunity to incorporate new information.

- Learning context is the total environment in which a learning experience occurs.
- Learning content is the curricula of the fields of study that public schools are required to and/or choose to teach. These include social studies, science, physical education/health, language arts, mathematics, visual arts, and performance arts.
- Learning styles refers to Dunn and Dunn's learning style model that includes 21 different learning preferences separated into the stimuli categories of environmental, emotional, physiological, psychological, and sociological (Dunn & Dunn, 1982).
- Movement is broadly defined as either gross or fine motor activity. This can be through apprenticeship learning, exercise, or other kinesthetic experiences.
- Primary grades are Kindergarten through third grade.
- Teaching methods are those styles of structuring, delivering, and monitoring a learning experience. Also referred to as "instructional methods."

Summary

This chapter presented the question to be investigated, the purpose of investigation, the relevance to educators, and the definition of terms. The following chapters explore the historical background of educational psychology, physical education, and learning styles. Presented next, a critical review of the current research, published in peer-reviewed scholarly journals, to assist in answering the question what effects do kinesthetic learning contexts have on the cognitive performances of primary grade students? The last chapter draws conclusions from the research, this writer's conclusions, implications for classroom practices, and further research needs.

CHAPTER TWO: HISTORICAL BACKGROUND

Before the veritable explosion of theorizing and research starting in the 1800's, the ideas about the mind and body had a long history. The integration of the mind and body in the education of people transpired in both Eastern and Western civilizations. In the Eastern world of South East Asia, these roots reach back to the 500's B.C.E. The body and mind were fundamental in the foundation of religions such as Buddhism, Hinduism, and Islam. The body was a receptacle of the spirit which could be accessed through the mind. Therefore, the body was a temple, to be quieted or excited, in order to engage the mind in the pursuit of wisdom. For the Buddhists, full wisdom would come through Enlightenment and result in Nirvana (Hawkins, 1999). Enlightenment would come when an individual had disciplined his or her body enough to allow the true wisdom to unfold within the mind. The integration of the mind and body in learning is shown in an ancient Chinese proverb:

> I hear and I forget
>
> I see and I remember
>
> I do and I understand.

Learning requires hearing, seeing, and doing, yet it is through the doing that an individual can understand, according to this proverb.

Western Europe

The cooperation of the mind and body were also an integral part of the Western civilizations and religions. The ancient Greeks built gymnasiums in which to train young boys and men in the realms of physical and moral growth. Physical pursuits such as competitions and games improved the body while mental pursuits such as Sophist dialogues improved the mind. Indeed Plato, in his work *Republic*, discussed the connection between the education of a man's body and mind (Wikipedia, n.d.).

Later in Western civilization kinesthetic learning is apparent in the apprenticeships that facilitated the feudal societies of Europe. Young boys would be contracted to apprentice in a trade and young girls would apprentice in the work of the household. Learning a trade or service was accomplished by the young watching, practicing, and finally performing the work. This practice of apprenticeship was conducted in both the wealthy and peasant classes. The wealthy youth would reside at another land-holder's estate to learn the trade of gentleman or lady. The peasant youth worked the land, the home, and the shops from an early age. An apprenticeship could be either a ticket to a better life or more like indentured servant hood. The practice of apprenticeship exists in many cultures today (Rogoff, 1990).

Subsequent to the medieval period, a wider range of human growth and development theories surfaced. Rene Descartes (1596-1650) was one of the influential philosophers of the Renaissance period in Western Europe. He developed theories in mathematics and physics. In 1640 he proclaimed that the mind and body were two distinctly separate entities. Descartes' philosophical theories were controversial for his time due to his disregard for religious authority. After his death, they continued to stir controversy and subsequent philosophers spent much effort arguing against them (Internet Encyclopedia of Philosophy, 2006). His idea of the mind and body as co-existing yet completely separate has been refuted numerous times throughout history.

The Age of Enlightenment closely followed the Renaissance in Western Europe. This was a period of time when theorists were breaking away from the discipline of the

Church and constructing theories of the mind and body based upon their own experiences and observations. A principle philosopher of that time was Jean-Jacques Rousseau (1712-1778). Rousseau espoused that humans evolve through experiencing life. An infant begins to learn immediately when it is allowed to discover its world through the physical senses. The child's learning path begins at birth via experiences within its environment. In an argument against the form of education common to his time, Rousseau stated that "experience precedes instruction" (Rousseau, 1762, p. 142). He viewed experience as the body's physical interaction with the environment. Instruction was the period of tutelage of the mind by an elder. Infancy and young childhood are formative years, a time when instinct and intuition speak loudest. Instinct and intuition were the synergy of the mind and body. As Rousseau summarized, "if the voice of instinct is not strengthened…it will die in the early years, and the heart will die, so to speak, before being born" (Rousseau, 1762, p. 63). Rousseau's views on allowing children to physically interact with their environment as a means of educating themselves (with the ever-present adult guide) were revolutionary. It wasn't long before others followed suit and carried the idea forward into more modern educational theories.

Shortly after Rousseau, Francois Delsarte (1811-1871) began experimenting and theorizing on movement as a means of understanding, within the context of acting. Delsarte was a professor of voice and acting in France. He developed a system of coordinating movement with music and acting. Delsarte focused his attention on the scientific study of gestures and their associated emotions in the belief that performers could depict their emotions through gestures, expressions, and body positions. Furthermore, an entertainer can feel the emotions that correspond to the body postures, thereby eliciting realistic emotional portrayals. Delsarte's theory centers on the concept that the mind and body are interconnected (Lewis, 1998).

Rudolf von Laban (1879-1958) was greatly influenced by the theory and practice of Delsarte. Laban was a clinical psychologist who emphasized that movement is the manifestation of emotion. He classified movements in terms of their elements, such as force and space. In the 1940's, Laban's principles of movement were being used in education. Many schools in Britain and the U.S. employed Laban's teaching strategies for movement within their physical education programs. One learning theorist, Newell Kephart, has recommended that Laban's movement education strategies be used in schools with students who demonstrate academic deficiencies. In 1973, the American Association for Health, Physical Education, and Recreation developed a set of guidelines to implement this type of instruction in physical education programs in the elementary schools. One of the guidelines is to relate movement to other curricular areas (Lewis, 1998).

To return to Laban's time, more connections between movement and learning were being explored within the fields of education, psychology, and medicine. Maria Montessori (1870-1952) was the first woman to practice medicine in Italy in 1896. She created theories about child development and education through her experience with pediatric medicine. By 1907, Montessori tested out her theories of learning when she directed a system of daycare centers for working class children in Rome. The Montessori Method revolves around the child engaging in the process of a task in order to learn the task. These tasks were to be presented through interactive materials. These materials were real items found in the context of the child's world which could be physically handled and worked. She believed that “it is therefore necessary that the [child’s] environment should contain the means of auto-education” (Montessori, 1965/1917, p. 72). The tasks were designed to be open-ended and pursued individually at each student’s own interest and pace. Montessori believed that the learning - the mind - would come from the physical interaction with the learning materials and environment - the body.

Another theorist during the early 1900’s in the field of child psychology and development was Jean Piaget (1896-1980). The idea of movement experiences as a means to integrating new information was identified in Piaget’s stages of child development. Piaget believed that children learn by building cognitive structures in their brains, schema, for understanding the physical experiences in their environment. He concluded that children progress at specific intervals through several stages of development. Three of the four stages are kinesthetic. Knowledge develops through environmental experiences first in the sensory-motor stage (birth-2 years), then in the preoperational stage (2 – 7 years), and finally in the concrete operational stage (7 – 11 years). Piaget stated that children needed to be given numerous physical opportunities to learn. When given these opportunities, children will learn on their own, within their stage of development (Singer & Revenson, 1996). The concrete operational stage is the stage that primary grade children are developing in. Piaget claimed that children of this age need to hold and manipulate materials in their environment to develop the intellectual concepts of academics. Therefore, the actions of the body will improve the mind. For instance, mathematical concepts such as percentage could be taught using sections of a pie, as opposed to simply seeing the numerical representation of a percentage. It is with the manipulation and physical representation of concepts that they can be learned more developmentally.

United States

In the United States a similar exploration of movement, child development, and education was occurring. Industrialized societies had transformed daily routines greatly. Prior to the urbanization of the mid-1800's, movement was not a concern of the educational system. People moved throughout their day in attending to their daily living. Children were still responsible for a portion of the physical work of the family when one room school houses were replacing home school settings (Spring, 2005). In the agricultural areas, school hours were set around the duties of the farm. In rural and urban areas, many schools had a long mid-day break so that children could walk home to have their meal and assist with family chores. As the population of school children increased, so did society's expectations of the schools' involvement in those children's lives.

The play movement began in the 1880's as an educational response to the need of increasing healthy life habits and decreasing juvenile crime brought on by urban living. It began with building small sandlots for children and grew to the creation of the parks system in Chicago in 1904. In 1895, a law was passed in New York stating that all new school buildings must have an open air playground attached or located near by for the use of the school children. This law was established when the parks committee found that crime rates were lowest in the areas of newly developed parks. The play movement expanded throughout many cities as an outlet for the nervous strain and crime that urban children experienced in their daily living conditions. Many leaders of the play movement argued that these outdoor play areas should be organized and directed by the parks personnel to establish games and activities that promoted team spirit, cooperative behaviors, and playing by the rules. These were behaviors that would prepare them for future work in industry (Spring, 2005). Playgrounds and other physical outlets for children were seen as a social responsibility by many citizens. It was to the schools that they looked to rectify this growing need.

As a response to society's demands for the education of not only its children's minds, but their bodies as well, physical opportunities were offered in schools. Some were in the form of calisthenics, gymnastics, and dance. Physical education slowly took hold in the public schools in the late 1800s. In 1866 California passed the first state physical education law. It required that physical education be given to students "as may be conducive to health and vigor of body as well as mind" (Lee, 1983, p. 80). Many states followed suit with physical education programs and trained teachers to conduct them.

Physical education was one aspect of a child's learning environment. John Dewey (1859-1952) believed, like Rousseau, Montessori, and Piaget that the physical environment played a large part in a child's learning. Dewey referred to the interaction between an individual and his environment as experiences. He purported that genuine education comes through experience, yet all experiences are not educative; "…everything depends upon the quality of experience which is had" (Dewey, 1938, p. 25). Dewey theorized that children learn from their social environment and are motivated best through intrinsic desire to discover their world. The concept of child-centered instruction was developed out of this theory. In this model children are guided by the teacher through learning experiences that are relevant and related to their lives. The curricula is developed out of students' interests, students are given freedom of movement, and cooperative learning is emphasized (Spring, 2006). Dewey believed that children learned from social experiences and that the learning environment should center on real life. For instance, in his laboratory school in Chicago, Dewey had seven year old students study the historical development of society. They did so by investigating occupations and experiencing these occupations through activities like weaving and building smelters (Spring, 2005).

Dewey's concepts of emphasis on relevant experiences within a child's environment had been playing out in the Bureau of Indian Affairs schools for Native Americans since the 1860's. Native American children were mandated by the treaties with the U.S. government to attend reservation and boarding schools to learn agricultural and household duties (Spring, 2005). These duties were deemed relevant by the European-American government, not by their own choice; quite a different scene from Dewey's experimental schools for White children in Chicago. The Indian schools were training young boys and girls in the physical labor and mental labors of agricultural work, similar to an apprenticeship. Indian learned with their minds and bodies in the classroom, fields, and household services. Although this is an example of kinesthetic learning through real life experiences in one's environment, it is not one to emulate.

Much more recently in the United States, since the 1970's, the field of education has expanded the theories on the interaction between the mind and the body. Cognitive style theory, learning styles, experiential learning theory, and multiple intelligences all focus on how individuals learn using the mind and body. All of these theories claim that there are multiple ways of learning and intelligence is not a single factor such as IQ. In 1967 Rita Dunn developed her learning styles theory as an extension of the cognitive style theory. In 1971, David A. Kolb followed with his experiential learning theory and cycle of how new information is processed by the brain. This, in turn, was followed by Howard Gardner's theory of multiple intelligences in 1983. More information about these theories will be covered in Chapter Three with the review of their research.

Summary

The mind and body have experienced periods of history in which they were considered separate entities and other periods in which they were an integral part of one another. Apprenticeship learning involved watching and then performing the task oneself. This practice has waned in modern times. In Europe and the United States, as urbanization became more widespread, the need for structured physical experiences became necessary. Both dance and physical education were a part of this structured physical environment. Many educational theorists and practitioners alleged that movement is a necessary part of a child's learning and should be included in public education. We are entering into a time when theory and research are exploring how the mind works, how the body is most efficient, and the relationship between the body and mind. Indeed, the results of scientific experimentation serve to inform not only their specific fields of study but, the implications for the field of education.

CHAPTER THREE: CRITICAL REVIEW OF THE RESEARCH LITERATURE

What research exists that can help answer the question about the effects on cognitive performances when movement is utilized in content area curriculum for primary students? This chapter will critically review the research studies on brain development, physiology, and classroom practices that effect cognitive development through kinesthetic experiences. All of the qualitative and quantitative studies summarized in this chapter were published in peer-reviewed scholarly journals and follow scientific research practices. I focused my synopsis into three sections: the mind, the body, and the mind-body connection. The first of these, the mind, explores current brain research on cognition. The second, the body, encompasses the physiology of learning. While the third, the mind-body connection, illuminates research into the effects of various classroom practices that utilize kinesthetic experiences.

I primarily focused my critique of the research studies on the use of a control group and the sampling of participants. A research study which utilizes a control group provides the opportunity to compare the effects of the treatment on participants with the effects of no treatment on another group. Control group procedure can rule out more confounding variables when the treatment group also acts as its own control. Own control group is not feasible for all studies designs. Only a few of the studies examined in this paper used own control groups (Metlzoff, 2004). By checking for control groups, I'm better able to establish whether or not movement in fact has an effect on student's cognition. Examination of sampling procedures is another area of critique for many of the studies included in this chapter. I look for adequate sample size, sample bias and assignment to treatment group. An adequate sample size can depend on the unique experiment, but in general a larger sample will show more patterns that can lead to clearer conclusions. The results from a homogenous sample can prevent a broad generalization to other populations. In the case of this project, it's particularly important to notice whether the studies on movement involve elementary aged students. I also attended to whether participants were randomly selected or volunteers.. When a study utilizes only volunteer participants the results may not reflect those of the general population due to prior beliefs in the experiment or access to participation in the experiment. The final aspect of sampling I examine is how participants were assignment to treatment groups. Is assignment systematic in either a prescribed matched grouping or random? If the treatment group consists of participants who are homogeneous, and different than the participants in the control group, the results can not be attributed to the treatment. Research designs differ on the best way to assign groups depending on what they are examining. This fact will be taken into consideration when critiquing the study.

I intend to learn more about the impact and effects of utilizing kinesthetic learning experiences for my future practice as a teacher. There is much information circulating among educators about multiple intelligences, learning styles, best practices, instructional methods, and optimal learning strategies. Each of these sections will build a scientific foundation and shed some light on these topics. I will be better prepared to enter teaching with this information.

Mind – Brain Research

The fields of kinesiology, neurology, cognitive neuroscience, and neurobiology have explored the physical processes of the brain and their relationship to cognition. There is a debate among the experts if a relationship exists, and if it does, to what extent can the brain's physical processes translate to educational practices, as discussed in Chapter One. Much of the research supporting kinesthetic approaches to brain-based learning has not been published in peer-reviewed journals therefore, can not be summarized in this paper. Despite the lack of peer-reviewed research studies on the brain and kinesthetic learning, many books have been published about brain-based learning and its application to education. John Ratey published one such book in which he argued that more connections between movement and learning are being unraveled as cognitive neuroscience delves deeper into the functions of the brain (Ratey, 2001).

Ratey referred to the following study by Goodwyn, Acredolo, & Brown (2000) on symbolic gesturing and infant language development. These researchers evaluated the effect of reinforcing communication through symbolic gesturing on verbal language development in hearing infants. The results of the study showed that infants who used symbolic gesturing were significantly ahead of their non-gesturing peers in verbal language development ($p < .001$). The Goodwyn et al. (2000) study illustrates a connection between the use of kinesthetic expressions, through an infant's symbolic gesturing, and increased language acquisition. This result may lend support to the use of other forms of kinesthetic expression, such as writing words in sand, by older children and their continued language development.

Goodwyn et al. (2000) studied 103 infants, 45 girls and 58 boys, who were predominantly from White, middle-class, English speaking families. These infants were separated into three groups, one treatment and two control groups. The treatment group (ST) received parental modeling and reinforcement of symbolic gesturing linked with the verbal word for the object or action. One control group (NC) received no treatment at all and was not aware of the intention of the study. The other control group was developed to accommodate for the training effect. This group (VT) experienced parental verbal labeling of as many things as possible throughout the daily routine. Each infant was tested for expressive and receptive language development at ages 11, 15, 19, 24, 30, and 36 months. Both receptive and expressive language data was analyzed using multivariate analysis of variance for several language measures including phonemic discrimination tasks, mean length of utterance, and one-word picture vocabulary tests. The researchers also analyzed scores of composite language development, expressive language plus receptive language, at 15, 19, and 24 months of age. The following results indicated significance for the treatment group: at 15 months ($p = .004$), at 19 months ($p = .04$), and at 24 months ($p = .008$).

This study design was strong in its use of two control groups, one to address the potential confound of infants improving in language acquisition due purely to the extra effort their parents assign to it. The sample size is adequate to draw broader conclusions, but the sampling design is not. The participants were too homogeneous in socioeconomic class, ethnicity, and birth language to draw conclusions that could apply to our diverse world. Yet, for this particular demographic, the conclusion that symbolic gesturing as a kinesthetic expression of language does improve an infant’s expressive and receptive language acquisition is supported by the research data. The implication this may have for older children, such as primary aged children, is that movement fosters brain development as it pertains to language. Further research possibly including a longitudinal study on these infants may reveal continued advancement in language acquisition. It would also be interesting to extend this type of study with primary students who experience a delay in speech and language. There are multiple future experiments to consider.

Movement and its connection to brain development is the focus of Educational Kinesiology (EduK), also known as Brain Gym, which was developed by Paul Dennison (1981). Educational Kinesiology is “the application of movement to enhance learning potential” (Dennison & Hargrove, 1985, as cited in Cammisa, 1988, p. 105). Dennison & Hargrove theorized that learning disabled children use an information processing method that is rigid and does not utilize much communication between brain hemispheres. Edu-K treatment uses specific movement patterns that activate both hemispheres thereby enabling individuals to assimilate and discriminate new information, making learning easier (Edukinesthetics, 1987, as cited in Cammisa, 1994). Most of the studies listed under Academic Publications on the website of the Educational Kinesiology foundation are case studies and anecdotal information written by practitioners in the field. Only two these studies listed were published in peer-reviewed journals (Sifft & Khalsa, 1991: Khalsa et al., 1988). Both focused on the effect of Educational Kinesiology on physical motor skills. There was not a direct correlation between improved motor performance and improved cognitive skills offered in either of the two studies. The supposition that Brain Gym improves elementary students’ cognition is not supported by either of these studies. Nor was this supposition supported by a third study on Brain Gym, which investigated the cognitive functions of elementary students after the use of Brain Gym (Cammisa, 1994). The Cammisa study was not listed on the EduK website’s Academic Publications page as of July 20, 2006.

The first study summarized is the Sifft & Khalsa (1991) research on Educational Kinesiology. It measured the motor performance in terms of response times after Brain Gym and found motor performance to be improved. This study was designed to answer the questions: 1. Does Educational Kinesiology (Edu-K) integration movements affect simple or four-choice response times of adults?; 2. Does Edu-K re-patterning increase the effect of the Edu-K movements alone?; and 3. Are there any gender differences involved? The researchers determined that there was an increase in response time (RT) after the Edu-K program. Furthermore, since the testing was done after only one session of Edu-K, they asserted that it is effective with adults with only one thirty minute treatment session. One of the strengths of this study was that it assessed simple and choice reaction times which provided a broader spectrum of cognition. The data was analyzed using a multivariate analysis of variance (gender by group) for both simple and four-choice RT. The results from the four-choice RT indicated a significant main effect for group ($p < .01$) and no significant effect for the simple RT ($p > .05$). The re-patterning group decreased their RT by 25.31 milliseconds, the movement group decreased by 15.97 milliseconds, and the control group decreased by 5.3 milliseconds.

Each participant was individually tested for RT for three blocks of ten simple RT trials, followed by a three minute rest, and then three more blocks of ten four choice RT. These trials were completed in 30 minute sessions. The test involved either a simple or four-choice reaction time in milliseconds. The four-choice reaction time tool used a .001 second digital clock. The participants watched a panel of randomly illuminating lights and pushed a button that corresponded to the light which appeared on each trial. For the simple reaction time test, the participants knew which light would be illuminated. The

Edu-K movement group performed seven Brain Gym (Edu-K) movements. The Edu-K re-patterning group performed the same Brain Gym movements plus a ten minute Edu-K re-patterning program that involved accessing the two hemispheres of the brain. The data was also analyzed for gender difference which will not be addressed in this summary.

Another methodological strength was the sample size and treatment group assignment. Sixty adults, thirty men and thirty women, volunteered for the study. The age range was between nineteen and forty years old, with a mean age of twenty-four and a half years. The participants were randomly assigned into three groups, with equal gender distribution. One group was the Edu-K movement only, the second group performed Edu-K re-patterning plus movement, and the final group was the control group with no Edu-K program. One negative aspect of the sample design was that the participants were volunteers whose belief in Brain Gym could have impacted the results.

This study presented several weaknesses. The authors' conclusion that Edu-K re-patterning and Edu-K Brain Gym is effective in improving reaction time is weakly supported by this study. Also, it appears from the report that only one session of 20 trials was completed for data gathering. The study could have used several sessions over a period of time. The results from one session could have been impacted by confounding variables such as fatigue and motivation. The ethnic, socioeconomic status and educational history of the participants are not included in this study. It is problematic to draw conclusions about young elementary children from a sample of adults. In addition, this study assessed the response time and it did not address the number of correct versus incorrect answers. If performance time increases and accuracy decreases, is that a desirable outcome for education? This study can not be generalized due to these areas of concern. In addition, the participants were all adults; therefore the ability to generalize the results of this study to primary aged children is not wise. This study appears to be a replication of the methodology used in its predecessor which is summarized next.

The second article summarized on Brain Gym involves a quantitative research study that was published by Khalsa, Morris & Sifft (1988). This study tested the effect of Brain Gym on the static balance of learning disabled elementary students. This study, as with the previous one, was not designed to measure the effect on cognitive skills. Its relevance to this paper is the use of the movement patterns that comprise Brain Gym with elementary aged participants within the classroom. It is also relevant in that balance in children has been associated with increase in cognition as will be discussed in the Body - Movement section of this chapter (Knight & Rizzuto, 1993). Khalsa et al. (1988) sought to answer the question: do Educational Kinesiology (Edu-K) techniques of re-patterning and/or integration movements affect the static balance of learning disabled elementary students?

The researchers concluded that the results support the idea that Edu-K movement treatment is effective in improving the static balance of elementary students with learning disabilities. The group which received both the Edu-K movement treatment and received re-patterning improved in static balance even more than the group which received only the movement program. The data was analyzed and was found significant ($p = .0001$) with the following mean results: the control group improved static balance by .3 seconds, the movement group by 4.9 seconds, and the movement plus re-patterning group by 7.6 seconds.

The study's strengths lay in the use of a control group and a reasonable amount of treatment time. The control group design allowed the effects of the treatment to be examined versus the effects of no treatment. The participants were separated into three groups which consisted of: one which received Edu-K movements, one which received Edu-K movements and a ten minute Edu-K re-patterning session, and the final group was the control in which no Edu-K programming was received. The treatment time included using the movement program over a six week treatment, five minutes twice a day for five days per week. In addition, the treatment frequency and duration were twice a week for six weeks, a reasonable amount of time to assess patterns in data. The Edu-K movement program involved four of the basic Edu-K movements. The specifics of the movements are not included in the literature of this study. This treatment was conducted by the classroom teacher.

A few problematic issues arose with the sample design of this study. The study was performed with a narrow population and a homogeneous sampling. The researchers used 60 participants identified as learning disabled from one elementary school. In addition, the ethnic, social-economic status, and educational history were not included in this study. These issues do not allow for the results to be generalized to any other population.

The final study on Brain Gym, Cammisa (1994), was a retrospective study to determine the efficacy of Educational Kinesiology (Edu-K) after one year of the program provided by a certified Edu-K instructor. This study informs the question because it evaluated the effects of Edu-K movements on perceptual motor and achievement skills in an elementary school. The study's conclusions that perceptual motor skills improved significantly ($p < .001$), but achievement scores on standardized tests did not improve with Brain Gym shed light on the debate of this program improving students' cognition. Only the data and results which involve cognition will be highlighted in this summary. The author found that the data analysis did not show a significant improvement in achievement scores after the Educational Kinesiology program.

The main strength of this study was found in the follow-up examination of the participants which enabled researchers to determine if the treatment effects lasted over time. The same students were examined after one full school year of the Educational Kinesiology program. The school records of 25 students attending a private school for children with learning disabilities were examined. A drawback of the study was the homogeneity of the participants, they were all White and from middle-class families. Their age range was from seven years to fourteen years, with a mean age of 13 years. The achievement scores, as determined by the Comprehensive Test of Basic Skills (CTB/McGraw-Hill, 1983, as cited in Cammisa, 1994), were obtained for the study year and the preceding year. Participants served as their own control with the assumption that skill improvement would be similar with each school year. In addition, the program treatment was conducted by a certified instructor, so it could be assumed that the treatment received was precise to the expectations of the Edu-K Foundation.

The author addressed several weaknesses in her conclusion. The primary weakness is the lack of a control group. The secondary weakness is the sample of participants was small and homogeneous in both ethnicity and socio-economic status. Several confounding variables could have been the result of the closing of the private school at the end of the Edu-K program. These variables were student motivation and emotions. Other variables during the Edu-K program that were present were changes in teachers, classes, and administration. One final weakness is the tool used to assess academic achievement. This test was normalized for averagely developing students and may not be an adequate tool to assess the academic achievement of students with learning disabilities. This study used participants with learning disabilities and the results may not be applicable to averagely developing students.

The conclusion from these three studies of Educational Kinesiology (Brain Gym) is that the use of prescribed body movements in the school classroom does improve the physical motor skills of learning disabled students. It would not be wise to generalize these results to other populations or to academic achievement without further research which utilizes these other variables. Yet, many educators and authors subscribe to the benefits of using Brain Gym with elementary students of varying academic abilities. Further research is needed to illuminate the effects that those in the field know occur.

Body – Movement

The question about the connection between movement, brain function, and cognitive development in young students remains open for some educators and researchers. Movement, as used in these next several studies, ranged from gross motor to fine motor skills. Movement also varied between defined, prescribed exercises to free mobility during school recess. Some studies focused on balance while others examined the quality of attention or achievement immediately after exercise. This section will present research on the effects of movement on the cognitive abilities of primary students and adults.

The first study, by Reynolds, Nicolson, & Hambly (2003), examined the impact of an exercise regime on reading and math skills for elementary aged students identified with dyslexia. These researchers found that literacy skills such as semantic fluency, verbal fluency, and phonemic awareness showed a significant improvement ($p < .05$) after the six month exercise program. In addition, the students' scores on standardized tests in comprehension showed a significant difference ($p < .01$) and test scores in writing and reading also exhibited a significant improvement ($p < .05$). The results of this study imply that movement, through a particular exercise regime, improves both the skills necessary for literacy and the reading achievement scores of elementary students with reading difficulties.

The specific exercise program for 18 children, ages nine to ten years old, was administered at home by their families. The treatment involved balance, eye-hand coordination, stretching, and body coordination exercises completed individually or two at a time. The authors chose not to disclose the details as they are "commercially sensitive" (Reynolds, 2003, p. 55). The program was called Dyslexia Dyspraxia Attention Deficit Treatment (DDAT). The control group did not receive any exercise treatment at home and was comprised of 17 children matched for dyslexia scores, gender, and age who. The weakness of this study lies in the lack of placebo treatment and its small sample size. The authors did not give any demographic information on the participants, so no conclusions can be implied as to its applicability to a population other than the one studied. The strength of this study is in its examination of movement on multiple variables: literacy skills, reading and mathematics standardized test scores, and incidence and remediation of cerebellum and vestibular problems. For the purposes of informing this master's question, only the literacy skills and reading standardized test scores will be discussed.

An interesting aspect of this study is that it was designed to examine two facets of cognition which were referred to as "near transfer of cognitive skills" and "far transfer to literacy skills" (Reynolds et al., 2003, p. 56). The near transfer involved phonological awareness, working memory, and speed of processing information. Far transfer was defined as the ability of a participant to accelerate their acquisition of literacy at or above the normal range. The researchers discovered that for two of the near transfer cognitive skills there was significant improvement; phonological segmentation ($p < .05$) and semantic fluency ($p < .05$) but no significance for working memory or speed. The reading scores were evidence of far transfer and showed significant difference ($p < .01$).
It was of interest to the researchers to note that the scores on the math tests of the treatment group did not show a significant difference between those of the control group.

The results of this study, tempered with its weaknesses, indicated that the presence of the DDAT movement program improved some literacy skills and reading test scores for this group of elementary students. This lends support to the positive effects movement has on cognition for some children. As more children are identified with learning difficulties such as dyslexia, the results from studies such as Reynolds (2003) shed light on methods of improving the cognitive skills for this population.

An earlier study conducted by Knight & Rizzuto (1993) also examined movement and its effect on academic achievement in elementary students. These researchers inquired about the effect of ten balance skills on the reading and math achievement scores of students in second, third, and fourth grades. They found that the standardized test scores increased in correlation to the increase in balance skills. While both academic areas increased, reading scores experienced a greater increase ($p = .002$) than math scores ($p = .015$).

The research article gave a brief synopsis of the study; terms were defined, method outlined, and results reported. The balance skills tested involved the kinesthetic receptive system in the brain as well as on a muscular level. The ten balance skills fell into either the dynamic or static balance category. Dynamic balance was defined as “the ability to maintain a balanced position, while moving through space…” (Thomas, Lee, & Thomas, p. 81-82, as cited in Knight & Rizzuto, 1993, p. 1296). Static balance was determined to be “the ability to maintain a stationary position, for a specific period of time…” (Thomas, Lee, & Thomas, p.81-82, as cited in Knight & Rizzuto, 1993, p. 1296). Every participant was tested on a pass or fail scale for each of the ten skills so that the balance scores ranged from zero to ten. There were 122 students, 64 boys and 58 girls, from the second, third and fourth grade classrooms in a Georgia public school. It’s difficult to assess potential demographic confounding variables because no other demographic information was included in the report. The academic achievement test scores were obtained from the Iowa Test of Basic Skills. The results indicated that as a student’s balance score rose, so did the student’s achievement score.

The results of this study lend support to the correlation between a student’s kinesthetic abilities, as assessed by balance, and her academic achievement in reading and math. Balance requires both the brain and the body to coordinate using many kinesthetic receptor systems. Educational Kinesiology as a way to improve static balance skills was tested in Khalsa, Morris & Sifft (1988), as discussed earlier in this paper. If, as the Knight & Rizzulto (1993) study suggests, balance and achievement are linked, then improving one's balance may improve one's achievement. The results found in this study help to inform the question of this paper. Kinesthetic learning opportunities can include performing balance skills, which may be related to a student's academic achievement.

The necessity of movement in a primary student's daily schedule has been under investigation recently in many school districts throughout the country. A 2004 statistic claimed that as many as 40 percent of elementary schools have eliminated recess (American Association for the Child's Right to Play, 2004, as cited in Zygmunt-Fillwalk & Bilello, 2005). The debate over the issue of recess time versus more instructional time has arisen in the United States in the last decade. Some educators and parents connect the timing with the Federal No Child Left Behind accountability measures for schools. Schools must meet achievement requirements in order to receive Federal funds and the pressure is on teachers, administrators, and students to improve academic test scores.

Many studies have been conducted to determine the need or lack of need for routine physical exercise in young children. This debate is important to the use of movement within content curriculum because the research helps to inform the effects of movement in general on the academic achievement of elementary students. The movement explored in the next study is free play during school recess. This quantitative study by Pelligrini, Huberty, and Jones (1995) examined the question How does recess timing affect children's behavior on the playground and their attention to tasks before and after recess? The authors of this study concluded that children need physical and social breaks from sedentary tasks. Inattention to task was significantly greater before recess than after ($p < .0001$). Furthermore, the data exhibited an increase in inattention especially in boys as the length of time between breaks increased. For the pre-recess period, the Kindergarten students' inattention measure had a significant main effect ($p < .03$). For the second and fourth grade students, a statistically significant main effect was found for grade ($p < .0001$) with the fourth grade students exhibiting less attention during the longer interval. The researchers asserted that the data gave evidence for shorter task times with more task variety.

The major positive attributes of this study were the large and varied overall sample size, observation protocol, attention to most potential confounding variables, and the three time repetition of the experiment. The study participants were a total of 145 students in intact classrooms of Kindergarten, second, and fourth grade. They attended public school in the southeast United States. There were a variety of socioeconomic, cultures, and social backgrounds; of which one third were African-American, "very few" Asian-Americans, and a majority of Euro-Americans (Pelligrini et al., 1995, p. 848). The distribution of participants within each grade for the first experiment was: Kindergarten with 17 students (11 boys, 6 girls), second grade with 24 students (13 boys, 11girls), and fourth grade with 21 students (10 boys, 11girls).

The observation protocol required for all three experiments involved observation of each student for two months. Students were observed for 20 minute periods before, during, and after recess. There were four observers which included three regular observers and one rotating observer to serve as a reliability judge. One month before the study observers were trained and practiced observation techniques using video taping, observation tools, and team meetings. Data was collected using instantaneous sampling which involved recording behavior every 30 seconds. Each student was observed and recorded an average of 21 times in each period. The behavior that was observed and recorded was inattention before and after recess as well as physical activity and social interaction during recess. The data on inattention will be summarized for the purposes of this paper. Inattention was defined as the direction of students' gaze towards the task or Teacher. The observations were performed four days per week. The daily class schedule was altered to manipulate the duration of pre-recess class work. For two days per week recess was at 10:00 a.m. (short deprivation) and for two days per week recess began at 10:30 a.m. (long deprivation). A deprivation period is any length of time that a desired activity is withheld.

The researchers attended to several potential confounding variables; gender, weather, grade level, and deprivation period. The first experiment took into account gender, grade level, and deprivation period. A confound of weather was discovered. Subsequently, the experiment was replicated two more times to examine the variable of weather impacting physical and social activity by conducting one experiment with indoor recess and another experiment with outdoor recess at a different time of the year.

The weaknesses of this study were the activity chosen for attention and behavior observation and the criteria for inattention and behavior. The activity observed was a teacher-directed, sedentary, and quiet activity conducted before and after recess. More specifically, the task was a teacher read story during which the students were sitting and listening. Inattention was defined as lack of direct gaze towards the teacher. This is problematic because direct gaze is a culturally specific indication of attention. Many cultures deem direct gaze at an elder or authority figure as disrespectful. It is also an incorrect indicator of inattention for many individuals who doodle or gaze away from task but are still very attentive to the task. Since the task observed by the researchers was listening to a story read by the teacher, the direction of a student’s gaze may have been the only observable measure for attention.

Although there are problematic evaluations of inattention to task and the sedentary nature of the task, this study demonstrated that children will engage in physical and social behaviors when given the opportunity, as during a recess period. Also, children learn best when learning is distributed across tasks. Therefore, since students’ attention waned as length of task period increased, learning tasks should be short in duration and varied materials and delivery methods employed. Due to this factor, some Japanese and Taiwanese schools include twice the number of recess periods in comparison to schools in the United States and maintain higher academic outcomes (Stevenson & Lee, 1990 as cited in Pellegrini, 1995).

This next study, conducted by Jarrett, Maxwell, Dickerson, et al. (1998), corroborated the findings of Pellegrini et al. These researchers also inquired about the effects of recess on the classroom behavior of second and fourth grade students before and after a recess break. The specific behaviors observed were attention to class work, fidgeting, and listlessness. Class work was defined as on-task behavior with assigned work, fidgeting was defined as excessive movement of the hands, arms, or legs, and listlessness was defined as head on the desk, staring off, or eyes closed. The data revealed that sixty percent of the participants increased their class work and/or fidgeted less after recess. There was a significant increase in class work ($p = .003$) and a significant decrease in fidgeting ($p = .001$).

The method accounted for two of the potential confounding variables in the Pellegrini (1995) study. The primary strengths of the Jarrett study were observation time and observed activity. Both of these were child-centered which provided for an authentic experience for the students. The students were observed during their regular daily routine, not just in a quiet sedentary activity. Also, these students were not accustomed to recess, so they were not conditioned for a non-structured physical and social break in their class work. This study was considerably smaller than the previous study, yet had an adequate sample size of 43 students from two fourth grade classrooms.

The primary weakness of this study was its narrow sample demographics which does not allow for the results to be generalized to other demographics. All the students were in the same grade and they resided in middle to upper middle class neighborhood with a 70 percent White and 30 percent Black ethnic make up. Eighteen of these students were boys and 25 were girls. One important factor the researchers identified in their analysis of individual differences was that five of the students were on medication for Attention Deficit Disorder (ADD). Each of these five students increased his or her on task behavior and decreased their fidgetiness after the recess periods.

The students were provided a 20 minute recess period for a total of six recesses between November and March. Recess periods were scheduled on days when students did not have PE, when weather permitted, and no school assemblies were held. The two classes participated in PE three mornings a week with no physical opportunities on the other two days of the week. The participants did not know ahead of time when they would receive recess so as to control for the factor that recess could be perceived as a reward for good behavior. One of the classes had recess after two and a half hours of instruction and the other class had recess after three and a third hours of instruction. The non-recess data that was analyzed occurred on the days closest to the recess days. This would allow for more continuity in comparing an individual’s behavior.

The Pellegrini (1995) and Jarrett (1998) studies both illustrate the benefits of a physical recess break for elementary students. They lend support to the controversy over whether or not a school should include recess on a daily basis. Their findings also illuminate the question of this paper. Kinesthetic learning opportunities within classroom instruction are a small means of providing a physical break from seat work. Both of these studies demonstrated that the presence of movement, during recess or PE, increased attention to class work and/or decreased off-task behaviors. This in turn could lead towards increased cognitive performance. It may be surmised that in addition to recess and PE, kinesthetic learning during instruction is beneficial to some cognitive and behavioral development of elementary students.

Children’s activities during recess provide them with opportunities for social interaction and exercise. Exercise is an integral part of the health and well being of all humans. Researchers have examined the physiological, psychological, and emotional impacts of exercise. The following three research studies focused on the relationship between exercise and several cognitive tasks for adults. While clearly focused on different age groups, the results of all of the studies could potentially inform the effects of exercise on younger participants.

In the quantitative research study performed by Cian, Barraud, Melin, & Raphel (2001) the question examined was what effects do heat exposure, exercise-induced dehydration, and fluid ingestion have on the cognitive functions of long-term memory, short-term memory, reaction time, perceptive discrimination, and unstable tracking? This study is relevant to this paper's question because it found that the physical state of the body is connected to cognition, in this case memory. Only the data analysis involving exercise and memory will be summarized. The researchers determined that exercise increased the cognitive processes of long-term memory and short-term memory.

The results demonstrated that after exercise participants performed higher on long-term memory after 30 minutes recovery both 30 minutes and 3.5 hours recovery in comparison to the control group. Also significant was that participants performed worse after exercise on short-term memory after 30 minutes recovery and performed comparably after 3.5 hours recovery period. The researchers determined that dehydration has a detrimental effect on long-term memory for the 30 minutes and 3.5 hours recovery periods ($p < .05$). Dehydration also has a significant negative effect on short-term memory ($p < .01$) after 30 minute recovery. The researchers determined that cognition returns to baseline with or without re-hydrating fluids.

This study presents two areas of strength in its methodology; attention to five variables and three time intervals for measurement of cognition. The method included five sessions for each variable (heat stress, exercise, fluid rehydration, and no fluid). The exercise regime consisted of a mean of two hours of exercise on a treadmill at 65 percent VO2max until a 2.8 percent loss of body mass (dehydration) resulted. Any fluid deficit in the control group was replaced completely.

The methodology of Cian et al. (2001) also included cognitive assessment after a short recovery period, 30 minutes, and a long recovery period, 3.5 hours. Test 1 evaluated the cognitive functioning of the participants 30 minutes after a two-hour trial of dehydration from exercise. Test 2 evaluated the same cognitive functions three and a half hours after the same exercise regime, with re-hydrating fluids or without fluids. There was a control group for all sessions. The cognitive functions assessed were long-term memory, short-term memory, reaction time, perceptive discrimination, and unstable tracking. Only long-term memory, short-term memory, and decision reaction time will be explained for the purposes of this summary. Long-term memory testing was accomplished by using a set of 12 pictures. Each picture was displayed for 10 seconds at the beginning of each test session. Free recall and recognition were assessed 30 minutes later. Each session provided a new set of 12 pictures. Short-term memory was assessed by participants memorizing a string of digits presented for one second with .5 seconds between digits. They then recalled the string of digits in the correct order by clicking on those digits of a visual keypad on a monitor.

The main weaknesses of this study are its extremely small sample size and homogeneity and some incongruence in the report. The participants were 7 endurance-trained, physically fit men with mean age of 25 years. One such incongruence appears when the authors state that the experiment was designed to study the effects of heat stress and exercise-induced dehydration and fluid ingestion on cognition. This was followed by the sentence, “Consistent with other studies, heat stress and exercise had a detrimental effect on cognition” (Cian, et al., p.249). It is not clear in these two sentences whether heat stress and exercise are detrimental to cognition or if dehydration *from* these two regimes is detrimental. The data provided illustrates that it is the dehydration that evokes the deleterious effect on cognition. These weaknesses may be due to the translation of this study from French to English.

The conclusions made by the authors suggest that activating the body activates the brain. In addition, the intention of the study was to determine the effects of physical dehydration on cognitive functions and the study found a correlation. This lends support to the growing interaction of physiology and neuroscience; there is a relationship between the physiology of the body and the cognitive functioning of the mind. Due to the small sample size, age, and physical fitness of the participants the results from this study are difficult to generalize to other populations. In addition, since the study examined dehydration after extreme exercise, its direct applicability to the elementary school student population in the United States is not possible. However, the study informs the question of the effects of movement, in the form of exercise, on long and short term memory in adults and would merit research in the future with an elementary school sample.

The next study, executed by Tomporowski, Cureton, Armstrong, Kane, Sparling, & Millard-Stafford (2005), was also an exploration into the effects of exercise on cognitive processes, this time of young adults. The researchers' finding of increased ability to perform cognitively after exercise lends support to the positive effects on learning with kinesthetic experiences. The question posed was what are the effects of individual bouts of aerobic exercise on young adults' performance of an executive processing task and on ratings of emotion and workload? They conducted two experimental procedures and in both experiments the results indicated a significant increase in the executive processing skills after exercise than before. For experiment 1, 13 training trials by eight participants (one was dropped due to inability to perform the Paced Auditory Serial Addition Test (PASAT) with practice) were analyzed separately by repeated-measures ANOVA. The analysis revealed that the number of correct responses increased with practice ($p < .05$). The study stated that the percent of correct PASAT responses increased from baseline with exercise, but that data is depicted in a graph in which the exact numbers are difficult to ascertain in order to support that claim. In experiment 2, the results were analyzed in the same fashion as experiment 1. These results suggest that PASAT results increased as a result of initial training ($p < .001$). The post-exercise performance was significantly increased from the pre-exercise performance ($p < .05$). The authors conclude that “periods of physical activity are linked to improvements in cognitive functions…” (Tomporowski et al., p.143). They continue this statement by linking these findings with implications for education and health.

This study used an unique cognitive assessment tool. The PASAT tool is an executive processing assessment instrument that was used in a modified format for this study. It is a pre-taped audio presentation of a random series of numbers from one to nine. The task is to add pairs of numbers so that each number is added to the preceding number, the sum is spoken out loud, the participant listens to the next number in the series, adds that to the preceding number (not the spoken sum) and says the new sum out loud. This is repeated for all the numbers in the series. Accurate performance requires the participant to understand the auditory input, add two numbers and verbalize the sum, and then recall the most recent number in the series in order to add it to the next number in the series. This assessment tool has been determined (in other studies) to induce negative moods (Tomporowski et al., p.133). The modification made was that each trial consisted of 120 digits presented at a rate of one per 1.6 seconds. Four unique sets of 120 digits were used.

The experiment protocol for the first experiment required each participant attend four sessions, separated by at least five days, at approximately the same time of the morning each day. The first session was used to teach the PASAT. The second, the participants completed five PASAT trials and performed physical baseline testing. The third session started with five PASAT trials and after 40 minutes of 60 percent VO2 max exercise, another three PASAT trials were completed. The final session was conducted seven days later and was identical to that of the third session. The second experiment was similar to experiment 1 except the participants performed in six sessions. The first session was used for PASAT training and baseline assessment. The remaining five sessions were used to test and gather data with a double-blind, counterbalanced design so that each participant was also her own control. The participants started with five PASAT trials with 120 digits presented at a rate of 1.2 seconds. The participants exercised using indoor cycling for 120 minutes at 60 percent and 75 percent VO2max, alternating every 15 minutes. Participants completed five PASAT trials after 30 minutes resting recovery period.

The main weakness was lack of statistical support for the author’s conclusions. The numbers supplied in the study article did not support the authors’ conclusions. Another weakness of this study was the conclusion drawn by the author that cognition improved with exercise. The resulting increase in cognitive performance may have been more closely aligned with practice than with exercise. In addition, the small sample size and sampling design were problematic. Experiment 1 consisted of nine men, with mean age of 22 years who were recruited via posters within the University community. They were active in physical recreation, but not highly trained. Experiment 2 involved ten women, with mean age of 30 years who were recruited via announcements made to members of community cycling clubs. They were highly trained competitive cyclists.

The study participants were able to improve their performance on a cognitive test after stimulating the whole body with exercise. Further research into the precise relationship between cognition and kinesiology needs to occur to extend the researchers conclusions to the kinesthetic experiences that can transpire in the primary classroom. Further research is needed with larger sampling and fewer experimental variables. There need to be several studies that replicate this methodology, eliminate the addition of drugs and re-hydrators, and use aerobically fit and less-fit participants. Moreover, a study is needed on children and youth within school settings in order to ascertain the applicability towards education and health.

The final study, conducted by Hogervorst, Riedel, Jeukendrup, & Jolles (1996), investigated the speed and accuracy of adults after exercise. The researchers asked would students perform faster on simple tasks after an endurance test than before the test? And would students perform worse on complex tasks after an endurance test than before the test? The results indicated the positive correlation between post exercise and increased speed of cognitive functioning thereby lending support to the inclusion of exercise in a child’s school day. The evidence also showed that there were no more errors made with increased performance speed. This summary will mainly focus on the completion time for cognitive tasks. The multivariate analysis revealed that participants took significantly longer to complete the color naming task than the color word reading task ($p < .001$). Also, time needed to complete the color word reading was significantly longer before exercise than after exercise ($p < .05$) and baseline ($p < .001$). For the color word interference task, time to complete was significantly longer before exercise than after ($p < .005$). In addition, the time to complete was significantly longer for baseline than after exercise ($p < .005$). The researchers determined that there were no more errors made with increased response time.

The research design was strong in its cognitive assessment tool and analysis. The cognitive tasks were assessed using the Stroop Color-Word test. This test had three categories, color word reading, color naming, and color-word interference. In the color-word reading, the participant read and verbalized the color names row by row as quickly as possible with no mistakes. In the color naming, the participants verbally named the color of patches. Finally, in the color-word interference, the participants were to name the color of the ink in which the names of the colors were printed without paying attention to the word itself. Psychomotor tasks were assessed for choice reaction time (RT). In this test participants pressed a button that lit up in increasing task complexity (simple RT, 3-choice RT, and incompatible RT).

This study suffers from a small sample size, limited treatment testing times, and participants who were highly trained athletes. Fifteen male triathletes and competitive cyclists enrolled in a validation study of endurance performance with a mean age of 24.9

years. The participants were only assessed for pre and post exercise cognition during one of the three experiment sessions. This study offers very limited data on a very small sample. This study referred to previous studies in which cognitive performance increases were attributed to the compensation effect. This compensation effect occurs with highly trained subjects and is mediated by the expectation that exercise has a beneficial effect on cognition (Tomporowski & Ellis, 1986, as cited in Hogervorst et al., 1996). It has also been shown that the opposite is true; participants who do not usually engage in high intensity exercise believe that it will have a detrimental effect, subsequently their performance decreases after exercise (Delignieres, Brisswalter, & Logan, 1994, as cited in Hogervorst et al., 1996).

The compensation effect seems to indicate that there is a correlation between expectancy and performance and could be applied in the classroom as a motivating method. It could be possible that if students believe they will perform better after exercise, then they are more likely to increase their performance. Movement is an essential component of exercise, so these results could be applicable to the inclusion of movement in the school curriculum. It could be surmised that exercise, and thereby movement, activates the functions involved in cognition. However, further research into exercise conditions as they relate to cognition in elementary students would be necessary to make this connection.

The final study summary for this section involved a highly specialized population. Polatajko, Law, Miller, Schaffer, et al. (1991) evaluated the effect of sensory integration therapy on academic achievement, motor performance, and self-esteem of elementary students with sensory integration (SI) dysfunction. This study is relevant to the inquiry of this paper in its exploration of the effects of sensory integration therapy on performing cognitive tasks such as reading, writing, and mathematics. The sensory integration therapy used involved several kinesthetic senses; proprioceptic, vestibular, and tactile as well as motor performances. All of these sensory experiences can be involved in learning through movement in the classroom. The results lend support to the theory that movement increases cognitive performance. The researcher sought to determine if there was a difference between the effects of an SI program or perceptual motor (PM) program on academic achievement, motor performance, and/or self-esteem in sensory integration dysfunction children. Sensory integration dysfunction was defined as the impairment of the organization and processing of sensory stimuli required to make adaptive response to the environment. Normal cognitive development depends on the adequate integration of the sensory systems, most notably the vestibular, tactile, and proprioceptic systems (Polatajko et al., 1991).

The researchers found that students improved in reading, writing, and mathematics after the six month SI and PM therapy. There was no significant difference in improvement between SI and PM therapy. There was a close to significant improvement in mathematical scores at the three-month test ($p = .054$) and at the nine-month test ($p = .058$). The researchers noted that if this data had been analyzed using a one-tailed test, SI therapy would have been significantly higher than PM therapy in the mathematical assessments. There was no significant difference in improvement in the motor performance between SI and PM therapy ($p = .955$). Of interesting note is the results show that these LD students performed comparably to the normal growth and development sample. Maintaining normal cognitive and motor growth and development is a significant outcome for students with sensory integration dysfunction (Polatajko et al., 1991).

Random selection of participants to treatment group and treatment methods were the two main attributes of this study. Participants were randomly selected to the sensory integration (n = 35) and perceptual motor (n = 32) therapy groups. Since all participants were identified with sensory integration dysfunction, this process eliminates some degree of test bias. The treatment method required that each group received one hour of therapy per week for a six month period. Participants were assessed at six months and nine months. The protocol required three months between experiment and any other therapy. The SI program used a scooter board and bolster swing to engage the vestibular sensory system. The PM program used fine and gross motor activities and eye-hand coordination tasks. The cognitive test used was the Woodcock-Johnson Psycho-Educational Battery (WJPEB, 1977, as cited in Polatajko et al., 1991) for reading, writing, and mathematics. The PM program used the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP, 1978, as cited in Polatajko et al., 1991). The authors do not explain these tools any further.

The main weakness of this study was that there was not a control group involved. The researchers originally designed this study to have a control group in which no occupational therapy was given. The researchers stated that they could not adequately recruit for the control group because the pool of participants was children who had already been referred to receive occupational therapy (OT). It was deemed to be unethical to not provide some type of OT treatment to a group of children referred for that purpose.

The study had an adequate sample size, 67 children between six and nine years old identified with sensory integration dysfunction and participating in occupational therapy. There were 58 boys and 9 girls. These children had normal IQs yet had an academic delay of six months to one year in reading, mathematics, and writing. Although the sample size would provide information to determine trends, the statistical analysis method did not allow for the isolation of data to examine individual performances. For example, the results of the psycho-motor testing showed that half of the participants performed above the average group and half performed below the average. The question to be explored in further research is why this occurred. Was there a difference in individual participants? Or was there a methodological factor involved? The researchers identify this unusual result in their discussion.

All of the study participants were students with identified learning disorders (LD). It would not be prudent to generalize the improvement in academic achievement to a population of averagely developing students. A few other studies involving LD, average, and accelerated students will be summarized in this paper and their results show differences in achievement depending on these factors. However, today's mainstream classrooms present diverse students, some of whom could benefit from multi sensory stimulation as did the students in this study.

The research collected pertaining to the body and movement contained experiments on elementary students' cognitive skills impacted by movement, school recess, exercise in adults, and sensory integration therapy in learning disabled students. One study reflected a significant improvement in literacy skills such as semantic fluency, verbal fluency, and phonemic awareness occurred after an exercise program (Reynolds et al., 2003). While another research experiment discovered that the students with more balance skills performed better on the standardized tests (Khalsa et al., 1988). Other studies addressed children's activities during recess (Jarrett et al., 1998; Pelligirini et al., 1995). Recess provided them with opportunities for social interaction and exercise. Many of the conclusions made by the researchers suggest that activating the body activates the brain (Hogervost et al., 1996; Jarrett et al., 1998; Knight & Rizzuto, 1993; Pelligirini et al., 1995; Tomporowski et al., 2005). Exercise is an integral part of the health and well being of all humans. In the study of sensory-integration therapy for students with sensory-integration dysfunction, the kinesthetic therapies were found to improve cognitive skills. Caution should be used in generalizing these research results to other populations. Yet, kinesthetic learning benefits some students and addresses the needs of a diverse population.

Mind-Body Connection – Classroom Practices

It is logical that classrooms in U.S. public schools would get more diverse as the overall population increases its diversity. Many educators would assert that a wide variety of students requires a wide variety of classroom practices. The practitioners, theorists, and researchers in the educational field have supplied their expert opinions on the issue of quality classroom practices. As one expert claimed one practice is the best, another expert claimed a different practice is the best. The following synopses of research studies on several classroom practices that utilized kinesthetic and/or tactile learning experiences should elucidate the scientific underpinnings of these claims. Many of these studies involved real teachers employing kinesthetic learning in their own classrooms. I hope to discover if incorporating this type of learning opportunities increased the cognitive skills of some students and if so, what kinesthetic methods were employed. Each study included in this section will be summarized with the purpose of illuminating the effects on cognitive performances with the use of kinesthetic learning contexts in content area curriculum for primary students.

The first empirical research study investigated the use of kinesthetic teaching methods and its effect on writing, reading, and spelling. Grant (1985) inquired what long term affects does using a kinesthetic approach to teaching writing, reading, and spelling have on at-risk students in first grade and their academic acquisition through fourth grade. The author defines kinesthetic as “muscular movement in response to visual, auditory, and tactile stimulation” (p. 455). Grant concluded that at the fourth grade level, the at-risk (treatment) students matched or surpassed the non-risk students (control). This increase in academic performance was especially noticeable in the skill of word meaning. The at-risk group scored fifteen points higher than the non-risk group; with a mean score of 63 for the treatment group and a mean score of 48 for the control group.

The research design employed in Grant’s study involved two groups of students, the treatment group was students identified in Kindergarten as “at-risk” for academic habits and the control group was students who were not at risk. Teachers evaluated the potential participants (first graders at the time of sample selection) by answering 23 questions concerning the student’s achievement in Kindergarten. There were 22 students determined to be “at-risk” in academic habits by teachers. Of the remaining first grade population, 22 students were chosen to be the control group by a process of matching their scores on the Otis Lennon Mental Ability Test-Form J with the scores of the treatment group participants. A match was considered equitable when the test scores were within 3 points of one another. Therefore, the difference between the control and treatment groups was in academic habits not measurable intelligence.

The major strength of this study was its longitudinal design. Longitudinal studies enable the evaluation of long term effects of treatment on the same participants. The protocol in this study required that the two groups were tested on speech, hand-eye coordination, self-reliance, cooperation, adjustment to task, mental habits and language in first grade. These two groups were then randomly mixed in subsequent grades and evaluated on word knowledge, word analysis, reading, total reading, spelling, word study skills, paragraph meaning, and language. The participants were then instructed with either a kinesthetic method (treatment group) or conventional method (control group) for one year. The control group was taught in conventional pedagogies of learning and in the order of first reading, then writing, followed by spelling. The experimental group was taught using kinesthetic approaches with auditory, kinesthetic/tactile, and visual methods in the following order; writing, then spelling, followed by reading. The kinesthetic methods utilized in writing were instructing students to trace individual letters in cursive in the letter order with the easiest motor requirements. Students then traced letter combinations and then progressed to individual and combinations of letters with more motor difficulty. The kinesthetic spelling instruction included hand motions for each letter and focused on visual and auditory discrimination between letter shapes and sounds in a sequence of vocabulary words. The treatments group’s kinesthetic instruction with reading was similar to spelling; letter hand motions were encouraged, yet the focus at this stage was in auditory and visual reading instruction. The reading program centered on student participation in choosing material and individual conferences with the teacher to work on making meaning of the texts.

This study's weakness is in its sample design. It drew from a limited population, 44 first grade students, from one non-public school in a Midwestern town with middle to upper-middle class residents. In addition, it did not use a reliable control group. For the control group to generate statistically comparable data it would need to be comprised of the same academically challenged population as the treatment group. The group that the author calls the "control group" was averagely developing in their academic habits. Although, the sample size is limited, the results support the author's conclusion that the participants who received kinesthetic instruction in first grade while they started the experiment out as "at-risk" were able to close the achievement gap, and in one area increase their performance, within three years. This study illustrates that kinesthetic teaching methods were beneficial to at risk elementary students in writing, reading, and spelling.

The next short empirical study connects the use of kinesthetic and tactile teaching methods to increased recall of scientific concepts. Searson & Dunn (2001) tested various teaching models which incorporated students' learning styles, one of which entailed kinesthetic and tactile experiences. Indeed, the results showed that when the teachers used tactile and kinesthetic methods of instruction, there was a significant difference in science achievement scores ($p = .00008$). These findings indicated that presenting science content curriculum in a kinesthetic manner greatly improved these students' higher level cognitive achievement.

This study's design divided the 59 third grade students into three groups who studied three science concepts, motion, forces and simple machines, and energy transformation. A benefit to this design was that each group received instruction for two of the three concepts with kinesthetic and tactile experiences while the third concept was presented with traditional methods. Therefore, each group served as a control group for one of the units. The groups alternated being the control. Another positive aspect of the design was that the researchers exposed the students to these manipulatives and floor games prior to the study period in order to control for increased learning due to the novelty of the materials.

The kinesthetic and tactile learning opportunities involved several manipulatives which enabled students to move their hands to find correct answers. Large muscle floor games were utilized to allow for full body movement while learning. More kinesthetic materials used were task cards, learning wheels and fans, puzzles, electroboards, role play, and application of the concepts in the field. The participants also conducted hands-on laboratory experiments with each of the units. Small group learning was the vehicle for the kinesthetic and tactile experiences. The traditional teaching methods employed were large group direct instruction lectures, textbook, and workbook activities. All of these learning experiences were congruent with the state's (New Jersey) curriculum standards.

The main weakness to Searson & Dunn's (2001) study design was its sample. The article did not give any demographic information except that the students attended a New Jersey suburban elementary school. The participants may have been a homogeneous sample. There is also no information on sample selection or teacher training in either traditional or kinesthetic teaching methods. All of these factors could impact the applicability of this study to other areas of the population.

Although the authors left several sampling and methodology questions unanswered, they discovered that sixty-five percent of these students performed significantly better on higher cognitive science skills. Higher level cognitive skills were defined as “behaviors and thoughts that students engage in during problem solving” (Searson & Dunn, 2001, p. 25). The improvements in achievement were not simply at the recall level, a lower level of cognitive processing. If the results from this study are applicable to other populations, then it lends support to the positive effects of offering kinesthetic learning opportunities to elementary students.

These last two studies involved science and literacy curriculum while the next study addresses interdisciplinary curriculum practices. Kinesthetic learning contexts are a part of a well balanced learning environment in single subject curricula and interdisciplinary curricula. The following study focused on infusing content area curriculum, such as mathematics, social studies, and literacy with the visual and performing arts curriculum. Arts curriculum stimulates the visual, tactile, auditory, and kinesthetic senses through drawing, acting, sculpting, building, and many other media. Hooper (2002) examined the impact of arts education on content literacy in Italian schools. Hooper referred to previous studies which concluded that “[t]he use of complex arts based tasks at all levels of learning increase internal motivation and decrease behavior problems”(Hooper & Glass, 2000; Hooper, 1994, as cited in Hooper, 2002, p. 23). This was also supported by the teacher questionnaire responses within this study. The author believed that arts curriculum taps into the right brain functions through visual and performing arts while building left-brain skills such as content literacy. In this qualitative study, Hooper asked: Are art-based methods used in Italian schools beyond preschool? If so, how are they used to help students acquire and express knowledge? The author determined that Italian schools do use arts based curriculum after preschool, but as students get older, the use decreases.

The strengths of this study lay in the combined use of quantitative and qualitative research methods. Quantitative research provides quantifiable data from which patterns can be determined. While qualitative research allows for sociological data collection. Combining quantitative methods with qualitative broadens the types of data to form a more comprehensive picture of the patterns. Quantitative methods were applied to the extensive sample demographics. The study participants were 545 students from 44 classrooms from preschool through middle school in the Italian public school system. Data was analyzed by gender, race, academic ability, socio-economic status, total number of teachers, teacher's gender, and years of teaching experience. Qualitative measures were employed for the data collection. The data was collected from almost 53 hours of audio and video, as well as still photo, running record, and teacher questionnaires. Tasks that utilized several levels of cognitive processing were measured; knowledge, comprehension, application, analysis, synthesis, and evaluation. The data tables referred to either complex or simple tasks. There is no data depicting the individual cognitive levels and their correspondence to number or frequency of tasks. Tasks were also categorized; one was concrete tasks requiring kinesthetic senses to perform. Kinesthetic activities were used the least often in all of the elementary classrooms, only 18 percent of the time. The study did not directly analyze the relationship between kinesthetic tasks and cognitive skills, but some of the data focused on kinesthetic learning opportunities and subsequent cognitive processes. Teaching techniques were observed and categorized as supportive of the learning styles of auditory, visual, tactile, and kinesthetic although that information does not appear in a data table. The data tables do depict these trends, as grade level increases the task levels become less concrete (from 27.3 percent to 18 percent) and tasks become cognitively simpler (from 23 percent to 46 percent).

The primary weakness of this study was that the sample consisted of self-identified arts based teachers who volunteered for the study. Also the study is locale specific; therefore the results and conclusions may not be generalized to other locations. The Italian schools system has a history of providing preschool education that is arts based, for instance the Regio Emilia schools have been highly successful in age appropriate arts based learning. It may be that some of the students in this study received Regio Emilia preschool education and have experience with learning, processing, and being assessed in this manner. Other weaknesses were that the researcher did not specify the time, schedule variables, and the sampling process. The time of day or part in the school schedule these observations took place could impact students' performances as well as the fact that 75 percent of teachers volunteered for this study. The teachers were self-selected and already employed arts-based curriculum in their classrooms. Despite these potential confounding variables and its specialized population, this study concluded that arts based curriculum, within this study group, increased motivation and decreased behavior problems. The purpose of this study was to explore the need of a better model of teaching for the diversity of today's students. The author expressed a need for further research on the connection of achievement, behavior, and arts based curriculum. It would be difficult to use this study to reliably ascertain what affects kinesthetic teaching has on students' cognition since this study examined motivation and behavior. Yet, when students are motivated and behaviorally on task they are more likely to be receptive to learning.

The next quantitative study addressed teaching to an individual's preferred learning situations in order to improve concept attainment. Could this possibly be a way to combine motivation, positive behavior, and learning goals? Brooks (2002) inquired into the impact of individualizing teaching methods for spelling for primary students in a mainstream school population. Several of the teaching methods centered on hands-on kinesthetic learning experiences such as tracing, outlining, and covering spelling words.

The results indicated a significant improvement on the rate of acquiring spelling for students receiving the individualized learning style preference instruction in second and third year. The spelling age at post test for the treatment groups was significantly higher than the control group for third year ($p < .001$) and second year ($p = .001$). The results also showed an increased spelling ability during the period of treatment. There was a significant difference between third and second year treatment groups in February ($p = .004$) and no significant difference between these groups in July ($p = .14$). Specifically, the September start group (third) exhibited greater spelling ability than the February start group (second) during the first period of the study and the February start group (second) exhibited a greater spelling ability over the second period of the study. The third year group evidenced an 11 month increase in spelling between September and February, for a total school year gain of nineteen months. The second year group showed a 10 month increase in spelling between February and July, with an increase of five to six months for the first period of the school year. The control groups showed a 10 month increase for the school year, September through July.

This study has several strengths; it's extensive control group, its use of a cross section of the population, and its use of multiple methods of instruction. Many studies use a control group that is part of the same student population receiving treatment. This study used controls from separate schools, both public and private. In addition, the control group received after school activities involving free and creative writing and drawing. This procedure was done in order to reduce the confounding variable of students improving due to receipt of treatment. The participants were second and third year students, aged six to eight years old from five primary schools in England. Three of the schools were public and two were private. All participants were in mainstream classrooms and represented a cross-section of the population in gender, ethnicity, academic ability, special needs, and ELL. Teachers in the schools selected the students based on school attendance, time available, and ability to adjust to a change in routine.

The sampling included a diverse selection in which participants from two schools, one private and one public, were selected into treatment groups by grade level based on learning style preference (n = 47). The other three schools, one private and two public, served as control groups in which no students received any treatment (n = 125) in order to determine average improvement in spelling with standard curriculum. The treatment groups received one of ten teaching methods utilizing phonics, whole language, and a combination of both. For the purpose of this summary, the two teaching methods that use kinesthetic activities will be discussed. One teaching method used tracing which concentrated on motor patterns in spelling and the other method combined many of the methods which used sound, visual, and motor movements. Learning style preferences were determined over an average of three weeks. The procedure included identifying a student's learning preferences and adapting teaching methods to accommodate it. The preferred method of learning was the method of instruction in which the student spelled the most words correctly.

Another strength in methodology was alternating treatment times and grade levels. The third year students were administered the treatment in September and the second year students began treatment in February. This was done to avoid communication about the experiment between the second and third year groups and to allow for at least two years of traditional spelling instruction. Treatment lasted for five months for both groups. Spelling was assessed for the treatment groups' pre and post treatment, therefore in September and February (third year) or February and July (second year). The control groups were assessed in the same pattern.

Another positive aspect of this study is that it was conducted in real classrooms with little additional work required of the teachers. The weakness in this study was the short length of time for treatment. This could have produced a temporary increase in spelling skills due to focused attention on this one area. It would be interesting to see this on a longitudinal level with the same participants or with a wider range of participants. Meanwhile, for this sample group, spelling scores increased greatly with the opportunity to learn in individualized methods that match leaning preferences, including kinesthetic learning opportunities. This study evidenced that when an individual's learning needs are met, his ability to acquire cognitive skills such as spelling improved. As always, more research is necessary to continue the exploration into the best ways to improve students' acquisition of cognitive skills. This study adds another piece of information into the inquiry of the effects of kinesthetic learning experiences on academic achievement in primary students.

This next study also focused on a variety of learning contexts and their impact on reading comprehension. Worden & Franklin's (1987) quantitative research study questioned: would the reading progress of beginning readers identified for remediation be affected by instruction which accommodated their perceptual strengths? The authors defined perceptual strengths as learning styles with modalities such as kinesthetic, visual, and auditory. This study appears to use the terms perceptual strength synonymously with learning modality. The question investigated by this study is closely aligned with the question of this paper. Its conclusions inform the effects of kinesthetic learning opportunities on reading comprehension and vocabulary recognition. The researchers determined that the findings supported the hypothesis that the reading achievement of below average students in second and third grade is significantly improved by instruction which accommodates their perceptual learning modality. The MANOVA results showed a significant effect for treatment group, time of test, and group by time of test indicating a need to use the ANOVA analysis. This second analysis also revealed a significant difference in these measures. There was also a significant difference between the kinesthetic and control groups and the visual and control groups ($p < .001$). There was no significant difference between the kinesthetic and visual groups. An interesting result occurred with the kinesthetic group. The kinesthetic group performed below the control group in the pretest and made significant gains over the control group at post test.

The data was thoroughly examined using multiple methods of variance. This study used a multivariate analysis and found significant differences between variables and then used a univariate analysis to see if those significant differences remained. Following similar results between analyses, the treatment groups were examined for significant effect. The researchers used a reasonable sample size across three elementary schools and two grade levels. The design and methodology of this study appear to be highly replicable and could be used for other samples and studies. The participants were placed in one of three treatment groups; 1. kinesthetic learners; 2. visual learners; and 3. auditory learners and mixed preference learners. The perceptual learning styles were assessed by using the Reading Style Inventory, Part II (Carbo, 1982, as cited in Worden & Franklin, 1987) and an informal assessment developed by the authors. The participants had to score 50 percent or greater in the kinesthetic and visual styles to be placed in those groups. The auditory learners were placed in the mixed style group due to the low number of participants who scored in that style. Each treatment group consisted of 24 participants who were separated into two groups of 12 for instructional purposes. The cognitive tests administered were the Passage Comprehension subtest of the Woodcock Reading Mastery Tests (Woodcock, 1973, as cited in Worden & Franklin, 1987) and the Word Recognition in Isolation word lists from the Basic Reading Inventory (Johns, 1978, as cited in Worden & Franklin, 1987). The instruction models were different for each treatment. The kinesthetic instruction model will be discussed for the purposes of this summary. The methods used included tactile/kinesthetic activities such as spelling words with sandpaper letters, illustrating word concepts, and outlining word shapes on paper or in the air. The instruction was done in groups of 12 students and one instructor.

Instruction was given twice a week for thirty minute sessions for a period of four months. The instruction focused on word recognition skills. The tests were administered in two forms, A and B, with form A serving as the pretest and form B as the post test. Data was collected on the number of correct words and reading comprehension scores.

The researchers made the assumption of the validity of the testing tools and perceptual strengths assessment tools. They concluded that classroom teachers have “an even more extended role concerning a student’s modality preference. They must continually adjust their reading instruction to provide a variety of sensory activities in order to meet the learning needs of their individual pupils” (Worden & Franklin, 1987, p. 47). This study represents research that supports the integration of a student’s learning modality preference and a teacher’s instructional methods as a means to improve reading comprehension and vocabulary.

The next two studies examined the effects of movement on the analytical performances of African American and White elementary students. The first study summarized was the most recent and replicated the methodology of the second. Boykin & Cunningham (2001) conducted an experiment which investigated what effects does including movement expressiveness in story content and learning context have on the encoding and inferring performance of African American children? The relevance this study holds is in its exploration of the impact of kinesthetic learning contexts and content on analytical skills. The researchers discovered that offering high movement expression (HME) combined with high movement themes (HMT) increased students’ scores in encoding and inferring. From looking at the data the converse is true; offering low movement expression (LME) combined with low movement themes (LMT) decreases scores in encoding and inferring. There was a significant main effect for story content ($p < .001$); learning context ($p < .001$); and type of process ($p < .001$). A significant two-way interaction emerged between story content and learning context ($p < .001$). Performance was significantly higher with HMT than LMT under the HME learning context.

The fact that all participants were exposed to both low and high movement story content and contexts was a strength of this study methodology. This allowed for the effects of both treatments to be observed on each group of participants. There were 64 African American children, ages seven to eight years old, from a large mid-Atlantic urban elementary school. Each participant was Title 1 classified (low income) and there were equal numbers of males and females. The experimental procedure included manipulation of the learning content and context. Two stories were adapted so that characters, events, and relationships between them were evident. The stories were also adapted to reflect LMT and HMT. The LMT example was “Sun and Moon are walking…” and the HMT example was “Sun and Moon are skipping…” (Boykin & Cunningham, 2001, p. 75). The learning contexts were also manipulated to include high and low movement opportunities. For the LME treatment participants were instructed to sit or stand while listening to the story. The investigator read aloud while standing in front of participants, no music included. The HME context included an audio recording of instrumental rhythmic/percussive/syncopated tune was used in one condition. Participants were instructed to sit or stand around the investigator as he read aloud. Movement and clapping to the beat of the music was encouraged.

Another positive aspect of Boykin & Cunningham's (2001) study was the procedure. The participants first heard a story under one learning context and responded to the questions immediately afterward. A three minute interval was allotted between stories. Then students listened to a different story under the alternative context and were asked to respond to questions. The order of the learning context and content were counterbalanced so that each combination of learning context and content was presented first an equal number of times. The analytical reasoning assessment was given to participants in small groups of two males and two females. The investigator posed ten encoding and ten inferring questions verbally to the group. Students answered the questions using free recall and could dictate if necessary. The cognitive processing skills of the questions were counterbalanced so that each type was presented first an equal number of times.

The one area of weakness involved the rhythmic music used in the HME context. This could have posed a confounding variable if the presence of the music increased cognition not the presence of movement. Further research is necessary to control this variable. The researchers set out to document the facilitating effects of movement and music for African American learners. As for the applicability of this study to the question of this paper, the results show a significant increase in the analytical reasoning performance of African American children when they are presented with a kinesthetic learning context and content.

The second study to be critically examined actually preceded the first study summarized. It was accomplished by Allen & Butler (1996) to determine if analogical reasoning performances of African American and White elementary school children are affected by learning contexts that differ in the amount of music and movement opportunities available? The relevance of this study lays in its examination of high and low movement learning contexts. The results reveal that African American students perform better on all three cognitive tasks under HME learning contexts and White students perform better on all three cognitive tasks under LME. The data analysis showed significant differences between race and learning context ($p < .000$). There were no significant differences involving cognitive task and race. Both African American and White students performed comparable when each race was involved in the best learning context for them. This conclusion supports the idea that African American students can perform well on cognitive tasks and their consistent underachievement may be a result of the learning context.

The research methodology was the same as Boykin & Cunningham (2001) except in the cognitive processes assessed and the test answer sheet. This study examined three analytical processes of encoding, inference, and mapping. The test answer sheet was multiple choice and the participant circled the correct answer. The participants were 28 students, 15 African American and 13 White, in third grade between the ages of eight and nine years old. There were 12 girls and 16 boys who attended an urban public school in the northeast. The African American students were from low-income families and the White students were from middle-income families. The school was selected for its large African American population. Participants were assigned to race-homogeneous and gender-heterogeneous groups of four. This study has similar strengths in methodology as does the preceding study.

A potential confounding variable of race and class was explained as non-confounding because “the groups would be maximally different culturally along the dimensions of interest” (Allen & Butler, 1996, p. 319). Yet, a potential confound of race is implicated. The African American experimenter was the oral reader of the story and could have altered the results due to change in routine for students. Also, this experimenter could have presented a different story telling style than the regular classroom teacher or the White experimenter. The question remains why did the African American experimenter read and not the White or both read? Another possible confounding variable could have been the students’ motivation. Motivation was not taken into account in the study design. The final feature of the design that may be problematic is the use of multiple choice questions to gage recall. There is a factor of the answer options aiding in the recall process. The use of free recall may bring to light different performance results

The use of a highly kinesthetic context over the use of low kinesthetic context improved the cognitive performance of the African American students. In contrast, the data indicated that White students performed best after low movement experiences; both of these results lend support to the theory that diverse students perform best under diverse learning contexts. The authors surmise that the positive effects of this culturally compatible learning context could be generalized to other school content. Further research is needed using HME in areas such as mathematics and reading.

The next study examined the variable of culture and its relation to an individual’s learning style. In Dunn, Gemake, Jalali, Zenhausern, et al. (1990) the question what is the impact of ethnic and cultural differences on learning styles in fourth, fifth, and sixth grade students was the focus. This study is relevant to the question posed in this paper because it evaluates the various learning styles of several different ethnic groups representative of the school population. It was statistically revealed that different students prefer different learning environments; one of which involved movement (mobility). A caveat is essential here; there are always individuals whose experiences are significantly different from the trends of the group. While the patterns evidenced in this study indicate that various ethnic groups prefer different learning styles, caution should be used in applying a blanket approach to individuals based on their ethnicity.

The researchers found many significant differences ($p < .05$) in learning styles within various ethnic backgrounds. The African-American and Chinese-American students displayed significant differences on 15 of the 21 elements, with African-Americans preferring mobility. The African-American and Mexican-American students showed significant differences on 12 of the 21 elements, with African-Americans preferring mobility. The African-American and Greek-American students exhibited significant differences on nine of the 21 elements, with no significant difference in mobility. The Chinese-American and Greek-American students revealed 13 of the 21 elements, with Greek-Americans preferring mobility. The Mexican-American and Chinese-American students displayed nine of the 21 elements as having significant differences, with mobility preferred by the Mexican-Americans. And finally, the Greek-Americans and Mexican-Americans showed the least number of significant differences, six of 21, with no significant difference involving mobility.

The major strength of this study is its extensive sample size and design. There were 300 secondary students involved from four ethnic backgrounds, public and parochial schools, in urban, suburban, and rural locations. The African-American students attended one suburban elementary and junior high school in New York. The Chinese-American students attended two public elementary schools in New York City. These students were first-generation Cantonese or Mandarin home language users. The Greek-American students attended an urban, parochial elementary school in New York City. These students were Greek home language users. The Mexican-American students attended a rural public elementary school in Texas. These students were first-generation Spanish home language users. All students were averagely developing academically, none were special needs or gifted. Twenty-five students from each ethnic background and from each grade were randomly selected to participate.

Each participant took two tests; the Learning Styles Inventory (LSI) (Dunn, Dunn, & Price 1986, as cited in Dunn et al., 1990) and the Group Embedded Figures Test (GEFT) (Oltman, Raskin, & Witkin, 1971, as cited in Dunn et al., 1990). The LSI measured 21 different learning styles through a 104 item questionnaire on learning preferences. The physiological learning style involving mobility will be discussed in this summary. The data was examined using several statistical analyses. A series of ANOVAs followed by a *post hoc* multiple comparison procedures were employed for the LSI by ethnic group. The GEFT scores, between ethnicities and grade levels, were computed using a MANOVA analysis followed by a *post hoc* multiple comparison procedure. The relationship between LSI and GEFT were analyzed using the Pearson product-moment correlation coefficients procedure where a significant correlation is valued at the .05 level (Dunn et al., 1990).

Another strength was the variety of ways the data was examined which provided for potentially more patterns to appear. The data was examined in the following ways: LSI by ethnicity, GEFT by ethnicity, GEFT by grade, and LSI by GEFT. There is no need for a control group because this study tested the differences between ethnic groups without any treatment performed. As the researchers stated, despite the large sample size, it is not wise to generalize the results by ethnic group across the nation. There are many individual, community, and regional differences when analyzing cultures.

The study did not clearly state what the GEFT measures or how it is measured. The authors assume that the reader is familiar with this tool. It would be advantageous to the reader for the authors to explain what this tool measures and how it accomplished that measurement.

The researchers concluded that students from different ethnic groups have different patterns of preferred learning styles. The implications stated were that classrooms should offer varied environments, procedures, and instructional methods in order to accommodate the wide variety of learners. The authors surmise that the differences in perceptual strengths, visual, tactile, kinesthetic, and auditory, require teachers to introduce new and challenging information in the student’s predominant learning modality. This study reveals more information in the quest to determine what effects do offering kinesthetic learning opportunities have for primary students.

Anther study that concerned a variety of learning styles and their implementation in the classroom was Braio, Beaseley, Dunn, Quinn, & Buchanan (1997). These researchers queried do achievement and attitude toward learning continue to increase incrementally as a result of gradually introducing learning style strategies to special education and low achieving regular education students in fourth, fifth, and sixth grade? The summary that follows will focus on the low achieving regular education students. This study tested achievement scores as a result of learning styles accommodations for low achieving elementary students. It lends support to the theory that academic achievement increases for individual learners when they receive instruction and environment that matches their LS. The participants were 35 regular education fourth, fifth, and sixth graders from a low socioeconomic, urban elementary school. The school population was approximately 31 percent African American, 41 percent Hispanic, and 29 percent White or other ethnicities. Of the 35 students, 10 were girls and 25 were boys who tested at least two grade levels below their chronological age on the Metropolitan Achievement Test (Prescott, Balow, Farr, & Hogan, 1986, as cited in Braio et al., 1997) and the Pupil Evaluation Program (as cited in Braio et al., 1997).

The authors determined that the findings support those of previous studies which reported that teaching special education and regular educations low achieving elementary students through their LS preference improves their academic achievement. Participants improved their performance from pretest to post test when they were involved in the phase that matched their LS. The data analysis showed a significant difference within phase ($p < .01$). Achievement scores decreased when LS were removed in Phase 5. The researchers determined that there was a strong main effect when LS accommodations were removed ($p < .05$). An unexpected decrease in achievement scores was found in Phase 4 when all LS were accommodated. The researchers discussed a possible reason for this was the degree of difficulty of the unit, suffixes.

The research protocol was intricately designed to provide incremental exposure to learning style strategies for a period of time and then remove those accommodations. All participants were read a children's story book about the different ways that children learn by describing the 21 elements of the Dunn & Dunn (1992) learning style (LS) model. This was done to increase the reliability of the students' LS self assessment (Andrews, 1990, as cited in Braio et al., 1997). In addition, students were given opportunities to experience the various learning environments; for example low light or high mobility. The LSI was given to each student after this exposure. Seven participants were classified as environmental/mobility learning style preferences, 27 demonstrated multiple LS, while one student did not demonstrate any LS (this student's data was excluded from the analysis). The LS treatment was performed by one trained classroom teacher in three developmental reading classes. The treatment period lasted for ten weeks in which all participants were instructed on structural analysis skills for 20 minutes every school day. The structural analysis skills were taught in five two- week units and consisted of compound words, plurals, prefixes, suffixes, and contractions. A 20 question pretest was completed by each student at the beginning of the instructional unit to assess prior knowledge. The same test was administered at the end of the two-week unit to assess achievement under each learning style condition. A panel of experts, school personnel and the researchers determined that each of the units was equivalent in difficulty (Braio et al., 1997). Each two-week unit was taught in a designed instructional manner and room environment referred to as a phase. Phase 1, compound words, was instructed with a scripted teacher directed lecture, text books, chalk board, worksheets, and no LS accommodations. During Phase 2, plurals, some LS accommodations were made and allowed for the 20 students who indicated those LS. These accommodations were for mobility and various environmental situations such as soft lighting, cushioned seating, and headphones for music or quiet. The remaining 15 students received no LS accommodations. Phase 3, prefixes, called for all participants to receive tactile and kinesthetic teacher instruction. This phase combined the accommodations in Phase 2, which enabled 32 students to have LS matches. Phase 4, suffixes, brought LS accommodations for all perceptual, environmental, and mobility preferences. During this phase, all but one student's LS was accommodated. Phase 5, contractions, was designed as a test on decrease in performance or attitude when LS were removed. This phase was identical to Phase 1 in instruction methods and no LS accommodations.

The authors discovered several confounding variables during the first analysis and performed a second analysis to address these. The confounding variables were that the units may not have been comparable in difficulty, sample was not homogenous at pretest and the variance across groups and phases were not homogenous. The existence of confounding variables and subsequent need for a second analysis resulted in data that informs on the relative position of academic achievement as opposed to exact academic gains. The sample size is also small and disparate. It would be necessary to re design the study methodology to obtain data that could be generalized to other populations. When a decrease in achievement scores was found in Phase 4, the researchers attributed it to a possible difference in unit difficulty. This decrease could have resulted from an over stimulated environment that contained too many LS accommodations. Any of the results of the data could have been confounded by the short length of time allowed for each series of LS implementation.

Learning styles preferences and use in the classroom was the topic of this study done by Rayneri, Gerber, & Wiley (2003). They asked what are the learning style needs of under achieving gifted secondary students in comparison to high achieving gifted secondary students while learning reading, language arts, social studies, mathematics, and science? This study could supply more information about what effects kinesthetic learning contexts have on students because two of the learning styles, modality and perceptual include kinesthetic senses. The researchers' conclusions stated that multiple learning styles exist within a classroom and that academic achievement could be influenced by learning style. The researchers found that there are many similarities in learning style preferences between under achieving and high achieving gifted secondary students. Yet they do differ in three of the elements, one of which is preference for tactile learning. Tactile learning is incorporated in the mobility element. In the category of mobility, 50 percent of the low achievers said it would be helpful in the learning environment while nearly 70 percent of the achievers said they preferred mobility. The researcher concluded from the data that the low achieving students needed to be involved in learning contexts with visual, tactile, and kinesthetic activities. Sixty-nine percent of the low achieving students demonstrated high need for tactile activities evidenced by T-scores between 60 -80; while 80 percent of this group had T-scores above the mean (50 – 80). Interestingly, more of the high achievers revealed a preference for mobility and most of the low achievers demonstrated a need for mobility. The researchers do not expound on this point.

This study's sample size was comparable to other similar studies conducted at one school. The 62 participants were identified as gifted students in sixth, seventh, and eigth grade. The low achievers numbered 16 while the high achievers numbered 46. The low achievers were categorized due to a GPA of below 85 percent. The high achievers had GPAs above 90 percent. The authors did not include any other demographic information. The methodology was also average for this type of experiment. All participants were administered the LSI (Price & Dunn, 1997, as cited in Rayneri et al., 2003) which contained 104 item questionnaire on 21 learning style preferences. The results indicate a high or low need or preference for a particular learning situation. The participants' raw scores were converted into T-scores to indicate learning style preferences. The T-scores ranged from 20 -80, with 50 as the mean and a standard deviation of 10. A T-score of 20 – 40 reveals a low or opposite learning preference and a T-score of 60 – 80 is a high preference. T-scores between 40 and 60 indicate that the learning style element is not crucial to the student's learning process and it may vary depending on subject matter or learning goal. The data analysis for the learning style preference of mobility will be summarized in this paper.

The weaknesses lay in the sample participants and the statistical analysis. The demographic information of the participants was not disclosed in this study. Therefore, the reader can not know the sample represented by this study. For instance; what type of school they attended (urban, rural, suburban, public, private, or parochial), the ethnic background, socioeconomic status, or primary language. It is not possible to generalize any of the results from this study. In addition, there was not a statistical analysis done. The researchers refer to data percentages that are not represented in any table or graph. This makes it difficult for the reader to effectively examine the data and confirm the conclusions. Therefore, this study does not reliably inform the question of this paper.

Several of the previous studies have used the learning style inventory outlined by Dunn and other researchers. Included next is a summary of a meta-analysis prepared by Dunn, Griggs, et al. (1995) in which they evaluated what statistical statements can be made about the overall effect size of GPAs produced by the learning-style interventions of the 36 studies. And what are the relationships among study characteristics and study results? This meta-analysis serves as a composite evaluation of the Dunn & Dunn learning styles model which informs the question of what are the effects of using kinesthetic learning contexts on the cognitive skills of primary students. The meta-analysis explores several variables; strength of preference, sample size, education level, socioeconomic status, academic achievement level, length of LS treatment, and content area. It is an extensive analysis.

The authors determined that the overall academic achievement of students whose learning styles are matched within the learning context increases. Specifically, the LS matched students will receive three-fourths of a standard deviation improvement over students who do not have their LS accommodated. This meta-analysis was considered highly reliable as the authors stated, “with a total sample size of 3,181, an alpha level of .01, and the general convention of .80 as a desirable level of power – the power of this study was estimated at .995” (Dunn et al, 1995, p. 357). As a result of evaluating the data, they determined that the 36 studies were heterogeneous which means that one or more variables mediated the effect size. One of the homogeneous indicators is the chi-square test and its results indicated a significant difference between variables (moderators) ($p < .001$).

The composite results demonstrated that: 1. Students with strong learning-style preferences showed greater academic gains as a result of congruent instructional interventions than those students who had mixed preferences or moderate preferences; 2. Studies conducted with small sample sizes showed greater academic gains than those with large or medium sample sizes; 3. College and adult learners showed greater gains than elementary school learners or secondary school learners; 4. Examination of socioeconomic status indicated that middle-class students were more responsive to learning-style accommodations than were lower middle-class or upper middle-class or lower class students; 5. Academic-level moderators indicated that average students were more responsive to learning-style accommodations than were high, low, or mixed groups of students; 6. Instructional interventions that were conducted for more than one year showed stronger results than those conducted for several days, weeks, or months; and 7. The content area most responsive to learning-style accommodation was mathematics, followed by other subjects and language arts (Dunn et al., 1995, p. 358). The determination of significance was derived according to Tallmadge (Talmadge, 1977, as cited in Dunn et al., 1995) with $r > .33$. The results exhibited that accommodating a student's physiological preferences has a significant positive impact on academic performance, ($r = .461$). The authors predicted that the greatest achievement would be found in the content of mathematics, in the context that accommodates learners with strong physiological preferences, and among academically average students from the middle class .

The strengths of this meta-analysis is the extensive sample size, the identification of variables that impact effect size, the conversion of multiple statistical measurements, and the inclusion of studies based upon one learning styles evaluation model. This is a meta-analysis of 36 experimental studies on the Dunn & Dunn Learning Style Model conducted between 1980 and 1990. A total of 3,181 participants of varying ages, academic abilities, socioeconomic status, and residential locations were included in the meta-analysis. The combined studies contained 65 individual effect sizes or comparisons due to each study observing multiple variables. This meta-analysis also acknowledges, addresses, and refutes the studies that serve as counterarguments. On the negative side, the methodology required many statistical measures conversions which in turn required the reader to be fully versed in statistics in order to critically examine the resulting data, which limits the audience for the study. The authors converted the various measurement statistics to a common measure of effect size; individual weighted effect size (WES)*r* using Schwarzer's Meta-Analysis Computer Program (Schwarzer, 1989, as cited in Dunn et al, 1995). The authors also used three indicators of homogeneity and rejected all three; more validation to the heterogeneity of the studies included. The conclusions from this meta-analysis are that there are many learning style inventories and they do not share the same reliability nor measure the same variables. The Dunn and Dunn learning style inventory was determined to be highly reliable.

Another learning styles instrument was developed and used in this study by Snyder (2000). Snyder inquired what is the relationship between learning styles and academic achievement in high school students? The data results that derive from the relationship between kinesthetic intelligence and academic achievement, as evidenced in GPA and standardized achievement tests, will contribute to the question of this paper.

The researcher found that the vast majority of participants, 81 percent, were tactile/kinesthetic learners. Kinesthetic intelligence was independent of academic achievement abilities as determined in Chi-Square tests (alpha = .05). The data indicated a significant difference between females and males in the bodily/kinesthetic intelligence ($p = .002$).

One of the strengths of this study is the creation and validity of the instrument. The researcher first developed an instrument that would measure a combination of multiple intelligences and some learning styles. This instrument's validity was determined by comparing this instrument's learning styles results with the results of the Learning Style Profile (Keefe et al., 1989, as cited in Snyder, 2000). The multiple intelligence results were also compared to another instrument, the Multiple Intelligences Inventory (Armstrong, 1994, as cited in Snyder, 2000). The results of this study's instrument was found reliable as evidenced by a significant positive correlation ($p = .001$). Furthermore, the researchers compared the results of this instrument with the Dunn Learning Style Inventory (Dunn & Price, 1997, as cited in Snyder, 2000) and found a stronger significant correlation of ($p = .001$). The validity of the Dunn LSI had been summarized previously in this paper (Dunn et al., 1995). It is not possible to corroborate the validity of the Keefe Profile (Keefe, 1989, as cited in Snyder, 2000) or the Armstrong Inventory (Armstrong, 1994, as cited in Snyder, 2000) at this point, so for the purposes of this paper, the validity of Snyder's (2000) instrument will be accepted.

A second strength of this study is its use of multiple standardized measures of academic achievement. The researcher collected data from three sources, the student's GPA, the Metropolitan Achievement Test (MAT-7) in reading, mathematics, and total, and the state's Basic Skills Assessment Profile (BSAP) in reading and mathematics. The participants included 128 high school students in one high school evaluated to be demographically representative of the U.S. population.

A confusing interpretation of the data occurred pertaining to the correlation between GPA and kinesthetic learners. The researcher stated that for the female participants, there was a positive correlation between GPA and both bodily/kinesthetic intelligence and tactile/kinesthetic learning style. Yet, the alpha2 value for bodily/kinesthetic was = .10 and tactile/kinesthetic = 10, not significant in comparison with other studies' determination of significant. This data information questions the reliability of the report in general. Albeit this discrepancy, this study ascertained that 81 percent of the sample tested as kinesthetic learners. This statistic adds to the information presented on the presence of students in today's classrooms who prefer to acquire and process information through their kinesthetic senses.

This next study, conducted by Kratzig & Arbuthnott (2006), tested the central hypothesis of learning style theory regarding the correlation between perceptual learning styles and learning proficiency. They questioned do learning styles reflect differential ability in remembering material presented in different sensory modalities? And what information does a learning style instrument actually assess? This study measured three modalities: kinesthetic, visual, and auditory (Kratzig & Arbuthnott, 2006). The results of this study indicated that the performance on memory tests did not correlate with learning style preferences. The specific data on kinesthetic exposure and testing will benefit the query of this paper.

The researchers conducted a two-tiered experiment in which they determined that results of the first study reflected that learning style, self-assessed or using a common questionnaire, did not correlated with objective memory performance in any of the modalities. They further tested this outcome on a smaller group of 29 participants within the original sample of 65 participants. This smaller sample consisted of individuals who demonstrated a consistent learning style category between the self-assessment and the Barsch Learning Style Inventory (BLSI) questionnaire (Barsch, 1991, as cited in Kratzig & Arbuthnott, 2006). This too was not significant ($p = -.024$). An unexpected outcome arose pertaining to the kinesthetic measures. The data revealed a positive correlation between the BLSI kinesthetic learners and performance on the visual memory test ($p < .01$). The researchers interpreted this to suggest that, to some degree, memory tests for visual and tactile memory tapped into the same underlying memory processes. The results of this study cast doubt on the learning style theory that individuals learn best in their dominant learning modality. It supports the theory that individuals have multiple learning modalities and utilize a combination of them dependent on the material and situation.

An attribute of this study was the testing tools it employed. The kinesthetic memory testing tool was the Tactual Performance Test (TPT; Arthur, 1947; Lezak, 1995, as cited in Kratzig & Arbuthnott, 2006). This apparatus involved a wooden board with ten unique geometric shapes cut out of it. Participants were blindfolded and instructed to place the ten shapes into their corresponding hole in the board. They did this with the dominant hand, then the non-dominant hand, and finally with both hands. After completion of the three trials, the blindfold, board, and shapes were removed. The participant was then instructed to draw a representation of the board and shapes. Scores were received for the total time to replace the pieces and on the representation and placement of the shapes in the drawing.

The results of study one triggered a second study to determine what information do participants consider when answering the learning style questionnaire. Study two indicated that learning success is more related to a participant's motivation and the learning environment than to a modality preference. Study two revealed that participants recall events, preferences, habits, and self-efficacy beliefs, not learning performances when responding to these questionnaires.

The researchers purported that there is variability between many of the learning style instruments and many have not been validated (Harrison et al., 2003, as cited in Kratzig & Arbuthnott, 2006). The results and implications from both study one and two lend support to previous research that indicated multiple learning modalities within each learner and that learning was a response to particular learning environments (Cassidy & Eachus, 2000, as cited in Katzig & Arbuthnott, 2006). The correlation between kinesthetic memory and visual memory is evidence of this multimodality theory.

All of the research articles pertaining to learning styles and perceptual strengths that have been summarized thus far have determined the effect of kinesthetic learning opportunities on cognitive skills. The next study examines this relationship from the other perspective, maturation of perceptual motor skills as reflective of future cognitive abilities. Solan, Mozlin, & Rumpf (1985) investigated does perceptual maturation correlate to early reading and learning readiness? Four tests were performed by the participants, two which measured kinesthetic skills, one measured visual skills, and one measured visual and auditory skills. The researchers found that there was a correlation between readiness scores and the two kinesthetic tests. The grooved pegboard test showed a significant correlation ($p < .005$) as did the divided foam board test ($p < .005$). Thereby leading to the conclusion that readiness is positively correlated with good perceptual-motor skill development. Furthermore, the researchers performed a multiple regression scheme including the two kinesthetic tests and the visual test and found it to be significant as well ($p < .0001$) (Solan et al., 1985).

The beneficial aspects of this study were the perceptual-motor tests and the data analysis. Only the kinesthetic tests will be summarized. The grooved peg-board test had five rows with five holes. The participant was instructed by the investigator to replace pegs one by one in sequence of left to right (for right dominant) and right to left (for left dominant). Three to five practice trials were allowed before the timed test. The six-figure divided form board test consisted of six figures, each with two halves, which fit into a specific hole. This task required engagement in tactile, visual discrimination, visual analysis, and synthesis. The participant observes the board assembled and disassembled by an adult and then was instructed to place all the pieces back as fast as possible. There were no practice trials with this test.

The data was analyzed for means, medians, and standard deviations. It was then analyzed using a correlation matrix to examine inter-task correlations in order to determine if the tasks necessitated different developmental skills. Data was compared to the Primary Mental Abilities Test – Readiness Level to acquire task correlations coefficients with total readiness. A final multiple regression analysis was completed as mentioned above.

Although this study used two kinesthetic tasks and found a correlation between maturation of perceptual motor skills and learning readiness, it is problematic. The authors did not give any details on the readiness test they used to determine correlations with perceptual motor tasks. Subsequently, it is not possible to critique the reliability of this test and the correlative results. The conclusions and implications from this study are questionable due to this lack of information. It would be necessary to obtain more information for this study to adequately inform the question of this paper.

The next study pertaining to kinesthetic learning opportunities within the elementary classroom concerned teaching practices and motivating student academic engagement. Dolezal, Welsh, Pressley, & Vincent (2003) performed an ethnographic qualitative research study on how nine third grade classroom teachers motivated their students' academic engagement. They discovered that the teachers who used multiple methods of motivating practices had the two highly engaging classrooms. These motivating practices involved learning opportunities that were "not just hands-on but minds-on as well" (Dolezal et al., 2003, p. 254). The researchers identified many of the teacher practices that support motivation, three of which were concrete authentic activities, games and playing, and learning by doing. An example given was that in one lesson students used balances to study mass, ratios, and percentages. This highly engaging teacher encouraged independence and student involvement in their own learning.

The research report was thorough in supplying the teacher questionnaire and supporting its conclusions with definitions and examples. The researchers included a full transcript of the ethnographic interview they conducted with the nine teachers which enabled the reader to assess the reliability of this tool. They also included definitions and examples of the specific practices identified as supportive of motivation in the classroom. This report appears to be a useful informational tool for third grade teachers who wish to examine academically motivating techniques.

It is also useful in exploring the effects of using kinesthetic learning contexts within a primary grade classroom. This study concluded that there are many instruction methods that are motivating to student academic engagement, three are specifically kinesthetic in nature; concrete authentic activities, games/playing, and learning by doing.

The final quantitative research summary in this section tied the concept of kinesthetic learning opportunities back to Piaget's theory which stated that scientific thinking originates with the sensory-motor experience of one's physical environment. Druyan (1997) executed three studies which looked at the how does the kinesthetic conflict effect the acquisition of three scientific concepts, length, balance, and speed in students from five years old to 12 years old? The meaning of the term kinesthetic conflict refers to Piaget's theory of cognitive development requiring a conflict between existing schema and new information. Thus, the kinesthetic conflict is the period at which new information is introduced and processed through kinesthetic senses. The results of this study will directly inform the question of this paper. The researcher constructed three separate experiments one on length, one on balance, and one on speed. The results from all three experiments indicated that kinesthetic learning opportunities are more effective in promoting scientific reasoning for length, balance, and speed within the elementary population than visual or social learning opportunities.

The data results on length demonstrated that the kinesthetic experience improved the concept of length, but only in the trials that required effort or measuring. The treatments of jumping and measured walking showed a significant effect ($p < .001$). The treatment of walking alone did was not significant ($p < .05$). Strength of this first experiment was in the data analysis. The data was examined first with a Chi-Square analysis and second with a Scheffe posttest analysis (Druyan, 1997). The experiment on balance determined that 80 percent of participants progressed in their level of understanding. The significant effect of kinesthetic experience over the control group who received no treatment was ($p < .001$). Finally, the results of the data on the concept of speed also determined that the kinesthetic learning opportunity provided a significant effect on the participants ($p < .001$).

A positive attribute of Druyan's study was in its methodology. Each experiment was structured with a control group which received no treatment and several treatment groups as variables. The kinesthetic treatment group for each experiment will be summarized here. The experiment on length had three kinesthetic treatments, walking, jumping, and measured (heel to toe) walking with a peer. Participants traversed a variety of straight, zigzag, and curved lines 10 and 15 meters long. The experiment concerning balance employed an apparatus that the participant could manipulate in order to cause a balanced or non-balanced situation. In addition, participants stood on the same table as the balance which "allowed the subject not only to watch the scale movement, but also to feel it in his muscles and thus to receive a kinesthetic feedback to his answer" (Druyan, 1997, p. 1091). The author did not describe the apparatus or set up enough to get a more thorough understanding of the treatment. The final experiment on speed employed a carousel-like apparatus from which a shaft protruded. The participant and the experimenter positioned themselves holding the shaft close to the center point and the other further away from the center point. Each walked pushing the shaft. The participant and experimenter then switched. After four trials the participant was asked to compare his speed to the experimenter's and explain.

The procedure for each experiment also contained a pretest, treatments, and posttest. The report gives detailed explanations of the contents and conditions of the pretest, treatments, and posttests. Strength lay in the data collection to evaluate cognitive change. The researcher collected data on the cognitive change for each participant in the categories of progression, regression, and no change. The homogeneity of the sample was a weakness of this study. Each experiment was conducted on participants who were from upper-middle class neighborhoods in Israel. Experiment one and two involved 64 and 100 students in kindergarten, ages five to six years. Experiment three used 72 sixth grade students. The sample size is adequate to large, yet the demographics are limited. The results can not be generalized to other populations. It would be interesting to find other studies that replicated this methodology with more variety in the samples. Although the results are limited to this sample, they do indicate that kinesthetic learning opportunities are beneficial to elementary students when learning scientific concepts such as length, balance, and speed.

The majority of the peer-reviewed research literature in the Mind-Body section focused on kinesthetic learning contexts, interdisciplinary practices, multiple intelligences, various learning styles, ethnic trends in learning styles, and perceptual-motor skills and how they inform classroom practices. The first research study investigated the use of kinesthetic teaching methods and its effect on writing, reading, and spelling for students identified as at risk for reading difficulties (Grant, 1985). The researcher concluded that by fourth grade the at-risk students who received treatment matched or surpassed the reading level of the averagely developing students. Another experiment tested various teaching models which incorporated students' learning styles, one of which entailed kinesthetic and tactile experiences (Searson & Dunn, 2001). The results from this study showed that when the teachers used tactile and kinesthetic methods of instruction for all the students regardless of learning style, there was a significant difference in science achievement scores. The study concerning interdisciplinary curriculum concluded that arts based curriculum, within this sample, increased motivation and decreased behavior problems. The one study summarized on multiple intelligences (MI) did not address kinesthetic intelligence, but was included to illustrate the connection between MI and the use of a variety of learning opportunities within the classroom. This researcher concluded that arts based curriculum, which inherently incorporates many intelligences, increase motivation and decrease behavior problems in students (Hooper, 2002).

Finally, several studies were summarized that indicated culturally specific trends in learning styles; for example the significant impact of movement on reading comprehension within African-American elementary students (Allen & Butler, 1996; Boykin & Cunningham, 2001; Dunn et al., 1990). Learning style accommodations were examined and found to improve students' overall academic achievement. Research evidenced that learning styles and their assessment tools vary by theory and application and some, such as the Dunn & Dunn model (1992), are better suited to the elementary school student.

The critics of learning style theory tested and determined that learning style, self-assessed or using a common questionnaire, did not correlated with objective memory performance in any of the learning style modalities. The results of that study cast doubt on the learning style theory that individuals learn best in their dominant learning modality. Although, it supports the theory that individuals have multiple learning modalities and utilize a combination of them dependent on the material and situation.

One study concerned teaching practices and motivating student academic engagement in which the researchers identified three kinesthetic contexts; concrete authentic activities, games and playing, and learning by doing. The final quantitative research summary in the mind-body section tied the concept of kinesthetic learning opportunities back to Piaget's theory that scientific thinking originates with the sensory-motor experience of one's physical environment. The results indicated that kinesthetic learning opportunities were more effective in promoting scientific reasoning for length, balance, and speed within the elementary population than visual or social learning opportunities.

Summary

There are many quantitative and qualitative studies that give information towards about the effects that kinesthetic learning contexts have on the cognitive skills of primary grade students. Some of the studies summarized in Chapter Three examined kinesthetic learning opportunities utilized in learning reading, writing, mathematics, and science. A small sample of the studies examined the impact of exercise and recess on memory, attention to task, and behavior in elementary students and adults. Many more studies focused on the existence of learning styles, especially mobility and other kinesthetic senses, in young students and how cognition was affected by accommodating the different modality preferences. The vast majority of these studies affirmed the significant effect that kinesthetic learning opportunities have on cognitive performances. Most of the studies had sound methodology and conclusions, although some did not. This chapter presented many studies that displayed a pattern of multi-faceted learning contexts positively impacting the cognitive processes of students. Several experiments used special needs students as their participants. Mainstreaming these students into general education classes is the reality in many school districts in our area. This is why I chose to include these studies in this analysis. I will work with special and general education students in my future classroom and I want to know how to accommodate all learners.

CHAPTER FOUR: CONCLUSION

Children are always learning. Both the content matter and context in which it is learned are essential factors in a person's education. As Dewey (1938) stated, every experience is a learning experience, it is the quality of that experience which makes it beneficial. I believe it is part of a teacher's responsibility to plan and implement a variety of quality learning opportunities which will engage and benefit all students. An essential way to accomplish this is for the teacher to know and understand her students' unique ways of learning. Young children learn by doing and need to be offered the opportunity within the classroom to explore new concepts with their bodies, as well as their minds. The age old model of apprenticeship still has a vital place in our classrooms. Many students benefit by watching a skilled peer or teacher perform a task and then practice that task on their own (Rogoff, 1990). The inquiry model of learning in which students set out to solve real life problems and investigate potential solutions also provides for kinesthetic learning opportunities in its experiential approach (Caine & Caine, 1997; Kolb, 1984; Zemelman, 2005).

Learning contexts which offer multiple sensory experiences, especially kinesthetic senses, are one way to include diverse learners. Wherever abstract concepts are introduced to elementary students, kinesthetic contexts will assist in the integration of this new information for some of these students (Caine & Caine, 1995; Montessori, 1965; Searson & Dunn, 2001). Kinesthetic learning contexts are beneficial in content areas such as reading, mathematics, science, and writing (Allen & Butler, 1996; Boykin & Cunningham, 2001; Brooks, 2002; Druyan, 1997; Knight & Rizzuto, 1993; Reynolds et al., 2003; Searson & Dunn, 2001; Worden & Franklin, 1987). These learning contexts promote the conversion of abstract concepts into concrete ideas; this is the developmental level in which the majority of elementary students are engaged (Singer & Revenson, 1996).

The purpose of this paper was to investigate the specific effects that incorporating kinesthetic methods of learning has on knowledge, analysis, and synthesis of new information. Chapter One gave my rationale for this inquiry. The second chapter presented the historical background of movement in Europe and the United States. An in-depth analysis of the current research data on the brain function, movement, and classroom practices that included kinesthetic learning was presented in Chapter Three. Finally, I proffer my conclusions, as influenced by the research, and implications for future research.

Summary of Findings

My original beliefs were supported by the information obtained through these empirical research studies. Some students benefit significantly from kinesthetic learning opportunities and therefore, it is important to include them in a well-balanced curriculum (Allen & Butler, 1996; Boykin & Cunningham, 2001; Braio et al., 1997; Brooks et al., 2002; Caine & Caine, 1990, 1995, 1997, 1998b; Dunn, 1995; Dunn et al., 1990; Gage, 1995; Gardner, 1983; Grant, 1985; Green, 2002; Gilbert, 1977; Hannaford, 1995; Jensen, 1998; Kolb, 1984; Ratey, 2002; Rayneri et al., 2003; Snyder, 2000; Tate, 2003; Wolfe, 2001; Worden & Franklin, 1987; Zull, 2002). Kinesthetic contexts are one means of meeting the needs of the diversity that exists among learners in our public school classrooms.

There were extremely limited peer-reviewed research reports available for the first section of this paper on the mind. I was able to find only four such studies. Practitioners in the field of education have published books espousing the benefits of teaching with the brain in mind (Caine, 1995; Jensen, 1998; Ratey, 2002). Therefore, I had expected to find a vast number of studies exploring the various sections of the brain and their function in cognition. I did not. There was a multitude of qualitative research reports published in non-peer reviewed journals that could not be included in this paper. The lack of peer-reviewed research available may be related to the current debate around teaching techniques and the brain. This debate among researchers and practitioners concerns the relationship between understanding the brain's functions during cognition and the implications to classroom practices (Caine, 1998a; Caine, 2000; Goswami, 2006). The research I found provided more support for the correlation between increased cognitive performance when teaching techniques were geared toward enhancing brain function. The specific studies will be addressed in the following paragraphs.

As stated earlier, teaching in a manner that enhances brain functioning is referred to as brain-based learning. One of the authors of a brain-based learning book, Ratey (2002), asserted that cognitive neuroscience has discovered more connections between movement and learning. He referenced the experiment conducted by Goodwyn et al. (2000) as an example of movement improving learning. The Goodwyn study compared the language acquisition of infants who utilized kinesthetic experiences while learning speech and those who did not include movement. The study illustrated a significant increase in language acquisition between infants who combined symbolic gesturing with verbal speech over infants who only verbalized.

The conclusion that can be drawn from the three studies of Educational Kinesiology (Brain Gym) is that the use of these prescribed body movements in the school classroom improves the physical motor skills of students with learning disabilities (Cammisa, 1994; Khalsa et al., 1988; Sifft & Khalsa, 1991). The results did not indicate an improvement in academic achievement or cognition. Yet, a plethora of non-peer reviewed studies, opinion papers, and books proclaim a positive connection between movement and learning (Caine & Caine, 1990, 1995, 1997, 1998a, 1998b, 2000: Dunn, 1995; Gilbert, 1977; Hannaford, 1995; Jensen, 1998; Kolb, 1984; Ratey, 2002; Tate, 2003). A controversy over the effectiveness of Brain Gym and brain-based learning practices exists within both the education and neuroscience fields (Caine, 1998a; Goswani, 2006). It is difficult to balance these divergent theories. Further research is needed to discover how Brain Gym and other movement skills work. There are theories, supported by magnetic resonance imaging (MRIs), of the areas of the brain involved during various cognitive processes and physical movements (Hannaford, 1995; Kolb, 1984; Jensen, 1998; Ratey, 2002; Zull, 2002). But the question still remains for me, how do I reconcile what many educators see in the field and what the current peer-reviewed research shows?

The second research section, the Body, presented studies on the effects of physical movement on the cognitive abilities of elementary students and adults. Several studies exhibited the positive correlation between movement and some levels of cognitive skills (Hogervorst et al., 1996; Knight & Rizzuto, 1993; Reynolds et al., 1003; Tomporowski et al., 2005). The use of movement during or prior to learning increased their ability to process new information for some participants in these studies. This holds true especially for elementary students who experience difficulties in reading and other cognitive and developmental delays (Knight & Rizzuto, 1993: Reynolds, 2003). This research on students with special needs was included because more classrooms today include students with special needs. The implementation of varied curricula, including kinesthetic learning opportunities, for the entire class will greatly benefit some of those students.

Two of the studies mentioned above used the responses of highly trained adult athletes after strenuous exercise (Hogervorst et al., 1996; Tomporowski et al., 2005). A caveat is necessary in these cases. The results of improved response time and cognitive skills could be contingent more upon the unique physical abilities of the participants than the physical exercise itself. Studies which examine the cognitive performance of elementary students involved in strenuous exercise are needed to determine effects on this specific population.

The research that made up the bulk of this paper appeared in the Mind-Body section. The majority of studies focused on the diversity of learners and their unique ways of processing new information; various learning styles. Kinesthetic learning opportunities address the needs of some students, especially those with movement and kinesthetic learning styles. The existence of different learning styles, intelligences, and modalities is widely accepted in the field of education. All but one of the research studies presented in the Mind-Body section of Chapter Three supported increased cognition through learning style teaching techniques in classroom practices (Kratzig & Arbuthnott, 2006).

Two of the remaining 14 studies serve as exemplars for the summary of this section. The first example was Grant's (1985) longitudinal study of the impact of kinesthetic teaching techniques on elementary students. The experiment involved first graders who were identified as at risk for poor academic habits. This group received kinesthetic treatment in reading, writing, and spelling. These same students were evaluated in fourth grade and found to have equaled or surpassed the performance of the control group who were not at risk and receive traditional teaching methods.

The second study, Searson & Dunn (2001), also serves as a good example of the effects of kinesthetic learning opportunities on students' cognitive abilities. These researchers examined kinesthetic and tactile teaching techniques in the subject of science. The results of the study showed a significant difference in achievement scores when manipulatives and movement activities were offered for students to use. This research supports my original beliefs that kinesthetic learning opportunities should be a part of diverse curricula for a diverse student community.

Classroom Implications

The diversity of students within public school classrooms; including students with special needs, various ethnicities, and different learning modalities, ensures that teachers need awareness of how individual students learn. Offering a wide variety of learning contexts will enable more students to obtain and process new information. The traditional methods of instruction focus on learners who are skilled at sitting and listening. These are the students who excel on the academic achievement tests which require these skills. Learning style theory and multiple intelligences theory espouse that individual learners obtain and process information in a variety of ways. Therefore, it is necessary to acknowledge these differences and offer learning opportunities that accommodate them (Allen & Butler, 1996; Boykin & Cunningham, 2001; Braio et al., 1997; Brooks et al., 2002; Caine & Caine, 1990, 1995, 1997, 1998b; Dunn, 1995; Dunn et al., 1990; Gage, 1995; Gardner, 1983; Grant, 1985; Green, 2002; Gilbert, 1977; Hannaford, 1995; Jensen, 1998; Kolb, 1984; Ratey, 2002; Rayneri et al., 2003; Snyder, 2000; Tate, 2003; Wolfe, 2001; Worden & Franklin, 1987; Zull, 2002).

A means of accommodating a variety of students is to present learning materials in multiple ways; through multiple learning modalities. I envision a classroom divided into learning stations which consist of meeting, writing, math/manipulatives, art, listening center, library, and science center. Students freely access these areas during interdisciplinary lessons (Rayneri et al., 2003). For example, a lesson on local forests would have students working in the science center analyzing deciduous and coniferous tree parts, examining the non-fiction books in the library, identifying bird songs in the listening center, and writing a letter to a friend about the class fieldtrip to the Capitol State Forest.

It is important to limit the amount of sitting time for students in Kindergarten through third grade (Jarrett et al., 1998; Pelligrini et al., 1995). When a mini-lesson is needed to guide a learning opportunity, the teacher and students can gather in the meeting area. Mini-lessons should give enough information for the students to use while they continue learning through their own inquiry (Zemelman et al., 2005). Students then move to the learning stations to which they are assigned or by choice, depending on the nature of the lesson. Structured and purposeful movement within the classroom enhances a student’s learning while providing for multiple learning styles and modalities (Dolezal et al., 2003). This is one way to incorporate movement into a student's learning environment.

Offering kinesthetic learning opportunities within content curricula is part of a balanced planning approach which engages all the students in a classroom (Allen & Butler, 1996; Boykin & Cunningham, 2001; Braio et al., 1997; Brooks, et al., 2002; Druyan, 1997; Dunn, 1995; Gage, 1995; Grant, 1985; Green, 2002; Gilbert, 1977; Hooper, 2002; Jensen, 1998; Rayneri et al., 2003; Schubert & Melnick, 1997; Tate, 2003). Incorporating both gross and fine motor functions in mathematics, science, social studies, and writing makes learning interactive and fun for many students. The whole body can be used to demonstrate connections between concepts or between parts of a whole (Gage, 1995, Jensen, 1998). For instance, a learning opportunity for the water cycle includes students representing trees, soil, aquifer, clouds, and streams while several other students represent the water. As the water students 'cycle' through the other students, their shape and movements change as the water changes in the water cycle. Meanwhile, the soil and stream students slow down or speed up the water students as they pass through.

Mathematics is a content area which is ripe for kinesthetic learning opportunities (Zemelman, 2005). The concept of place value can be processed via whole body and manipulatives. Students can stand on a life-sized place value board representing ones, tens, and hundreds. When a new student joins nine "ones" they change to become one "ten", and so on. This experience can be an extension of the more common use of math manipulatives. Another math learning opportunity can be utilized when teaching multiplication. Students can place different colored counters on columns and rows of a grid paper in various patterns. This activity supports the learning of multiplication as repeated addition and determining area.

Reading and literacy also lend themselves to kinesthetic learning (Allen & Butler, 1996; Boykin & Cunningham, 2001; Gage, 1995; Hooper, 2002; Knight & Rizzuto, 1993; Reynolds et al., 2003; Schubert & Melnick, 1997; Worden & Franklin, 1987). Role playing, through readers' theater, gets the body and mind moving. Role playing encourages individuals to take on the perspective of others; an EALR requirement. When teaching phonemic awareness as a part of reading, the students create a movement to accompany the sound of a letter or letters. The sounds and movements are then combined to form short words. A writing curriculum also benefits from kinesthetic activities (Brooks, 2002). Young elementary students trace or free hand letters in a sand tray. One partner 'writes' a secret message on another's back while the partner guesses the letters and words. Magnet letters provide an opportunity for students to manipulate letters into words, building word recognition without the fine motor dexterity required to write with pencil and paper. When introducing new words the teacher claps, stomps feet, or slaps a leg with each letter in a rhythm which can help some students recall the correct spelling. The teacher encourages the students to respond with the same rhythm when they spell back the word. All of these instructional techniques can become part of a teacher's daily repertoire.

Teaching Strategies

The following section outlines some kinesthetic teaching strategies I envision using, but do not have specific research studies to inform their contributions, if any, to cognition. Here are a few cross-content kinesthetic learning opportunities a teacher could use in the classroom. Concept review Twister is a fun cooperative way to help students discover what they already know, or need to know, about a concept. The students form small teams to answer the review question posed by the teacher. They choose one student to move on the Twister board to the color spot if they get the question correct. Another fun learning game to try with students is blackboard shuffle board. The teacher writes several questions from any content area across the width of the blackboard. Students come up to one end of the blackboard and slide an eraser along the tray. The student answers whichever question the eraser lands under. This game can be done individually or with small teams.

Many simple movement opportunities can be interspersed throughout the daily routine (Jensen, 1998). Students convene in the meeting area for large group instruction or discussion and then move back to their tables. Learning activities involve many of the stations around the classroom. Students allowed sitting, standing, or kneeling near their tables or desks when doing table work. Movement between areas of the classroom becomes a student's way of taking responsibility for her or his own learning. It also permits a student to identify what he needs to make his learning space optimal.

In my experience as an educator I witnessed students acquire new information through their kinesthetic senses. I saw them more engaged and perform better on assessments during and after kinesthetic learning experiences. I personally learn more quickly and with increased retention when I move my body. The connection between movement and learning is not a question for me – I know they are inextricably entwined.

Learning is an unique process for each individual (Caine & Caine, 1998b; Kolb, 1984; Zull, 2002). Our world is a wonderful array of diverse people. Honoring the diversity of the learners in our classrooms enables each child to excel in her or his own way. We all have different strengths and gifts. When each is allowed to shine, the whole is greater than the sum of its parts. Our classrooms, our students, our schools will excel.

Implications for Further Research

Many educators and authors subscribe to the benefits of using Brain Gym with elementary students of varying academic abilities (Cammisa, 1994; Dennison, 2006; Hannaford, 1995; Khalsa et al., 1988; Sifft & Khalsa, 1991). Further research into how and why Brain Gym works is needed. The few studies reviewed for this paper showed a correlation between Brain Gym and motor performance but not cognition (Cammisa, 1994; Khalsa et al., 1988; Sifft & Khalsa, 1991). I'm left with the question what effects does Brain Gym movements have on children's cognition and what specifically happens to the brain as a result of these movements? Some educators believe there is a direct correlation between Brain Gym and cognitive growth in elementary children (Dennison, 2006; Hannaford, 1995).

Further research into brain based learning such as the precise relationship between the brain, its functions, and kinesthetic learning is called for. Many people in the education field promote the benefits of brain based learning (Caine & Caine, 1990, 1995, 1997, 1998a, 1998b, 2000; Jensen, 1998; Kolb, 1984). Indeed, international educator training programs exist which support brain based learning. I would like to see several brain based research studies which use elementary aged students as their participants. Is there a difference in how to teach to the brain for young people versus adults? Which teaching techniques are best suited to elementary students' cognitive growth? How exactly does movement during learning affect the brain in elementary students?

Furthermore, some of the studies utilized movements to improve balance (Khalsa et al., 1988; Knight & Rizzuto, 1993; Reynolds et al., 2003). What is the connection between balance and cognitive skills? It would be interesting to conduct an experiment that increases balance in students to determine if that would in turn increase their achievement scores. These are some of the questions which still remain after my inquiry into this topic.

I see a need for more research on the effects kinesthetic learning has on acquisition of the concepts embedded in science, mathematics, reading, and social studies for elementary students. For instance, does using manipulatives during mathematics increase all or just some students' cognition? Also, what are the effects on comprehension of using movement, such as role playing, during reading? Do students reach higher cognitive levels, such as application, when they are permitted to perform their own hands-on science inquiry? All of these questions about 'what' lead me to more questions about the 'how' of kinesthetic learning and the brain processes.

I continue to question the extent of the impact recess and physical education (PE) has on elementary students' cognition. Research into the effects of no recess or PE would benefit this inquiry. What are the effects on cognition of strenuous exercise within an elementary school setting? What are the effects of longer periods of recess or PE? Is there a difference in cognition when only recess or PE is experienced by students? Which venue, recess or PE, impact cognition greater, or at all? Is there a difference on cognition between the structured activities of PE versus the unstructured activities students experience during recess? Lastly, how does the current epidemic of childhood obesity impact the effects of either recess or PE on students' cognition?

Finally, I wonder how neuroscience, kinesiology, and education fields can collaborate to answer the question, how does the brain develop through the use of movement and how can those findings be applied to classroom practices? I believe that interdisciplinary approaches between these three fields could enable educators to understand the brain's function in cognition and how best to facilitate and guide acquisition and application of new knowledge. Teaching and learning are reciprocal processes; as one teaches, one learns, and is better able to teach. The learning process continues throughout our lives. It is a worthy process to delve into.

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