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The integration of kinesthetic learning through the math & movement program: pilot study 2015

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The Integration of Kinesthetic Learning through the Math & Movement Program: Pilot Study

By:

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Abstract

Purpose: The primary purpose of this pilot study was to verify that the use of kinesthetic learning (Math & Movement Program) in the classroom increases retention of multiplication facts at a greater rate than traditional drill and practice. The Math & Movement Program uses a kinesthetic learning-based approach for practicing, learning, and memorizing mathematics through the incorporation of bodily movement(s). **Participants:** The directors of the research project for the participating school district selected the sample of convenience. The population size of this study included 213 third and fourth grade students during the second half of the 2011-2012 school years. **Data Analysis:** The instrument used to collect data was a math exam focusing on student understanding of their multiplication facts. Students were given a pre-test and post-test of 70 math questions to be completed in two minutes. The researcher analyzed data using SPSS software. A repeated measures test was conducted and the analysis was divided: 2 x 2 (pre and post-test & experimental and control group) repeated measures ANOVA. For purposes of this study, the statistical significance was determined at $p < .05$. **Results:** Results from the 2 x 2 ANOVA test of within-subjects contrasts showed no significant difference for the experimental group and control group ($F(1, 211) = .844$, $p = .359$), whereas results from the test of between-subjects effects (comparing both groups) showed a significant difference between the two subjects ($F(1, 211) = 11.43$, $p = .001$). The results indicated that the control group's overall average score was higher than the experimental group's overall average score. Results from the research study provided no significant relationship between kinesthetic learning and academic achievement. **Conclusion:** Additional research as to how kinesthetic learning impacts the performance of the brain and its role on cognition needs to be further investigated.

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CHAPTER ONE: INTRODUCTION

Introduction

There is a debate over whether or not kinesthetic learning has a positive or negative impact on student achievement (Mobley & Fisher, 2014). As educators adopt new ways of teaching students inside a classroom, school districts face challenges over ways to keep students physically active amidst budget cuts, diminished educational funding, and the growing influence and questionable effectiveness of technology (Howie & Pate, 2012). In this study, the researcher focused on the incorporation of kinesthetic learning through the Math & Movement Program developed by Suzy Koontz (2011). The researchers focus is to understand if the Math & Movement Program has any measureable effect on student achievement in mathematics.

A Central New York School District was awarded a $20,000 grant from the Elmira Corning Community Foundation to pilot the integration of kinesthetic learning through the Math & Movement Program (materials and teacher training) in the elementary schools. The grant required the school district to conduct a research study to ascertain the benefits of using this approach, which is aligned with the Common Core Learning Standards (CCLS). The purpose of the Math & Movement Program was to help enhance the school district's existing Mind Body Experience (MBE) program. The MBE program was created in all of Elmira's elementary schools as an influential strategy to bring physical education activities into the classroom. Based on the research from Lengel and Kuczala (2010) moderate to vigorous physical activity (MVPA) can help promote retention of what is learned with the inclusion of kinesthetic activities in the classroom as opposed to static learning.

Since the implementation of the *No Child Left Behind Act*, politicians as well as school administrators have used standardized test scores in specific subject areas to measure and assess academic performance. Frequent testing and data reports have put tremendous responsibility on public education (Yell & Drasgow, 2005). The NCLB Act's plans to enhance student performance in the classroom has forced school districts, school administrators, and teachers to place a higher prominence on teaching core subjects evaluated through standardized tests. This expansion has come at the cost of diminished time spent on subjects not evaluated by standardized tests such as physical education.

The mandate of NCLB and the new common core standards has reduced the administrator's ability to give students time to participate in daily physical activity (Maeda & Murata, 2004). Critics of the NCLB Act have expressed concern about this, saying that increasing standardized testing in school and decreasing the amount of physical activity for students will negatively impact cognitive development (Dee & Jacob, 2011). Research suggests that promoting and encouraging physical fitness and improving opportunities for physical activity has positive benefits for academic achievement (Chomitz, Slining, McGowan, Mitchell, Dawson, & Hacker, 2009).

In 2013, the average New York State test scores in math for elementary schools in the area where research was being conducted averaged between 30%-36% (Data Widgets, 2013). Additionally, the school district faced economic challenges during this period that have had a significant impact on the district's budget. These included anticipated cuts in federal and state aid, holdbacks and employee firings. Since 2008 the school district has had to reduce program expenses by more than $21.7 million. In 2011,

Governor Andrew M. Cuomo cut $7.5 million in state aid, and over the past three years New York State was forced to reduce aid to the school district by approximately $11.5 million.

The demands of *No Child Left Behind* and the Common Core Learning Standards have created tremendous pressure on school districts and teachers alike (Maeda & Murata, 2004). Districts have often responded by intensifying traditional teaching methods; however, according to Wiles and Bondi (2007) these traditional teaching methods, where students are seated and inactive for long periods of time, are not beneficial to a student's physical and mental performance. Additionally, research has found positive correlations between movement and cognitive functioning (Emery, Shermer, & Hauck, 2003). Research has shown using movement in the classroom can help enhance engagement, motivation and concentration of the student (Lengel & Kuczala, 2010).

Helgeson (2011) described how incorporating physical activity in the classroom could offer the potential benefit of engaging students both mentally and physically while helping to decrease the quantity of student off-task behavior in the classroom. Additionally, increased movements can narrow concentration at target tasks (Weinberg & Gould, 2011). For example, stretching permits the musculoskeletal system and eyes to relax (Hill et al., 2010) which increases energy levels, decreases stress/anxiety, and increases coordination and attention. According to Strean (2011), Wolfe (2009), and Zimmerman (2002), educators who have integrated movement into classroom lessons reported positive attributes such as student engagement, motivation, and student concentration.

Statement of the Problem

No existing research has been conducted on the Math & Movement Program. The study focused on what effects kinesthetic learning through the Math & Movement Program had in a classroom setting on the cognitive performance of students in mathematics.

Purpose of the Study

The primary purpose of this study was to verify that the use of kinesthetic (movement) learning in the classroom increased retention of multiplication facts at a greater rate than traditional drill and practice. The Math & Movement Program uses a kinesthetic learning-based approach for practicing, learning, and memorizing mathematics through the incorporation of bodily movement(s).

Hypotheses

The following hypotheses were generated for this research study:

Research Hypothesis

Students (experimental group) who participate in the Math & Movement Program showed a significant increase in retention of multiplication facts.

Alternate Hypothesis

Students (control group) who participate in the study showed a significant increase in retention of multiplication facts through drill and practice.

Null Hypothesis

Students (experimental group) who participate in the Math & Movement Program did not show a significant increase in retention of the multiplication facts.

Specifically for this study, it was projected that students in the experimental group

who were receiving more physical activity during the day and more practice in mathematics through kinesthetic learning would score higher on the post-test assessment.

Delimitations

Delimitations of the research study include:

1. This study confined itself to only elementary classrooms in one city school district.
2. The population of the sample was limited to teachers and students in one city school district.
3. The population of this study was limited to elementary school students in grades three, four and five.

Limitations

Limitations of the research study include:

1. The study only targeted elementary schools in the Central New York School District. Consequently, the results cannot be generalized for other schools.
2. The original participants in this study were third, fourth, and fifth grade students. Therefore, the results cannot be generalized for the other grades.
3. The study began in February 2012 (half way through the school year) and ended in May 2012. Therefore, the results cannot be generalized to a full year study.
4. The researcher did not create or distribute the math exam students took for the pre and post assessment.
5. No reliability or validity of the instrument was taken into account in this research study.

Assumption

It has been noted in the introduction that there is an ongoing debate over whether or not kinesthetic learning has a positive or negative impact on student achievement in school. According to Fredericks, Blumenfeld, & Paris (2004), past research confirm students succeed academically when engaged in the classroom. The study assumes students who are active in the classroom will perform better on classroom tests and schoolwork when compared to students who learn through traditional drill and practice. The research study will seek to uncover whether or not kinesthetic learning does in fact have a significant impact on classroom learning and retention.

Definitions of Terms

This section provides a brief description of the key terms and technical language used in the study.

Academic Achievement/Academic Performance- The outcome of education: the extent to which a student, teacher, or institution has achieved its educational goal (Ward, Stoker, & Murray-Ward, 1996).

Cognitive Function- An intellectual process by which one becomes aware of, perceives, or comprehends ideas. It involves all aspects of perception, thinking, reasoning, and remembering (Mosby's Medical Dictionary, 2009).

Kinesthetic Learning- Learning style in which learning takes place by the student while engaged in some form of physical activity, rather than listening or merely watching a demonstration (BenZion, 1999).

Movement- The action in which something or someone changes position or moves from one place to another**.** *Longman dictionary of contemporary English* (4th ed.). (2003).

Harlow, England: Longman.

Neurocognitive- Of or relating to cognitive functions associated with particular areas of the brain**.** Mosby, Inc. (2009). *Mosby's dictionary of medicine, nursing & health professions*. St. Louis, Mo: Mosby/Elsevier.

Physical Activity- The movement of the body that uses energy. *Longman dictionary of contemporary English* (4th ed.). (2003). Harlow, England: Longman.

Physical Fitness- The capacity to perform physical activity (Haga, 2009).

Significance of the Study

Numerous factors could influence (positively and/or negatively) student performance in school. This research study helped contribute to the existing body of knowledge concerning the significance of kinesthetic learning and physical activity in school. The interactions between the brain and the body led previous researchers to ask if there is a connection between movement and cognitive function.

According to Dwyer and colleagues (2006) physical activity (cardiovascular endurance, muscular strength/endurance, stretching, etc.) has been shown to increase concentration and student behavior in the classroom. This increase has a close connection with improvement in academic achievement and positive impact on neurocognitive development of the brain. The use of kinesthetic learning in the classroom can help engage students who are typically passive, sedentary, and disinterested learners to become more active and attentive (Honigsfeld & Dunn, 2009). As a result, integration of kinesthetic learning into the classroom could be the solution to increase student academics (Shoval, 2011).

CHAPTER TWO: REVIEW OF THE LITERATURE

This chapter outlines existing literature on the connection between kinesthetic learning (physical activity), neurocognition and academic achievement. These areas formed the foundation for the hypotheses in the study. Specific sections in this chapter include the theoretical framework, educational background and research associated with physical activity and kinesthetic learning on academic performance.

Theoretical Framework

Theoretical frameworks are paradigms that present a context for examining and bridging the links between concepts (Gilner & Morgan, 2000). The theoretical framework for this study focused on kinesthetic learning, which is one of eight types of learning styles in Howard Gardner's theory of multiple intelligences. In the late 1970's early 1980's Gardner's theory of multiple intelligences analyzed intelligence as the ability to solve problems valued in one or more educational settings (Gardner & Hatch, 1989). According to Chen, Moran, & Gardner (2009), since its inception, Gardner's theory of multiple intelligences has received positive attention, mainly from educators and psychologists. Schools on all continents have incorporated and adopted the principles of Gardner's theory of multiple intelligences into their mission, school curriculum, and pedagogy.

Gardner's theory of multiple intelligences was the basis for this study especially, his theory of bodily-kinesthetic intelligence. The research study focused on the rationale that a person(s) who learns kinesthetically in the classroom will remember information more accurately than a person(s) who is taught in a traditional learning practice (auditory or visual) (Gardner, 1999). Students participating in the study were moving,

communicating through body language and understanding multiplication facts through physical activity (acting out and role playing). "By permitting students to integrate physical activity into their learning experiences, they may essentially learn and retain additional information" (Gardner & Hatch, 1989, p. 4). Research focusing on Gardner's theory of multiple intelligences provided the foundation for the inclusion of movement to enhance student learning in past studies (Honigsfeld & Dunn, 2009) as well as this study.

Educational Background

In 1983, the United States was identified as "A Nation at Risk" (The U.S. Department of Education, 1983). As early as the 1920's, there have been numerous attempts at restructuring schools to improve the curriculum so that it meets all core and state standards (Maeda & Murata, 2004). With the implementation of NCLB, schools and teachers have experienced increased pressure and responsibility to enhance academic achievement so all students are performing at grade level or better.

Coe, Pivarnik, Womack, Reeves, & Malina, (2006) suggested that with the increased pressure from NCLB, the time allotted for recess and physical education has been reduced or eliminated in some school districts. These programs are being replaced with alternate programs in an effort to improve the students' academic performance as measured by standardized tests (Murline, Prater, & Jenkins, 2008). Helgeson (2011) described in his research study how imperative incorporating kinesthetic learning in the classroom has on the potential benefit of engaging students both mentally and physically. Aside from helping students become engaged and focused incorporating kinesthetic learning helps to decrease the quantity of student off-task behavior in the classroom.

Additionally, increased movements can narrow concentration at target tasks

(Weinberg & Gould, 2011). Other investigators have discussed how counter-intuitive it is to reduce physical activity during the school day since it is viewed as reducing the potential for educating the whole child (Rairigh & Townsend, 2001). In other words if students are not active in school they will be disengaged, off-task and disruptive in the classroom (Weinberg & Gould, 2011).

Benefits of Physical Activity

The research described below summarizes the literature in which the current study is designed. Literature focusing on the benefits of being physically active and its impact on neurocognition is presented in the following sections: physiology of the brain, animal research, impact of physical activity and kinesthetic learning in the classroom, and development of motor skills.

Physiology of the Brain

The fields of neurobiology, neurology, kinesiology, and cognitive neuroscience have investigated the development of the brain and its connection to memory and learning (Cotman, Berchtold, & Christie, 2007). Presently, there is an argument among experts as to whether connections (movement, learning and memory) truly exist, and if so, to what extent can the brain's physical processes translate to academic performance (Cotman et al., 2007). Trudeau and Shephard (2010) stated that increased levels of arousal and improved levels of neurotrophins (stimulation of neural connections in the hippocampus; learning center of the brain) occurred when the body moves. Researchers have viewed physical activity as an important component in the way individuals' think and feel (Putnam, Tette, & Wendt, 2004).

Past research indicated that physical activity positively improves neuroplasticity by

assisting in many cognitive and physiological benefits (i.e. neuroprotective, neuroadaptive, and neurogenerative processes) (Dishman et al., 2006). According to Taras (2005), physical activity increased blood flow to the brain, improved cerebral capillary growth, oxygenation, raised levels of norepinephrine (triggers release of glucose, helps circulate blood flow to skeletal muscles and helped supply oxygen to the brain), and improved brain tissue volume. According to Trudeau & Shephard (2008), these improvements and modifications in the body could have a positive connection towards improving cognitive function(s) including concentration, memory retention/retrieval, and short term/long term memory.

Previous research studies have showed that physical activity has a direct effect on the human brain (Ellemberg & St. Louis-Deshenes, 2010; Hillman et al., 2009; Pesce et al., 2009; Cotman et al., 2007; Davis et al., 2007). Blakemore (2003) conferred that physical activity had several positive effects on brain function. Physical activity increased and improved the flow of oxygenated blood through the circulatory system, increased the amount of capillaries surrounding the neuron (Blakemore, 2003) and increased distribution of nutrients (glucose) to the brain (Cotman et al., 2007). Increased angiogenesis (growth of new blood vessels from pre-existing vasculature) created the foundation for microcirculation whose sole purpose is to supply oxygen/nutrient-rich blood to numerous areas of the brain involved in cognitive functioning (Cotman et al., 2007; Blakemore, 2003).

When the body is physically active electrical impulses and chemical messages (neurotransmitters) are relayed throughout the brain across axonal clefts called synapses (Cotman et al., 2007). Physical exercise also triggered the release of the brain derived

neurotrophic factor (BDNF), which enabled one neuron to communicate with another neuron (Kinoshita, 1997). BDNF is a major regulator of neurogenesis (birth of neurons) and helps expand dendrites (branched projections of neurons that act to conduct electrochemical stimulations received by other neural cells to the cell body) and axons (conduction of information from one part of the body to the other). In addition BDNF played a strong role in the regulation of synaptic plasticity, influenced the growth of brain connections, density of dendrites, as well as played an important role in neurocognition (Yamada, Mizuno, & Nabeshima, 2002). BDNF congregates in reserve pools next to the synapse and is released when we get our blood pumping. In the process of physical activity/exercise an abundance of hormones, such as IGF-1 (insulin-like growth factor), VEGF (vascular endothelial growth factor) (Radak et al., 2007) and FGF-2 (fibroblast growth factor) interact with BDNF inside the brain to increase learning (Cotman et al., 2007).

Trophic Factors IGF-1, VEGF, and FGF-2

Trophic factors IGF-1, VEGF, and FGF-2 are produced within the brain and promote stem-cell division, especially during exercise or any type of physical activity (moderate/vigorous). The importance of these factors cannot be over-looked as there is a direct connection between the body and the brain. For example, IGF-1 is a hormone that is released by the muscles when they sensed the necessity for more energy during activity. During physical activity and exercise BDNF assists the brain in increasing the uptake of IGF-1, (which is also important for nerve growth and regeneration) (Alnar, Sullivan, & Feldman, 1999).

Another important component in neural development is the growth factor vascular

endothelial growth factor (VEGF). VEGF is involved in neurogenesis and is an essential protein in both angiogenesis and vasculogenesis (formation of the circulatory system) (Fabel et al., 2003; Ding et al., 2006). As a result, there is a potential that moderate to vigorous physical activity could result in improved oxygen and energy supply to the brain (Radek et al., 2007). In addition to the fore mentioned factors, another growth factor of importance for the brain is fibroblast growth factor-2 (FGF-2), which, like IGF-1 and VEGF increases in the circulatory system during exercise and physical activity and is also necessary for neurogenesis.

Improved brain function is caused by an increase in the development of nerve cells. Ploughman (2008) clarified that physical activity may possibly cause higher neuronal movement, which could lead to cells integrating into neuronal connections. Research suggests that physical activity raised norepinephrine and serotonin (improved the brain's processing of information) and endorphins (increased levels of alertness). Research studies investigating humans confirm areas that are connected with movement and cognitive function are closely linked and therefore physical activity may increase neural connections (Ploughman, 2008). In the quest for further information on human cognition researchers must investigate how a connection between physical activity effects neurocognition and memory in humans. This can be investigated through animal research.

Animal Research

Past research supported the idea that physical activity and/or movement resulted in improvement in neurocognition and memory in humans (Hillman, Erickson, & Kramer, 2008). However, there are ethical limitations to direct observation of the human brain.

Animal research has been used to investigate the molecular and cellular cascades stimulated through exercise (Hillman, Erickson, & Kramer, 2008) as well as how the influence of exercise positively impacts the neural system. Many animal studies have focused on the hippocampus, which is responsible for long term memory (Kramer, Erickson, & Colcombe, 2006).

In one particular experiment scientists conducted research on improving spatial learning and neurocognition using the Morris Water Maze. The Morris Water Maze positions the rodents in a circular pool of water and they must locate an invisible platform in order to escape. The invisible platform never moves during each trial; however the rodent is positioned at different locations when entering the pool, and must therefore discover the location invisible platform by using different cues (Kramer, 2006).

Most recently, van Pragg, Shubert, Zhao and Gage (2005) used the Morris Water Maze in a study and observed that older rodents that exercised more often displayed quicker attainment and retention of the hidden platform location than the aged-match control group. In an earlier study conducted by van Pragg, Kempermann, & Gage (1999) two groups of mice had unlimited access to a running wheel to test whether aerobic exercises improved brain cell restoration and development, while one group was housed in a small cage without a running wheel (control group). Results from the study showed increased cell proliferation in mice exposed to the running wheel, but overall showed no difference in running distance between the 19-month-old mice and the 3-month-old mice. van Pragg and colleagues established that aged mice displayed faster learning on the Morris Water Maze and displayed an increase in the development of new neurons in the dentate gyrus (part of the hippocampal formation) than the control group. According to

van Pragg and colleagues (2005) even though more research is needed; exercise does help the development of new neurons, but may not have a strong connection towards enhancing cognition.

Impact of Physical Activity and Kinesthetic Learning in the Classroom

It is frequently assumed by administrators that spending time on physical activity (recess/brain breaks) during the school day decreases a child's opportunity to learn in core classes such as social studies, science, math, and language arts (Martin & Chalmers, 2007). Based on the research of Robinson & Goodway (2009) and Robinson & Wadsworth (2010) a young child's participation in recess/brain breaks is important and it is planned physical activity that assists in development of gross motor skills in addition to meeting fitness guidelines. According to Wiles & Bondi (2007), traditional educational teaching methods, where students are seated and inactive for long periods of time, are not beneficial to a student's physical and mental performance.

Additionally, researchers have found correlations between movement and cognitive functioning in the classroom and how helped enhance engagement, motivation and concentration of the overall student (Emery et al., 2003; Lengel & Kuczala, 2010). The use of kinesthetic learning in the classroom helped engage students who are typically passive, sedentary and disinterested learners to become more active and attentive (Honigsfeld & Dunn, 2009). Kinesthetic learning is important for a successful school experience (Hannaford, 2005). Additionally, when educators who have integrated movement into classroom lessons, positive attributes have been reported such as increased student engagement, motivation and student concentration (Strean, 2011; Wolfe, 2009; Zimmerman, 2002; Trudeau & Shephard, 2008).

In 2009 Donnelly and his research team investigated the impact of Physical Activity Across Classrooms (PAAC) on body mass index (BMI) and cognitive functioning over a three-year stretch. The investigation focused on classroom teachers incorporating moderate to vigorous physical activity (MVPA) through PAAC for approximately 90 minutes per week. Results from the study displayed an improvement in academic performance, minor improvements in BMI, and improvements in MVPA in students participating in more than 75 minutes of PAAC per week compared to students participating in less than 75 minutes of PAAC per week (Donnelly et al., 2009). Furthermore, the study revealed students in the PAAC program continued on with MVPA over the weekends and during school days.

Donnelly and his research team (2009) proposed this change in MVPA was due to a strong approach encouraged by the PAAC program. The study found positive connections between being physically active and academic achievement. It should be taken into consideration that not all research studies on this specific topic have found statistically significant results (Donnelly et al., 2009). Future research is needed on this topic to carry out a study that is reliable and has the potential of finding valid results (Donnelly et al., 2009).

In 2013, Gao, Hannan, Xiang, Stodden, and Valdez investigated the impact of newly established programs focusing on physical activity and its effect on physical health and academic achievement in a Hispanic population. The researcher's main focus was to investigate how exercising using Dance Dance Revolution (DDR) could impact Hispanic students' physical activity, neurocogntion, and academic performance in school. The researchers conducted a two-year study with 208 Hispanic students and used a repeated

measures crossover design to collect data. In its first year of investigation, the intervention group (students in the 4th grade) was given approximately thirty minutes of exercise through DDR (aerobic dance/fitness) approximately three times per week and the control group (3rd and 5th grade students) was given no structured aerobic exercise at school. In the second year of the investigated study, students in the 4th grade were again assigned to the intervention group, whereas students in the 5th and 6th grade were in the control group.

According to Gao and colleagues (2013), results from the investigation showed a significant difference between the intervention and control groups in the 1-mile run and math scores in years 1 and 2. The researchers also discovered differences between the intervention and the control group scores on the 1-mile run for students in the 3rd grade ($p<0.01$). In addition, "students yearly pre and post-test BMI group changes differed ($\chi(2)((2)) = 6.6$, $p<0.05$) only for the first year of the investigated study" (p. S-244-S245). The researchers concluded the intervention of DDR-based exercise improved the progress of children's cardiovascular endurance and math scores over a period of time. Furthermore, they suggested that school administrators and health professionals should highly consider incorporating *exergaming* programs and/or activities in schools towards accomplishing the goal(s) of promoting a physically active lifestyle, enriched and healthy learning environment, and enhancing academic achievement among Hispanics as well as other race/ethnicities in the United States.

Relationships of Physical Education, Physical Fitness, Physical Activity and Academic Achievement

The research described below summarizes literature in which the current study is

designed. The literature of this section focused on studies that have investigated the connection between physical education, physical fitness, physical activity, and academic performance.

Physical Education and Academic Achievement

"Physical education is a field that advocates a holistic approach to human development" (Sibley & Etnier, 2003, p.243). Since physical education classes provided students with an opportunity to be physically activity during the school day, several researchers have investigated its relationship to academic achievement. In the spring of 2001, Tremarche and her colleagues planned and administered an investigation to verify the influence of improved physical education class time on the Massachusetts Comprehensive Assessment System (MCAS) standardized test scores. The investigated study was administered over a two-month period (April-May) and focused on 311 fourth-grade students from two different Massachusetts schools. The research study was administered to get a better understanding if exercise/physical activity does in fact have a positive impact on neurocognition.

Each school received different hours of physical education; school 1 received 28 hours of physical education and school 2 received 56 hours of physical education (Tremarche et al., 2007). Both schools administered the MCAS within the two-month period. Students participating in the research study were tested in Mathematics and English and Language Arts (ELA). Data were analyzed using an independent t-test to verify whether or not a significant difference existed between groups in academic achievement. Students from school 2, received more hours of physical education, scored significantly higher on the ELA exam compared to school 1 (received fewer hours of

physical education). However, school 2 did not score significantly higher on the math portion of the exam although the average on the math exam was higher than school 1.

The data confirmed students who received increased hours of physical activity in physical education class could achieve higher scores in different content areas of the MCAS test. Today, standardized testing continues to be an important measurement of student progress in academics. Although the study had positive results, further research is needed to investigate the relationship between physical activity and cognitive functions.

Researchers Coe, Pivarnik, Womack, Reeves, and Malina (2006), conducted an investigation using 214 sixth-grade students intended to verify the impact physical activity has on academic performance at the middle school setting. The researchers randomly selected students for the first/second trimester to participate in physical education classes. Student participation in MVPA was assessed in four-core academic classes by the researchers (social studies, science, ELA, and mathematics) and standardized test scores (Terra Nova percentiles) measured academic achievement. From the results the researchers concluded that students who excelled or met the guidelines for increased vigorous physical activity had significantly higher standardized test scores ($p<0.05$) than students participating in minimal to no vigorous physical activity in both semesters. Even though academic achievement on the standardized test was not significantly associated with student participation in physical education class, higher scores in common core classes were connected with increased levels of vigorous physical activity. The investigators noted an increase in physical activity did not result in a decrease in academic achievement.

The body of research on physical activity and academic performance validated the importance of physical education programs. According to Kelso (2009), reducing or eliminating physical education programs from school will not improve academic performance in the classroom. Physical education programs in the school setting are important for promoting healthier life choices (sports/nutrition) for preadolescents and adolescents (Kelso, 2009). Schools designed positive experiences for children through physical activity. Schools have also provided students with an understanding on how to lead an active/healthy lifestyle and why it is beneficial both mentally and physiologically. "A greater understanding of the relationship between physical activity/physical education and academic achievement can help present schools and organizations with the proof required to improve the blueprint for academic and physical activity programming" (Ehrlich, 2008, p. 43).

The relationship between physical fitness and academic performance: Physical fitness test scores have been positively associated with academic performance. Chomitz, and colleagues (2009) examined the association between physical fitness levels in five domains adapted from the Amateur Athletic Union (AAU) and FITNESSGRAM and their impact on student(s) academic performance in an urban public school. According to Chomitz and colleagues (2009) the method used to conduct this study from 2004-2005 was a cross sectional analysis (populated data collection analysis at one specific point in time). Academic performance was evaluated by the MCAS achievement exams in English (fourth and seventh grade, n = 744) and mathematics (fourth, sixth, and eighth grade, n = 1103).

The researchers (Chomitz et al., 2009) found a statistically significant correlation

between physical fitness and academic performance. On the MCAS students' odds of passing both the English and math portion of the exams increased as the number of fitness levels increased. Results from the study showed students who were physically fit from the beginning to the end of the study displayed a higher average score on standardized tests (science, reading, social studies and mathematics). Academically, the next best group in all four content areas consisted of fifth grade students who were not physically fit, but by the time they reached seventh grade transformed into physically fit students. Lastly, the lowest academic test scores were associated with students who were not physically fit in either fifth or seventh grade.

The researchers suggested that shifting the focus to increased physical education and physical fitness is important and strongly recommended in the school environment. Although more research is required, the promotion of physical fitness through increased and improved physical activity opportunities during recess, physical education, and after school programs dedicated to health and fitness can possibly support academic performance in all grade levels (Chomitz et al., 2009).

Grissom (2005) found similar results when examining physical fitness scores and academic achievement. Grissom's study took place in a California School District in 2002. The participants in the study included fifth, seventh and ninth grade students. Grissom (2005) used the scores from a physical fitness test (PFT) in addition to comparing mathematical and reading scores from the Stanford Achievement Test. Grissom discovered when overall PFT scores were positively associated with academic performance (based on standardized tests) the association connecting physical fitness and academic performance was higher in females as compared to males and also higher for

students having a high socio-economic status (SES) compared to lower SES students (Grissom, 2005).

In a similar study, Castelli, Hillman, Buck, & Erwin (2007) investigated aerobic exercise and cognitive function in preadolescent students. Their findings suggested a relationship between physical fitness and attention and working memory. The participants for this study were 259 students (third and fifth grade) from four Illinois middle schools. The study used the FITNESSGRAM (aerobic capacity, muscle fitness, and body composition) to measure health-related fitness levels. Students with higher scores on BMI and aerobic capacity achieved higher scores in reading and mathematics on the Illinois Standards Achievement Test (ISAT) than students with lower scores. The results from this investigation confirmed that physical fitness, as measured by body composition and aerobic capacity, is generally associated with academic achievement at the elementary school setting.

In 2013, Holt, Bartee, and Heelan investigated how the implementation of physical fitness inside the educational curriculum enhances student engagement and academic performance in an elementary setting. The researchers used four elementary schools and applied a district-mandated 20-minute daily physical activity policy. Participants for the study included students in kindergarten through fifth grade and sixty-eight classroom teachers. The investigators wanted to: (1) identify how teachers met the policy, (2) know how often classroom teachers met the 20-minute physical activity policy, and (3) evaluate the level of intensity of physical activity provided in the classroom. During the school day teachers participating in the study recorded results/observations in a physical activity log and approximately142 students (grades K-5) participating in the study wore

accelerometers to measure daily physical activity.

The researchers (Holt, Bartee, & Heenan, 2013) found 40% of classroom teachers in September 2010 and 4% of classroom teachers in February 2011 met the 20-minute physical activity policy for all five days. 72.5% of classroom teachers in September 2010 and 47.5% of classroom teachers in February 2011 correspondingly incorporated physical activity for at least 3 days per week. In conclusion, the researchers deemed that the teachers didn't meet the daily 20-minute physical activity policy, but found that increased quantity of physical activity attained every week through the classroom teachers' efforts to be an important factor toward complying with total daily physical activity for students.

Research Linking Physical Activity and Academic Achievement

Stevens, To, Stevenson, & Lochbaum (2008) studied physical activity outside of physical education and its relationship to academic performance. Stevens and colleagues (2008) measured physical activity using parental ratings on three variables; (1)- child's occurrence of aerobic capacity on a daily basis, (2)- in a typical week, and (3)- how many days their child engaged in any type of daily physical activity (e.g. sports leagues). The researchers indicated that parents reported that engagement in physical activity outside of school was more positively associated with reading and mathematic accomplishment at home and in school than was participation in physical education class. In conclusion, the investigators reported that physical education neither improved nor diminished from academics, specifically reading and math achievement.

The outcome from this study supported the results of Grissom (2005) and Coe and colleagues (2006). Coe and colleagues (2006) established through research that over two semesters the physical education program was not associated with academic

achievement, but engagement in physical activity met various or complete guidelines for MVPA were significantly associated with higher grades. Similarly, Stevens and colleagues (2008) found that physical education programs in many schools do not increase or decrease academic achievement in young students. It is the amount of physical activity that was the key exercise factor in this study.

Mahar and colleagues (2006) conducted a study in Eastern North Carolina where students (K-fifth grade) were given multiple ten-minute brain breaks to do some sort of physical activity throughout the school day for twelve weeks. The researchers developed a classroom-based physical activity curriculum called Energizers. The activities offered participants a chance to improve on their regular physical activity intensity throughout the school day by agreeing to let students stand and move around for the duration of educational instruction. Mahar and colleagues evaluated students for thirty minutes prior to and following every break; teachers were informed when they were being observed for physical activity and when they would be observed for on task-behavior.

Pedometers measured levels of physical activity to see if there was a difference in activity levels for students participating in Energizers in contrast to students not participating in Energizers. The researchers discovered an eight percent improvement in on-task behavior when physical activity breaks were incorporated (Mahar et al., 2006). The researchers also discovered a twenty percent increase in on-task behavior for students who struggled with concentrating in the classroom, when physical activity breaks were incorporated in the classroom. According to Mahar and colleagues (2006), "a classroom-based physical activity program was effective in support of increasing daily in-school physical activity and improving on-task behavior during academic instruction"

(p. 2086).

In a similar study, Holmes, Pellegrini, and Schmidt (2006) similarly investigated the impact of different times in recess on preschoolers' classroom concentration and awareness. Results from the study indicate preschoolers' classroom concentration and awareness increased after a quick recess break. According to Jarrett and colleagues (1998) recess periods revitalize cognitive functions to assist students in being able to focus more on classroom tasks. Finally, students who have been exposed to additional physical activity in the classroom showed improvement in behavior (Mahar et al., 2006), attention, acknowledgment and recollection in mathematical and reading skills (Fredericks, Kokot, & Krog, 2006; Uhrich & Swalm, 2007).

Math & Movement Review

The Math & Movement Program created by Koontz in 2011 is a relatively new program that is still being introduced into school systems around the United States. There is little research available on the program and at this time there is no known research or any journal publications about the Math & Movement Program. Information that is available about the Math & Movement Program notes that the program is designed around movement for students of all ages. The Math & Movement Program uses simple and fun exercises and through movement students are able to learn, retain information and build valuable skills while strengthening the mind and body through physical activity (Koontz, 2011). According to Koontz (2011) the Math & Movement Program makes it easier than ever to boost engagement and achievement while learning mathematics.

Summary

The importance of kinesthetic learning, physical activity and physical education on

academic achievement is supported by research previously stated in this chapter. The results from research previously stated in this chapter showed positive outcomes on academic achievement when students were highly engaged in classroom activities. Neuroscience provided evidence that daily physical activity enhances neurogenesis, promoted the development of blood vessels, and increased synaptic activity between brain cells (Hillman, et al., 2008). Tremarche and her colleagues believed teachers and school administrators have a responsibility to evaluate past brain research studies and investigate important information associated with learning physical activity and learning inside and outside the classroom (2007). Other researchers have found that physical education, physical fitness, and physical activity (including classroom PA breaks) can enhance academic performance. In past studies, researchers (Grissom, 2005; Coe et al., 2006; Holmes et al., 2006; Mahar et al., 2006; Castelli et al., 2007; Stevens et al., 2008; Chomitz et al., 2009) all found increased results on academic performance when physical education, physical fitness and/or physical activity was a factor.

Even though additional research is essential, it is clear that investments of time and resources in physical activity, physical education, and physical fitness during the school day do not detract from academic performance and could possibly be constructive (Chomitz et al., 2009). Hillman and colleagues (2008) proposed physical activity could possibly improve student cognitive function or capability to concentrate in addition to improving performance on standardized tests. The intention of the Math & Movement program is to capitalize on the positive relationship between kinesthetic learning and academic achievement to enhance acquisition and retention of math skills.

CHAPTER THREE: RESEARCH MANUSCRIPT

Introduction

The primary purpose of the study was to verify that the use of kinesthetic learning (Math & Movement Program) in the classroom increases retention of multiplication facts at a greater rate than traditional drill and practice. Past research has provided evidence that when incorporating kinesthetic learning in the classroom it could help enhance student engagement, enthusiasm and concentration (Lengel & Kuczala, 2010). Allowing students to be physically active in and around the classroom motivates students who are typically passive, sedentary and disinterested learners to become more active and attentive (Honigsfeld & Dunn, 2009).

Educators who have integrated physical activity into classroom-based lessons have stated positive effects of student engagement, motivation and concentration while students are moving (Strean, 2011; Donnelly et al., 2009; Gao et al., 2013; Tremarche et al., 2007; Coe et al., 2006; Chomitz et al., 2009; Stevens et al., 2008; Grissom, 2005; Holmes et al., 2006). Through numerous studies researchers have found reasons as to why physical activity and movement should be incorporated into the classroom (Donnelly et al., 2009; Gao et al., 2013; Tremarche et al., 2007; Coe et al., 2006; Chomitz et al., 2009; Stevens et al., 2008; Grissom, 2005; Holmes et al., 2006). Kinesthetic learning engages students both mentally and physically, furthermore, helps to decrease the quantity of off-task student performance in the classroom (Helgeson, 2011). Additionally, increased movements can narrow concentration at target tasks when the body is active because physical activity positively impacts memory function (Weinberg & Gould, 2011).

With the increased pressure from *No Child Left Behind*, recess and physical education classes have either been condensed or removed in some school districts (Ryan & Beighle, 2010). They are being replaced with different programs in an attempt to improve the students' achievement measured through the means of standardized tests (Coe et al., 2006). Many school districts are choosing to exclude physical activity from the school day (Ryan & Beighle, 2010). As a result, physical activity opportunities in school seem to be decreasing (Murline, Prater, & Jenkins, 2008).

Wadsworth et al., (2012) suggested that integrating physical movements into the classroom or academic concepts into the physical education class can expose students to academic concepts as well as help them stay active. Strong verification that integration is an important teaching technique and approach towards enhancing student achievement in core classes is supported by past research studies from the following researchers: Grissom (2005); Coe et al., (2006); Castelli et al., (2007); Stevens et al., (2008); Chomitz et al., (2009); and Gao et al., (2013). Each investigator(s) found when physical education, physical activity and/or physical fitness were a factor in the study; results showed increases or significant increases in academic performance.

Grissom (2005) examined physical fitness scores and academic achievement. Grissom's study took place in California public schools in 2002. The participants in the study included fifth, seventh and ninth grade students. Grissom (2005) used the scores from a physical fitness test (PFT) in addition to comparing mathematical and reading scores from the Stanford Achievement Test. Grissom discovered when overall PFT scores progressed, the mean math and reading scores also showed signs of progression and showed a positive association between physical fitness and academic performance.

Coe and colleagues (2006), conducted an investigation using 214 sixth-grade students in a study intended to verify the effects of physical activity on academic achievement at the middle school setting. Students were randomly selected to participate in physical education class during the first or second semester. Students' participated in moderate to vigorous physical activity (MVPA). Students were assessed in four-core academic classes (ELA, mathematics, science, and social studies) by the researchers and academic achievement was measured by standardized test scores (Terra Nova percentiles) (Coe et al., 2006). The results from the study found that students who excelled or met Healthy People 2010 guidelines for increased vigorous physical activity had significantly higher common core grades ($p<0.05$) than students who performed in minimal to no vigorous physical activity during both semesters.

Even though academic achievement on the standardized test was not significantly associated to student participation in physical education class, higher scores in common core classes were associated with higher levels of vigorous physical activity when students met the recommended levels for Healthy People 2010 (Coe et al., 2006). Due to the increased levels of vigorous physical activity gained during class time, the results showed students who participated in physical education displayed an improvement in academic achievement in the classroom as opposed to students who did not participate in any physical education. The results from the study also showed that a decrease in academic achievement did not occur.

In a similar study, Castelli and colleagues (2007) investigated aerobic exercise and cognitive function in preadolescent students. Their findings suggested a positive effect between physical fitness and attention and working memory. The participants for this

study were 259 students (third and fifth grade) from four Illinois middle schools. The study focused on components within the FITNESSGRAM (aerobic capacity, muscle fitness, and body composition) and how it positively related to academic achievement. Students who displayed a strong performance score on two components of the PTF (BMI and aerobic capacity) achieved higher scores in reading and mathematics on the Illinois Standards Achievement Test (ISAT). The researchers compared students who displayed strong performance scores to students who achieved low performance scores on the physical fitness tests. The results from this investigation (Castelli et al., 2007) confirmed that physical fitness, as measured by body composition and aerobic capacity, is generally associated with academic achievement in an elementary school setting.

Stevens and colleagues (2008) studied physical activity outside of physical education and its relationship to academic performance. Stevens and colleagues (2008) measured physical activity using parental ratings on three variables; (1)- child's occurrence of aerobic capacity on a daily basis, (2)- in a typical week, and (3)- how many days their child engaged in any type of daily physical activity (e.g. sports leagues). The researchers indicated that parents reported that engagement in physical activity outside of school was more positively associated with reading and mathematics accomplishment at home and in school than was participation in physical education class. In conclusion, the investigators reported that physical education neither improved nor diminished from academics, distinctively reading and math achievement.

The outcome from Stevens and colleagues (2008) study supported the results of Grissom (2005) and Coe and colleagues (2006). Coe and colleagues (2006) established through research that over two semester's physical education was not associated with

academic achievement. However, results showed engagement in physical activity met various or complete guidelines for MVPA were significantly associated with higher grades. Similarly, Stevens and colleagues (2008) found that physical education programs in many schools do not increase or decrease academic achievement in young students. It is the amount of physical activity that was the key exercise factor in this study.

Chomitz and colleagues (2009) examined the association between physical fitness levels in five domains adapted from the Amateur Athletic Union (AAU) and FITNESSGRAM and its impact on student(s) academic performance in an urban public school. According to Chomitz and colleagues (2009) the method used to conduct this study from 2004-2005 was a cross sectional analysis (populated data collection analysis at one specific point in time). Academic performance was evaluated by the MCAS achievement exams in English (fourth and seventh grade, $n = 744$) and mathematics (fourth, sixth, and eighth grade, $n = 1103$) (Chomitz et al., 2009). The researchers (Chomitz et al., 2009) found a statistically significant correlation between physical fitness and academic performance.

On the MCAS students' odds of passing both the English and math portion of the exams increased as the number of physical fitness exams passed increased. Results in the study found students fitness was strongly associated with math achievement scores compared to English. Chomitz and colleagues (2009) suggested that shifting the focus to increased physical education and physical fitness is important and strongly recommended in the school environment. Although more research is required, the promotion of physical fitness through increased and improved physical activity opportunities during

recess, physical education, and after school programs dedicated to health and fitness can possibly support academic performance in all grade levels (Chomitz et al., 2009).

In 2013, Gao and colleagues investigated the impact of newly established programs focusing on physical activity and its effect on physical health and academic achievement in a Hispanic population. The researcher's main focus was to investigate how exercising using Dance Dance Revolution (DDR) could impact Hispanic student's physical activity, neurocogntion, and academic performance in school. The researchers conducted the study using 208 Hispanic students and used a repeated measures crossover design to collect data.

The study lasted two years. In its first year of investigation, the intervention group (students in the 4th grade) was given approximately thirty minutes of exercise through DDR (aerobic dance/fitness) approximately three times per week and the control group (3rd and 5th grade students) was given no structured aerobic exercise at school (Gao et al., 2013). In the second year of the investigated study, students in the 4th grade were yet again assigned to the intervention group, whereas students in the 5th and 6th grade were in the control group (Gao et al., 2013).

According to Gao and colleagues (2013) results from the investigated study showed a significant difference between the intervention and control groups in the 1-mile run and math scores in years 1 and 2. The results also discovered differences in the intervention versus control group scores on the 1-mile run for students in the 3rd grade (p<0.01) (Gao et al., 2013). Finally, Gao and colleagues (2013) revealed that the intervention of DDR-based exercise improved the progress of children's cardiovascular endurance and math scores over a period of time. The researchers suggested that school administrators and

health professionals should highly consider incorporating exergaming programs and/or activities in schools towards accomplishing the goal(s) of promoting a physically active lifestyle, enriched and healthy learning environment, and enhancing academic achievement among Hispanic's as well as other race/ethnicities in the United States.

Research has revealed that exergaming programs in school can support light to moderate physical activity in children and contribute towards achieving the recommended 60 minutes of daily activity (Daley, 2009; Bailey & McInnis, 2011). Student engagement and energy used in exergaming activities is similar to walking, jogging, and/or skipping on a treadmill (O'Louglin, Dugas, Sbiston, & O'Louglin, 2012). In addition, children who are more passive, sedentary and disengaged in traditional forms of physical activity in school or outside of school favor exergaming (Daley, 2009). Furthermore, although researchers have found positive effects while students are engaged in exergaming activities, they worry that it should not replace all types of physical activity (Daley, 2009; Bailey & McInnis, 2011; O'Louglin, Dugas, Sbiston, & O'Louglin, 2012).

Research has supported the importance of physical activity on academic achievement. Although additional research is essential, investments of time and resources in physical activity, physical education, and physical fitness during the school day do not detract from academic performance in core subjects, and may even be beneficial (Chomitz et al., 2009). Hillman, Erickson, & Kramer, (2008) propose that physical activity could possibly increase students' cognitive control or ability to concentrate and also result in improved performance on academic achievement exams.

Research for this study focused on the incorporation of kinesthetic learning

through the Math & Movement Program created by Suzy Koontz (2011). The purpose of the Math & Movement program is to permit students to become physically active while learning and practicing math concepts as well as strengthen student's mathematical skills and improve their capability to concentrate in class. The primary purpose of this study is to verify that the use of kinesthetic (movement) learning in the classroom increases retention of the multiplication facts, at a greater rate than traditional drill and practice.

Methods

Participants

The directors of the research project for the participating school district selected the sample of convenience. The population of the study were 213 third and fourth grade students and 21 teachers form six participating elementary schools during the second half of the 2011-2012 school years for this research study. The fifth grade were part of the original study, but were later removed after the preliminary analysis because of a ceiling effect in the results. The experimental group featured 110 students and 16 teachers (6 classroom & 10 physical education teachers), whereas the control group featured 103 students and 5 classroom teachers after the fifth grade was removed from the study.

At the beginning of the research study, the directors of the Math & Movement Program gathered experimental group teachers. Everyone who was present at the training seminar was shown a power point on why the Math and Movement Program was created and why it should be implemented in school. They also received a Math and Movement Program guide and demonstration of skip counting of mathematics through whisper/loud movements, tapping at the table, locomotor movements on floor mats, and through yoga.

Classroom teachers and physical education teachers participating in the experimental group were given the Math and Movement equipment after the seminar concluded. The equipment was to either be set up in the gymnasium and/or in the classroom. The physical education teachers were allowed to use the equipment during warm up or cool down activities (no interference with units or activities previously created at the beginning of the school year) and the classroom teachers were allowed to use the equipment anytime during the day in the classroom. It was recommended that the classroom teachers in the experimental group take at least ten to fifteen minutes each day allowing students to move around the classroom freely while learning math or they could gather around in group activities and learn mathematics together referencing the guidebook for suggestions. Teachers participating in the experimental group were not allowed to discuss the program or use of equipment with any teacher participating in the control group.

Instruments Used in Data Collection

The instrument used to collect data was a math exam focusing on student understanding of their multiplication facts. The research directors collected all of the elementary student's math scores during the 2012 school year. The directors administered and gathered the pre assessment tests at the beginning of the program (end of February) and at the end of the program (Memorial Day Weekend). All exams were v by high school honors students and scores were verified by the researcher of the study. The information was disclosed to only the researcher and the directors of the program.

Design & Procedures

The researcher sought permission from the directors of the program first. All data

was kept confidential and anonymous. Student names were not used in the study. Instead, they were given a numerical code. The researcher was given an activity log sheet from the classroom teachers in the experimental group and survey pertaining to the research study (February-May 2012). The pre-assessment math test was administered in February 2012. Students were given two minutes to complete 70 math questions. The post-assessment math test was administered in May 2012; students were given the same test and given two minutes to answer 70 math questions in the set time period. Example of test can be seen in the appendices section under appendix A.

Data Analysis

The researcher collected and entered data of the pre-test and post-test scores using Microsoft Excel. Data were analyzed using SPSS software. A repeated measures 2 x 2 (pre and post-test & experimental and control group) ANOVA was used to determine if a significant difference exists.

Mauchly's Test of Sphericity was used to test and see if differences between all pairs of groups were equal and to validate a repeated measures analysis of variance (ANOVA). Mauchly's Test of Sphericity determined whether the data violated the assumption of sphericity. For purposes of this study, the statistical significance was determined at $p < .05$.

Results

Mauchly's Test of Sphericity showed no significant difference and the assumption of sphericity were not violated. Results from the 2 x 2 ANOVA test of within-subjects effects showed no significant difference between the experimental group and control group ($F(1, 211) = .844$, $p = .359$) pre-test and post-test scores. However, results from

the test of between-subjects effects (comparing both groups) showed a significant difference between the experimental and the control group ($F(1, 211) = 11.43$, $p = .001$) pre-test and post-test

scores.

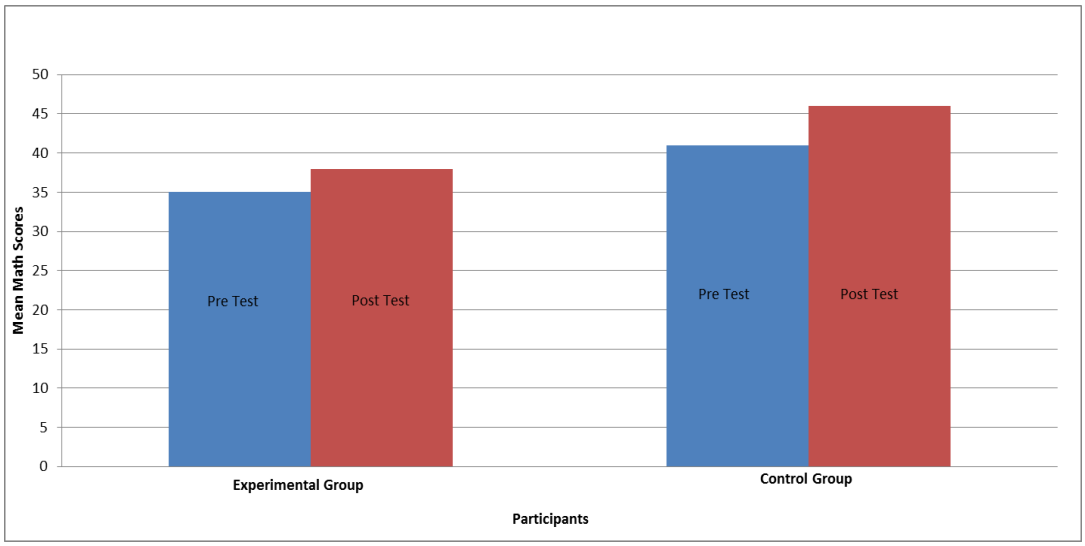

Figure 1- Pre-test and post-test assessment averages for the experimental and control group (2012)

Figure 1 above shows the experimental group and control group pre-test and post-test averages. The bar graph showed that both the experimental group and control group increased test score averages from the pre-test assessment and post-test assessment. The experimental group showed a pre-test average of 35 and at the end showed a post-test average of 38. The control group showed a pre-test average of 41 and post-test averages of 46.

The results indicated that the control group's overall average score was higher than the experimental group's overall average score. Even though both the experimental group and control group increased their test score averages the control group did slightly better than the experimental group. As a result the research study, the researcher accepts the alternative hypothesis of this study, which stated students (control group) who

participate in the study showed a significant increase in retention of multiplication facts through drill and practice.

Discussion

The results from the research study indicate no significant difference within-subject contrasts (comparing the experimental group pre-test and post-test averages only and comparing the control group pre-test and post-test averages only). However, results from the study showed a significant difference between-subjects effects (comparing both groups). Even though the researcher found that the experimental group and control group showed an increase in test averages (pre-test and post-test) the control group had a higher pre-test and post-test average. The control group scores were higher than the experimental group scores; the researcher retained the alternative hypothesis for the research study.

The results from the study differ from other studies (Donnelly et al.; 2009, Gao et al., 2013; Tremarche et al., 2007; Coe et al., 2006; Chomitz et al., 2009; Stevens et al., 2008; Grissom, 2005; Holmes et al., 2006), in that an abundance of studies have found a significant relationship between physical activity/kinesthetic learning and academic achievement, but this study found no significant difference between the experimental and control group. The results of this study do not support the work of previous researchers. It is possible that unrelated variables could have affected the results of this research study that were not evaluated in this study or was not brought to the researcher's attention.

Recommendations for Future Research

This study was based on the belief that integration of kinesthetic learning opportunities can positively impact student retention in the classroom for any subject

faster than traditional drill and practice. In this case the researcher was focusing on how the Math & Movement Program could help students understand multiplication facts. The Math & Movement Program is a new program and it showed potential weaknesses. A few weaknesses that were present in the study were no reliable or valid test (test was created by directors), teachers volunteered to participate in the study, and teachers in the experimental group were never observed or evaluated when using the Math & Movement Program in class.

If future research is conducted on the Math & Movement program a universal test must be created, teachers should be picked (instead of volunteering) and teachers who are participating in the study must be evaluated or observed. These changes will allow for the program to be carried out properly with minimal errors. It will become more reliable to use and valid.

Teachers who participated in this research study completed a survey. The survey allowed teachers to make suggestions regarding the piloting of the Math & Movement Program and make future recommendations they may want to see if the research study were to continue at the selected elementary schools, or recommendations for new schools. Participating teachers from the six elementary schools suggested ways of improving and incorporating the Math & Movement Program through the following:

1. Start the Math & Movement Program at the beginning of the year (September). Teachers felt that if the program began at the beginning of the year then they could get through all math activities, which were listed in the training manual.
2. Utilize the program as part of the transitioning routine (example: social studies to math).

3. Pilot the study for higher grade levels.
4. Develop appropriate modifications to meet all student(s) needs.
5. Incorporate the Math & Movement Program at different grade levels for each school. For example: School A uses the Math & Movement Program for 5th grade only while School B uses the Math & Movement Program for 3rd grade only.
6. Input accurate data of students' progress and mastery of math.
7. Add supplemental written materials.
8. Alter the tests to be appropriate for all. Tests should not look the same for each grade. Higher grades should be challenged with complex math facts.

Teachers were also asked to explain the positive aspects of the Math & Movement Program throughout the 4-5 months the study was being administered. Teachers said that the Math & Movement Program was:

1. Entertaining
2. Educational
3. Creative
4. Positive
5. Enthusiastic

Teachers said that their students were highly engaged in the math and movement activities and saw a big change in student learning before and after the math and movement activities were incorporated in the classroom. Classroom teachers were delighted that all of the students were engaged, having fun and learning all at the same time. All of the teachers said, if they had the opportunity, that they would use the Math

& Movement Program again in class. The creator and directors of the Math & Movement Program will take the feedback and recommendations written by each teacher into account for future practices. The feedback and recommendations help increase the likelihood of incorporating the Math & Movement Program into elementary and secondary schools in the United States and possibly outside of the United States.

This study needs to be replicated at other schools, grade levels and in other states. Some considerations for future research are establishing the validity of the program as well as improving administration of the program. The Math & Movement team must improve collection of data based on:

1. Frequency of each activity used during the day
2. Intensity of each activity used during the day
3. Time used for each activity during the day
4. Type of activity used
5. The questions of each test should be different for each grade level
6. Tests should be administered twice a month (pre-test and post-test)

By focusing on each of these factors when administering and evaluating student performance the researcher(s) has a better understanding of student performance. The research becomes reliable and valid when it has to be presented to the Board of Education, the creator, and people looking to donate money to help other schools and institutions. Since this study did not have a significant relationship between kinesthetic learning and academic achievement, more research is necessary to offer validation on this relationship. The more research conducted on this topic, the closer researchers are to

obtaining a reason as to why past studies showed a relationship between physical activity/kinesthetic learning and academic achievement.

Additional research as to how kinesthetic learning impacts the performance of the human brain and its role on cognition needs to be further investigated. Extensive neurocognitive research is beginning to give researchers additional in-depth data results and answers. However, this is not limited to elementary and secondary students, but older adults and the elderly. Additionally, future research on other variables (e.g. brain breaks) that effect academic achievement would be beneficial allowing physical education and kinesthetic activities to be made a part of the integration of learning.

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Appendices

Appendix A

Math Attitude and Skip Counting (Untimed) Circle one: pre-test post-test

Name of Student_____ Date_____

Grade_____ School #_____ Teacher#_____

Birthdate_____

1. How do you feel about math? (Circle one number)

1	2	3	4	5	6	7	8	9	10
I don't understand math				I like math					I love math

2. I find multiplication to be (Circle one number)

1	2	3	4	5	6	7	8	9	10
Very Hard				Sort of Hard					Easy

Can you skip count? Fill in the blanks.

2, 4, _____, 8, _____, 12, 14, 16, 18, 20

3, 6, 9, _____,_____,_____, 21, _____,_____,_____, 33

4, 8, _____, _____, _____, _____, _____, _____, _____, _____

5, 10, _____, _____, _____, _____, _____, _____, _____, _____

6, 12, _____, _____, _____, _____, _____, _____, _____, _____

7, 14, _____, _____, _____, _____, _____, _____, _____, _____

8, 16, _____, _____, _____, _____, _____, _____, _____, _____

9, 18, _____, _____, _____, _____, _____, _____, _____, _____

10, 20, _____, _____, _____, _____, _____, _____, _____, _____

Evaluation of Multiplication Two–Minute Timed MIXED Set

Circle one : pre-test post-test

Name of Student_____ Date_____

Grade_____ School #_____Teacher #_____Birthdate_____

1 ×8	5 ×3	3 ×2	0 ×5	4 ×4
2 ×7	5 ×1	6 ×1	2 ×2	10 × 8
8 ×2	6 ×5	2 ×4	1 ×7	4 × 6
3 ×4	0 ×3	10 ×6	5 ×2	2 ×9
7 ×7	10 ×4	10 ×0	7 ×6	4 ×8
5 ×7	10 ×5	3 ×3	9 ×4	0 ×2
6 ×8	10 ×7	6 ×3	3 ×7	10 ×3
8 ×3	6 ×6	10 ×2	0 ×7	3 ×9
1 ×1	10 ×10	9 ×8	5 ×4	8 ×7
7 ×9	9 ×9	8 ×8	5 ×5	10 ×5
1 ×2	10 ×9	3 ×1	5 ×9	7 ×4
4 ×1	10 ×1	6 ×2	9 ×1	8 ×0
8 ×5	6 ×0	10 ×9	1 ×0	4 ×0

9	9	10	0	6
×6	×0	×5	×0	×9