MATHEMATICS AND PHYSICAL EDUCATION CO-CURRICULAR INTEGRATION: THE EFFECT ON STUDENT ACADEMIC ACHIEVEMENT

A Dissertation

Presented to

The Faculty of the Education Department

Carson-Newman University

In Partial Fulfillment

Of the

Requirements for the Degree

Doctor of Education

By

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May 2017
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Tammy J. Lohren

May 2017
Abstract

Through curriculum integration, the merging of two or more subject areas into one class will elicit learning across the curriculum that occurs both inside and outside the classroom. Since integrative learning makes connections across content areas, so do the theories used in this study. A combination of Howard Gardner’s theory of multiple intelligences, Albert Bandura’s social cognitive theory, and the constructivist theory comprised of Piaget, Dewey, and Bruner’s philosophies are intertwined in this integrative study. Since the inception of the No Child Left Behind Act (NCLB), standardized testing has been emphasized, and non-tested subjects such as physical education have been deemphasized. Thus, there is a decrease in physical activity among youth. The technology explosion in America has also had a tremendous negative impact on the health of the nation’s youth due to the immense amount of time using technology, resulting in developmental delays linked to a decrease in academic performance. The purpose of this study was to examine if integrating mathematics into a physical education (PE) setting would elicit a positive result on student academic achievement. This was a mixed-methods study, which produced both qualitative and quantitative data, and convenience sampling was utilized. The paired t-test: one-sided and two-sided analyzed the data. A box-plot illustrates the distribution of the data. Qualitative data were obtained from semi-structured interviews. Statistical analysis indicated there was a positive correlation between integrating mathematics in PE and academic achievement. However, there was no significant gain on the STAR assessment. The interviews indicated that there was a gradual increase in knowledge and comprehension of the math concept integrated. This study provided findings that indicate areas of improvement. Successful integration requires interdisciplinary cooperation, collaboration, time, and professional development providing integrative strategies.

Keywords: integration, formative assessment, STAR, semi-structured interviews

Dedication

“For nothing will be impossible with God” (Luke 1:37).
I thank my Lord and Savior Jesus Christ for paying the ultimate sacrifice. I am eternally grateful to God the Father for giving His only Son, Jesus Christ, to die on the cross for all of our sins so we can have eternal life.

I dedicate this work first and foremost to my parents. My mother, Beryl Lohren, has been my cheerleader and inspiration behind the scenes. Selflessly, she wants the very best for me and believes in creating options in life. My father, Carl Lohren has exposed me to the most important thing in my life, the Word of God. My father is the instrument behind where I am today, the teaching arena. Without the love, devotion, instruction, and support of my parents, this would have never been possible.

A tremendous amount of gratitude goes to my sisters, their husbands and niece and nephew. Holly and Bill Lohren-Monahan for their continued support, love, selfless help, thoughtfulness, and countless prayers. Ann and Scott Shulman, Lohren and Trent Dyer, and Eric Shulman for their countless prayers, words of encouragement, love, devotion, and constant support during this journey.

A very special thank you, to Chris Dibble for his unselfishness, consistent positive outlook, unwavering patience, and unconditional love.

Finally, I dedicate this work to my late grandmother, Betty Lohren who never doubted me. She has been the rock of our family and the coolest 104-year-old “Grams” ever.

Acknowledgements
Many other people need to be acknowledged for their support, open door policy, patience, flexibility, and time. A special thank you to Dr. Julia Price, my dissertation chair, for taking me under her wing. Dr. Price has a tremendous calming effect. She is firm, but to the point and radiates a sense of belief in her students. She is inspiring and knows when positive reinforcement is necessary. I cannot thank her enough for her honesty and helping me to pursue my endeavor completing this doctoral journey. Dr. P. Taylor, my methodologist, displayed and instilled a tremendous calming effect when needed and obviously was a necessary link to the success of this study. Dr. Jean Love, a member of my committee, spent an immense amount of time helping organize and teaching me how to write the work presented. Dr. Jean Love instilled a sense of belief and words of encouragement when needed. I cannot thank Dr. Cynthia Lynn and Dr. Andy Rines enough who had the daunting task of editing this dissertation. God bless all the members of my committee who stayed the course.

A tremendous amount of gratitude is expressed first and foremost to my principal, Lana Shelton-Lowe. Her open door policy and willingness to help at any time was truly a blessing. I was also very fortunate to have amazing assistant principals that were always willing to share their time and expertise: Aaron Maddox, Denise Gordon, and Rebecca Headrick. I cannot say enough about the following teachers as they have been an inspiration to me both personally and professionally: Lori Dixon, Kim Lueneburg, Marla Crossley, Thomas Foshee, Tiffany Corum, Jessica Wallis, Kim McDaniel, Sandy Wallen, Karen Talley, and Kelly Zunich. A special thank you to Thomas Tilson for his time and help in the statistical aspect of this study.

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CHAPTER 1: ORGANIZATION AND PURPOSE

Introduction

“Since this is social studies, spelling doesn’t count, right?” (Wraga, 2009, p. 88). Through curriculum integration, the merging of two or more subject areas into one class will elicit learning across the curriculum in an exciting manner that not only relates to the academic world, but to the real world as well. Educators are searching for strategies to help students make sense out of the multitude of life experiences and the pieces of knowledge taught in the typical over-departmentalized, splintered school curriculum (Vars, 1991). By integrating interdisciplinary studies in the classroom, children experience how to make associations and transfer information from one topic to another, resulting in a plethora of connections between the academics and life. Integration aids in information retention and holistic child development.

This study implemented math into a physical education (PE) setting to study the effects of integration on academic achievement of children’s grades using the STAR screener and a formative pre-post assessment. According to statistics provided by the research school, the STAR screener helped to determine whether students are on track in demonstrating skills necessary to achieve grade level standards.

Background of the Study

Integrating interdisciplinary studies is not a new concept. One of Da Vinci’s many quotes depicting his belief in integration is “Painting is poetry that is seen rather than felt and poetry is painting that is felt rather than seen” (as cited in Lock 2009, p. 4). Daly, Brown, and McGowan (2012) believe integration emerged when drawings were found in caves depicting history through art, just as Egyptian hieroglyphics and ancient
Chinese characters integrated language through art. Mathematics was also used in ancient Egyptian art depicting figures drawn in correct proportion (Lock, 2009).

Badley (2009) credited Johann Herbart with the concept of correlational studies. As early as 1835, Herbart exhorted educators to teach so students would see the correlation between subjects. Klein (2005) noted the earliest use of the term integration appeared in psychology books authored in the mid to late 19th Century by Herbert Spencer, William James, and Alexis Bertrand. Knudsen (1937) reported that the central idea to Bertrand’s theory was that “all true instruction must be integral and that we should not divide and hand out in small bits that which is naturally one and indivisible” (p 16). Vars (1991) explained the most important time for curriculum integration came during the progressive education movement of the 1920’s. The progressive education movement gave strong emphasis on student-centered and integrative approaches to education.

Dewey (1900), Piaget (1950) and Bruner’s (1960, 1977) beliefs all stipulated that it was important to educate a child by a holistic means. They believed learning takes place through the experiential means of learning by doing, which is the active process (Bruner, 1960, 1977; Dewey, 1900, and Piaget, 1950). Dewey (1902) contended a curriculum that divides children into separate discrete disciplines does an injustice to the child. On the contrary, “experiential learning is vital to schooling for sustainability” (Sly, 2015, p. 2).

**Statement of the Problem**

A compounding problem exists in today’s education system. Since the inception of the No Child Left Behind Act (NCLB) in 2001, the focus is standardized testing. Due to the high stakes testing, there has been an elimination of specific subjects and a
decrease in the time spent on non-tested subjects, such as physical education. By eliminating those subjects not addressed in standardized testing, more teaching time is devoted to topics addressed as part of standardized testing.

Secondly, the technology explosion in the United States has negatively impacted the overall health of America’s youth, as well as their academic performance. According to Rowan (2014), technology use restricts movement, resulting in delayed development. A child’s mental, physical, emotional, and social well-being is negatively influenced by countless hours spent on computers, cell phones, and television time. The result is a vicious cycle of behaviors interrupting child development.

Due to the integrative nature of society, education should incorporate integrative strategies in the classroom as it did centuries ago. Jones (2009) found that many statistical reports conclude that students who receive interdisciplinary techniques have higher test scores in both core knowledge and critical thinking problems. However, research is scarce regarding the results of integrating PE and mathematics. DeFrancesco and Casas (2012) mentioned that more research is necessary in this area.

**Purpose of the Study**

According to Cone, Werner, Cone, and Woods (1998), beginning in the 1990’s and into the 21st century, there was a resurgence of interest in interdisciplinary teaching. Today, educators are held accountable at a higher cost due to the importance placed on standardized testing. An immense amount of time has diminished from non-tested subjects, such as PE, to support spending educational time in a more compartmentalized manner on tested subjects. Wraga (2009) indicated students no longer study subject matter as an end in itself, but for the narrower end of passing a test. The reduction of course offerings in schools hinders the development of the whole child, resulting in a
decline in academic achievement. Integrative learning links two or more subjects together acting as a “continual source of energy feeding the educational process” (Cone et al., 1998, p. 4). Teachers who integrate subjects embed more relevant knowledge and skills in real-life contexts causing cognitive growth (Cone et al., 1998).

Another aspect with a direct relationship to education is the increased number of health issues among school-aged children due to the escalated use of technology. The lack of physical activity attributes to youth spending an immense amount of time watching television or using some form of technology, causing developmental delays. According to the American Academy of Pediatricians (2015), children are spending an average of seven hours per day on entertainment media. The obesity epidemic and the rise of other health problems cause adverse physical, emotional, and social consequences, as well as cognitive consequences related to technology use. Children spend more time using entertainment media than in school or on schoolwork, attributing to the decline in academic achievement. Common Sense Media (2013) reported that nearly 40% of children under two years old have used a mobile device. The need for PE in schools is even more imperative because of the lack of activity among American youth. Many types of physical activity are connected to enhance academic achievement. Therefore, it is a natural fit to integrate cross-curricular subjects into a moving environment such as PE.

According to Etnier, Salazar, Landers, Petruzzello, Han, and Nowell (1997), there are a plethora of studies and research regarding the positive effects that exercise, physical activity and/or movement has on the brain. This has induced favorable academic effects, with nearly 200 studies on how exercise affects cognitive functioning, which suggests physical activity supports learning. Jensen (2005) indicated the part of the brain that
processes movement is the same part that processes learning; therefore movement and learning are integrated.

Consequently, integrative learning recognizes the integrity and the uniqueness of each subject, yet at the same time acknowledges the interrelationships among them (Cone et al., 1998). Contardi, Fall, Flora, Gandee, and Treadway (2000) concluded an integrated curriculum supports a belief that an individual’s direct experience is crucial to purposeful learning. Integration also offers heightened levels of mastery of content and real-world applications, which inevitably enhances the opportunity for deeper levels of learning. Due to a limited amount of time allocated for certain subjects and the plethora of information to be taught, integrating two or more subjects enriches the students’ cognitive function in a more holistic manner by connecting and assisting in making applications to real life.

This proposed study specifically examined whether integrating mathematics and physical education elicits a positive result on student academic achievement. This study specifically explored the Math Standard Module 1: Number and Operations In Base Ten (Tennessee Mathematics Curriculum Guide, 2016-2017) in an urban East Tennessee elementary school. The math and PE teacher used the STAR assessment to examine 5th grade student results in Module 1: Number and Operations In Base Ten. As a way for students and teachers to analyze results together, the STAR screener was administered monthly. This aided in the instillation of intrinsic motivation for the students. One PE class was designated as the experimental group that had integrative activities incorporated relating to the math standard students had more difficulty mastering. Another PE class was designated as the control group without the implementation of integrative learning. Special education students were also included in the study.
Significance of the Study

Due to the lack of research on the integration of mathematics and PE, this study contributes to the body of knowledge in this area. There are many studies showing a relationship between students who are physically active and exhibit higher academic grades and self-esteem, but not due to integrating interdisciplinary subjects (Etnier et al., 1997). Chanal, Sarrazin, Guay, and Bioche (2009) confirmed that studies have shown a positive relationship between physical fitness and academic achievement.

Carlson et al. (2008) discovered an increased amount of time spent in PE on a weekly basis revealed a slight, but significant increase in academic achievement in both math and reading for girls. There was neither a positive or negative effect on academic achievement for boys, therefore concluding that PE does not negatively affect academic achievement for elementary students. Chanal et al. (2009) stated “despite these findings no studies to their knowledge have investigated the effects of achievement in physical education on mathematics” (p. 7).

Math is an area of great importance in regard to today’s high stakes testing culture due to the NCLB. According to Programme for International Student Assessment (PISA) (OECD, 2012), the United States falls below average in math compared to 34 other countries. Studies revealed the integration of two or more subjects has positive effects on academic achievement (Costley, 2015). Exercise and physical activity have proven to have positive effects on academics. Therefore, it would be a natural fit to integrate mathematics into the PE setting.

Phillips and Marttinen (2013) concluded that teachers have constant pressure with regard to adding more to the daily curriculum. They mention the integration of subjects can be a useful tool to manage time and reinforce learning in real life situations.
Therefore, it is important for physical educators to be team players. Thus, collaboration between PE teachers and general education teachers will only strengthen the academic foundation of students. Therefore, the study of the integration of math into PE is vital to explore the effect it would have on students’ academic performance.

**Theoretical Framework**

What effect does the integration of math into physical education have on student achievement?

In today’s dynamic global economy, centered on the development and exchange of knowledge and information, individuals prosper who are fluent in several disciplines and comfortable moving among them. “Creativity, adaptability, critical reasoning, and collaboration are highly valued skills and are more apt to be developed in an integrated curricula” (Bogan, King-McKenzie, and Bantwini, 2012, p. 1055).

Bogan et al. (2012) stated that integration connects subjects in ways that reflect the real world and include the interests and inquiry of children. Developing ways to combine and teach subjects in a seamless manner also aid children in passing life’s tests, not just standardized tests.

Since the inception of the NCLB, time spent on certain subjects, such as PE, has decreased. Due to the intense pressure placed on schools and increased accountability measures as measured by standardized testing, there has been an increase in the amount of time spent on tested topics. Franklin (n. d.) addressed the fact that elementary schools have increased instructional time devoted to reading by 47% and increased instructional time devoted to mathematics by 37%. With the increased amount of time on tested subjects, time spent in PE and recess has decreased by 35% and 28%, respectively.
Being physically active is a vital component to learning and physical health, especially with the school-age obesity epidemic and the gross use of technology. Jacobs, Ude, and Toscano (2014) suggested exercise encourages the brain to work at a more maximum capacity. According to Van (2012), neuroscience substantiates the connection between movement and brain activity. The cerebellum, which is part of the brain that processes movement, is the same part of the brain that processes learning (Jensen, 2005; Van, 2012).

In the 1990’s, neuroscientists discovered the brain-derived neurotropic factor (BDNF), which is an important factor in regard to the association between movement and learning. BDNF is present in the hippocampus, which is related to memory and learning (Ratey and Hagerman, 2008). Exercise also increases BDNF, thus adding more reasons why movement increases learning (Nalder and Northcote, 2015; Van, 2012). Therefore, the integration of mathematics or any subject matter into PE would create an enriched learning environment.

In order to be successful, content integration requires interdisciplinary cooperation and skill. For example, extra planning time may be required in order to gain additional knowledge and confidence in another subject area. Care must be exercised to maintain the rigor and integrity of both physical education and the additional subject. Ongoing collaboration with general education teachers is essential. Additional professional development may be required to elevate the educator’s knowledge and skill. Further knowledge in assessment and the ability to accommodate all types of learners is also needed.

According to Abdi and Juniu (2014), Greek culture brought body and mind together. Abdi and Juniu (2014) examined how “Greek philosophers advocated the
relationship of body and mind for the pursuit of wisdom and virtue as fit bodies provide sharper discipline. As an individual lives day to day, a person constructs the essence of self, soul, and mind through interactions with the world” (p. 2738).

There are many studies that show an increase in academic achievement by integrating two or more subjects (An, Capraro, and Tillman, 2013; Baker, 2013; Bogan, King-McKenzie, and Bongani, 2012; and Cunnington, Kantrowitz, Harnett, & Hill-Reis, 2014). There is a plethora of research and evidence displaying either no effect or positive effects on learning due to the incorporation of physical education in the schools’ curriculum (Carlson et al., 2008; Connor-Kuntz, and Dummer, 1996; Derri, Kourtessis, Goti-Douma, and Kyrgiridis, 2010; Trudeau and Shephard, 2008). Therefore, it can be determined time spent in PE does not detract from academic achievement. There is a lack of research and development in the area of integrating mathematics and physical education and its effects on academic achievement; therefore more research is necessary in this area.

“There is no unique or single pedagogy for integrative interdisciplinary learning” (Klein, 2005, p. 9). Integrative learning emerged in the 1800’s (Bogan, King-McKenzie, & Bantwini, 2012). There are many different terms, theories, and strategies used for integrative education. The Gestalt Theory amounts to “the whole is greater than the sum of the parts” (Gestalt Theory, 2016; Koffka, 1935), which signifies integrative learning. Constructivists believe in atmosphere where teachers and students are actively involved by working together to build an education based upon student experiences and knowledge for the purpose of making learning more meaningful (Gray, 2007). Constructivists develop a more in-depth knowledge of subjects, hence, moving away from topics taught in an isolated manner (Lake, 1994).
Therefore, the theoretical framework for this research is a combination of Albert Bandura’s theory of social learning (2005), Howard Gardner’s theory of multiple intelligences (Cone, et al., 1998), and the constructivist theory. The constructivist theory is based on the theories of Piaget, Dewey, Bruner, and others, who hold a holistic view of learning (Bruner, 1977; Dewey, 1900; and Piaget, 1950).

Albert Bandura’s theory of social learning exists in an interdisciplinary setting where students work together to solve problems, construct knowledge, and make connections between existing curriculums. Bandura’s (2003a) social cognitive theory provides a perspective on how both environmental and cognitive factors interact to influence human learning and behavior. Bandura (2003b) discussed how people learn from one another, encompassing such concepts as observational learning, imitation, and modeling.

Gardner’s theory (2006) explains humans possess multiple intelligences such as linguistic, musical, logical-mathematical, spatial, tactile-kinesthetic, intrapersonal, and interpersonal intelligence. Individuals possess different strengths in each area of intelligence, which affects the learning mode. Areas of intelligence should be nourished so they may function at their fullest potential.

The root of constructivism lies in the theories of Dewey and Piaget, who developed theories of childhood development and education that led to the evolution of constructivism, known today as Progressive Education (Concept to Classroom, 2004). The theories of Dewey (1902), Piaget (1969), and Bruner (1977) are concerned with children having an understanding of concepts and underlying structures. According to Piaget (1969), young children are in a preoperational stage of learning operations and gradually move into a concrete stage. Children profit from concrete, practical, active
learning experiences that bridge the gap between abstract concepts and the hands-on real world.

Dewey (1900) indicated how school is connected with life. He explained that the experience a child gains from familiar surroundings, such as the home, is made useful in school, and what the child learns in school is carried back and applied in everyday life, thus “making school an organic whole instead of a composite of isolated parts” (Dewey, 1900, p. 80). Dewey (1900) further suggested that all sides of the world in which humans live are connected and studies grow from the interrelated sides of the one common world, producing naturally unified studies.

A spiral representing the past, present, and future is a constructivism model. The reflection process is critical as students use this process to integrate new ideas or information. The teacher encourages the learning and reflection process and aids in developing students to become active learners instead of passive learners. The Spiral Model for Constructivism illustrates how students reflect on their experiences, which gain in complexity and power, resulting in integrating new information (Concept to Classroom, 2004).

Brooks and Brooks (1993) developed five guiding principles for the theory of constructivism to help guide curriculum structure and lesson planning (p. 33):

Principle 1 states problems of emerging relevance should be posed to students. The teachers can make the activity relevant for the students by adding activities; relevancy does not need to preexist for the students. The second principle states structuring learning around primary concepts is the quest for essence. Students should break wholes into parts and avoid beginning a concept with the parts to build a whole. The third principle 3 says that the teacher should seek and value the student’s point of
view, and in a constructivist’s classroom, students, should have the opportunity to elaborate and explain information obtained and understood. The environment should also lend itself to an open-ended, nonjudgmental questioning setting. The fourth principle stipulates that constructivists adapt curriculum to address students’ suppositions, and the teacher needs to monitor the students’ perceptions and ways of learning. The fifth principle notes that assessing student learning is in the context of learning. A teacher figures out how much and what kind of help a student needs to be successful (Concept to Classroom, 2004).

Twelve different strategies can be used as the conceptual framework to implement into the classroom when using the constructivist theory. The Concept to Classroom (2004) discussed the following 12 strategies: The first is to encourage and accept students’ initiative and autonomy while motivating students to take charge of their own learning by guiding them through activities and assessments.

The second strategy implements physical materials that are both interactive and uses raw data as primary resources. The third strategy is to use terminology that increases opportunities for students to explore learning. Examples of these terms would include “analyze,” “create,” “classify,” and “predict.” The fourth strategy is to allow student responses that may cause the teacher to alter content being taught or change instructional strategies.

The fifth strategy suggests that teachers inquired about students’ knowledge of concepts prior to sharing his/her own understandings. Dialogue between groups, the class, and teacher should be encouraged, and teachers should ask open-ended, thoughtful questions. Students should also ask questions of each other. The eighth strategy is to
have students elaborate in their initial responses, especially for those students who are shy.

The ninth strategy is to have students participate in experiences that may contradict their initial investigation and then encourage discussion. In this strategy, students experience situations that test their understanding, which may cause the students to revise and strengthen their knowledge. Students should also be allowed, "wait time" after questions are asked. One must provide ample time for thinking to occur in a class discussion. Teachers should provide time and model for students the best practices for constructing relationships and creating metaphors. Finally, teachers should nourish students' natural curiosity through the three-step Learning Cycle Model, which can also be used as a general framework for many kinds of constructivist activities.

A constructivist teacher encourages students to create their own understanding and knowledge of the world through experiments and real-world problem solving, as well as guiding the students to reflect on those experiences to gain deeper understanding of them making changes if necessary (Concept to Classroom, 2004). “Movement as a language is a natural and powerful way to express ideas and demonstrate understanding” (Cone et al., 1998, p. 5). Movement enhances the mind, body, and emotion connection (Van, 2012).
**Research Question**

What effect does the integration of math into physical education have on student achievement?

**Null Hypothesis and Hypothesis**

Null Hypothesis: There is no relationship between the integration of mathematics in the PE setting and the effect on student academic achievement.

Hypothesis: Integrating mathematics into the PE setting elicits a positive effect on student academic achievement.

**Delimitations**

The delimitations for this study were the following:

1. The study took place at an urban, Title I elementary school with a population of 701 students.

2. Those observed in the study were a total of 45 heterogeneous participants. The same math and PE teacher taught the 45 students.

3. The selected problem was determined by using benchmark data from the STAR assessment taken in 2016 revealing deficiencies in certain math concepts. The specific math standard the math teacher thought was necessary to integrate into PE was module 1: Number and Operations in Base Ten: understanding place value.

4. Place value was taught in 3rd grade and reviewed in 4th grade.

5. The STAR screener was given monthly revealing a weakness for 5th graders in number and operations in base 10: place value.
Limitations

Approximately 17% percent of the school’s population was special education that received some form of intervention. These students were included in all physical education classes and were accounted for on the STAR assessments. The elementary school has a 26% mobility rate, which is defined as students transferring to and from the school, causing some state of instability. Behavior issues are a rising problem for the school, causing disruptions in class. A behavior team has been established along with school-wide expectations, incentives, and interventions to help aid in this area in order to minimize class disruptions. Absenteeism and tardiness is also a cause for skewed results.

Assumptions

Participants in this study were expected to know place value and to round whole numbers to any place. Also, participants in this study were expected to know how to add and subtract, compare numbers, and multiply numbers. Additionally, participants in this study were expected to cooperate and collaborate with one another.
Definitions of Terms

The following terms were selected for this study and defined as:

**General Education**: Subjects that include: English language arts, math, science,

**Integration**: The teaching of two or more subject areas at the same time with the goal of fostering enhanced learning in each subject area through different modes (Cone, et al., 2009; Hall, 2007; Kitchen and Kitchen, 2013; and Thompson and Robertson, 2015). Integration allows students to learn and make applications to real world experiences rather than learning information in a compartmentalized subject-specific way.

**Math**: For the purpose of this study, math is defined as number and operations in base ten.

**Physical Education**: Physical education develops the whole person: cognitively, physically, emotionally, socially and spiritually. The separate entities learn to work seamlessly together, producing a well-rounded, physically literate, productive citizen who exhibits responsible personal and social behavior that respects self and others (Shape America, n. d.).

**Star Screener**: According to statistics of the research school, the STAR screener is to help determine whether students are on track to demonstrate the skills necessary to achieve grade-level standards. The screener provides valuable information for the teacher to assist in planning instructional activities in small groups as well as for the whole class.

**Technology**: For the purpose of this study, technology refers to any desktop or hand held device that people use, such as television, computer, iPod, iPad, cell phones, gaming devices, and all forms of social media.
**Organization of the Document**

This research study is organized into five chapters. Chapter One describes integration and provides background information regarding the topic. A statement of the problem, the purpose and significance of the study, and the theoretical foundation were thoroughly discussed. Chapter One also contains the research question, as well as limitations, delimitations, assumptions, and definitions of terms. Chapter Two presents the review of literature regarding the integration of subjects, the benefits of physical education, and how they work in sync adding depth to the development of the whole child. Specific studies are depicted thoroughly so the effects of integration on academic achievement can be acknowledged. The “testing obsession” (Wraga, 2014) and the technology explosion are discussed in detail to offer insight on the negative effects of these areas on education, thus emphasizing the need of integrating subject matter, specifically math into PE.

Chapter Three depicts the methodology and research design of the study. The description of instruments used, population, sample, research procedures, time period, and how the data was analyzed are described in this chapter, along with the response to the research question. Data is analyzed, and a discussion of the findings is presented. Chapter Five encompasses the conclusions, implications, and any recommendations for studies in the future. The study concludes with notes, references, and the appendices.
CHAPTER 2: LITERATURE REVIEW

Introduction

Integrative education reflects the interdependent real world of learning. It involves the learner’s body, thoughts, feelings, senses, and intuition in learning experiences that unify knowledge and provide a greater understanding than that which could be obtained by examining the parts separately (Shoemaker, 1989; Walker, 1996). The most important impetus for integration is that the child is a “meaning-seeking creature” (Busching and Schwartz, 1983, p. 10). Children do not wait passively to be taught (Busching and Schwartz, 1983). They possess a variety of physical, mental, emotional, and social capacities that must be nurtured and developed to the fullest potential.

To prepare diverse learners for various roles in life, the learning environment should enable students to develop individual skills while contributing to the knowledge of the classroom community (Tate and DeBroux, 2001). Therefore, an integrated curriculum supports a belief that an individual’s direct experience is crucial to purposeful learning (Contardi, Fall, Flora, Gandee, and Treadway, 2000). Together, teachers and children create the moments that encourage integrated learning. Textbooks and curriculum guides will never replace direct learning experiences (Busching and Schwartz, 1983). Contardi et al. (2000) reported that learning occurs at a deeper level when connections are made, rather than through disconnected conceptual frameworks. When curriculum is integrated, material is connected in the way in which it exists around us and throughout the world.
The Importance of Integrating Co-Curricular Academics

According to Ciccorico (1970), the 1930s, two recurrent themes occurred regarding interdisciplinary integration. First, integration takes place in the person rather than in courses or subject matter. Secondly, integration is important in the preparation of individuals to participate in a democratic society. According to Duerr (2008), the benefits of interdisciplinary instruction are multifaceted. Students become more involved, while teachers are able to dissolve discipline lines. This is accomplished by integrating various subject matter domains with interdisciplinary themes that incorporate real life roles and experiences (Tate and DeBroux, 2001).

According to Wrightstone (1938), educational reformers in the United States have had a definite influence on present-day school practices. Newer educational practices have evolved by embracing student interests and powers through hands-on activities rather than by passive assimilation of knowledge. In addition, conventional curricula performing drills in specific academic areas have been replaced with activities that correlate and integrate skills, guide student interests, experiences, and activities, causing progressive development in reading, language arts, and arithmetic (Wrightstone, 1938). The key thought behind an integrative process is to develop relevancy and applicability of the disciplines to the existing student experiences (Davison, Miller and Matheny, 1995). Wrightstone’s (1938) study provides student evidence that indicates equal or superior achievement where curricular integration was implemented.

Encouraging students to make connections between subject matter and life experiences makes the subject matter more meaningful, therefore increasing student learning (Wraga, 2009). Educational integration better meets the needs of a more diverse student population. Individual learning styles, diverse backgrounds, abilities, disabilities,
talents, and individual challenges make curricula integration even more important. Instruction must be designed to engage such students, therefore information becomes more meaningful as they progress through material presented in an integrated, individualized manner (Tate and DeBroux, 2001). According to Sly (2015), interdisciplinary learning enables teachers to better differentiate instruction and create more interesting methods of assessment. Research has also demonstrated that interdisciplinary teaching can increase students’ motivation for learning and enhances student engagement, thereby becoming more involved in the learning process (Sly, 2015).

**How the Brain Learns at its Optimal Level**

It is imperative for educators to understand how the brain functions in order to help each student reach his/her maximum potential in all areas of life. These functions include cognitive, social, affective, physical, and psychological potential. Students exhibit different ways of learning, and educators should be aware of different instructional practices that stimulate various sensory systems to activate the brain centers and aid in the learning process (Moore, 2006). According to Jensen (2005), a thorough understanding of brain physiology better prepares the educator to implement educational techniques designed to stimulate functionality.

As a complex organ, the brain receives and interprets the work. The brain has an endless capacity to learning new information and applies it to daily life (Caine and Caine, 1991). Learning is divided into the broad categories of explicit learning and implicit learning (Jensen, 2005). Explicit learning occurs through reading, writing, and talking. It is conveyed by means of lectures, videos, textbooks, and pictures. Implicit learning occurs through life experiences, games, habit, experiential learning, and other hands-on activities.
The brain has exceptional features in regard to learning. For example, the brain has the ability to detect patterns and to make approximations (Caine and Caine, 1991; Craig, 2003). It also has the ability to resist meaningless patterns imposed upon it (Craig, 2003). The brain has a phenomenal capacity for various types of memory (Caine and Caine, 1991). For example, there are nine different types of memory, which are sensory, short-term, long-term, explicit, implicit, declarative, procedural, episodic, and semantic (Mastin, 2010). The brain has the ability to self-correct and learn from experiences by way of analysis of external data and self-reflection (Caine and Caine, 1991). The brain also has an infinite capacity to create.

Learning occurs as a result of external stimulus (Craig, 2003). Input from the five senses (sight, sound, taste, smell, and touch), or input generated internally through imagination or reflection enters the nervous system and is processed and prioritized (Craig, 2003; Jensen, 2005). Powerful learning, therefore, begins with high levels of sensory input from experiences (Craig, 2003).

Innovative ways to maximize knowledge for today’s generation is to expose individuals to basic stimulatory effects. For example, pleasant odors (aromas) stimulating the olfactory senses, implementing stimulating rhythmic music, and integrating movement are ways to enhance learning in the classroom (Moore, 2006). Integration and connectivity are essential features of the brain. The critical attribute that makes the brain work so well is its degree of connectivity, not its individual structure (Jensen, 2005). Ultimately, engaging students with multiple stimuli rather than the traditional ways of learning is necessary for today’s learning environment (Moore, 2006).

Learning is also built on the process of detecting and making patterns, which are necessary to link new knowledge to existing patterns in the human brain (Caine and
Caine, 1991; Craig, 2003; King, 1997). New learning requires comparing what is being learned to prior knowledge and values, then connecting the information and experiences (Caine and Caine, 1991; Craig, 2003). In essence, educators and learners embrace meaningful schooling and the art of capitalizing on experience (Caine and Caine, 1991).

Another common practice that enhances learning is active learning. Active learning includes role-playing, group learning, discovery learning, and cooperative learning. Active learning engages all learning styles. Kinesthetic learning is a type of active learning that uses body movements with hands on approach, and is very effective as well (Craig, 2003).

Cognition and emotion must be recognized as two interrelated aspects of human functioning and cannot be separated (Craig, 2003; Immordino-Yang and Damasio, 2011). Therefore, learning is tied to the state of mind experienced at the moment of learning (Bransford, Brown, and Cocking, 1999; Caine and Caine, 1994; Craig, 2003; Jensen, 2005; and King, 1997). According to Craig (2003), the emotionality of a learning experience directly influences retention. Immordino-Yang and Demasio (2011) stated the aspects of cognition that are recruited most heavily in education include learning, attention, memory. Decision-making, motivation, and social function are all profoundly affected by emotion.

Emotional interest in a topic enhances memory, therefore educators should present information that is emotionally relevant to the student for the material to be properly stored for recall (Moore, 2006). If the emotional components of learning are ignored, students are deprived of a meaningful learning experience (Craig, 2003). A situation, either real or imagined, has the power to induce an emotion. The response elicits physiological events, resulting in sharper focus, relevant memory recall, and
learning associations between events and their outcomes. The response is enhanced if lessons are created to engage emotions in a productive way (Craig, 2003; Immordino-Yang and Damasio, 2011).

Today’s generation of students are growing up and developing in a fast paced world of technology with constant environmental stimulation. The time consumed with technological devices is detrimental to physical, emotional, social, psychological, and cognitive well-being. Students become easily bored and require some form of stimulation with an electronic device. Therefore, it is even more imperative for educators to present information in a variety of ways to keep students’ attention. As more evidence is released about the brain’s capacity to seek and perceive patterns, create meanings, integrate sensory experience, and make connections, educators can also become more adept at solving practical problems, selecting appropriate methodologies, effectively assessing learning, designing schools, and administering education (Caine and Caine, 1991).

Different Ways of Integrating Co-Curricular Academics

“There is no unique or single pedagogy for integrative interdisciplinary learning” (Klein, 2005, p. 9). Various types of integrative or holistic curriculums are proposed, including “core curriculum,” which focuses on the problems, issues, and concerns of students (Vars, 1991). Palmer (1991) suggested that educators help students process information in real context instead of in a definite, departmentalized manner. Cross-curricular teaching adds meaning to learning.

According to Morris (2003), curriculum integration models are effective when knowledge is connected in a meaningful way relevant to other areas of learning and real life. When students are able to bring personal interests and talents into the classroom, the
material makes sense. Students can interact with the content and create their own meanings. Duerr (2008) stated that students will take interest in the subject and experience success when the material holds personal meaning.

To integrate a curriculum requires the combination of subjects, which meet objectives across the curriculum, rather than individual subjects (Morris, 2003). Integrating interdisciplinary learning requires planning and collaborating with other educators to develop mutual objectives and learning themes. All must work as a cohesive unit to limit confusion and prevent disruption in student learning. By properly integrating interdisciplinary instruction, critical thinking skills, creativity, and effective teaching methods are encouraged (Duerr, 2008). Mustafa (2011) explained that curriculum integration comes in a variety of levels, designs, and models to properly integrate co-curricula subject matter.

Levels of Integration

Bresler (n. d.) discussed how “the arts can be taught in an interdisciplinary manner as part of the broader curriculum and can make immense contributions to the teaching of other disciplines” (p. 4). The following levels of integration can be operational in the day-to-day curriculum in ordinary schools (Bresler, n. d.).

The subservient level integrates one subject that is used to help another academic subject (Mustafa, 2011). An example is having students take their heart rates in PE after different activities and plot them on a piece of graph paper with the “X” and “Y” coordinates displayed. This activity in PE helps concepts in math. Bresler (n. d.) noted that the arts were used to help other subjects. For example, students sang the song “Fifty Nifty United States” to aid the students in memorizing the states.
The co-equal cognitive level equally integrates two disciplines with each other. Therefore, this style requires knowledge of the specific disciplines being integrated (Mustafa, 2011). Teachers adopting this style encourage active perception and critical reflection on the technical and formal qualities of a project, which include higher order cognitive skills. Affective level of integration is composed of two subcategories that fulfill the following roles of mood changes and creativity. Music use as a medium for relaxation utilizes the arts to help students immerse themselves in feelings and responses to it. These activities provide a change of pace, a change of mode, and a change of mood. The social level of integration complements the affective style of integration, while providing social functions that incorporate the arts. These social functions are viewed as opportunities to help create a community atmosphere for the school and its surrounding areas and businesses (Bresler, n. d.).

**Designs of Integration**

The following design continuum established by Jacobs (1989) provides a range of choices for planning an integrated curriculum program (See Figure 2.1). To consider a design option, one must consider its characteristics, advantages, and disadvantages.

**Figure 2.1 Integrated Design Continuums**

<table>
<thead>
<tr>
<th>Discipline Based</th>
<th>Parallel Disciplines</th>
<th>Multi-Disciplinary</th>
<th>Interc-Disciplinary</th>
<th>Integrated Day</th>
<th>Completed Program</th>
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*Figure 2.1 Continuums of Options for Content Design (Jacobs, 1989).*

The discipline-based content design makes no attempt of integration; it is avoided (Jacobs, 1989). This design focuses on strict interpretation of the disciplines with
separate subjects in separate time blocks during the school day, and this form does not reflect the reality of life outside of school. Teachers coincide what they are teaching with one another in the parallel discipline design. They are not integrating the information. Instead, they are rescheduling the time of when specific subject matter is taught so students can connect what is being taught in one class with another. For example, a social studies unit on World War II may be taught the same term as a reading assignment in English. Students must uncover for themselves the relationships between content areas. The complementary or multi-disciplinary unit design-related disciplines are brought together in a formal unit to investigate a theme or issue, such as asking questions that connect from one discipline to another. Bringing several disciplines together in this fashion requires less effort in lesson planning than a fully interdisciplinary unit. In an interdisciplinary unit design, the full ranges of disciplines in the schools’ curriculum are deliberately brought together for a course of study. Teachers can plan interdisciplinary work around themes or issues that emerge from the ongoing curriculum, causing various disciplines to support each other. This design is stimulating and motivating for both teachers and students. The integrated day model design is a full-day program based on problems and themes emerging from the child’s world. The curriculum focuses on the child’s questions and interests rather than school or state specific mandates. Motivation is high because the areas of study are linked to children’s lives. The complete program design is the most extreme form of interdisciplinary work. Students live in the school environment and create the curriculum out of their day-to-day lives. For example, if there is a conflict regarding students’ behavior at school, they could study rules or government and try to resolve the situation. This is a radical approach to integration.

Models of Integration

Fogarty’s ten levels of curricula integration (1991).

Fogarty (1991) presented 10 models teachers can utilize to help students make valuable learning connections. The 10 models are divided into three categories: single disciplines, across several disciplines, and across networks of learners. The fragmented model is the traditional design for organizing the curriculum that dictates separate and distinct disciplines. Each academic area, such as math, science, language arts and social studies, is seen as, a separate “entity”. The connected model provides a close-up of the details, subtleties, and interconnections within one discipline. This model denotes making explicit connections within each subject area. This deliberately relates ideas within the discipline rather than assuming students will automatically make the connections. The nested model of integration takes advantage of natural combinations and targets multiple dimensions of a lesson. Teachers can lead the students to use the thinking skills of envisioning and cause and effect when utilizing this integrated model. In the sequenced model, topics are taught separately but are rearranged and sequenced to provide a broad framework for related concepts. Teachers can arrange topics so that similar units coincide. That the shared model brings two distinct disciplines together into a single focused image. By overlapping concepts, both teachers will plan together to identify priorities, key concepts, skills, and attitudes that overlap in the specific subject areas. Both teachers from different disciplines will team up and point out commonalities to the students. The webbed model is utilized when a cross-departmental team chooses a theme and the members use it as an overlay to the different subjects to integrate subject
matter, such as inventions. Inventions could lead to simple machines in science, reading and writing about inventors in language arts, designing and building models in industrial arts, drawing and studying contraptions in math, and to making flowcharts in computer technology classes. The threaded model takes the “big idea” that is enlarged throughout all content. This model threads thinking skills, social skills, study skills, graphic organizers, technology, and multiple intelligences approaches to learning throughout all disciplines. The threaded model supersedes all subject matter. For example, “prediction” is a skill used to estimate in mathematics, forecast in current events, anticipate in a novel, and hypothesize in a science lab. The integrated model blends the four major disciplines by finding the overlapping skills, concepts and attitudes in all four. As commonalities emerge, teachers make matches as integration blooms from within the various disciplines. The immersed model takes place within learners with little or no outside intervention. Graduate and doctoral students are totally immersed in a field of study and are constantly making connections to their subjects. Finally, in the network model, learners direct the integration process, knowing the intricacies and dimensions of their field, and can target the necessary resources within and across their areas of specialization.

**The planning wheel model (Palmer, 1991).**

The planning wheel is another tool used for integrating subject matter. The teachers in the Howard County (MD), Public School System use the planning wheel to create interdisciplinary curriculums that make learning more meaningful. There are two major needs necessary to make curricular connections. The teachers’ content-area should be kept central, and allowances should be made for the integration of the logical, natural elements of associated content. The design allows the insertion of as many subject areas as needed, and the discipline designated “pies” change according to specific needs. The
design is teacher friendly because it allows the classroom teacher to determine the appropriate connections. Students’ increased use of the tool has made students more aware of the need to integrate information (Palmer, 1991).

**Effects on Student Achievement through Co-Curricula Integration**

Do interdisciplinary techniques promote learning (Lattuca, Voight, and Fath, 2004)? Drake and Burns (2004) indicated when students are engaged in learning, whether they are taking part in the arts or role-playing in a micro society, they do well in unconnected academic arenas. According to Jones (2009), many statistical reports conclude that students who receive interdisciplinary techniques have higher test scores in both core knowledge and critical thinking skills. Lattuca et al. (2004) mentioned that the evidence of student learning is sparse with regard to curricula integration. Even though integration has been around for centuries, research conducted on this topic has been very limited. Only a few studies at the college level lend support to the idea that interdisciplinary studies have positive effects on learning.

Studies were conducted to determine if integrating the arts with other subjects would impact academic achievement. Arts for Academic Achievement (AAA) in the Minneapolis public schools and the Chicago Arts Partnership in Education (CAPE) both showed student academic gains (Catterall and Waldorf, 1999; Ingram and Seashore, 2003). The AAA funded teams at 31 schools the first year and expanded to 45 schools the third year. During the 1999 CAPE program, 20 schools remained active through the six initial years. In both programs, a variety of approaches were developed when collaboration between the art specialists and general education teachers occurred to implement integrative strategies. English/Language Arts was the most common subject-area that implemented the integrative program, more than mathematics, but student gains
occurred in both areas. The analysis of both programs indicated a significant relationship between arts integration and improved student learning in reading and mathematics.

Bresler (n. d.) stipulated that the arts taught in an interdisciplinary manner as part of the broader curriculum provide immense contributions to the teaching of other disciplines. In some cases, the relationship between arts integration and student achievement was more powerful for disadvantaged learners (Ingram and Seashore, 2003). Rabkin and Redmond (2006) mentioned how low-performing students in art-integrated programs consistently exceeded teachers’ expectations. Evidence that displays this relationship was the grade 3 reading test in the 2003 AAA program. A gain score was used, which is the difference in a student’s test score form one year to the next, to indicate learning (Ingram and Seashore, 2003). The teacher integrated the arts into English and reading lessons and the students’ gain score increased by 1.02 points. The relationship between arts integration and reading achievement was stronger for students in the free and reduced lunch program. Math achievement and arts integration among 3rd graders in the 2003 AAA program was also statistically significant. Scores increased by 1.08 points for every unit the teacher integrated arts into math. Grade 4 reading scores were higher for those teachers that used art integration. Gain scores increased by 1.32 points. In grade 5 mathematics where teachers integrated art, the gain score increased by .71 points.

The North Central Regional Laboratory (NCREL) provided evaluation services throughout the CAPE study (Catterall and Waldorf, 1999). The NCREL collected data on student achievement in reading and math and analyzed it from 1992-1998 on the Iowa Test of Basic Skills (ITBS), which is nationally based. From 1998-1999, a CAPE team was developed and performed a total of 52 test-score analyses of CAPE schools and
comparison non-CAPE schools. CAPE schools were compared to other Chicago Public schools (CPS) in various ways. Some highlights regarding student outcomes resulted in CAPE schools out-performing non-CAPE schools in all 52 comparisons. The existing achievement gaps in reading and math that favored CAPE schools continued to increase over time. A very strong case of support was made for the CAPE program and its effects in reading and math at the 6th grade level. Evidence revealed that 25 of 40 reading test comparisons in grades K-8, CAPE schools increased the lead over non-CAPE schools. It was also revealed how the CAPE program had another substantial impact on student achievement. In the CAPE program, 6th grade children performed at or above grade level in mathematics seven different years. Prior to the CAPE study, CPS averaged 28% at or above grade level, while CAPE schools averaged 40%. By 1998, more than 60% of CAPE 6th graders were performing at grade level, while the remainder of CPS averaged just over 40%. This is a sizeable, substantial, and significant statement regarding academic gains.

Ingram and Seashore (2003) discussed how integrating art allowed teachers to recognize unexpected student strengths, discover options for assessing student learning, and recognize student learning that may have been overlooked. The arts are not only expressive, but also cognitive (Baker, 2013). Unsworth (1999) stated “Art is not demeaned by connecting it with math, science, social studies. All are enriched. The connections give substance to the artwork and shape to the subject content” (as cited in Baker, 2013, p. 1).

Reed and Groth (2009) conducted a middle school study using academic teams promoting cross-curricular applications. The team of teachers covered math, science, social studies, and language arts. The teachers studied the state standards and
collaborated with one another to develop integrative strategies to plan effective lessons. The goal was to improve literacy by having the interdisciplinary teams facilitate and create a literacy improvement plan. The school demonstrated greater improvement in the average passing rate on the state accountability tests in all subject areas compared with the gain of other middle schools. Structured use of cross-curricular academic teams fosters improved integration of subject matter and deeper understanding of content and pedagogy related to state standards.

In 1983, A Nation at Risk (National Commission on Excellence in Education [NCEE], 1999) established the resurgence for the science, technology, engineering, and mathematics (STEM) movement in education (Mahoney, 2010; Meyrick, 2011). Empirical studies have concluded that course acceleration alone is not a strong enough factor to improve individual learning. However, learning activities where students practice using integrated skills to solve problems allow for deeper and more meaningful student learning (Meyrick, 2011; Wai et al., 2010). Contardi et al. (2000) acknowledged that knowledge connections result in a deeper level of learning. An integrated curriculum enhances information connections and applications to real life experiences. This process only adds depth to a child’s knowledge bank.

**Student Math Achievement and Educational Integration**

There is a vital need for mathematic academic gains in the United States. A 2012 report issued by the Programme for International Student Assessment (PISA) (Organization for Economic Cooperation and Development (OECD), 2012) compared mathematics, reading, and science in 34 countries. The results revealed that the United States performed below average in mathematics and was ranked 27th among the 34 countries that were studied. One in four United States’ students did not reach the PISA
baseline Level 2 of mathematics proficiency and had a below average share of top
performers compared to the other countries. United States’ students are particularly
deficient when asked to perform math tasks with higher cognitive demands, such as
taking real world situations and transferring them into mathematical terms, and
interpreting mathematical aspects in real world problems.

People learn in a multitude of ways, therefore it is necessary to provide
differential instruction to students. According to Gardner (2006), an array of multiple
intelligences exists. All are able to know the world through language, logical-
mathematical analysis, spatial representation, musical thinking, and the use of the body to
solve problems or to make things and to understand self. Also, there are individual
differences in learning styles, which challenges the educational system. More students
and society as a whole could benefit from diverse learning and varied assessment
methods.

According to Fiske (1999) and Erickson (2001), teaching through the arts can
transform learning environments, reach students who may not be easily reached, promote
communication among students, provide opportunities for adult involvement, offer new
challenges to successful students, address important problems, issues, and concepts,
decrease curricular fragmentation, allow teachers and students to explore knowledge
more deeply, challenge higher-levels of thinking by helping students connect knowledge,
and connect in-school learning to the real-world.

One method of enhancing mathematical proficiency is the integration of music
and math. An, Capraro, and Tillman (2013) suggested that the musical arts is an ideal
companion to math integration. The links between music and mathematics are very rich
and include melody, rhythm, intervals, scales, harmony, tuning, and temperaments.
These musical concepts are related to the mathematical concepts of proportions and numerical relations, integers, logarithms, and arithmetical operations, as well as the content areas of algebra, probability, trigonometry, and geometry (An, Capraro, and Tillman, 2013; Beer, 1998; Harkleroad, 2006).

The An, Capraro, and Tillman (2013) study provided evidence that the ability levels of students in Grade 1 and Grade 3 in all three areas as assessed by the Model-Strategy-Application (MSA) approach showed statistically significant improvement after the interventions (See Table 2.1). In the mathematical ability area of Model (M), the 21 1st grade students improved from 2.50 ± 0.59 on the five pre-tests to 3.41 ± 0.51 on the five post-tests with an effect size of 1.66, while the 25 3rd grade students’ average level improved from 2.15 ± 0.46 on the five pre-tests to 3.39 ± 0.27 on the five post-tests with an effect size of 3.40. In the mathematical ability area of Strategy (S), the 1st grade students’ average level improved from 1.94 ± 0.61 on the five pre-tests to 3.06 ± 0.67 on the five post-tests with an effect size of 1.75, while the 3rd grade students improved from 1.84 ± 0.52 on the five pre-tests to 3.39 ± 0.38 on the five post-tests with an effect size of 3.44. In the mathematical ability area of Applications (A), the 1st grade students’ average level improved from 1.98 ± 0.82 on the five pre-tests to 3.07 ± 0.46 on the five post-tests with an effect size of 1.70, while the 3rd grade students improved from 2.23 ± 0.37 on the five pre-tests to 3.54 ± 0.40 on the five post-tests with an effect size of 3.00. This study demonstrated that music and math integrated lessons have positive influence on mathematical content areas.
Table 2.1.

Model-Strategy-Application Approach (MSA) (An et al., 2013)

<table>
<thead>
<tr>
<th>Model-Strategy-Application</th>
<th>21 First Grade Students</th>
<th>25 Third Grade Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach</td>
<td>5 Pre-Tests</td>
<td>5 Post-Tests</td>
</tr>
<tr>
<td>Model</td>
<td>2.50 ± 0.59</td>
<td>3.41 ± 0.51</td>
</tr>
<tr>
<td>Strategy</td>
<td>1.94 ± 0.61</td>
<td>3.06 ± 0.67</td>
</tr>
<tr>
<td>Application</td>
<td>1.98 ± 0.82</td>
<td>3.07 ± 0.46</td>
</tr>
<tr>
<td>Model</td>
<td>2.15 ± 0.46</td>
<td>3.39 ± 0.27</td>
</tr>
<tr>
<td>Strategy</td>
<td>1.84 ± 0.52</td>
<td>3.39 ± 0.38</td>
</tr>
<tr>
<td>Application</td>
<td>2.23 ± 0.37</td>
<td>3.54 ± 0.40</td>
</tr>
</tbody>
</table>

The Framing Student Success project (Cunnington, Kantrowitz, Harnett, and Hill-Ries, 2014) was developed to test an instructional program integrating high quality standards-based instruction in the visual arts, math, and literacy in urban, high-poverty elementary schools. It was also designed to make explicit connections between visual arts and math or literacy, while maintaining the integrity, depth and rigor of instruction in both subject areas. The math units used in this project specifically reinforce and extend prior experiences with measuring, geometric reasoning, and other math skills and knowledge, providing real-world applications. The use of grids became a natural connection between art and math when a collage unit was taught using African-American quilts and paintings. A printmaking lesson inspired by Adinkra textiles from Ghana was
used to teach 4th graders how to explore hidden meanings of abstract forms, create their own symbols, and explore the area and perimeter using the grid. 5th graders used the grid to learn how to scale up and transfer drawings of local school neighborhoods. Students learned that artists used grids for this purpose as far back as ancient Egypt (Cunnington et al., 2014). The three-year Framing Student Success project highlighted a few lessons learned, such as the importance of collaboration and communication among artists, instructors, and teachers, as well as the need for differentiation of each curriculum unit. The treatment group achieved higher mean scale scores all three years in math when compared to the control group. From 2010-2011, the performance gap in math was 693.54 for the treatment group and 684.48 for the control group, with an increase of almost 100%. From 2011-2012 both groups decreased slightly. The treatment group scored 691.71 and the control group scored 673.71. Math scores declined on average across all New York City (NYC) public schools from 2010-2012 due to a revision of assessment scoring procedures. In 2012, the treatment score was 687.86 compared to the control group’s score of 672.83. The results of this study indicate that rigorous interdisciplinary instruction supports cognitive skill development and increases student math skills while developing art skills and enhancing the ability to reflect on their own work and the work of their peers. Finally, students discover connections between art and math within real world experiences.

Math and science are also integrated areas with long histories (Kurt and Pehlivan, 2013). These two disciplines are suitable for integration because of their fields of application and their mutual scientific approach towards problem solving (Kiray, 2012; NRC, 1996). Hurley (2001) studied 31 cases where the integration produced positive academic results. The study revealed that a much higher level of achievement occurs in
the area of science compared to math, but overall a positive correlation occurred in both courses (Hurley, 2001; Kurt and Pehlivan, 2013).

A research study conducted by Ross and Hogaboam-Gray (1998) explored student learning effects by integrating science, math, and technology. A school that integrated three subjects in grade 9 was compared to a school that taught the three subjects to 9th graders without educational integration. The results revealed curriculum integration contributed to stronger diagramming skills and to a better application of learning outcomes that were shared by the three disciplines. A second result was curriculum integration contributed to student motivation. Students were more likely to maintain a mastery orientation to learning than students in the segregated course setting. Additionally, curriculum integration contributed to students being motivated to work together. Schools that implemented integration noticed that students were engaged in more productive task-talk compared to schools that were in the segregated setting, where more off-task talk occurred. Davison et al. (1995) concluded that the “doing” of math and the “doing” of science create a new way for students to look at the world that develops depth rather than breadth in all subject areas.

**How Physical Activity Affects The Brain and Cognition**

“It’s truly astonishing that the dominant model for formal learning is still “sit and git.” It’s not just astonishing; it’s embarrassing” (Jensen, 2005, p. 60). For centuries, the mind, body, and emotions have been treated as separate and distinct entities (Van, 2012). Math, science, and reading instruction have suffered the same fate. According to Jensen (2005), the reason for the separation of movement and learning is the educational and scientific worlds seemed to believe that thinking and movement should remain separate. Movement enhances the mind, body, and emotional connection (Van, 2012). Jensen
(2005) explained how movement is an effective cognitive strategy to strengthen learning, improve memory and retrieval, and enhance learner motivation and morale.

Since the brain is housed in the body, the action of the body directly affects what happens in the brain (Van, 2012). Ratey (2008) stated, “The point of exercise is to build and condition the brain. Building muscles and conditioning the heart and lungs are essentially side effects” (p. 3). Movement sends more oxygen and blood to the brain, which enhances brain activity, therefore enhancing learning (Jensen, 2005; Van, 2012). Recent developments in neuroscience confirm how physical movement has a positive impact on brain function and is directly connected (Jensen, 2005; Nalder and Northcote, 2015).

Cotman and Berchtold (2002) suggested that exercise provides a means to maintain brain function and promotes brain plasticity. The brain is an adaptable organ that can be molded by input, which is analogous to the way muscle can be sculpted by lifting weights. The more the brain is used, the stronger and more flexible it becomes (Ratey and Hagerman, 2008).

The cerebellum is the part of the brain associated with motor control (Jenson, 2005). It is also known as the “little brain” because it is one-tenth of the brain by volume, but it contains nearly half to all its neurons (Van, 2012). The neurons transmit information throughout the body. Ratey and Hagerman (2008) suggested that the cerebellum also coordinates thoughts, attention, emotion, and social skills. A New York medical team traced a pathway from the cerebellum back to parts of the brain involved in memory, attention, and spatial perception, and concluded that the part of the brain that processes movement is the same part of the brain that processes learning (Middleton and Strick, 1994, as cited by Jensen, 2005, p. 61).
Ratey (2008) stated “BDNF is a crucial biological link between thought, emotions, and movement” (p. 40). Wrann (2013) also indicated that exercise can improve cognitive function and has been linked to the increased expression of BDNF. Cotman, Berchtold, Christie, (2007); Mattson (2012) reported specific beneficial effects of exercise on the brain, such as increased amounts of blood flow to the hippocampus, morphological changes in dendrites and dendritic spines, increases synapse plasticity, and de novo neurogenesis in various mouse models of exercise.

According to Ratey (2008), exercise improves learning on three levels. First, exercise optimizes the mind-set to improve alertness, attention, and motivation. Secondly, exercise prepares and encourages nerve cells to bind to one another. Additionally, exercise spurs the development of new nerve cells from stem cells in the hippocampus. It is becoming clear that exercise provides a stimulus, creating an environment in which the brain is ready, willing, and able to learn.

Co-Curricula Subjects Integrated into Physical Education

As further research provides evidence between the positive benefits for the integration of physical activity and learning, the physical education (PE) specialist’s positions should be increasing in the United States. Due to standardize testing, subjects such as PE are being eliminated to make time for assessment content. The reality of this scrutinized focus toward academic performance prompted the decrease in quality and quantity of physical education programs (Hall, 2007). Removing selected subjects from the curricula takes away future opportunities for students. Exposure to different content areas leads to future options in life.

Another area of concern is the technology explosion. American culture is moving toward a high level of dependency on technology, eliminating physical activity in
everday life. It is alarming that childhood obesity has more than doubled in children and quadrupled in adolescents in the past three decades. In 2012, more than one third of children and adolescents were overweight or obese (Centers for Disease Control and Prevention, 2015).

Students learn best through active learning experiences, and many abstract and complex concepts can be clearly understood when they are experienced in a physical setting such as a PE class (Rauschenbach, 1996). Schumacher (1999) agreed that students participating in PE not only have to demonstrate their performance of specific skills, but need to display their competence in other ways such as listening, speaking, reading, and writing. This supports the idea that a PE program that integrates language assists in a child’s written and oral development.

Derri, Kourtessis, Goti-Douma, and Kyrgiridis (2010) conducted a study examining the effect of the integration of PE and language on oral and written speech of preschool children. Sixty-seven children (34 girls and 33 boys) between 4-6 years old participated in the study. Group A participated in a five-week movement and language program in the gym while Group B participated in the same program, in class, without the movement integration. A specifically designed test was constructed to access children’s oral and written speech, including 19 tasks associated with PE and everyday life. Topics were related to movement concepts such as “body awareness.” Body awareness relates to knowing parts of the body and its movement. Spatial awareness, which is the understanding of how to move forward, back, left, right, etc., was also incorporated. Effort concepts relate to how quickly or slowly one is moving. The relationship concept means how to move individually or with a partner while moving with an instrument. Movement skills, involving locomotor and manipulative skills, such
as throwing, catching, and kicking, were integrated as well. Children in Group A displayed better scores on the post-test and the retention test in both the oral and written speech areas. Scores for both groups in all measures: pre-test, post-test, and retention, are presented in Table 2.2.

**Table 2.2**

Test scores on oral and written speech with the integration of PE.

<table>
<thead>
<tr>
<th></th>
<th><strong>Pre-test</strong></th>
<th></th>
<th></th>
<th><strong>Post-test</strong></th>
<th></th>
<th></th>
<th><strong>Retention Test</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Group A</em></td>
<td><em>Group B</em></td>
<td><em>Group A</em></td>
<td><em>Group B</em></td>
<td><em>Group A</em></td>
<td><em>Group B</em></td>
<td><em>Group A</em></td>
</tr>
<tr>
<td></td>
<td><em>M</em></td>
<td><em>SD</em></td>
<td><em>M</em></td>
<td><em>SD</em></td>
<td><em>M</em></td>
<td><em>SD</em></td>
<td><em>M</em></td>
</tr>
<tr>
<td>OS</td>
<td>21.3</td>
<td>6.36</td>
<td>29.6</td>
<td>7.28</td>
<td>36.7</td>
<td>6.45</td>
<td>32.1</td>
</tr>
<tr>
<td>WS</td>
<td>16.5</td>
<td>5.5</td>
<td>19.2</td>
<td>4.31</td>
<td>21.0</td>
<td>2.96</td>
<td>20.5</td>
</tr>
<tr>
<td>TS</td>
<td>37.8</td>
<td>11.9</td>
<td>48.8</td>
<td>9.94</td>
<td>57.7</td>
<td>8.49</td>
<td>52.6</td>
</tr>
</tbody>
</table>

*Note.* OS = oral speech; WS = written speech; TS = total score; *M* = mean; *SD* = standard deviation.

Connor-Kuntz and Dummer (1996) studied whether language enriched PE, whether language intervention improved language development, and whether the implementation of language instruction compromised motor skill development. Study participants consisted of special education preschool students, Head Start (HS) preschool students, and students in typical preschool classes. Subjects in both the experimental and the control groups received 12 hours of instruction three times per week for eight weeks. The experimental group was language enriched within the context of physical activity lessons, while the control group received physical activity without emphasis on language concepts. A pre-test and post-test was administered, along with a three month retention test. The results revealed the integration of language instruction into PE did not require extra instructional time. Both groups were timed using a video and audiotape. For
example, the experimental group received a detailed lesson plan that took 23 minutes. The control group received the same lesson plan that took 24 minutes. The second aspect of the study found that all subjects increased their scores in improving language skills, regardless of their preschool placement. The HS group scored higher on the school-readiness composite compared to the children in the special education preschool and higher on direction and position skills, as expected. Finally, language-enriched PE did not have a negative impact on the subjects’ motor skill performance. All subjects in all three groups increased their scores across repeated measures in motor skill performance. Overall, this study revealed that all subjects benefitted from a language enriched PE program.

Lepine (2013) conducted a multifaceted study in order to determine if there was an increase in PE participation and to ascertain if there was an effect on student content-retention by integrating elements of classroom work into PE. Each class consisted of 25 students, grades 1-3. The experimental groups participated in games that implemented the solar system, including names, sizes, and the order of the planets. Conversely, the control group followed a standard PE curriculum. For the control group, the solar system lesson was restricted to classroom learning. The results did not reveal positive or negative results regarding student behavior and participation in PE, even if a solar system game was not integrated.

A solar system pre and post-assessment was administered to all students. Both groups improved due to learning about the solar system for weeks. The experimental group of 1st and 2nd graders scored lower than the control group. The distribution of students was similar. The 1st grade experimental group averaged 28 on the pre-assessment compared to the 1st grade control group that averaged a 62. The 2nd grade
experimental group averaged 30 on the pre-assessment compared to the 2nd grade control group that averaged a 90. The post-test revealed a big jump for the experimental group. First graders averaged an 82 and 2nd graders averaged 78. The control group of 1st graders averaged 95 and 2nd graders averaged 118. The number of questions answered correctly more than tripled by the 1st grade experimental group and increased more than two and a half times for the experimental 2nd graders. These results are credited to the experimental group having extra practice with the concepts and vocabulary due to the integration process in PE.

When one uses gross motor skills in an interactive activity, it aids different cognitive areas that reinforce deeper understanding of the specific subject matter integrated (Rauschenbach, 1996). Educators should actively engage children in learning experiences to help teach concepts because students are concrete learners and learn actively by doing (Cone et al., 1998).

**Studies Integrating Math into Physical Education**

DeFrancesco and Casas (2012) conducted a study that determined learning becomes more meaningful to children when math is taught in a more enjoyable manner by utilizing movement and games. This study investigated 2nd grade student achievement with math and PE curricula integration. The study utilized two heterogeneous groups of 28 students grouped by reading level. The students participated in eight PE lessons with math concepts embedded. The math teachers developed a specific pre and post-instructional math test paralleling the math portion of the Florida Comprehensive Assessment Test (FCAT). The pre and post-tests each consisted of 20 math problems. As part of the four week study, both classes had daily math instruction for one hour and PE two times per week for 30 minutes. Both classes had comparable PE
activities, but the experimental group had math concepts incorporated and the control
group did not. The post-test was administered after four weeks. No significant
differences were found between the 2nd grade classes on the pre-test. The score of the
math and PE class was $M = 13.81$ and the score of the control group was $M = 13.62$. The
post-test also revealed no statistical differences between the two groups. The
experimental group score was $M = 15.23$ and the control group score was $M = 14.10$. It
was recognized that the two math teachers were not teaching their classes in conjunction
with the PE teacher, thus math concepts were not being reinforced or practiced
simultaneously. More collaboration in planning was needed. More research is needed to
determine the true effects of collaborative planning and embedding academic areas in PE.

Thompson and Robertson (2015) conducted a study to ascertain the effect of
integrating mathematic concepts into a PE setting. The goal was to determine if the
integration process helped 1st graders understand money concepts and if the integration
process would make an overall difference in the learning experience. The research
consisted of four 1st grade classes. Each class had PE four days per week for 30 minutes
per session. Four different types of data were gathered to measure the impact of
integrating math into PE. A pre and post-test was administered and assessed students in
coin recognition, coin value and the addition of coins. The researcher kept an
observational journal consisting of daily activities and notes on any improvements or
successes made. Student feedback was given at the conclusion of the study to determine
thoughts and feelings regarding the interdisciplinary unit. Finally, an open dialog for 1st
grade teachers was established to retrieve information about integration and its effects on
classroom learning. Instruction time and student activity time were two common themes
affected by integration. Instruction time that typically lasted three to four minutes
increased an additional four to seven minutes, therefore decreasing activity time. This required adjustment in order to maximize activity time in PE. The integrated lessons created a positive environment, as students became peer tutors for those needing extra help with the different money concepts. The evidence revealed that the 1st graders scored an average of 52.8% correct on the pre-assessment. The highest possible score on the pre-assessment was a 10. Students averaged 2.64 out of 4 on the recognition portion of the pre-assessment and the post-assessment improved by 18.75%. Students improved almost 30% for understanding coin values and improved 25% for understanding addition of coins. Students showed more understanding of recognition of the pre-assessment than value, but made more improvement in the value portion of the post-assessment. The arithmetic mean for the total score went from 5.28 correct out of 10 to 7.76 correct out of 10. Improvement could be attributed to a variety of factors, such as money concepts being taught in both PE and the classroom. Each teacher could have used different methods to present information, and the duration of time spent on currency concepts could have varied. Teachers believed there was a connection between the body and the mind. They believed the integrated lessons helped the learning outcome because it reinforced what was taught in the classroom, thus expediting the learning process. The teachers also discussed how the blending of two subjects provided a practical, real life experience. The students were excited about the integrated experiences and found that it played a large role in fostering the enjoyment of using money in the classroom setting.

Hatch and Smith (2004) stated that PE students can benefit from an integrated curriculum, although physical educators have written little on the topic. American students show achievement levels that rank among the lower 25th percentile in science and math, compared to students of 13 other industrialized nations (Roth, 1993). Hurd
(1991) alluded to the fact that these same students are ill-prepared upon graduation to enter the work force and to become productive members of a fast-paced, technologically advancing society.

Integrating co-curricular studies in a physically active environment is a way to remediate the problem. Students engaged in integrated studies become more involved in the learning process, which increases motivation that improves student performance (Hatch and Smith, 2004). Integration is especially beneficial when incorporated in the PE setting. The PE setting provides a dual benefit of physical activity to help the overall health of students and the academic performance of all students, specifically the reinforcement of math skills (Thompson and Robertson, 2015).

**Conclusions**

Education means a focus on the whole person as opposed to a narrow range of skills or abilities (Schumacher, 1999). “The idea that physical activity promotes mental acuity, or “mens sana in corpore sano” (a sound mind in a healthy body) is ancient” (Davis and Pollock, 2012, p. 1). The Greek culture brought body and mind together (Abdi and Juniu, 2014). According to Abdi and Juniu (2014) “Greek philosophers advocate the merging of the body and mind for the pursuit of virtue and wisdom as fit bodies provide sharper discipline” (p. 2738).

“Physical activity is brain food” (Zientarski, 2013, p. 1). Exercise physically and literally transforms the brain (Ratey and Hagerman, 2016). By integrating other subjects into PE, how can a child not experience positive effects, whether physically, academically, emotionally, socially and/or a combination of attributes? To keep the brain at peak performance, human bodies need to work hard (Ratey, 2016). Children learn about their world through exploration and play (Cone, et al., 1998). Therefore, PE is a
natural fit in integrating interdisciplinary studies. Physical education facilitates students acquiring the essential kinesthetic learning experiences that will enhance the ability to learn both movement and other content areas through movement.
CHAPTER 3: METHODOLOGY

Introduction

This study was created to determine whether integrating specific math concepts into a physical education (PE) setting affects student academic achievement. A mixed-methods approach was incorporated, comprising quantitative and qualitative analysis to evaluate the effect of integrating math into a PE curriculum. The STAR math assessment was selected to analyze student weaknesses and strengths. STAR assessments provide achievement and growth data for teachers to screen, monitor progress, and guide instruction (Renaissance, 2016).

Participants and Setting

One urban East Tennessee elementary school was selected to participate in this study. The study was conducted in the 2016-2017 academic year. This Title I school educates students pre-Kindergarten through 5th grade. There were 701 students (347 female, 354 male) enrolled for the 2016-2017 school year. The school qualified for the Full Service Community Schools Program (FSCS). The purpose of the FSCS program is to provide comprehensive academic, social, and health services for students, family members, and community members with the goal of improving educational outcomes for children (U.S. Department of Education, 2015). All students at the research school qualified for a community eligibility program, which provides free breakfast and lunch to the eligible students.
Student enrollment increased from 635 in the 2015-2016 academic year to 701 in the 2016-2017 academic year, a gain of 10.4%. Student enrollment decreased from 713 in 2014-2015 to 635 in 2015-2016, a decline of 10.9%. As shown in Table 3.1 the majority of students enrolled at the school have been Caucasian, followed by African-American students. However, Caucasian student enrollment increased by 34% from the 2015-2016 school year to the 2016-2017 school year. The following information was gathered according to statistics provided by the research school.

Table 3.1

Demographics Enrollment

<table>
<thead>
<tr>
<th>Demog.</th>
<th>2016-2017</th>
<th>%</th>
<th>2015-2016</th>
<th>%</th>
<th>2014-2015</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>452</td>
<td>59.2</td>
<td>336</td>
<td>52.9</td>
<td>408</td>
<td>57.2</td>
</tr>
<tr>
<td>African American</td>
<td>237</td>
<td>31.1</td>
<td>230</td>
<td>32.2</td>
<td>241</td>
<td>33.8</td>
</tr>
<tr>
<td>Hispanic Native</td>
<td>68</td>
<td>8.9</td>
<td>62</td>
<td>9.8</td>
<td>58</td>
<td>8.1</td>
</tr>
<tr>
<td>American Native</td>
<td>3</td>
<td>0.39</td>
<td>4</td>
<td>0.6</td>
<td>3</td>
<td>0.4</td>
</tr>
<tr>
<td>Hawaiian</td>
<td>2</td>
<td>0.26</td>
<td>1</td>
<td>0.2</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Asian</td>
<td>1</td>
<td>0.13</td>
<td>2</td>
<td>0.3</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>All Students</td>
<td>763</td>
<td></td>
<td>635</td>
<td></td>
<td>713</td>
<td></td>
</tr>
<tr>
<td>BHN *</td>
<td>308</td>
<td>40.4</td>
<td>296</td>
<td>46.6</td>
<td>302</td>
<td>42.4</td>
</tr>
<tr>
<td>Non-BHN</td>
<td>455</td>
<td>59.6</td>
<td>339</td>
<td>53.4</td>
<td>411</td>
<td>57.6</td>
</tr>
</tbody>
</table>

Note. Demog. = demographic background; # = number of students enrolled from a specific background; % = percentage of students enrolled from a specific background; *BHN = *Black, Hispanic, Native American is represented as parents/guardians could have checked more than one race or ethnicity.
As detailed in Table 3.2 the school provides special services for the economically disadvantaged students, students with disabilities, and ELL students (See Table 3.2). In the 2016-2017 academic year, enrollment among economically disadvantaged students increased by 7.7% compared to the 2015-2016 academic year. Enrollment among students with disabilities increased by 26.7% from 2015-2016 to 2016-2017, but student enrollment for ELL students slightly decreased in 2016-2017.

**Table 3.2**

Special Services School-Wide.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#</td>
<td>%</td>
<td>#</td>
</tr>
<tr>
<td>ED</td>
<td>629</td>
<td>89.7</td>
<td>584</td>
</tr>
<tr>
<td>Non-ED</td>
<td>72</td>
<td>10.3</td>
<td>51</td>
</tr>
<tr>
<td>SWD</td>
<td>128</td>
<td>16.8</td>
<td>101</td>
</tr>
<tr>
<td>Non-SWD</td>
<td>573</td>
<td>81.7</td>
<td>534</td>
</tr>
<tr>
<td>ELL</td>
<td>28</td>
<td>3.7</td>
<td>29</td>
</tr>
<tr>
<td>Non-ELL</td>
<td>673</td>
<td>96.0</td>
<td>606</td>
</tr>
</tbody>
</table>

*Note.* Spec. Serv. = special services; # = number of students with or without a special service; % = percentage of students with or without special services; ED = economically disadvantaged; Non-ED = non economically disadvantaged; SWD = students with disabilities; Non-SWD = students without disabilities; ELL = English language learners; Non-ELL = non-English language learners.

Chronic student non-attendance and tardiness are both problematic at the school. Chronic absenteeism is defined as missing 10% of a school year (Balfanz and Byrnes, 2012). According to statistics provided by the school, 22.8% of students missed at least 10% of the school year in 2015-2016. Missing school and being late wreaks havoc on the learning process long before it is discovered (Balfanz and Byrnes, 2012). As evidenced...
in statistics provided by the school, five thousand minutes of documented instructional
time were lost each week due to tardiness.

Student attendance fluctuated only slightly between the 2015-2016 school year
(93.2%) and the 2014-2015 school year (93.3%). See Table 3.3 for 2014-2015 and 2015-
2016 attendance records. As noted in Table 3.3 and 3.4, attendance is distinguished by
race, ethnicity and special services.

**Table 3.3**

Student attendance for two years.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># Students</td>
<td>% Present</td>
</tr>
<tr>
<td>Caucasian</td>
<td>336</td>
<td>92.8</td>
</tr>
<tr>
<td>African American</td>
<td>230</td>
<td>93.1</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>62</td>
<td>94.8</td>
</tr>
<tr>
<td>Native American</td>
<td>4</td>
<td>98.6</td>
</tr>
<tr>
<td>Asian</td>
<td>2</td>
<td>95.9</td>
</tr>
<tr>
<td>Native Hawaiian</td>
<td>1</td>
<td>94.8</td>
</tr>
<tr>
<td>All Students</td>
<td>635</td>
<td>93.2</td>
</tr>
<tr>
<td>BHN*</td>
<td>296</td>
<td>93.5</td>
</tr>
<tr>
<td>Non-BHN</td>
<td>339</td>
<td>92.8</td>
</tr>
</tbody>
</table>

*Note. Abs. by race = absences by race; # = number of students; % = percentage of
students; BHN* = Black Hispanic Native American is represented as parents/guardians
could have checked more than one race or ethnicity.*
Table 3.4 displays the attendance rate for special services, encompassing Economically Disadvantaged (ED), Students With Disabilities (SWD), and ELLs. SWDs had a 92.4% attendance rate in 2015-2016. ED students had an attendance rate of 92.9% in 2015-2016 and an attendance rate of 95.7% in 2014-2015.

**Table 3.4**

Attendance for students with special services.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td># Students</td>
<td>% Present</td>
<td># Students</td>
</tr>
<tr>
<td>ED</td>
<td>584</td>
<td>92.9</td>
</tr>
<tr>
<td>Non-ED</td>
<td>51</td>
<td>95.7</td>
</tr>
<tr>
<td>SWD</td>
<td>101</td>
<td>92.4</td>
</tr>
<tr>
<td>Non-SWD</td>
<td>534</td>
<td>93.3</td>
</tr>
<tr>
<td>ELL</td>
<td>29</td>
<td>96.1</td>
</tr>
<tr>
<td>Non-ELL</td>
<td>606</td>
<td>93.0</td>
</tr>
</tbody>
</table>

**Note.** Spec. Serv. = special services; # = number of students with or without special services; % = percentage of students with or without special services; ED = economically disadvantaged; Non-ED = non economically disadvantaged; SWD = students with disabilities; Non-SWD = students without disabilities; ELL = English language learners; Non-ELL = non-English language learners.

A full quarter of white students missed 10% of school and SWD missed another 26.7%. According to Balfanz and Byrnes (2012), achievement, especially in math, is very sensitive to attendance. Attendance strongly affects standardized test scores, graduation, and dropout rates. The parents should be the responsible ones to make sure their children get to school.
The urban East Tennessee school is located in a district that has a Parent Responsibility Zone (PRZ) as designated by the district transportation department. The PRZ is determined by the measurement of the shortest route from the student’s residence to the bus drop-off location the school the student is zoned to attend. Elementary students who live within one mile of the school are considered to be located in the PRZ, thus they are not eligible for transportation service. As displayed in Table 3.5, chronic absences are revealed by grade level.

**Table 3.5**

Chronic absences by grade level.

<table>
<thead>
<tr>
<th>Grade</th>
<th>2015-2016</th>
<th>2014-2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abs. More 10%</td>
<td>Abs. More 20%</td>
</tr>
<tr>
<td>K</td>
<td>#</td>
<td>%</td>
</tr>
<tr>
<td>1st</td>
<td>19</td>
<td>20.0</td>
</tr>
<tr>
<td>2nd</td>
<td>23</td>
<td>22.3</td>
</tr>
<tr>
<td>3rd</td>
<td>24</td>
<td>19.0</td>
</tr>
<tr>
<td>4th</td>
<td>18</td>
<td>18.0</td>
</tr>
<tr>
<td>5th</td>
<td>29</td>
<td>26.1</td>
</tr>
<tr>
<td>All Students</td>
<td>145</td>
<td>22.8</td>
</tr>
</tbody>
</table>

Sparks (2016) explained how student mobility refers to the number of times students change classrooms, schools, or districts. A high mobility rate can have a negative impact on classrooms and schools and pose a greater threat to academic achievement (Isernhagen and Bulkin, 2011).
As noted in Table 3.6, the mobility rate in this study was 30%, including pre-K, or 26% excluding pre-K in 2015-2016. Kerbow (1996) discussed how changing schools could certainly disrupt a child’s learning experience. For example, the effects of changing schools for a 2nd grade student could have an immediate negative impact on achievement due to an adjustment period the student has to make, which could be reflected on test scores during the year after the change. There is also a correlation linked between students from a lower socioeconomic status enrolled in lower performing schools and the mobility rate.

**Table 3.6**

Mobility rate.

<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>26%</td>
</tr>
<tr>
<td>Second</td>
<td>24%</td>
</tr>
<tr>
<td>Third</td>
<td>27%</td>
</tr>
<tr>
<td>Fourth</td>
<td>23%</td>
</tr>
<tr>
<td>Fifth</td>
<td>22%</td>
</tr>
</tbody>
</table>

According to statistics provided by the research school, there was a 15% decrease in behavior issues in 2015-2016 compared to 2013-2014. Barriga, Doran, Newell, Morrison, Barbetti, and Robbins (2002) reported that behavioral and academic problems exert reciprocal influences on one another. Numerous studies documented the association between problem behaviors and academic achievement, negatively affecting the development of individuals and their environments.

Of the 70 students suspended in 2015-2016 from the research school, 11% were suspended at least one time. In grades 3-5, 3rd graders accounted for 21.4% of suspensions, 4th graders accounted for 12% of suspensions, and 5th graders accounted for
18.9% of suspensions. The BHN group comprised 16.2% of suspended students, ED students made up 11.8% of the suspensions, SWD comprised 12.9% of suspended students, and the ELL group made up 11.8% of the suspensions. Male students accounted for 16.5% of student suspensions. According to the research district, the school is the central site for students with behavioral issues that are caused by emotional disturbances and other disabilities. Additionally, many students do not have adequate role models for social-emotional skill development. It has become necessary for the research school to implement a social emotional life skills class into their curriculum to help students modify behavior and develop various behavior skills.

Participants in this study were 5th grade students, and convenience sampling was utilized. This procedure is known as a quasi-experiment, as individuals are not randomly assigned (Creswell, 2009). A convenience sample is a naturally formed group such as a classroom, an organization, a family unit, or volunteers. The rationale for choosing 5th grade for this study was determined by the structure of the PE and 5th grade encore schedules, which was established by school administrators. To be included for group selection, students had to be enrolled in a math class taught by the same teacher, and these students also had to be enrolled in PE class with the same teachers. Math was taught daily for 90 minutes to each group. The groups attended PE classes on a six-day rotation for 55 minutes per day. Depending on the rotation schedule, students could attend PE either once or twice per week.

For the 2016-2017 school year 95 5th grade students, ages 10-12, were enrolled at the research school. This constituted 13.5% of the total school population. The 5th grade student body was comprised of 52 males and 43 females. There were 67 Caucasians, 27
African Americans and 1 American Indian or Native American. There were 28 students that received special services, which is 29.5% of the total 5th grade population.

The 45 5th grade participants comprised 48.4% of the total number of 5th grade. Fifteen students were SWD, comprising 32.6% of the study population. Three ELL students (6.5% of the study population) participated in the study. Eight students (17.4% of the study population) had either office referrals or suspensions. Three students (6.5% of the study population) qualified for weekend backpack food service and 27 students (58.7% of the study population) lived with only one parent or guardian.

Over 50% of the research participants in this study are from a single parent home. Studies have mentioned that these students are three times more likely to drop out of high school than children from two-parent families. The single parent is usually the primary source of financial support for the family. The single parent has less time to help children with homework, is less likely to use consistent discipline, and therefore has less parental control. The conditions of a single family home could lead to lower academic achievement (The Black Family Initiative, 2015).

The experimental group was composed of 22 5th grade students receiving integrative math strategies in the PE setting. The control group was composed of 23 5th grade students who did not receive the math interventions in the PE setting. Both groups completed a STAR pre-test and post-test assessment and a formative pre-test and post-test designed by the assigned math teacher, and these assessments were administered before and after the study. The initial STAR pre-test was used as a baseline and provided information for the educators to analyze student deficiencies in math. The formative assessments addressed the specific math concepts revealed as student deficiencies by the STAR pre-test (See Appendix A). According to Dodge (2016), formative assessments
support learning during the learning process. Formative assessments also aid teachers in making decisions for future and differentiated instruction, checking subject matter comprehension, and providing feedback for students to improve their performance.

The independent variable for the study was integrating math into the PE class, and the dependent variable was to examine whether the intervention influenced academic achievement. Helmenstine (2016) explained that the independent variable is not affected by any other variable. It is the variable that is under control. The dependent variable is the condition that is measured in an experiment and is dependent on the independent variable.

The study utilized quantitative and qualitative methodologies analyzing the pre and post STAR assessments, formative pre and post-assessments, two case studies involving two student interviews conducted at different stages of the research, and quick checks implemented each time the experimental group attended PE class. Quantitative research makes observations more explicit and easier to aggregate, compare, and summarize numerical data (Babbie, 2011). Qualitative research involves in-depth interviews, diary and journal exercises, studies of small groups to guide and support the hypotheses. The results are descriptive rather than predictive (Qualitative Research Consultants Association, 2016).

Assessments

The STAR assessments are norm-referenced and criterion-referenced, comparing students’ progress to normal expected growth and toward criteria for mastery of state standards (Renaissance Star 360, 2016). STAR assessments are not only used to guide instruction and monitor growth of a child in areas of math and reading, but are also used to project student performance on end of year state comprehensive exams.
The STAR math assessment was administered to 5th grade students on a monthly basis for this study. The STAR math assessment evaluates eleven learning domains in grades 1-8. The assessment includes the following: counting and cardinality, operations and algebraic thinking, geometry, expressions and equations, number and operations-fractions, functions, ratios and proportional relationships percent, ratios, proportions, the number system, measurement and data, number and operations in base ten, and statistics and probability. The STAR assessments are computer adaptive and automatically adjust each item based on previous student responses. This reduces testing time and limits student frustration associated to the level of challenge (Renaissance, 2016).

Therefore, the assessment is customized for individual student needs. Depending on student responses, question delivery is adjusted in relation to knowledge. The level of question difficulty increases with each correct response. This aids both teacher and child in determining specific areas where students require further instruction or more challenge. The STAR assessment does not reveal the type of questions on the assessment, but provides a class state standards report revealing how students performed pertaining to each math standard tested. Students are then grouped by estimated mastery.

Formative pre-tests and post-tests developed by the designated math teacher and administered in PE class focused on specific math concepts found as deficient through the STAR assessment. The specific math standard integrated into the PE setting was Module 1: Number and Operations in Base Ten (Tennessee Mathematics Curriculum Guide, 2016-2017) encompassing the CCSS that requires understanding of place value for multi-digit whole numbers.
The combination of the control and experimental groups revealed 43 of 45 students scored below the mastery level on the STAR pre-assessment on this specific math standard (See Table 3.7). In the “below” category, 35 students’ STAR scores suggested additional help is needed to reach the Estimated Mastery Range (EMR) by May, 23, 2017 (STAR Math, 2016). There were two students who scored within the mastery level. In the experimental group, all 22 students scored “below” the estimated mastery level. The STAR test suggested additional help is needed for 18 of the 22 students. In the control group, 20 of 23 students scored below the estimated mastery level. The STAR test suggested additional help is needed for 17 of the 23 students in the control group. Two students from the control group scored “within” the mastery level.

Table 3.7

STAR Pre-Assessment Results

<table>
<thead>
<tr>
<th>Students Grouped By Estimated Mastery</th>
<th>CCSS.Math.Content.5.NBT.A Understand the place value system (STAR Math, 2016).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group</td>
</tr>
<tr>
<td></td>
<td>Experimental Group</td>
</tr>
<tr>
<td></td>
<td>Control Group</td>
</tr>
<tr>
<td></td>
<td>Combination of Both Groups</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Quick checks were also utilized to help the PE teacher evaluate students’ work to determine understanding of specific place value skills. Quick checks were implemented in the PE class and administered to the experimental group only. The quick checks also allowed the teacher to analyze any mistakes that were made in order to provide feedback for the purpose of preventing students from repeating mistakes. According to Fisher and Frey (2014), checking for understanding is a way for teachers to identify learning goals, provide students feedback, and plan instruction based on students’ errors and misconceptions.

**Interviews**

From the experimental group, two students were selected to participate in interviews. The selected students scored below the mastery level that needed additional help on the STAR math assessment. They were interviewed three times throughout the study.

Qualitative research contributes to rich, insightful results by allowing the researcher to probe beyond initial responses and rationales, allowing the opportunity to observe, record, and interpret non-verbal communication, such as body language, tone of voice, which is valuable during interviews and during analysis, and engaging respondents more actively than in a more structured survey (Qualitative Research Consultant Association, 2016).

There are different methods of qualitative interviews. This study utilized the general, or semi-structured approach, which provided enhanced focus compared to the conversational interview. In addition, the general interview allows increased freedom and adaptability in data collection (Valenzuela and Shrivastava, n. d.). The semi-structured interviews consist of series of questions or probes that are prepared in advance,
to elicit certain types of information from the students being interviewed (Cohen and Crabtree, 2006). The questions utilized for the interview process for both case studies are located in Appendix B.

**Procedures**

Proper protocol in conducting research involving human participants requires the Institutional Review Board for Human Participants (IRB) to review, approve, disapprove or require changes in research relating to human participants (Cornell University, 2014). Prior to this study, participants and parents or guardians were fully informed of the research that would be conducted in physical education. Parents or guardians and participants signed and dated an informed consent document explaining the risks, benefits, and procedures involved in the study.

This study utilized a quasi-experiment experimental design. Creswell (2009) stated that a quasi-experiment uses both a control group and an experimental group. The experimental group received the intervention. This study used a readily available group, also known as a convenience sample. Classroom student assignment was the criteria for assignments into either the control or experimental group.

The comparison with the experimental group was to analyze whether integrating math into the PE setting impacted the students’ STAR and formative assessment scores. The control group was also compared to the experimental group by examining all STAR and formative assessments before and after the integration intervention occurred. To ensure confidentiality in collecting and handling data, several methods were utilized for this study. Coding was used to protect anonymity, and identifying information such as name, address, date of birth, and social security numbers were excluded. Identifying information was not available to anyone other than the researcher. Interview notes and
transcriptions were stored in locked locations. Audio recordings were not accessible to anyone other than the researcher without a secure passcode. Study codes are used to protect the confidentiality of participants in research (Virginian Polytechnic Institute, 2016).

The STAR pre and post-assessments were administered to both groups on the same days. The STAR math assessment was provided initially as a pre-test to collect data in order to examine student deficiencies. The STAR math assessment was analyzed, and it was determined that the specific math standard to be integrated into PE was Number and Operations in Base Ten (Tennessee Mathematics Curriculum Guide, 2016-2017). The CCSS refers to understanding the place value system (STAR Math, 2016). Of the 22 students in the experimental group, 100% scored below the estimated mastery level on the state standards STAR report. The math teacher suggested that the skills pertaining to that standard be integrated into PE instruction.

STAR also utilizes the Student Growth Percentile (SGP) to measure growth data. The SGP views student growth over time, and it compares as many as two previous test scores to current test scores while measuring the growth alongside academic peers. A STAR individual instructional planning report is also available that reveals the current scaled score (SS) and a projected scaled score (SS) once the assessment has been completed. The report is represented by a colored graph. The red indicates urgent intervention, yellow indicates intervention, blue indicates on watch, and green represents at or above benchmark (Renaissance, 2016). As indicated on the Tennessee State Standards report, suggested skills for each student were presented.

A summary report and test record report for each student was available. The test record report recorded the STAR assessments from the previous year. Both reports
included grade placement (GP), scaled scores (SS), grade equivalent (GE), percentile rank (PR), and the normal curve equivalent (NCE). The GP is a numeric representation of a student’s grade level based on the specific month the student takes a STAR math test. The SS was based on the difficulty of questions and the number of correct responses. It was useful to compare student performance over time and across grades. The STAR math SS ranged from 0 to 1400 and all norm-referenced scores are derived from SS. The GE represents how a student’s test performance compares to others nationally. GE has a norm-referenced score ranging from 0.0 to 12.9+. The student PR indicates a measure of a student’s math ability compared to other students in the same grade nationally. PR ranges from 1 to 99, revealing the percentage of students nationally who obtained scores equal to or lower than the score of the specific student. The NCE scores range from 1 to 99 and are mostly used for research making comparisons between different achievement tests and for statistical computations (Renaissance, 2016).

In this study, STAR reports were collected and examined to provide evidence of academic achievement, both before and after the intervention was implemented and to identify student deficiencies. In addition, data were collected and analyzed from the pre and post formative assessments administered to both groups. Quick checks were also a form of assessment to guide the PE teacher’s knowledge relating to student difficulty in learning the concept of place value. Finally, two case studies were chosen from the experimental group, revealing that these students scored below the mastery level needing additional help. Interviews provided substantial information regarding the integration process of math into PE and its utility for student retention.
Time Period of the Study

The STAR assessment was administered to 45 5th grade students in 2016 as a pre-assessment. The initial data were acquired and analyzed prior to the implementation of the integrative math strategy in a PE setting. The data were used to determine student weaknesses in specific math domains. Benchmark data acquired from the STAR screener revealed the greatest deficiencies. This information prompted the PE and math teacher to collaborate for the purpose of determining which math concepts should be integrated into the PE setting. The integration of the specific math concepts began in December 2016 and continued through the middle of February 2017. Due to the PE schedule rotation and the East Tennessee school district closing school for five days due to weather and illness, the intervention was utilized six times for 55 minutes each time, for a total of 330 minutes.

The initial data from the 2016 STAR assessment were collected and compared to the February 2017 STAR assessment. The data were analyzed to determine whether the STAR assessment scores were affected by the integrative math strategy implemented in PE, specifically the area of place value. The control group scores were also examined and compared to the experimental group receiving the intervention on the STAR pre-test and STAR post-test and the formative pre-test and post-test. The qualitative component of this research regarding case studies added more information to help analyze quantitative results. Interviews were administered during the pre, mid, and post-assessment stages of the study.
Analysis of Data

The t-test was used to analyze the mean of the changes in the data collected from the formative pre-test and post-test. Specifically, a paired t-test was utilized. The paired t-test is a statistical technique used to compare two population means in the case of two correlated samples used in ‘before and after’ studies (Statistic Solutions, 2016). In this study, paired t-tests were used to determine if the applied interventions affected student’s academic achievement. Accordingly, paired t-test data were measured before and after treatment intervention (General Practice Notebook, 2016).

The formula for a t-test is a ratio. The numerator is the difference between the two averages or means, and the denominator measures the dispersion of the scores known as the standard error of the difference. Typically, the purpose of most social research is to test the level of significance by setting a risk level, also known as the alpha level (Trochim, 2006). Frost (2015) explained that the alpha level is the probability of rejecting the null hypothesis when it is true. According to Statistic Solutions (2016) and Trochim (2006), the alpha level is set to 0.05 in most instances. Frost (2015) noted that a significance level of 0.05 indicates a 5% risk of concluding that a difference exists when there is no actual difference. Subsequently, another paired t-test was conducted comparing the control group results with the experimental group results after the intervention took place.

A box plot was also used to display the distribution of data between the experimental and control groups formative pre and post-tests. A boxplot splits the data into quartiles. Within the box, a vertical or horizontal line is drawn, indicating the median of the data, and vertical or horizontal lines that extend from the top and bottom or the front or back of the box are known as “whiskers” (Stat Trek, 2017). According to
Hoffman (1981), the whiskers displayed above or below show the locations of the minimum and maximum. The individual outlying data points represented by filled circles are known as outliers.

Finally, two student interviews from the experimental group were conducted. Both students were asked questions pertaining to their opinions on the implementation of math skills in the PE setting. Interviews provide the human element that is not taken into consideration when computerized tests are administered. Interviews allow the students the freedom to express their views in their own terms and provide reliable, comparable qualitative data (Cohen and Crabtree, 2006). It also provides students the opportunity to communicate their feelings and thoughts on the topic and how that could provide important, meaningful feedback.

Conclusions

This study was conducted in the 2016-2017 school year in one urban East Tennessee elementary school. Twenty-two 5th grade students participated as the experimental group and 23 5th grade students were the control group. The 11 specific math domains were examined to identify student weaknesses relating to specific math concepts. Through test assessments and the input of the 5th grade math teacher, the math concept to be integrated was selected. A STAR pre-test and post-test and a formative pre-test and post-test were administered and analyzed. Quick checks were conducted each time the experimental group had class, revealing student knowledge of the specific math concept. Two student case studies consisting of specific material interviews were conducted that also provided substantial evidence of the intervention process.

The assessments were compared with one another. The control group scores were compared to the experimental group scores for the STAR and formative
assessments. After the formative pre-assessment was administered, the intervention was applied. A STAR post-assessment was provided approximately 45 days later. The math STAR assessment was utilized to determine if there was a significant statistical impact on student academic achievement after the intervention. The paired t-test was utilized to compare the formative pre and post assessment data and to compare assessment scores between both groups.
CHAPTER 4: ANALYSIS OF DATA

Background

The research question guiding this investigation is: What effect does the integration of math into physical education have on student achievement?

Integrating two or more subjects supports all areas of a curriculum and teaches the whole child (Thomas, Lee, and Thomas, 2008). Due to the testing obsession, the No Child Left Behind Act (NCLB) inflicts a brutal testing system that has caused educators to devote their time and energy preparing for tests in a limited number of subjects, such as English, language arts, and math, deterring from other curriculum opportunities, including art, music, physical education, and more (Walker, 2014).

According to the Tennessee Mathematics Curriculum Guide (2017), students must understand place value for multi-digit whole numbers. This study integrated the concept of place value into the physical education curriculum to determine the effect, if any, this would have on student learning.

The study utilized the paired t-test noted in Chapter Three. The paired t-test analyzes subjects twice, resulting in paired observations, such as pre and post-test scores (Statistics Solutions, 2016). The study occurred at a Title I East Tennessee urban elementary school. There were 22 5th grade students in the experimental group and 23 5th graders in the control group. The intervention occurred six times for 55 minutes each, totaling 330 minutes. Integrated lesson plans were developed (See all lesson plans in Appendix C). Minor delays in data gathering due to school system schedules were experienced. Therefore, the experimental group missed interventions during that time. Once the interventions were completed, a paired t-test was used to analyze the data of the experimental and control groups of the East Tennessee urban elementary school.
The research required a variety of assessments that were administered to the control and experimental groups. First, the 5th grade math teacher administered a pre-post STAR assessment. The math and PE teachers analyzed the pre-STAR data to decide what math strategy should be integrated in PE. The post-STAR assessment was analyzed to determine if academic achievement occurred due to the integration of math into the PE class.

Secondly, the researcher designed the pre-post formative assessment consisting of 37 questions that correlate with the CCSS of understanding place value concepts (See Appendix A). The math teacher suggested that the 4th grade CCSS be implemented as 43 of 45 5th grade students scored below the mastery level on the STAR assessment. The paired t-test was utilized to examine the data collected from the formative pre-post tests to determine whether there was an impact on student academic achievement due to integrating math into PE.

Quick checks were implemented into each intervention to provide the PE teacher information regarding the experimental groups’ comprehension of the integrated math concept. A qualitative aspect was also incorporated into the research involving two case studies. Two students from the experimental group were interviewed three times each: before, during, and after the intervention. The researcher designed 11 open-ended questions that concentrated on the area of study (See Appendix B) according to the Tennessee Mathematics Curriculum Guide (2017) that encompass the CCSS that requires students to understand place-value for multi-digit whole numbers. In addition, as noted in Chapter Three, attendance significantly affects academic achievement. Therefore, data regarding attendance for the 45 students involved in the study are also presented in this
chapter. The results for this study are expressed in the text and described in detail in table format.

**Research Question and Hypotheses**

The purpose of this study was to examine if integrating mathematics in a physical education (PE) setting would have an effect on student academic achievement.

The research question developed to conduct this analytic study was:

What effect does the integration of math into physical education have on student achievement? From the research question, the following hypotheses were developed and tested:

- **H₀₁a:** There is no difference in academic achievement for the experimental group following the integration of mathematics into PE.
- **H₀₁b:** There is no difference in academic achievement for the control group.
- **H₀₁c:** There is no difference in academic achievement for the experimental group following the integration of mathematics into PE.
- **H₀₁d:** There is no difference in academic achievement for the control group.

**Paired T-Test Data**

The paired t-tests were utilized to compare the student’s formative pre and post-test scores to examine whether student academic achievement was impacted due to the integration process of math into the PE class. A paired t-test compares two population means in which multiple observations occur within the same subject (Shier, 2004).

The two-sided paired t-test was used for both the experimental and control groups. A two-sided paired t-test tests for the possibility of the relationship in both directions; irrespective of the direction of the relationship one hypothesizes (UCLA, 2017). The two-sided paired t-test for the experimental group compared the formative
pre-test scores to the post-test scores. Using a confidence interval (CI) of 95%: $2.28 < \mu < 11.96$. The degrees of freedom [df] = 21 based on the sample size. The t-value = 3.0593; the probability value (p-value) = 0.005955. The null hypothesis is the true difference in means equal to 0: $H_0: \mu_1 = \mu_2$. The alternative hypothesis is the true difference in means not equal to 0: $H_1: \mu_1 \neq \mu_2$ concluding that a significant statistical difference exists between the experimental group’s pre-test and the experimental group’s post-test. The mean of the differences is 7.118182.

Table 4.1 summarizes the findings of the two-sided paired t-test for the experimental group comparing the formative pre-test scores to the post-test scores.

**Table 4.1**

<table>
<thead>
<tr>
<th>Two-sided paired t-test: experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental Group (Post) – Experimental Group (Pre)</strong></td>
</tr>
<tr>
<td>95% CI</td>
</tr>
<tr>
<td>DF</td>
</tr>
<tr>
<td>T-value</td>
</tr>
<tr>
<td>P-value</td>
</tr>
<tr>
<td>Mean</td>
</tr>
</tbody>
</table>

*Note.* Post = post-test; Pre = pre-test; CI = confidence interval; DF = degrees of freedom.
A two-sided paired t-test was conducted to compare the control group formative pre-test scores to the post-test scores. The findings of the two-sided paired t-test used a confidence interval of 95%: $-5.26 < \mu < 8.67$. The degrees of freedom \([df] = 18\) based on the sample size. The \(t\)-value = 0.51434 and the probability value (p-value) = 0.6133. The null hypothesis states that the true difference in means is equal to 0: \(H_0: \mu_1 = \mu_2\). The alternative hypothesis states that the true difference in means is not equal to 0: \(H_1: \mu_1 \neq \mu_2\) concluding that a statistical difference exists between the control group’s pre-test and the control group’s post-test. The mean of the differences is 1.705263.

Table 4.2 summarizes the findings of the two-sided paired t-test for the control group comparing the formative pre and post-tests scores.

**Table 4.2**

Two-sided paired t-test: control group

<table>
<thead>
<tr>
<th></th>
<th>Control Group (Post) – Control Group (Pre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>95% CI</td>
<td>$-5.260233 &lt; \mu &lt; 8.670760$</td>
</tr>
<tr>
<td>DF</td>
<td>(18)</td>
</tr>
<tr>
<td>T-value</td>
<td>0.51434</td>
</tr>
<tr>
<td>P-value</td>
<td>0.6133</td>
</tr>
<tr>
<td>Mean</td>
<td>1.705263</td>
</tr>
</tbody>
</table>

*Note.* Post = post-test; Pre = pre-test; CI = confidence interval; DF = degrees of freedom.
A one-sided paired t-test was conducted for both the experimental and control groups. A one-sided paired t-test tests for the possibility of the relationship in one direction and completely disregards the possibility of relationship in the other direction (UCLA, 2017). The findings of the one-sided paired t-test for the experimental group used a confidence interval (CI) of 95%: 3.114465 < μ < Inf (infinity). The degrees of freedom [df] = 21 based on the sample size. The t-value = 3.0593 and the p-value = 0.002978. The null hypothesis states that the true difference in means is less than or equal to 0: H₀: μ₁ ≤ 0. The alternative hypothesis states that the true difference in means is greater than 0: H₁: μ₁ > 0. It was concluded that there was a significant statistical difference that exists between the experimental group’s pre-test scores and the experimental group’s post-test scores. The mean of the differences is 7.118182.

Table 4.3 summarizes the findings of the one-sided paired t-test for the experimental group that compared the scores of the formative pre-test to the post-test.

Table 4.3

<table>
<thead>
<tr>
<th>95% CI</th>
<th>3.114465 &lt; μ &lt; Inf</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF</td>
<td>(21)</td>
</tr>
<tr>
<td>T-value</td>
<td>3.0593</td>
</tr>
<tr>
<td>P-value</td>
<td>0.002978</td>
</tr>
<tr>
<td>Mean</td>
<td>7.118182</td>
</tr>
</tbody>
</table>

Note. Post = post-test; Pre = pre-test; CI = confidence interval; DF = degrees of freedom.
A one-sided paired t-test was conducted for the control group comparing the formative pre-test scores to the post-test scores. The findings used a confidence interval (CI) of 95%: $-4.043934 < \mu < \text{Inf}$ (infimum). The degrees of freedom [df] = 18 based on the sample size. The t-value = 0.51434 and the p-value = 0.3066. The null hypothesis states that the true difference in means is less than or equal to 0: $H_0: \mu_1 \leq 0$. The alternative hypothesis states that the true difference in means is greater than 0: $H_1: \mu_1 > 0$. There is a statistical difference that exists between the control group’s pre-test scores to the control group’s post-test scores. The mean of the differences is 1.705263.

Table 4.4 summarizes the findings of the one-sided paired t-test of the control group that compared the formative pre-test to the post-test assessments.

**Table 4.4**

<table>
<thead>
<tr>
<th>Control Group (Post) – Control Group (Pre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>95% CI</td>
</tr>
<tr>
<td>DF</td>
</tr>
<tr>
<td>T-value</td>
</tr>
<tr>
<td>P-value</td>
</tr>
<tr>
<td>Mean</td>
</tr>
</tbody>
</table>

*Note.* Post = post-test; Pre = pre-test; CI = confidence interval; DF = degrees of freedom.
Represented in Table 4.5 is the average of the experimental and control group’s scores on the formative pre and post-assessments. The experimental scores revealed an increase of 7.11% after the intervention was integrated in the PE class. The control group displayed a slight increase of 1.61% from the pre-test to the post-test; no integration occurred. The experimental group scored 22.97% higher compared to the control group on the pre-assessment. On the post-assessment, the experimental group scored 28.47% higher than the control group.

Detailed tables of each individual score on the formative pre-test and post-test are located in Appendix D for the experimental group and Appendix E for the control group. The researcher also designed specific tables displaying how many students answered each problem correctly or incorrectly on the formative pre-tests, which are located in Appendix F, and post-tests, which are located in Appendix G. The tables are categorically divided between control group, experimental group, pre-test, and post-test. This information was imperative for the PE teacher as it helped guide integrated instruction, resulting in focusing more on certain aspects of place value as opposed to other areas.

Table 4.5

Average of formative pre-test and post-test scores.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>74.60%</td>
<td>51.63%</td>
<td>81.71%</td>
<td>53.24%</td>
</tr>
</tbody>
</table>

Note. Ttl. = total.
**Box Plot**

According to Hoffman (1981), a box plot is a visual that is a standardized way of distributing data, and is based on a five number summary - minimum, first quartile, median, third quartile, and maximum. The horizontal line in each box represents the median line. The vertical lines that extend below and above the box are known as whiskers. The upper and lower whiskers represent scores outside the middle 50% (Wellbeing, n. d.).

The box plot represented in Figure 4.1 is divided into two sides. One side represents the control group and the other side represents the experimental group. The scores are represented from 0 – 100, and each group illustrates a pre and post box plot so differences can be compared visually.

The box plots illustrate there is a significant difference between the experimental group and the control group. The experimental group outperformed the control group in both the pre and post formative assessments. The box plots also display that there was an increase in performance from the pre-test to the post-test for both groups, but the experimental groups’ scores were higher compared to the control group. The experimental scores were also in a cluster format on both the pre and post-tests compared to the control group. The control group’s data were scattered.

There is approximately a 32-point difference between the pre-test scores of the experimental group compared to the control group. There is approximately a 28.5-point difference between the post-test scores comparing the experimental group to the control group. The experimental group scored higher on both assessments. The median line for the control pre-test is slightly below the score of 50. The median line for the experimental pre-test scored approximately 81. The median line for the control post-
assessment increased to an approximate score of 60 and the median line for the experimental post-assessment increased to an approximate score of 88.5.

**Figure 4.1** Box Plot

*Figure 4.1. Box plot of the formative pre and post-tests for the control and experimental groups. This figure illustrates the distribution of data for both the control and experimental group pre and post-tests. The score is represented in 25-point increments.*
Interviews

Two semi-structured interviews were conducted with students from the experimental group. The female student was designated as Participant A and the male student was designated as Participant B.

Semi-structured interviews are used to acquire knowledge relative to the implementation and effectiveness of interventions. In semi-structured interviews, questions must be pre-planned, which makes it possible to ask the same questions repeatedly. This allows the interviewer to further explore particular themes or responses (Evaluation Toolbox, 2010).

The interviews were conducted separately, but face-to-face. The students were interviewed three times each - before, during, and after the study. The interviews were audiotaped and notes were taken. The six interviews are located in Appendix H and I. The pre, mid, and post interviews for Participant A (C11) is located in Appendix H. The pre, mid, and post interviews for Participant B (C9) is located in Appendix I. McLeod (2014) explained that open-ended questions enable the interviewees to answer a question in as much detail as they like in their own words, and also noted that open-ended questions allow the researcher to probe for more in-depth answers.

The two case studies chosen were students that fell below the mastery level on the STAR assessment, and additional help was suggested: Students were coded as C11 (Participant A) and C9 (Participant B) to ensure anonymity. Interview questions regarding place value for multi-digit whole numbers were developed from the research district’s curriculum guide.

The researcher asked both students participating in the case study if they thought integrating math in PE was beneficial. Unlike other questions that specifically pertained
to place value, this was a more open-ended question. The researcher was interested in ascertaining if the students believed the integration process helped them in math. Furthermore, the researcher was interested in determining how and why integration was or was not beneficial. Some responses to that question are presented below.

C11 (pre): It makes it more fun and you are also doing physical learning too.

C11 (post): I think it was a good idea because it makes math more fun instead of sitting at a desk with a pencil. It’s helped me keep it in my brain because I can do it at home. Like, in gym when we played a game with math problems in it, I sometimes use those games at home. An example is the basketball game and the cones and I use sticks and paper.

C9 (mid): Yes, because when we look at the wall we see the multiplication facts and we learn all the facts when we need them in problems.

C9 (post): Because when I throw the ball at the wall every time I say the number and it helps me think better and the number is right.

Both students displayed a gradual increase of comprehension of the math standard, as their answers to various questions revealed throughout the study. After the initial interview, student answers began to reflect an enhanced understanding of the material. For example, both students could not compare the terms “place” and “value” during the pre-interview. During the mid-interview, they defined each term. In the post-interview, the students gave examples explaining what each number represented relating to both terms “place” and “value”. Subsequently, the students applied sound knowledge to their answers. They were also able to analyze the information, which produced more in-depth answers.
As evidenced in various interviews, student responses revealed an increase in comprehension of the topic place value, which correlates with their formative post-test scores. One student’s (C9) score increased by 24.3 points, from a 37.9 on the pre-test to a 62.2 on the post-test. In like manner, another student’s (C11) score increased by 13.5 points, compared to a 70.3 on the pre-test to an 83.8 on the post-test.

**STAR Screener**

STAR screener assessments are utilized to guide instruction and monitor student growth in both math and reading, as well as to project student performance on state end-of-course exams. STAR data was analyzed to aid the 5th grade math teacher and PE teacher in order to identify students’ academic deficiencies. STAR data used for this study indicated that all students needed remediation when learning place value because 43 of 45 students scored below the mastery level in this area.
Table 4.6 illustrates the STAR data accrued from the pre-assessment. Out of 45 students, only two (4.4%) scored within the mastery level. Forty three (95.6%) students scored below mastery and 35 (77.7%) of those students needed additional help in the area of understanding place value. In the experimental group, 17 (77.3%) students scored below mastery needing additional help. Five (22.7%) students scored below the mastery level. In the control group, two (8.7%) students scored within the mastery level, three (13%) students scored below the mastery level and 18 (78.3%) students scored below the mastery level, needing additional help.

**Table 4.6**

STAR baseline data pre-assessment

<table>
<thead>
<tr>
<th>Group</th>
<th># Students</th>
<th>Above Mastery</th>
<th>Within Mastery</th>
<th>Below Mastery</th>
<th>Bel. Mast. NAH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exprmntl</td>
<td>22</td>
<td></td>
<td></td>
<td>5 = 22.7%</td>
<td>17 = 77.3%</td>
</tr>
<tr>
<td>Control</td>
<td>23</td>
<td></td>
<td>2 = 8.7%</td>
<td>3 = 13.0%</td>
<td>18 = 78.3%</td>
</tr>
<tr>
<td>Combination</td>
<td>45</td>
<td>2 = 4.4%</td>
<td>8 = 17.8%</td>
<td>35 = 77.8%</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Bel Mast NAH = below mastery needing additional help; Exprmntl = experimental group; CCSS.Math.Content.5.NBT.A. Understand the place value system (STAR Math, 2016).
The STAR post-assessment in Table 4.7 reveals three (7.3%) students scored within the mastery level, which is an increase of 2.9%. One student from the experimental group moved from below to within the mastery level. Two students (4.9%) within the experimental group scored below the mastery level. There were an additional two students from the experimental group that moved to below mastery needing additional help, increasing to 19 (86.4%) students in that category and a total of 17 (89.5%) students from the control group in the same category. There were 36 students (87.8%) in the below mastery needing help category. Overall, there was a 10% increase in the below mastery needing additional help category and a 12.9% decrease in the below mastery category. Three students transferred and one student was placed in the PBIS class, so there were 41 students who completed the study. The four students that were eliminated from the study were initially in the control group.

**Table 4.7**

<table>
<thead>
<tr>
<th>Group</th>
<th># Students</th>
<th>Above Mastery</th>
<th>Within Mastery</th>
<th>Below Mastery</th>
<th>Bel. Mast. NAH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exprmntl</td>
<td>22</td>
<td></td>
<td>1 = 4.5%</td>
<td>2 = 9.1%</td>
<td>19 = 86.4%</td>
</tr>
<tr>
<td>Control</td>
<td>19</td>
<td></td>
<td>2 = 10.5%</td>
<td></td>
<td>17 = 89.5%</td>
</tr>
<tr>
<td>Combination</td>
<td>41</td>
<td></td>
<td>3 = 7.3%</td>
<td>2 = 4.9%</td>
<td>36 = 87.8%</td>
</tr>
</tbody>
</table>

*Note.* CCSS.Math.Content.5.NBT.A Understand the place value system (Star Math, 2017).
Quick Checks

Quick Checks (QC) are a form of assessment to help the teacher discern student understanding and knowledge, as well as identify areas in which students need additional help. The quick checks were incorporated as part of the math and PE integrative activities found in the six detailed lesson plans in Appendix C. There were two types of quick checks used in this study. The first form of quick check was conducted as students entered the gym. Students answered a math problem represented on an index card that concentrated on a specific place value concept. The results are found in Appendix J, revealing whether the student answered the math area of focus correctly or not. Skills tests were incorporated to ensure and exhibit the integrity of this study regarding true integration of math into a PE setting.

Table 4.8, shown below, represents a summary of how the experimental group scored on each QC when entering PE.

Table 4.8

Averages for the experimental group per Quick Check.

<table>
<thead>
<tr>
<th>Experimental Group Total Average Per Quick Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>QC 1</td>
</tr>
<tr>
<td>100%</td>
</tr>
</tbody>
</table>

Note. QC = Quick Check.
The second form of quick check utilized is incorporated in each lesson plan found in Appendix C. The PE teacher examined the formative pre-assessment in order to determine which questions posed the most difficulty for students. Subsequently, six quick checks containing six math problems were implemented. The six QC scores for each individual are located in Appendix K. This activity, which was integrated into PE, was termed “Math Wiz.”

Table 4.9 depicts the grading scale for 5th grade. Each question was worth 16.7 points: A is 93 – 100; B is 85 – 92; C is 76 – 84; D is 70 – 75; U is 0 – 69. Five (22.72%) students’ average score was a 69 or less, equating to a U. Five (22.72%) students averaged between 70 and 75, earning a D. Seven (31.81%) students’ averages ranged between 76 and 84, earning a C. Four (18.18%) students averaged between 85 and 92, earning a B, and one (4.54%) student earned an A with an average of 97.22. Over 50% of the 5th grade students had difficulty comprehending 4th grade place value concepts. Seventeen students scored a C or below.

Table 4.9

Fifth grade grading scale.

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Numerical Grade</th>
<th># of Students</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>93 – 100</td>
<td>1</td>
<td>4.54</td>
</tr>
<tr>
<td>B</td>
<td>85 – 92</td>
<td>4</td>
<td>18.18</td>
</tr>
<tr>
<td>C</td>
<td>76 – 84</td>
<td>7</td>
<td>31.81</td>
</tr>
<tr>
<td>D</td>
<td>70 – 75</td>
<td>5</td>
<td>22.72</td>
</tr>
<tr>
<td>U</td>
<td>0 - 69</td>
<td>5</td>
<td>22.72</td>
</tr>
</tbody>
</table>
Student Attendance

Previously mentioned absences, tardiness, mobility rate, and student behavior are variables that have negatively affected academic achievement. Chronic absenteeism is defined as missing 10% of a school year (Balfanz & Byrnes, 2012). Student non-attendance and tardiness are problematic at this East Tennessee urban elementary school.

Detailed student attendance is depicted in four tables (See Appendix L, Appendix M, Appendix N, Appendix O). The attendance for the experimental group prior to the start of the study is located in Appendix L. The attendance for the control group prior to the start of the study is located in Appendix M. The attendance for the experimental group during the study is located in Appendix N. The attendance for the control group during the study is located in Appendix O. Each table in the Appendices consists of the following student codes – absences, tardies, early dismissals, and transfers. It was imperative to disclose the attendance history of the subjects because of the potential impact on this study.

There were 72 school days prior to the inception of the study, and the study encompassed 45 instructional days. However, due to inclement weather and illness, five school days were cancelled, which allowed 40 instructional days for research.

The attendance results reveal a significant pre-study disparity between the experimental and control groups. The control group had almost double the number of absences and tardies than the experimental group, and had more than double of the behavior problems prior to November 30, 2016. The control group (23 students) is made up of three different classrooms, and the experimental group (22 students) is made up of only one classroom. Data illustrates, however, that student absences (162-163 absences) within both groups was essentially the same during the time period of the study.
Summary

This study examined the integration of mathematics into a physical education setting and the impact it had on student academic achievement at an East Tennessee urban Title I elementary school. This chapter presents descriptive analysis of the data acquired from different sources. The research question was: What effect does the integration of math into physical education have on student achievement?

The paired t-tests were used to analyze the data collected from formative pre-post assessments administered to 45 5th grade students. A t-value and p-value was provided for each analysis. Each analysis determined if the researcher accepted or rejected the null hypotheses. Data were collected from the STAR screener and analyzed comparing results from a pre-assessment to the post-assessment.

Quick checks provided data that helped guide the researcher in learning strengths and weaknesses of the students related to the math concept studied. Two case studies provided qualitative data of the integrative process. The interviews contributed insight into students’ true knowledge of the topic. Attendance was also scrutinized to determine its negative effect on academic outcomes.
CHAPTER 5: FINDINGS, CONCLUSIONS, and RECOMMENDATIONS

Purpose and Research Design

The purpose of this study was to determine what effect integrating mathematics into physical education would have on student academics in the area of mathematics. Research was conducted at an urban elementary school in East Tennessee collecting data from 45 5th grade students. Formative pre and post-tests were analyzed using the paired t-tests. Specifically, the two-tailed and the one-tailed t-tests were used to examine the experimental pre and post-tests and the control pre and post-tests.

The STAR assessment was utilized initially for a baseline measurement to analyze the areas of math in order to determine student deficiencies in specific academic areas. The STAR pre-test was compared to the STAR post-test of both groups. The research question guiding this study was:

What effect does the integration of math into physical education have on student achievement?

Summary of the Study

According to Drake and Burns (2004), integration is the unification of all subjects and experiences and emphasizes the importance of making connections. History has shown superior learning outcomes for well-designed and well-implemented integrated initiatives (Michigan Department of Education, 2014).

Jensen (2005) stated that most neuroscientists agree that movement and cognition are powerfully connected or integrated. Movement can be an effective cognitive strategy to strengthen learning, improve memory and retrieval, and enhance learning motivation.

The population for this quantitative study included 45 5th grade students from an urban East Tennessee Title I elementary school for the 2016-2017 school year. The
experimental group was comprised of 22 students and the control group consisted of 23 students. Additionally, two case studies were included in the experimental group. These case studies were interviewed before, during, and after the interventions were implemented. These case studies were chosen due to baseline STAR assessment scores and a discussion with a 5th grade teacher at the research school. Each case study scored below the mastery level requiring additional help.

**Findings**

Research question: What effect does the integration of math into physical education have on student achievement?

Table 5.1 illustrates the formative assessment null and alternative hypotheses results. Each hypothesis test makes a statement about the difference \((d)\) between the mean of one population \(\mu_1\) and the mean of another population \(\mu_2\) (Stat Trek, 2017). The set in Table 5.1 incorporates a numerical value and indicates whether it is the experimental (exp) or control (ctrl) group. The following is an interpretation of Table 5.1.

Set 1 - experimental group in a two-sided paired t-test: The null hypothesis \(H_0: \mu_1 = \mu_2\) was rejected. There is no difference in academic achievement after integrating math into PE. The alternative hypothesis \(H_1: \mu_1 \neq \mu_2\) was accepted, concluding that a statistical difference exists between integrating math into PE and the impact on academic achievement.

Set 2 – control group in a two-sided paired t-test: The null hypothesis \(H_0: \mu_1 = \mu_2\) was rejected and the alternative hypothesis \(H_1: \mu_1 \neq \mu_2\) was accepted. The control group did not receive the intervention of integrating math into PE.
Set 3 – experimental group in a one-sided paired t-test: The null hypothesis $H_0$: $\mu_1 \leq 0$ is less than or equal to zero. The alternative hypothesis $H_1$: $\mu_1 > 0$ is greater than zero, concluding that a statistical difference exists between integrating math into PE and the impact on academic achievement.

Set 4 – control group in a two-sided paired t-test: The null hypothesis $H_0$: $\mu_1 \leq 0$ is less than or equal to zero. The alternative hypothesis $H_1$: $\mu_1 > 0$ is greater than zero concluding that a statistical difference exists. Math was not integrated into the PE class for the control group.

**Table 5.1**

Formative assessment paired t-test hypothesis results.

<table>
<thead>
<tr>
<th>Set</th>
<th>Null Hypothesis</th>
<th>Alternative Hypothesis</th>
<th># of Tails/Sides</th>
</tr>
</thead>
<tbody>
<tr>
<td>1exp</td>
<td>$H_0$: $\mu_1 = \mu_2$</td>
<td>$H_1$: $\mu_1 \neq \mu_2$</td>
<td>2</td>
</tr>
<tr>
<td>2ctrl</td>
<td>$H_0$: $\mu_1 = \mu_2$</td>
<td>$H_1$: $\mu_1 \neq \mu_2$</td>
<td>2</td>
</tr>
<tr>
<td>3exp</td>
<td>$H_0$: $\mu_1 \leq 0$</td>
<td>$H_1$: $\mu_1 &gt; 0$</td>
<td>1</td>
</tr>
<tr>
<td>4ctrl</td>
<td>$H_0$: $\mu_1 \leq 0$</td>
<td>$H_1$: $\mu_1 &gt; 0$</td>
<td>1</td>
</tr>
</tbody>
</table>

1. The findings of the two-sided paired t-test for the experimental group revealed that the students scored higher on the post-test than the pre-test after the interventions occurred. The mean of the difference was 7.118182.

2. The findings of the two-sided paired t-test for the control group revealed that the students scored higher on the post-test than the pre-test without the intervention being incorporated. The mean of the differences was 1.705263. However, the control groups’ scores on the post-test were much lower than the experimental groups’ scores.

3. The findings of the one-sided paired t-test for the experimental group revealed that the students scored higher on the post-test than the pre-test after the interventions
occurred. The mean difference was 7.118182. The positive impact on academic achievement could be due to the integration of math into PE.

4. The findings of the one-sided paired t-test for the control group revealed that the students scored higher on the post-test than on the pre-test without the intervention being incorporated. The mean difference was 1.705263. The control group scores were much lower than the experimental group scores.

5. The findings indicated that the experimental group scored 22.97% higher than the control group on the pre-assessment.

6. The findings indicated that the experimental group scored 28.47% higher than the control group on the post-assessment.

7. The findings indicated that the experimental group’s average score on the pre-test was 74.60%, compared to the control group’s average score of 51.63%.

8. The findings indicated that the experimental group’s average score on the post-test was 81.71%, compared to the control group’s average score of 53.24%.

9. The findings illustrated on the box plot display an approximate 32-point difference between the pre-test scored comparing the experimental group to the control group. The experimental group scored 32 points higher. There was a 28.5-point difference between the post-test scores comparing the experimental group to the control group. The experimental group scored 28.5 points higher.

10. The findings illustrated the median line for the control group pre-test on the box plot was just below 50. The median line for the experimental group pre-test was approximately 81.

11. The findings showed the median line for the control group post-test on the box plot increased to an approximate score of 60, a gain of approximately 10 points. The
findings illustrated the median line for the experimental group post-test increased to an approximate score of 88.5, an increase of approximately 7.5 points.

12. The findings demonstrated that the data is distributed in cluster form for the experimental group, compared to scattered data for the control group on both the pre and post-test.

13. Interviews revealed that students had gradually increased their knowledge and comprehension of place value as the interventions were implemented into the PE setting.

14. The findings showed that attendance does play a role in academic achievement.

15. The findings suggested that there was no significant impact on academic achievement regarding the place value topic when both groups took the post STAR screener.

Discussion

The findings indicated a positive correlation between the integrative process and the formative post-test data. Additionally, the findings revealed a correlation between the integration of math in PE, as well as gains in knowledge and the comprehension of place value with regard to both case studies.

As research noted in Chapter 3 indicates, attendance, tardies, multiple relocations, and early dismissals negatively impact academic achievement. Thus, it was reasonable to assume these factors could impact the results of this study. Chang and Romero (2008) defined chronic absence as missing 10% or more of the school year, which is equivalent to 18 days out of a 180-day school year. The study was conducted at a Title 1 elementary school, where 89% of the students live at or below the poverty level. According to
Romero and Lee (2007), student non-attendance rates are higher among disadvantaged families, and this negatively affects academic achievement in reading, math, and general knowledge.

This research study was administered over 45 instructional days. Five instructional days were lost due to the school closing for inclement weather and sickness, and school opened late one day due to weather. This resulted in an 11.1% loss, or five instructional days, in which the study could take place.

Five students of the experimental group missed an additional four to 12 days of school during the time of the study, accounting for anywhere from 10% to 30% of missed instructional time. Four out of five students with the additional absences increased their formative post-test data between 5.4% and 13.5% scores, ranging from 29.8 to 94.6. One of the five students with chronic absences decreased the post-test by 2.7%, translating into a score of 56.8, and missed a total of 11 days during the study. One student was absent a total of 17 times during the duration of the study and increased the post-test by 10.18%, scoring a 29.8. This student’s score revealed a lack of understanding of place value and could be attributed to 17 absences. The gains on the formative test scores could be attributed to the intervention in PE.

Eight students in the control group missed an additional 4 to 12 days of school, which is equivalent to missing as little as 10% of instructional time and as much as 30% of instructional time. Their formative post-test scores ranged from 2.8 to 89.2. Five of the eight students increased their scores 8.2% - 35.1%. Three students decreased their post-test 2.7% - 18.9%. One student, who is periodically in a Positive Behavioral Interventions and Support program, raised the pre-test score from 2.8 to 35.2. The gains demonstrated by this student could be attributed to a lack of desire to complete the pre-
test, followed by better effort on the post-test despite a lack of understanding of place value. The scores revealed that students do not understand place value. One student out of the eight who is chronically absent displayed some knowledge of place value. Two students, one in the control group and one in the experimental group, who had the most absences, are siblings.

The results of the STAR post-screener noted that 38 of 41 students scored below the mastery level. The STAR screener indicated that 36 of 38 students needed additional help. There were no statistical differences between the experimental and control groups in this study. Initially, there were 45 students participating in this study. However, three of these students moved and one student required complete PBIS support, so 41 students participated in the study. In sum, 21 students in the experimental group scored below the mastery level on the STAR post-test. Additionally, STAR suggested that 19 students should receive additional help in this area. One student scored within the mastery level. In the control group, 17 students scored below mastery and two students scored within the mastery level.

It should be noted that STAR results are often difficult to analyze, and data is difficult to interpret. Negative results could also be attributed to students having to read the test. Many students struggle with reading and comprehension. However, the research school does not offer headphones, which would allow the test to be read to the students. Therefore, some students who have mastered the math concepts may be unable to read the test questions, which could alter test results.

The paired t-test was utilized to examine the data collected from the formative pre and post assessments for the control and experimental groups. There was a mean of the differences of 1.705263 in the two-sided paired t-test for the control group. In the two-
sided paired t-test for the experimental group, a mean of the differences was 7.118182. The mean of the differences for the one-sided paired t-test for the control and experimental group was the same as the two-sided paired t-test for each group.

The experimental group’s post-test reveals 16 students increased their scores on the post-test, ranging from 29.8 - 100. Two students’ scores did not change - 100 and 81.1. Four students’ post-test scores decreased - three by 2.7% and one by 18.9%. These students’ scores ranged from 56.8 to 97.3. The average increase of the 16 students’ scores was 82.28. The average of the four scores that decreased was 75.03.

In the control group, eight students increased their scores on the post-test, ranging from 8.2 – 89.2. One student’s score remained the same at 32.5. Ten students’ scores decreased scores by 2.7% -18.9%, from 13.6 – 94.6. The average increase of the eight students’ scores was 58.48. The average decrease of the ten students’ scores was 51.13. Many variables, including lack of sleep, homelessness, placement in foster care, abuse, and absenteeism, may have impacted these scores.

The box plot was also utilized as a visual representation of test scores for both research groups, and this revealed positive distribution of data for the experimental group compared to the control group. The box plot also divulged an increase from the pre to the post-test for the experimental group. The median of scores increased for both groups from the pre to the post-test. However, the experimental groups outperformed the control group in all areas, which can be attributed to the applied interventions.

The complimentary case studies also enriched this research. The interview process provided insight into student understanding.
More studies integrating math and other subjects into PE need to be established. DeFrancesco and Casas (2012) administered a study of incorporating math skills into a 2nd grade PE class, and this indicated that more research in this area is needed.

The researcher’s findings indicated positive results regarding the integration of math in the PE setting when comparing the formative pre-post tests. However, there was not an increase on the STAR assessments, and it is worth noting that STAR will not be used at the research school after the 2017-2018 school year.

Conclusion

Research question: What effect does the integration of math into physical education have on student achievement?

The purpose of this study was to determine what impact, if any, integrating mathematics had on student achievement. Specifically, the Common Core State Standard (CCSS) defined as “understanding place value for multi-digit whole numbers” was scrutinized. The study concluded that there is a statistical significant difference between the formative pre and post-test data for the experimental group compared to the control group. Two-sided and one-side paired t-tests were utilized to compare the pre-post assessments. The paired t-tests were examined, and results indicated a significant increase in the experimental group scores compared to the control group following the integrative strategies.

Results also showed that students who frequently did not attend school and students who were placed in PBIS increased their test scores following the intervention. However, the increased scores still reflect that students have difficulty understanding place value. The lack of comprehension could be attributed to frequent absenteeism and other factors.
The two students that were interviewed throughout the study displayed a gradual increase of knowledge and comprehension of place value. The interviewees expressed that integrating math into PE helped them retain the information. The retention was attributed to moving and participation in physical activities while incorporating the different math concepts.

**Recommendations**

The findings of this study indicate an increase in the formative post-assessment scores related to the mathematical place value concept that was integrated into a PE setting. Although there was an increase in test scores in the completed analysis, more information is needed to validate this research. Therefore, a study focused on integrating mathematics into the physical education setting is warranted due to possible future contributions to academic achievement. Future research could include an increase in the number of interventions integrated, which would allow for an extended study. Physical education courses could be offered consistently during the week, as opposed to once or twice weekly on a rotating basis.

An extended study conducted with a larger population could also benefit the findings of this research. It is also recommended that the formative pre-test and post-test be administered in the same manner. In this study, the experimental group took these tests in the classroom. However, due to class sizes, the control group took the pre-test and post-test in the gym.

Future research could include requiring encore classes such as art, music, technology, and library to incorporate additional work in core courses such as English, reading, math, and science. As noted by the 5th grade math teacher at the research school, many students are working below grade level and are not academically prepared for the
5th grade curriculum. Thus, utilizing encore teachers to integrate basic skills could help remediate this problem.

The general education teachers could suggest topics they feel are necessary to be integrated, such as addition, subtraction, force, compound words, nouns, verbs, etc. This integration could occur on a regularly scheduled basis (ex: weekly or monthly).

School administrators could develop a weekly schedule, which would permit encore teachers to observe general education classes. This would allow encore teachers to be exposed to teaching strategies that are utilized in these subjects, and it would also enable encore teachers to become more familiar with the vernacular that is common in these subjects. Professional development activities for encore teachers could be conducted to help these teachers facilitate the implementation of integrative strategies.

Future studies could enable students to use headsets for math assessments, such as STAR, in order that students may have the tests read to them. The STAR results in this study could be attributed to students’ inability to read and/or difficulties in reading. Even if students understand the math concepts, reading difficulties may preclude them from performing well on these assessments. The utilization of headsets would help researchers to better determine student mastery of mathematical concepts.

It would also be advisable to study the time lost from physical activity (PA) in PE classes when other subjects are integrated. For example, requiring students to solve a math problem when entering the gym detracts from time needed for physical activity. Thus, it is recommended that this strategy be utilized on an incremental basis.

Yearly data analysis of standardized tests in multiple subject areas (pre-tests and post-tests) could be used to determine if interventions had either positively or negatively impacted student achievement.
If more students were to participate in the interview process, this would provide additional data and enrich the qualitative components of the study. Also, future research could compare the interventions that impact academic achievement and determine which combinations of integration and physical education are most successful.
References


Appendix A

Formative Pre-Test and Post-Test
Pre-Post Formative Assessment: SHOW ALL WORK!  

Code: _____________

1. What is 4,596 in word form?
   a. four thousand five hundred six
   b. four thousand five hundred ninety six
   c. four million five hundred ninety six
   d. forty thousand ninety six

2. What is 21,406 in word form?
   a. twenty one thousand four hundred six
   b. twenty million four thousand six
   c. twenty one thousand forty six
   d. twenty thousand four hundred and six

3. What is 54,264,510 in word form?
   a. fifty four million two hundred sixty four thousand five hundred
   b. fifty four thousand two hundred sixty four
   c. fifty four million two hundred sixty four five hundred
   d. fifty four million two hundred sixty four thousand five hundred ten

Write the following in standard form:

4. 5000 + 500 + 80 + 7

5. Seven million, three hundred twenty thousand, five hundred two

6. 3,000,000 + 400,000 + 20,000 + 200 + 4

Write the value of the underlined number:

7. 34,906

8. 46,371

9. 42,369,124

Write the following in expanded form:
10.  6,452

11.  10,041

12.  46,400,213

13. Round to the nearest hundred.

   362  ______________  1429  ______________  499  ______________

14. Round to the nearest ten.

   427  ______________  388  ______________  264  ______________

15. Solve the following problems. Show your work.

   364  5000  1666  333
   +294  - 482  + 489  - 27

16. Compare the following numbers and place the proper symbol (<, >, =) in the box:

   42,769  □  42,709

   473,296  □  474,192

   2,468,302  □  2,459,782
17. Place the following numbers in order from least to greatest:

   1,473  1,437  1,448  1,484  1,432

   23,664  22,847  23,632  22,469  23,720

18. Place the following numbers in order from greatest to least:

   3,752  3,598  3,506  3,953  3,905

   86,023  85,396  86,029  85,357  86,138

19. Solve the problems. Show your work.

   \[ \begin{align*}
   36 \times 9 &= \quad \text{83} \times 47 = \\
   74 \times 39 &= \quad 249 \times 26 = \end{align*} \]

20. Solve the problems. Show your work.

   \[ \begin{align*}
   24 \div 2 &= \quad 54 \div 9 &= \quad 68 \div 2 &= \quad 96 \div 3 &= \end{align*} \]

Responses are voluntary.
Answer Key - Formative Pre-Post Assessment.

1. B
2. A
3. D
4. 5587
5. 7,320,502
6. 3,420,204
7. 30,000
8. 70
9. 2,000,000
10. 6,000 + 400 + 50 + 2
11. 10,000 + 40 + 1
12. 40,000,000 + 6,000,000 + 400,000 + 200 + 10 + 3
13. 400
   1400
   500
14. 430
   390
   260
15. 658
   4518
   2155
   256
16. >
   <
   >
17. 1,432 1,437 1,448 1,473 1,484
    22,469 22,847 23,632 23,664 23,720
18. 3,953 3,905 3,752 3,598 3,506
    86,138 86,029 86,023 85,396 85,357
19. 324, 2,886, 3,901, 6,474
20. 12, 6, 34, 32
Appendix B

Interview Questions: Pre-Mid-Post
1. What is the relationship between the digits in this number? 44
2. Compare the terms value and place.
3. How would adding a 0 to this number impact its place value? Justify your answer. 35
4. How does your understanding of place value help you to compare and order numbers?
5. What makes 5 special in rounding?
   Round the following number to the nearest hundreds place and explain how you solved the problem. 2,487
   Round the following number to the nearest tens place and explain how you solved the problem. 1,464
6. How can place value be used to determine the sum or difference of two numbers?
7. Why is there an extra digit above the tens column?
8. In which other place value column will there be an extra digit as the addition proceeds? Explain why.
9. Do you think integrating and/or implementing math into the physical education setting could help you with math? How? Why?
10. How much greater is the value 5 in the number 560 compared to 56? How did you arrive at that answer?
11. In the number 650, what number is in the hundreds place? What is the value?
    Explain your answer.

Responses are voluntary.
Appendix C

Six Lesson Plans
Lesson Plan 1

**Objective:** We will know the steps in sequence to execute the overhand throw.

Step 1: Sideways feet together
Step 2: “L”
Step 3: Step with opposite foot
Step 4: Overhand throw
Step 5: Ready position

**Frayer Model word is Execute:** Students usually learn new word that is stated in the objective. Frayer model implemented consists of definition, synonym, antonym, and picture.

**Sub-objective:** We can catch at three different levels.

**Warm-Up:** Upon entering the gym, students will answer a math problem (multiplication) and will perform the locomotor skill around the perimeter of the gym that is written on the index card.

**Partner warm-up (pre-assessment of overhand throw):** Teacher mixes up warm-up activities to keep students thinking and from getting bored. This applies to all lesson plans.

**Math wiz:** Teacher will have students solve the first math problem by writing down the answer on the Quick Check #1 (QC). The partner who solves the problem first picks up an object, runs and overhand throws the object at each wall (4), returning back home. The partner who returns home first receives a point = Math Wizard. When the PE teacher says “Math Wiz” students know to work on the next QC problem. Students repeat activity: do problem, get ups, runs, and throws.

An example of another warm up activity is, “Math Facts.” Students know when teacher calls out “Math Facts” students will go to any strip of multiples they choose that are hanging around the gym on cork strips from 1 to 13; for example multiples of three (3x1=3, 3x2=6, 3x3=9, 3x4=12…3x12=36). The students will perform a non-locomotor skill that the teacher calls out in front of the multiple strip of their choice. Students will see, say, and do the math fact multiples. In this case students are throwing at the wall as they see, say the multiples and throw all at the same time.

Teacher and students go over objective: Students shadow practice with teacher saying and doing each step.

Student’s practice saying and doing each step of the overhand throw against wall.

**Individual:** Students practice correct steps of overhand throw while integrating comparing numbers (greater/less than). All students are on the centerline with an object to throw. Teacher holds up two numbers ie: 387 □ 393 Students run to either the “greater” or “less” line and proceed to overhand throw twice at the wall going through the steps before returning to the centerline. New problem is held up. Repeat.
**Group Activity: Football throw and catch point’s game:** Each side of gym is divided into sections by cones with the place values on each cone. If a student catches a football that was thrown from the other side near the tens section the student runs to the opponents side and asks politely for two beanbags. He runs back to his side and gives it to his guard who places it in their bucket. If a football is caught near or in the ones section it is worth one beanbag, tens section receives 2 beanbags, hundreds section receives 3 beanbags etc. The team that has the most points wins. The teacher will call out a number (1,506,723) and the team to get in the proper order holding up each number will receive an extra point. The teacher will ask for the person in the hundreds place to take a knee. Each team can earn extra points.

**Materials:** Zapp corners are where materials are found and the steps to the objective with pictures are also located. Students are assigned Zapp corners at the beginning of the year. Students are able to be anywhere in the gym and be able to know what the objective is and the specific steps in order to master it by looking in a Zapp corner. Student folders with QC #1 and pencils, foam balls (different sizes), footballs, two buckets with 25 juggling cubes in each, two sets of cones with ones, tens, hundreds, thousands, ten thousands, hundred thousands, millions on each cone, place value chart, Multiplication Facts hanging on cork strips around gym, Frayer model, Mr. Bones, place value chart, and music/IPod.
Math Wiz 1
Pre-Assessment of Overhand Throw

1. What is 406 in word form?

2. Write in standard form: 5,000 + 500 + 80 + 7

3. Write in standard form:
   seven million three hundred twenty thousand five hundred two

4. Write in standard form:
   3,000,000 + 400,000 + 20,000 + 200 + 4

5. Write in standard form:
   50,000,000 + 4,000,000 + 200,000 + 60,000 + 4,000 + 500 + 10

6. Bonus question:
   Write the following number in expanded form.

   3,160,478

Responses are voluntary.
1. What is 406 in word form?
   Answer: Four hundred six.

2. Write in standard form: 5,000 + 500 + 80 + 7
   Answer: 5,587

3. Write in standard form:
   Seven million three hundred twenty thousand five hundred two
   Answer: 7,320,502

4. Write in standard form:
   3,000,000 + 400,000 + 20,000 + 200 + 4
   Answer: 3,420,204

5. Write in standard form:
   50,000,000 + 4,000,000 + 200,000 + 60,000 + 4,000 + 500 + 10
   Answer: 54,264,510

Bonus question:
Write the following number in expanded form.

3,160,478

Answer: 3,000,000 + 100,000 + 60,000 + 400 + 70 + 8
Lesson Plan 2

Objective: We can overhand throw using the steps in proper sequence 5 out of 5 times to pass assessment. Frayer model word is assessment.

Sub-objective: We will know the steps in sequence to overhand throw properly.

Step 1: Sideways feet together
Step 2: “L”
Step 3: Step with opposite foot
Step 4: Overhand throw
Step 5: Ready position

Warm-up: Students will answer a math problem relating to the “place” of a number upon entering the gym and will perform a specific locomotor skill written on the index card.

Individual: Warm-Up mixes the performance of locomotor and non-locomotor skills while practicing overhand throw with a partner or individually. Teacher will call out “Math Facts”. Students will overhand throw ball at wall where multiplication fact strips hang saying each multiplication problem while throwing. An example of a multiplication fact strip would be the three’s: 3 x 1 = 3, 3 x 2 = 6, 3 x 3 = 9, 3 x 4 = 12, 3 x 5 = 15, … 3 x 12 = 36. The teacher may say “Math Wiz”. Students will answer the next question on the QC #2. Once done writing answer, students will run and overhand throw ball at each wall. Next, the teacher will say “Partner Non-locomotor skill” toss and catch. Teacher will demonstrate the non-locomotor skill while throwing and catching with a partner such as performing plank and tossing and catching with partner; sit-ups, toss, and catch with partner, skaters, toss and catch with partner, etc.

Teacher reviews and models the objective explaining how students are to peer assess one another on the overhand throw, giving each other specific academic feedback.

Partner Place value overhand throw activity: Index cards are placed in the center circle of the gym with numbers written on them face down. On each card one number is circled, for example 1,378 and the 3 is circled. The place value terms are attached to cones and are set up in self-space randomly (ones, tens, hundreds... millions). When the music starts both partners go to the center circle and they each turn over a different number. They figure out what place the circled number is in. They replace the index card they chose face down. The partners then run to the place value cone that was represented by the circled number on the card. The partners begin to overhand throw from their place value cone to each other five times and then repeat process, going back to the center circle turning over a new card.

Peer-Assessment: Students assess each other’s overhand throw. To receive 100 the student must perform each step in proper sequence 5 out of 5 times. Students give each other specific academic feedback both pro and con.
**Game: Clean your Backyard:** There are throwing objects on each side of the gym. When the music plays both sides overhand throw objects using correct form to the other side. Music stops, the team with the cleanest backyard earns a point. The team that uses correct form more often earns two points.

**Bonus points:** Each team will have a set of cards with numbers 0 – 9. The teacher will call out a number such as 2,503,498. The first team to line up in the correct order will earn a point. The teacher will call either ones, tens, hundreds, etc. and the student holding the specific number in that specific place will step forward and take a knee. The other team must say the value of the number for an additional point.

**Materials:** Zapp corner containing students folders with QC#2, overhand throw assessment and pencils; math facts hanging from cork strips, foam balls of different sizes, two sets of numbers 0 – 9 on each side of gym, place value chart, math problems, Frayer model, Mr. Bones, music/IPod, cones with place values on each cone for example, ones, tens, hundreds…millions, and index cards with numbers and one number is circled in red on each card, and place value chart.
1. What is 2,526 in word form?

2. Write in standard form: \(20,000 + 3,000 + 500 + 60 + 9\)

3. Write in standard form: four hundred sixty seven thousand three hundred five

4. Write in expanded form: 284,631

5. Write in expanded form: 3,615,208

**Bonus Question:**
Solve the following problem. Show your work

\[
\begin{array}{c}
28 \\
\times 19
\end{array}
\]

Responses are voluntary.
1. What is 2,526 in word form?
   Two thousand five hundred twenty six

2. Write in standard form: 20,000 + 3,000 + 500 + 60 + 9
   23,569

3. Write in standard form: four hundred sixty seven thousand three hundred five
   467,305

4. Write in expanded form: 284,631
   200,000 + 80,000 + 4,000 + 600 + 30 + 1

5. Write in expanded form: 3,615,208
   3,000,000 + 600,000 + 10,000 + 5,000 + 200 + 8

Bonus Question:
Solve the following problem. Show your work

\[
\begin{array}{c}
28 \\
\times 19 \\
\hline
532 \\
\end{array}
\]
### Overhand Throw Assessment #1

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<tr>
<th>Sideways Feet Together</th>
<th>“L” Step with Opposite Foot</th>
<th>Overhand Throw</th>
<th>Ready Position</th>
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<td></td>
<td></td>
</tr>
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<td></td>
<td></td>
</tr>
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<tr>
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<td></td>
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<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lesson Plan 3

Objective: We can overhand throw with **accuracy**.
Frayer model word is **accuracy**.

Sub-Objective: We can execute the overhand throw using the proper steps in the correct sequence.

**Warm-Up:** Students will answer a math problem relating to the “value” of a number upon entering the gym performing a locomotor skill written on the index card.

**Partner Warm-Up:** Math Wiz/QC #3 and Math Facts were part of warm up when called out. New accuracy warm-up activity: each partner has a yarn ball. One partner is standing on one centerline and the other partner is standing opposite his partner on a parallel centerline in the gym. The teacher will call out or write a number on a white board underlining one of the numbers. There are two end lines, one on each end of the gym. One group of students standing on one of the centerlines is closest to one of the end lines designated as the ones, tens, and hundreds end line. The opposite centerline is closest to the other end line that is designated as the thousands, ten thousands, hundred thousands, and millions end line. Once the problem is written for example: 23, 496; the students on the thousands line will turn and run to the end line designated as the thousands, ten thousands, hundred thousands, and millions end line without getting hit by their partner overhand throwing a yarn ball at them. Both partners run in a straight pathway. One partner chases the other and throws the yarn ball at him or tags him with it. If the partner makes it to the end line without getting hit, he scores a point. If his partner throws the yarn ball and hits him, that partner gets the point. They run back to the starting centerline for the next number. Students need to know “place” in order to participate in this activity and at the same time it works on accuracy.

**Partner Accuracy Activity:** Partner overhand throw and catch. Partners start five paces away from each other. Partners observe one another’s form in the overhand throw. If the partner throws to his partner that is not accurate, causing him to move to the right or left taking steps out of his area to retrieve a ball, the partners have to take a step closer to each other. If the throw is accurate not causing his partner to move out of his area they will take a step back, further from each other. The object of this activity is to see how far apart the partners can get from each other but still maintaining accurate overhand throws.

**Partner Math Target Stations (8 stations):** Stations: 1. Tic-tac-toe boards are on the wall with light small foam balls and math cards (x, -, +). Students must answer a math problem correctly before overhand throwing to tic-tac-toe board on the wall. If the ball hits a square the student writes the answer of the problem in his square with a colored marker. 2. Bowling pins on crates and yarn balls; students add up points. This is a duplicate station. 3. Bulls eye targets on chairs with tennis balls; students add up points. This is a duplicate station. 4. Trash Math station: There are a variety of math problems students can answer. They pull out a math problem on a piece of paper, solve it, and overhand throw it into a trash can or bucket of their choice. 5. Footballs and hula-hoops. A hula-hoop is hanging from the basketball goal and the students try to overhand throw
the football through the hula-hoop for points. This is a duplicate station. Place value math concepts are at each station.

Materials: Zapp corner containing student folders with QC #3, pencils, yarn balls, tennis balls, light small foam balls, tic-tac-toe on wall, crates, bowling pins, bulls eye targets, buckets, paper to throw with math problems typed on them, footballs, hula-hoops, chairs, Frayer model, math problems on index cards, Mr. Bones, music/IPod, math strips, and place value chart.
1. Write the value of the underlined numbers.

81,602: __________________________________________________

121,836: ________________________________________________

2. Write the place of the underlined number.

3,509,375: _______________________________________________

3. Round to the nearest hundred.

472: _____________________________________________________

4. Round to the nearest ten.

245: _____________________________________________________

4,082: __________________________________________________

Responses voluntary.
1. Write the value of the underlined numbers.

   81,602: Six hundred

   121,836: Twenty thousand

2. Write the place of the underlined number.

   3,509,375: Five hundred thousand

3. Round to the nearest hundred.

   472: 500

4. Round to the nearest ten.

   245: 250

   4,082: 4,080
Objective: We can overhand throw with accuracy and precision scoring 5 out of 5 hitting the target.
Frayer model word is precision.

Sub-objective: We can overhand throw using the proper steps to ensure accuracy.

Warm-Up: Student’s will answer a math problem relating to the “value” of a number upon entering the gym performing a locomotor skill written on index card.

Place Value Tag Warm-Up: A quarter of the students are taggers and a quarter of the students have a ball and a place value card with a math problem on it. The cardholders unfreeze the students that were tagged. Students tagged do jumping jacks until a cardholder arrives and has the tagged student answer the math problem. If he/she answers it correctly they overhand throw the ball back and forth three times and the student is now untagged. If the tagged student answers incorrectly, the card holder must explain what the correct answer is and the student remains tagged, doing jumping jacks until a new card holder arrives to free him; going through the same process.
Math Wiz/QC #4 and Math Facts were mixed in with this warm-up.

Teacher reviews objective and discusses the difference between accuracy and precision.

Peer Assessment: Partners assess each other on how accurate or precise their overhand throw is. Students must hit the target 5 out of 5 times from different distances depending on skill level performing the overhand throw to score 100. Partners may help each other giving specific academic feedback after each throw.

Math problem throw: Numbers are painted on the gym walls with +, -, and = symbols. Teacher calls out math problem such as make 125 into expanded form. Students would overhand throw to each number on the wall in the answer, for example: 125 in expanded form would be 100 + 20 + 5 that is painted on the wall. Students would throw to a 1, a 0 twice etc.

Satellite Ball: 2-3 space ships built on each teams side (with hula hoops), 6 towers (bowling pins), a satellite with satellite ball (Cone and ball), and 5-7 foam balls on each side. When the music starts student’s use the overhand throw technique to try to knock the other teams space ships, towers, and satellite down first. If the satellite is still up but the other objects are knocked down teammates can rebuild the spaceships and put up the towers. Once the satellite is knocked down then the other objects that are knocked down, stay down. There are numbers placed on cones 0 – 9 near the objects. A number is displayed on the place value chart hanging on the wall such as: 34,588,204. A ball caught in or near a certain coned area can run to the other side staying outside the playing area and throw the ball that was caught at an object in the place value area that the student caught it in. For example the student caught a ball in the air near the cone with the #5 on it. The 5 is in the hundred thousand place therefore the student can throw at the
object in the hundred thousand place object. If the objects are already knocked down in that area the student can go try to knock down any other object.

**Materials:** Zapp corners containing student folders with QC #4, Accuracy assessment, and pencils, Mr. Bones, 24 hula hoops, 14 foam balls different sizes, 2 cones with 2 small balls that are placed on top of the cone, 20 cones with the numbers 0 – 9 placed on each cone, 12 bowling pins, music/IPod, math cards, math strips, and place value chart.
Math Wiz 4  
Precision of Overhand Throw

1. Round to the nearest hundred.

23,460: _______________________________________________________

2. Round to the nearest ten.

637: __________________________________________________________

3. Solve the following problem. Show your work.

\[
\begin{array}{c}
4000 \\
- 326
\end{array}
\]

4. Solve the following problem. Show your work.

\[
\begin{array}{c}
2777 \\
+ 348
\end{array}
\]

5. Compare the following numbers and place the proper symbol (<, >, =) in the box.

\[
\begin{array}{c}
5,607,342 \quad \square \quad 5,607,243
\end{array}
\]

\[
\begin{array}{c}
395,633 \quad \square \quad 395,681
\end{array}
\]

Responses voluntary.
1. Round to the nearest hundred.

   23,460: 23,500

2. Round to the nearest ten.

   637: 640

3. Solve the following problem. Show your work.

   \[ 4000 - 326 \] \hspace{1cm} \text{Answer: 3,674} \\

4. Solve the following problem. Show your work.

   \[ 2777 + 348 \] \hspace{1cm} \text{Answer: 3,125} \\

5. Compare the following numbers and place the proper symbol (<, >, =) in the box.

   \[ 5,607,342 \quad \square \quad 5,607,243 \quad \text{Answer: >} \]

   \[ 395,633 \quad \square \quad 395,681 \quad \text{Answer: <} \]
<table>
<thead>
<tr>
<th>OHT #1</th>
<th>OHT #2</th>
<th>OHT #3</th>
<th>OHT #4</th>
<th>OHT #5</th>
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</thead>
</table>

Code: __________

Accuracy of the Student’s Overhand Throw #2

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<th>OHT #3</th>
<th>OHT #4</th>
<th>OHT #5</th>
</tr>
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</table>

Code: __________

Accuracy of the Student’s Overhand Throw #2
Lesson Plan 5

Objective: We can know the three cues to dribble correctly.
1. Finger pads (Phalange pads)
2. Waist level or below (Pelvis)
3. Eyes up
Frayer model word is cues.

Sub-objective: We will discuss other activities or sports that we dribble in.

Warm-Up: Students will “compare” numbers (<, >, =) upon entering the gym performing a locomotor skill written on the index card.

Warm-Up will include a mix of Math Wiz QC #5, Math Facts, and Pot of Gold. Pot of Gold contains a variety of math problems in a pot located in the center circle of the gym. There are 10 cones with a number 0 – 9 on each one in 10 different areas. There is a non-locomotor skill also taped to the cone with the number of repetitions student must do, such as 12 jumping jacks, 10 standing lunges each leg etc. When the term Pot of Gold is called students run to the center, take out a math problem and solve it. If the answer is 142 the student must go to the 1 first and perform the exercise, the 4 next, and finally the 2 doing each non-locomotor skill. Then the student returns to the Pot of Gold to answer a new problem. The students are exploring with the basketballs during this activity and are challenged to be creative by doing the exercises with the basketball.

Teacher and students go over the objective.

Individual practice: Students have time to say the three cues as they perform it. Teacher will call out dribble challenges such as: dribble with dominant/non-dominant hand, on knees, walk on knees, on gluteus maximus, lie on your back/stomach. Dribble to the red/white/blue lines, maintaining dribble when army/navy is played. When teacher calls out Army students dribble to the army line, if teacher says “hit the deck”, students go down on their knees and cover their head but in this case they have to dribble on knees and cover head with one hand, teacher calls out “all clear” students get up keeping their dribble and move to the line that is called out.

Partner dribble: Partner Stare Down activity: Partners each have a ball and stand opposite each other with a hula-hoop in between them. Both partners dribble as they stare at each other in the eye. They can move around the hula-hoop but the first person to blink or look away the other partner wins the point. This activity works on all three cues. Juggle cube activity. Each hula hoop has two juggle cubes (one for each partner). The student must maintain their dribble as they pick up one cube, drop it, and then pick it up with the opposite hand but must maintain dribble. One can also toss cube in air with one hand while dribbling with the other, catch it with the opposite hand and continue dribbling with the other hand (more difficult).

Dribble Place Value Activity: Teacher will write numbers or math problem on white board. Students will dribble as they look at the problem. Students continue to dribble as
they dribble to each numbered cone of the answer and touch the top of each cone before returning back to home base which is the center line. For example the math problem would be to convert the expanded number $3,000 + 200 + 50 + 1$ into standard form. Students would dribble and touch the 3 cone, 2 cone, 5 cone and 1 cone before returning home.

**Shark Dribble:** One partner stands in a hula-hoop (fisherman) in self-space on half the gym (ocean) due to the size of the class. The other partners (sharks) stand on sideline dribbling ball. When the music starts the sharks try to dribble across the ocean without getting tagged or losing their dribble. If they get tagged or lose their dribble they go out to practice dribbling. Music stops the roles are switched.

**Materials:** Zapp corner containing student folders, QC #5, pencils, 24 basketballs, hula-hoops, 24 juggling cubes, white board, cones with a number from 0 – 9 on it, pot with variety of math problems in it, locomotor skills on each cone with number of repetitions, and music/IPod, place value chart, and math strips.
Math Wiz 5
Warm Up Activity: Basketball Skills

1. Solve the following problems:

   36 + 27
   2194 + 451

2. Solve the following problems:

   32 - 17
   143 - 46

3. Place the following numbers in order from least to greatest.

   2,809  2,098  2,898  2,903  2,930

4. Place the following numbers in order from greatest to least.

   34,652  36,425  34,564  36,264  34,648

Responses are voluntary.
Math Wiz Answer Key – Quick Check 5
Warm Up Activity: Basketball Skills

1. Solve the following problems:

\[
\begin{align*}
36 & \quad 2194 \\
+ 27 & \quad + 451 \\
\hline
63 & \quad 2,645
\end{align*}
\]

2. Solve the following problems:

\[
\begin{align*}
32 & \quad 143 \\
- 17 & \quad - 46 \\
\hline
15 & \quad 97
\end{align*}
\]

3. Place the following numbers in order from least to greatest.

\[
2,809 \quad 2,930 \quad 2,898 \quad 2,903 \quad 2,098
\]

\[
2,098 \quad 2,809 \quad 2,898 \quad 2,903 \quad 2,930
\]

4. Place the following numbers in order from greatest to least.

\[
34,652 \quad 36,425 \quad 34,564 \quad 36,264 \quad 34,648
\]

\[
36,425 \quad 36,264 \quad 34,652 \quad 34,648 \quad 34,564
\]
Lesson Plan 6

Objective: We can perform a proper chest pass.

Sub-objective: We can review and pass a dribbling assessment. Students must dribble 10 times with dominant and non-dominant hand using the three cues.

Warm-Up: Students answer a math question related to “rounding” numbers upon entering the gym. The following warm-up activities will be mixed up.

Dribble Math Tag: Everyone dribbles. Math cards are located in two areas of the gym on opposite sides. There are two dribbling math guards at each area. The math cards focus on rounding and comparing problems (<, >, =). 2-3 students are “It”. If a student gets tagged they must maintain their dribble as they travel to one of the math areas. They pick up a math card; show the problem and answer the problem in front of the dribbling math guard. The math guard either allows the student to re-enter the game if he answers it correctly, or has the student pick up a new problem if he or she answered the problem incorrectly. Students must correctly answer the problem to re-enter the game.

Math Facts: Students dribble to a strip of multiplication facts of their choice and go see, say, and dribble each math fact. For example a student may choose 8’s. They would look at the number, say it out loud as they dribble: 8 x 1 = 8, 8 x 2 = 16, 8 x 3 = 24,… 8 x 12 = 96.

Math Wiz: Students dribble to their Quick Check that is located on the perimeter of the gym and answer the first problem only. Once they finish the first problem they dribble end line to end line. Then teacher calls out a different warm-up activity.

Peer Assessment: Students assess dribbling of their partner. Students must dribble 10 times with their dominant hand and 10 times with their non-dominant hand. Partners can help and give specific academic feedback.

Teacher goes over objective. Students perform shadow chest pass.

Individual practice: Students say each step as they perform each step of the chest pass to a spot on the wall.

Partner activity chest pass: Ordering numbers. Partners chest pass as they travel from sideline to sideline. Teacher will call out hula-hoop greatest to least or least to greatest. Partners will chest pass to a hula hoop that will have 2 sets of five different numbers for each partner to order numbers from either greatest to least or least to greatest depending on what teacher called out. Once they are done they will pop up and continue to chest pass waiting for teacher to call out hula-hoop. Partners will chest pass to a new hula-hoop and order new set of numbers.

Chest pass tag: If tagged by the chest passers a dribbler will come and chest pass with the student who got tagged four times. (McCormick, Brian. Basketball Team Passing Tag – https://youtu.be/0Jooublo6aw).
Materials: Zapp corner containing student folders, quick check #6, dribbling assessment, pencils, music, iPod, basketballs, hula-hoops, rounding math cards, comparing math cards, ordering math cards, and place value chart.
Warm Up Activity: Basketball Skills

1. Solve the following problems:

\[
\begin{align*}
2,594 + 4,426 & \quad 285 - 69 \\
\end{align*}
\]

2. Place the following the numbers in order from greatest to least.

   26,387  26,738  26,804  26,878  26,376

3. Place the following the numbers in order from least to greatest.

   40,529  40,295  40,512  40,285  40,385

4. Round to the nearest ten.

   3557  

5. Round to the nearest hundred.

   65,642  

Responses voluntary.
Math Wiz Answer Key – Quick Check 6
Warm Up Activity: Basketball Skills

1. Solve the following problems:

\[
\begin{array}{cc}
2,594 & 285 \\
+ 4,426 & - 69 \\
7,020 & 216
\end{array}
\]

2. Place the following the numbers in order from greatest to least.

\[
\begin{array}{ccccc}
26,387 & 26,738 & 26,804 & 26,878 & 26,376 \\
26,878 & 26,804 & 26,738 & 26,378 & 26,376
\end{array}
\]

3. Place the following the numbers in order from least to greatest.

\[
\begin{array}{ccccc}
40,529 & 40,295 & 40,512 & 40,285 & 40,385 \\
40,285 & 40,295 & 40,385 & 40,512 & 40,529
\end{array}
\]

4. Round to the nearest ten.

\[
3555 \quad 3560
\]

5. Round to the nearest hundred.

\[
65,642 \quad 65,600
\]
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**Basketball: Dribbling Assessment**

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<tbody>
<tr>
<td>Dribbling 10 times w/non-dominant hand.</td>
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<table>
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**Dribbling Assessment**

| Dribbling 10 times w/dominant hand. |
| Dribbling 10 times w/non-dominant hand. |
Appendix D

Formative Pre-Post Test Scores – Experimental Group
Formative Assessment Experimental Group

| Code | Pre-Test | | Post-Test | | Diff. Between |
|------|----------|----------|----------|----------|
|      | # Wrong  | Score %  | # Wrong  | Score %  | Pre-Post % |
| C1   | 0        | 100      | 1        | 97.3     | -2.7       |
| C2   | 2        | 94.6     | 0        | 100      | +5.4       |
| C3   | 14       | 62.2     | 12       | 67.6     | +5.4       |
| C4   | 0        | 100      | 0        | 100      | Same       |
| C5   | 3        | 91.9     | 2        | 94.6     | +2.7       |
| C6   | 4        | 89.2     | 3        | 91.9     | +2.7       |
| C7   | 7        | 81.1     | 2        | 94.6     | +13.5      |
| C8   | 14       | 62.2     | 5        | 86.5     | +24.3      |
| C9   | 23       | 37.9     | 14       | 62.2     | +24.3      |
| C10  | 9        | 75.7     | 7        | 81.1     | +5.4       |
| C11  | 11       | 70.3     | 6        | 83.8     | +13.5      |
| C12  | 4        | 89.2     | 2        | 94.6     | +5.4       |
| C13  | 5        | 86.5     | 2        | 94.6     | +8.1       |
| C14  | 8        | 78.4     | 4        | 89.2     | +10.8      |
| C15  | 3        | 91.9     | 1        | 97.3     | +5.4       |
| C16  | 7        | 81.1     | 2        | 94.6     | +13.5      |
| C17  | 30       | 19       | 26       | 29.8     | +10.8      |
| C18  | 29       | 21.7     | 17       | 54.1     | +32.4      |
| C19  | 9        | 75.7     | 16       | 56.8     | -18.9      |
| C20  | 3        | 91.9     | 4        | 89.2     | -2.7       |
| C21  | 7        | 81.1     | 7        | 81.1     | Same       |
| C22  | 15       | 59.5     | 16       | 56.8     | -2.7       |

Note: The (-) symbol represents the math score from the pre to post-test decreased and the (+) symbol represents the math score increased. “Same” means there was no difference between the pre and post-test and “Diff. Between” represents difference between.
Appendix E

Formative Pre-Post Test Scores – Control Group
Formative Assessment Control Group

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Note: “Diff. Between” represents difference between; “Same” represent scores that did not change from the pre to the post-test; the symbol (-) represents a decrease in scores and the symbol (+) represents an increase in scores. *PBIS: Student S6 began school having PE and the fifth grade math teacher whose classes was part of this study. Due to behavior S6 was eventually placed in PBIS full time. Due to the uncertainty of whether or not S6 would return to PE and attend the teacher’s math class, both the pre and post formative assessments were administered to the student. S6 scores were not accounted for in this study because the PBIS teacher was responsible for the student’s coursework and the student has not returned to general population.
Appendix F

Number of Questions Answered Incorrectly

Formative Pre-Test
Formative Pre-Test

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Note: Exp. (Experimental); Cnt. (Control)
Appendix G

Number of Questions Answered Incorrectly

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Appendix H

C11 Interviews: Pre-Mid-Post
Student C11 Pre-Interview administered December 8, 2016 at 9:05 a.m.

1. What is the relationship between the digits in this number? 44

   The relationship between 44 is both of the numbers are the same.

2. Compare the terms value and place?

   Value and place, are the same because, the term are like, um value is, I don’t really know it. I know that place means where a number is at.

3. How would adding a 0 to this number impact its place value? Justify your answer. 35

   Thirty-five with a 0 added on it would be 350. If you cover up the 5 and the 0 it would be 3 but if you make the 5 into a 0 it’s 300 and then just put on 50.

4. How does your understanding of place value help you to compare and order numbers?

   Place value helps me compare and order numbers because, um when I stack the numbers up it helps me find out which one is bigger and which one is smaller put them in order.

5. What makes 5 special in rounding?

   Because it’s 5 or more the number will go up but 4 or less let it rest.

   A. Round the following number to the nearest hundreds place and explain how you solved the problem. 2,487.

      2,487 rounded to the hundreds place would be; I think it would be 2,500.

      Because the 8 would tell the 4 to go up to a 5 the 78 downwards would be 0.

   B. Round the following number to the nearest tens place and explain how you solved the problem. 1,464.
1,464 rounded to the tens place would be one thousand forty-six hundreds, I think.

C. How did you get to that number?

Because the 4 tells the 6 to stay the same and the 4 would have to turn into a 0.

6. How can place value be used to determine the sum or difference of two numbers?

Place value can lead to determine the difference in between two numbers because if I have a 5 and a 2, um like if I have 25 and you’re rounding it to the tens place, place value can determine the difference because um… I don’t know.

7. Why is there an extra digit above the tens column?

There is an extra digit above the tens column because… I don’t know.

8. In which other place-value column will there be an extra digit as the addition proceeds? Explain why?

I don’t know it.

9. Do you think integrating/implementing math into the PE setting could help you with math? How? Why?

I think it will help me with my math because, in math class it’s like not fun but if you add it into a sport or something it might get a little more fun.

10. How much greater is the value 5 in the number 560 compared to 56? How did you arrive at that answer?

The 5 would be much greater in the value, in the number 560 because if you turn the 6 into a 0 that would be 500 and if you turn the 6 into a 0 in 56 it would just be 50.

11. In the number 650, what number is in the hundreds place? What is the value?

Explain you answer.
In the hundreds place in 650, in the hundreds place would be 6 because if you turn the 5 into a 0 it would be 600. The value of 600 is; the value of 6 is…I don’t know it.

Responses are voluntary.
1. What is the relationship between the digits in this number? 44
   The relationship between 44 is both of the numbers are the same.
   A. Anything else?
      No.
   B. We are working on place value you don’t see any other relationship?
      Not really.

2. Compare the terms value and place.
   Value means how much it is, and place means what spot it is in.

3. How would adding a 0 to this number impact its place value? Justify your answer. 35
   It will make it thirty-five hundred.
   A. What do you mean thirty-five hundred? If the number is 35 how would adding a 0 to this number impact its place value?”
      Because it will make it in the hundreds place instead of the tens place.
   B. What is in the hundreds place?
      The three is in the hundreds place.
   C. How would that number sound?
      It would be thirty-five hundred.

4. How does your understanding of place value help you to compare and order numbers?
   Because it helps me know which number is bigger and which one is smaller.

5. What makes 5 special in rounding?
   Because five and up you raise the number, but four or less you let it rest.
   A. Can you give an example?
For 35 if you were trying to round it to the tens place it would be forty because the five would make the three go up one and the five would turn into a zero.

**B.** Round the following number to the nearest hundreds place and explain how you solved the problem. 2,487

Two thousand four hundred eighty-seven rounded to the hundreds place would be two thousand five hundred.

**C.** How did you know that?

Because the four would turn to a five because the eight is higher than the four.

**D.** What happens to the eight and the seven?

The eight and seven would turn into a zero after.

**E.** What was the answer again?

Two thousand five hundred.

**F.** Round the following number to the nearest tens place and explain how you solved the problem. 1,464

One thousand four hundred sixty-four would be one thousand four hundred sixty because the four before the six would turn into a zero and it’s not higher than a five.

**G.** What four are you talking about? What place is it in?

The ones place.

6. How can place value be used to determine the sum or difference of two numbers?

I don’t really know. (Bad question).

7. Why is there an extra digit above the tens column?
A. (Rephrased the question) Why could there be an extra digit above the tens column? Why would there be an extra digit above the tens column if we did an addition problem?
Because, um I don’t really know.

8. In which other place value column will there be an extra digit as the addition proceeds? Explain why.
I think in the hundreds. (Did not know why).

9. Do you think integrating and/or implementing math into the physical education setting could help you with math? How? Why?
Yes, because it would make it more fun and you are also doing physical learning too.
A. Is it helpful?
Yes, because it’s making it fun and it’s making it kind of easier.
B. Does the chart that is up help you and if so why?”
Yes, because when I’m stuck on a problem I usually look up there and it usually helps me solve the problem.

10. How much greater is the value 5 in the number 560 compared to 56? How did you arrive at that answer?
Because in fifty-six hundred the five is in the hundreds place other than in fifty-six the five is in the tens place.
A. How much greater is the five in the number 560 compared to 56?
I don’t really know.

11. In the number 650, what number is in the hundreds place? What is the value?
Explain your answer.
The six is in the hundreds place and the value is six hundred.

A. Explain the answer.

For the hundreds place part the zero is in the ones, the five would be in the tens, and the six is in the hundreds; for value if you turn the five into a zero it’s six hundred.

Note: After the interview the teacher and C11 discussed question one. The teacher asked C11 what place is each 4 in and what is the valued of each one? C11 knew the answers and the relationship between both fours. They also discussed how C11 understood the concept of questions 3 and 10 but C11 was saying the number incorrectly. The teacher wrote the numbers that was said: 3500 and 5600. C11 then saw where the mistake was. They did a few more and C11 said each number correctly: 450, 4500, 330, 3300, 260, 2600.

Responses are voluntary.
Student C11 Post-Interview administered February 15, 2017 at 9:05 a.m.

1. What is the relationship between the digits in this number? 44

   The relationship in 44 is that both numbers are 4 and the first one which is in the ones column is just 4 but in the tens column it would be 40.

   A. What would 40 represent? (Reminded child we are working on place value).

      40 would represent the tens place.

   B. Is that how much it is worth? Is that the value of the number 40?

      No, it is in the place.

   C. What is the value of the 4 in the ones place is worth?

      The ones.

   D. What is the value of the 4 in the tens place and how much is it worth? How

      Tens.

   E. What was the other number you mentioned?

      40. (Teacher may have confused student with the questioning. Student had confidence initially answering the question correctly.)

2. Compare the terms value and place.

   Value means how much the number costs and place means what spot it is in.

   A. Can you give an example?

      For 54 the 4 would be in the ones place and the value would be 4; the value of the 5 would be 50 and the place would be in the tens.

   B. Can you give the same explanation for 44?

      The first 4 which is in the ones place and the value is 4, but for the tens place the value would be 40 and the place would be tens.

3. How would adding a 0 to this number impact its place value? Justify your answer. 35
Adding 0 to 35 will make the number 3 to go into the hundreds place and the 5 would go into the tens and the 0 would go into the ones place.

A. How would you say that number?

Three hundred fifty.

4. How does your understanding of place value help you to compare and order numbers?

Place value helps me to compare and order numbers because it helps me to find out what number would go: if you had a 1, 4, and 10, the place would help me to find out what spot to put it in and how big it is and value would tell me how to find out how much it is.

A. How would that help you in comparing and ordering numbers?

Because the value shows me how much it is so since the 1 is in the tens place you know that the 10 is bigger than the 4 and the 1. You also will be able to tell the 4’s value because it doesn’t have two numbers so you have to know the value to see how much it is.

5. What makes 5 special in rounding?

5 if special in rounding because we learned that 5 or more we have to raise the score and 4 or less you let it rest.

A. Round the following number to the nearest hundreds place and explain how you solved the problem. 2,487

The number in the hundreds place is a 4 and the number in the tens place is 8 which is higher than 5 so the 4 would go up to a 5 so it would be two thousand five hundred.

B. Round the following number to the nearest tens place and explain how you solved the problem. 1,464
One thousand sixty-four rounded to the nearest tens place would be one thousand four hundred sixty because the 4 is lower than a 5.

C. Which 4?

The 4 in the ones place.

6. How can place value be used to determine the sum or difference of two numbers?

Sum or difference means like sum means the same or to compare them and difference means they are different.

(Teacher asks the question again.) C11 wants to move on.

7. Why is there an extra digit above the tens column?

If you are adding like 22 to (C11 had difficulty thinking of another number); whenever you add a number where it is above 10 you have to put one of the numbers in the next column; so there may be an extra digit above the tens, an extra digit above the hundreds, thousands, ten thousands, hundred thousands, millions, and so on.

8. In which other place value column will there be an extra digit as the addition proceeds? Explain why.

The hundreds, the thousands, millions.

9. Do you think integrating and/or implementing math into the physical education setting could help you with math? How? Why?

I think it was a good idea because it makes math more fun instead of sitting at a desk with a pencil and it’s helped me keep it in my brain because I can do it at home. Like in gym when we played a game with math problems in it I sometimes use those games at home. An example is the basketball game and the cones and I use sticks and paper.
10. How much greater is the value 5 in the number 560 compared to 56? How did you arrive at that answer?

   In 560 the 5 is in the hundreds place so it would be 500 for the value but in 56 it is in the tens place so the value is 50.

   A. How much greater is the 5 in the hundreds place compared to the 5 in the tens place?

   I don’t know.

11. In the number 650, what number is in the hundreds place? What is the value?

   Explain your answer.

   In 650 the 6 is in the hundreds place and the value would be 600.

   A. Can you explain it?

   Because when you say 650 and you take out the 50 part it would be 600 and that would be the value.

Responses are voluntary.
Appendix I

C9 Interviews: Pre-Mid-Post
1. What is the relationship between the digits in this number? 44

   They are both fours and that’s all I know really.

2. Compare the terms value and place.

   Value is um…I don’t know. Place is like um…I forgot that.

3. How would adding a 0 to this number impact its place value? Justify your answer. 35

   It’s 35 right now, but it’s about to turn into 350, because you put the 0 right there (at the end) and it’s going to like change the number like 350.

4. How does your understanding of place value help you to compare and order numbers?

   By looking at it’s place and value…By looking at the tens, hundreds, and thousands.

5. What makes 5 special in rounding?

   I don’t know.

   A. Round the following number to the nearest hundreds place and explain how you solved the problem. 2,487

   We got 2,487 and we go to the 4 and the 2 is not bigger than the 4, so the 4 stays the same, the 2 stays there and the 8 turns into a 0 and the 7 turns into a 0.

   B. Round the following number to the nearest tens place and explain how you solved the problem. 1,464

   We got 1,464 and we go to the 6 and the 4 is not greater than the 6 so the 6 stays the same, the 4 stays the same, the one stays the same and the 4 turns into a 0.

6. How can place value be used to determine the sum or difference of two numbers?

   I don’t know. (Bad question).

7. Why is there an extra digit above the tens column?
I don’t know.

8. In which other place value column will there be an extra digit as the addition proceeds? Explain why.

I don’t know.

9. Do you think integrating and/or implementing math into the physical education setting could help you with math? How? Why?

Yes. Because if we learn math in games or something um like a chart or something on the wall like a board or something that shows us like all the ones, to the tens and if we don’t know it we can go over and look at it to find our answer.

It could help us count better.

10. How much greater is the value 5 in the number 560 compared to 56? How did you arrive at that answer?

56 is 50 and the 5 in that one (560) is 500 and that’s all.

11. In the number 650, what number is in the hundreds place? What is the value?

6 is in the hundreds place. The value is 600. The 6 is in the hundreds place because if…, the 0 is in the ones, the 5 is in the tens, and the 6 is in the hundreds place.

Responses are voluntary.
Student C9 Mid-Interview administered January 31, 2017 at 9:05 a.m.

1. What is the relationship between the digits in this number? 44
   That they are both fours.
   A. Is there anything else you can tell me?
   No.

2. Compare the terms value and place.
   Value means like the value of a number and place is where it is.
   A. Can you go deeper with what the value of a number means?
   Like three thousand is three thousand.
   (The teacher could have asked what was the value of a specific number in the example C9 gave.)

3. How would adding a 0 to this number impact its place value? Justify your answer. 35
   To make it a larger number; it would be three hundred and fifty.
   A. Where would the 0 be?
   In the back of the five.
   B. What place would the 0 be then?
   The ones.

4. How does your understanding of place value help you to compare and order numbers?
   By looking to see if it’s larger; like if it’s forty and thirty, forty is bigger than thirty and forty would go first and thirty goes last.

5. What makes 5 special in rounding?
   It makes the numbers go up and not go down.
   A. Can you explain it further by giving an example?
Such as fifty-five the five rounds the other five to turn to a six and it would be sixty.

**B.** What place would the five make the other five a six to be sixty?

The ones.

**C.** Round the following number to the nearest hundreds place and explain how you solved the problem.  2,487

Two thousand and four hundred is the answer.

**D.** How did you get that answer?

Because when I rounded the four, wait, it’s a five because the eight is bigger. So the answer would be two thousand and five hundred.

**E.** Round the following number to the nearest tens place and explain how you solved the problem.  1,464

One thousand four hundred sixty.

**F.** How did you get that answer?

The four is lower than the five.

**G.** What four in what place?

The four in the ones place.

6. **How can place value be used to determine the sum or difference of two numbers?**

I don’t know. (Bad question)

7. **Why is there an extra digit above the tens column?**

(Teacher rephrases question).

Why could there be an extra digit above the tens column?

Because, to make it bigger.

**A.** Why would it make it bigger?
Because there would be a number in the hundreds place.

8. In which other place value column will there be an extra digit as the addition proceeds? Explain why.

I don’t know.

9. Do you think integrating and/or implementing math into the physical education setting could help you with math? How? Why?

Yes, because we could learn our facts and why is because if we got stuck we would know in our heads.

A. How?

Because if you want to know your twelve’s you can just go over look at the twelve’s and remember them until you got them.

B. Does it help you by moving around?

Yes.

C. Why?

Because when I throw the ball at the wall every time I say the number it helps me think better and the number is right.

10. How much greater is the value 5 in the number 560 compared to 56? How did you arrive at that answer?

If you took off the zero it would be fifty-six so that’s five hundred sixty.

(Teacher asked the question again.)

Five hundred with a question tone.

A. How did you arrive at that answer?

No, it’s six hundred because the six is higher than the five so, I took off the zero and that would be fifty-six.
11. In the number 650, what number is in the hundreds place? What is the value?

   Explain your answer.

   Six and the value is six hundred.

   A. Explain your answer.

   I knew it because there is a six there and it is in the hundreds place, so it’s six hundred.

Responses are voluntary.
Student C9 Post-Interview administered February 16, 2017 at 9:05 a.m.

1. What is the relationship between the digits in this number? 44

   They are both 4’s and one is 40 and one is 4. The 40 represents tens and the 4 represents the ones.

2. Compare the terms value and place.

   Value means if you had 30 the value would be 30. Place is like the ones, tens, hundreds.

   A. In your example of 30 tell me the place of each number.

   The 0 is in the ones and the 3 is in the tens.”

3. How would adding a 0 to this number impact its place value? Justify your answer. 35

   It would turn into 350.

   A. How or why?

   Because you put the 0 right there (pointing to the ones place at the end of the number) and it impacts it makes it bigger, larger.

   B. Where did you put the 0?

   At the end.

   C. What place is that?

   The ones.

4. How does your understanding of place value help you to compare and order numbers?

   It helps me to compare and order numbers by I know which one is bigger or less.

   A. How can you tell?

   Because if there was 5,000 and 4,000 I look in the thousands place and there is a 5 and a 4 I knew that the 5 is bigger than the 4.

5. What makes 5 special in rounding?
The 5 makes it go up or if there is a 4, 3, 2, or 1 it makes it stay the same.

A. Can you give me an example?
Like 45. The 5 makes it go up.

B. Makes what go up?
The 4 turns into 50. I looked at the 5 because it was bigger than a 4, 3, 2, or 1 so it is 50.

C. Round the following number to the nearest hundreds place and explain how you solved the problem. 2,487
I underline the 4 and the 8 is bigger so the 4 goes up to a 5 so it is two thousand five hundred.

D. What place did you look at; the 8?
The tens.

E. Round the following number to the nearest tens place and explain how you solved the problem. 1,464
I underline the 6 and that is a 4 so that stays the same; the 6 stays the same so it is one thousand four hundred and sixty.

F. Which four did you look at?
In the ones.

6. How can place value be used to determine the sum or difference of two numbers?
I don’t know.

7. Why is there an extra digit above the tens column?
When there is a bigger number and there is no where to put it you put it up top and when you do the other numbers and you count that one in, it makes the other numbers bigger.
A. Can you give me an example?

If the numbers were both 10’s and there was no way to put like a 1, 2, 3, and you put it up top you go to the other number and you solve that one and if there is one left over you count that one in.

B. Is it in division, multiplication, adding, or subtracting?

Adding.

8. In which other place value column will there be an extra digit as the addition proceeds? Explain why.

Ones, tens, hundreds, thousands.

A. Could it be in the ones.

No.

B. Why?

Because it’s the first number and you got to count that one up to get the one up top.

9. Do you think integrating and/or implementing math into the physical education setting could help you with math? How? Why?

Yes because when we look at the wall we see the multiplication facts and we learn like all the facts when we need them in problems.

A. Do you think it has helped you and how has it helped you

Yes. I didn’t know my 2’s and I went to my 2’s and I threw the ball and hit the wall and I could throw it till I got to the end and then I switched. C9 acknowledged that he/she liked doing that.

B. Do you think the moving and the activity helps and why?

Yes.
10. How much greater is the value 5 in the number 560 compared to 56? How did you arrive at that answer?

The 5 in 560 is 500 and in 56 the 5 is 50.

A. How much greater or how much bigger is this 5 in 560 than this 5 in 56? C9

A lot.

11. In the number 650, what number is in the hundreds place? What is the value?

Explain your answer.

The 6 is in the hundreds place and the value is 600.

A. How did you get that answer?

By looking in the hundreds place and there is a 6 and I hear the hundreds and it gave me it.

Responses are voluntary.
Appendix J

Quick Checks Entering Gym
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Note: OHT = overhand throw assessment; Drib = dribble assessment; Multi = multiplication problem; Cmpare = compare; T = tardy; Abs. = absent; DNF = did not finish; Check (√) means student is present and answered math problem correctly; (✗) means student is present but answered the math problem incorrectly; ✓✗ means the student answered the problem incorrectly the first time but answered another problem correctly the second time.
Appendix K

Student Quick Check Scores – Math Wiz
### Quick Check Scores - “Math Wiz”

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*Note: QC = Quick Check; Abs. = absent; Tot. Avg. = total average of the 6 QC.*
Appendix L

Attendance Prior to Study – Experimental Group
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*Note.* Out of school suspension is reflected by OSS.
Appendix M

Attendance Prior to Study – Control Group
### Prior to November 30, 2016 - Control Group

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*Note.* Out of school suspension is referred to as OSS. Positive Behavior Intervention and Supports is represented by PBIS.
Appendix N

Attendance During Study – Experimental Group
### November 30, 2016 Research Began - Experimental Group

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*Note:* +5SS (+5 Snow and Sick Days School System is Out), +1SS (1 Snow or Sick Day School System delay).
Appendix O

Attendance During Study – Control Group
**November 30, 2016 Research Began - Control Group**

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*Note.* Out of school suspension is reflected by OSS; +5SS (5 Snow or Sick Days School System is Out); +1SS (1 Snow and Sick School System Delay); Positive Behavior Intervention and Supports Full Time is represented by PBISFT, and B1, B5 and S13 moved.
Appendix P

Parent Information Letter
Dear Parent/Guardian,

This note is to inform you of the exciting upcoming physical education (PE) and math program. Your child is one of a few fifth grade students who have been selected to participate in this special program to help all (school name) students. The physical education teacher will integrate math concepts with a few classes, in a fun active environment while maintaining the integrity of the PE curriculum. The math teacher suggests the math concepts to be implemented. The combination of PE and math will help determine whether this program could enhance/help your child and other (school name) students academically.

If you have any questions, contact Tammy Lohren, (school name) Physical Education.

Thank you for your time.

Sincerely,

Tammy Lohren
(School name) Physical Education

Principal’s Name
School Name
Appendix Q

Parent Consent Letter for Interview
Dear Parent/Guardian,

Your child is invited to participate in a research study conducted by Tammy Lohren, Carson-Newman University, Curriculum and Instruction Department. I, Tammy Lohren am the Physical Education teacher at (school name) and in the process of getting my doctorate in education. I hope to learn whether the integration of mathematics into physical education has an effect on student academic achievement. Your child was selected to be interviewed and to participate in this study because he/she is a positive role model to our school and their peers, and data has revealed that he/she could use additional help in this specific area.

If you decide to allow your child to participate in the interview process I will interview your child before, during, and after the intervention and the pre-post formative assessments that all participants will take. Interviews should take no longer than thirty minutes during school. The interviews will be audiotaped. Questions asked in the interview process will pertain to the specific math concepts that are integrated into PE. This is a check for student comprehension. Other types of questions will be to see if your child thinks integrating math is helpful to them, if it makes learning more fun, and if they like the challenge or not.

There is no cost for participating. I cannot guarantee that your child personally will receive any benefits from this research. The study is conducted during their normally scheduled physical education time. As always, there are risks and discomforts involved in the gym when students are moving, exercising, being active; at the same time math will be incorporated into their PE class. If someone gets hurt they can go to the nurse, get water, and/or sit out depending on the situation. The possible benefit of the program is the student’s will display positive growth academically in specific math concepts in a fun, moving environment.

Any information that is obtained in connection with this study and that can be identified with your child will remain confidential and will be disclosed only with your permission or as required by law. Subject identities will be kept confidential by using codes instead of names. Locking the gathered information: the journal and audio in a secure place will safeguard the information. The information gathered will be released to Carson-Newman University in Jefferson City, TN.

Your child’s participation in the interview process is voluntary. Your decision whether or not to allow your child to participate will not affect you or your child’s relationship
with Tammy Lohren, (school name) physical education teacher or any other aspect of the school environment. If you decide to allow your child to participate, you and/or your child are free to withdraw your consent and discontinue participation at any time without penalty.

If you have any questions about the study, please feel free to contact me: Email: tlohren@cn.edu or cell phone: (phone number). Dr. Julia Price is my advisor at Carson Newman University. If you have questions regarding your rights as a research subject, please contact the IRB (irb@up.edu). You will be offered a copy of this form to keep.

Your signature indicates that you have read and understand the information provided above, that you willingly agree to allow your child to participate, that you and/or your child may withdraw your consent at any time and discontinue participation without penalty, that you will receive a copy of this form, and that you are not waiving any legal claims.

Parent/ Guardian Signature: __________________________________________
Date: ____________________________

Thank you in advance for your consideration.

Tammy Lohren
(School name) Physical Education Specialist
Carson-Newman University EDD Program