SCHEDULING OF RECESS BEFORE MATHEMATICS AND THIRD GRADE STUDENTS' MATHEMATICAL ACHIEVEMENT IN VIRGINIA: A CAUSAL COMPARATIVE STUDY

by

Sarah Elizabeth Danaher

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

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ABSTRACT

Recess is a vital piece of the elementary school day. The impact of this time extends beyond students' physical, emotional, and social health. Recess has also been shown to have a positive impact on the classroom performance of students. The purpose of this causal comparative study was to test the theory of the impact of recess in elementary school that relates to the scheduling of mathematics directly after recess time to achievement on a standardized mathematics assessment for third grade students in Central Virginia. Grade level and assessment type were controlled for in this study. Participants were third grade students from one school division in Region Five of Virginia. The students were divided into two groups: students who participated in an unstructured recess break directly prior to mathematics instruction and students who did not have an unstructured recess break directly prior to mathematics instruction. The researcher collected archived Third Grade Mathematics Standards of Learning Assessment scores for participating students and used a two-way ANOVA to analyze the data. The results of the two-way ANOVA showed no significant difference between the means of students who had mathematics class after an unstructured recess time and students that did not have mathematics after an unstructured recess time. Male students scored significantly higher than female students regardless of the timing of mathematics instruction. Recommendations for future research include further exploration of gender difference in elementary mathematics and the impact of unstructured recess breaks using a different measure of academic achievement.

Keywords: recess, physical activity, mathematics, academic achievement

Dedication

This manuscript is dedicated to my Papa, James Wewetzer, who always encouraged me to exercise prior to taking a test in order to “get the juices flowing.”

Acknowledgments

I would like to thank my amazing family for the tremendous amount of support, love, and encouragement they provided me during this challenging endeavor. I would also like to thank my chair and committee members for giving of their time and providing valuable guidance throughout the dissertation process.

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List of Abbreviations

Attention Deficit Disorder (ADD)

Center for Disease Control and Prevention (CDCP)

Functional Magnetic Resonance Imaging (fMRI)

Grade Point Average (GPA)

Magnetic Resonance Imaging (MRI)

Standards of Learning (SOLs)

Virginia Department of Education (VDOE)

CHAPTER ONE: INTRODUCTION

Overview

The concept of taking a break is well-established; in the work force people often have mandatory break. In sporting events there are time outs and half-time breaks, and in elementary school there is a break in the form of a recess period for students to socialize and play. Pellegrini (2005) describes recess as being a given part of the school day since the institution of school began. The recess break has many physical, social, emotional, and cognitive benefits (Centers for Disease Control and Prevention, 2016; Kieff, 2001; Pellegrini, 2008; Pellegrini & Bohn, 2005). However, in recent years the established routine of recess in elementary school is being threatened in an attempt to increase cognitive performance through additional time spent on core academic content (Brusseau & Hannon, 2015; Pellegrini, 2005; Pellegrini, 2008; Pellegrini & Bohn-Gettler, 2013; Shervey & DiPerna, 2017; Yesil Dagli, 2012). Chapter One begins with an explanation of the background. Next, the problem, purpose statement, and an explanation of the potential significance of this research are discussed. The chapter concludes by listing the research question, null hypotheses, and essential definitions.

Background

Research has shown that recess, a regularly scheduled period for students to participate in free play, is a critical part of the elementary school day. According to the Center for Disease Control and Prevention (CDCP) (2016), recess improves students' memory, attention, and concentration, which can then lead to fewer classroom disruptions. According to Bjorklund and Brown (1998), taking a break from high cognitive demand tasks is not only beneficial, but is necessary for young children. In addition to the social benefits of this recess time, there are also cognitive benefits (Pellegrini, 2008; Ramstetter, Murray, & Garner, 2010). Recess, as an

unstructured break time, fosters students' ability to learn (Pellegrini & Bohn, 2005) and has both immediate and long-term academic benefits (Kieff, 2001). Further, a loss of instruction time to provide for recess breaks does not have a negative effect on young students' reading achievement (Yesil Dagli, 2012), and the many benefits of this time outweigh any potential costs (Keiff, 2001). Elementary students in classes that participate in more frequent breaks perform better in mathematics (Fedewa, Ahn, Erwin, & Davis, 2015; Ramstetter et al., 2010). Further, at what point these recess breaks occur within the school day is critical (Drollette, Shishido, Pontifex, & Hillman, 2012; Kohl & Cook, 2013b). For example, participating in a physical activity break prior to an academic assessment has been shown to improve cognitive performance (Howie, Schatz, & Pate, 2015; Phillips, Hannon, & Castelli, 2015).

Historical Overview

The promotion of exercise as a beneficial activity dates back thousands of years to the ancient Chinese and Greek civilizations who promoted physical activity as a means to maintain health (Deuster & Silverman, 2013). Physical activity was considered a necessary part of the day in ancient India, where the philosophy of yoga was first developed in 3,000 B.C. (CDCP, 1999). In 1873, Edward Stanley, the 15th Earl of Derby said, "Those who think they have not time for bodily exercise will sooner or later have to find time for illness" (Desuster & Silverman, 2013, p. 25). Medical literature throughout history also alludes to the importance of physical activity. Works from 16th century Spain, 17th century England and Scotland, and 19th century America, all discuss physical activity as vital to maintaining health (Berryman, 2010).

Using new scientific advancements during the late 1900s, researchers and doctors began investigating the impact of exercise on the physiology of the brain (Jensen, 2008b). For over thirty years, research regarding the effects of physical activity and fitness on brain functioning in

older adults has been conducted. Findings consistently showed that physical activity can improve cognitive functioning in elderly people (Kamegaya et al., 2012). In older adults, regular physical activity increases cognitive speed (Hillman, Belopolsky, Snook, Kramer, & McAuley, 2004), improves working memory (Kamegaya, Maki, Yamagami, Yamaguchi, Murai, & Yamaguchi, 2012) and increases reasoning, which leads to a quicker reaction time (Clarkson-Smith & Hartley, 1989).

Providing students with time for recess is a well-established requirement and expectation within Virginia's public elementary schools (Railey, 2016). However, there is limited historical documentation regarding recess in the United States. Pellegrini (2005) infered that this speaks to the lack of importance historically placed by educators on this time of the school day.

Social Context

Society today values physical fitness as part of a healthy lifestyle, as there are numerous health and social benefits associated with being physically active (American Heart Association, 2016). In one study, Canadian adults were interviewed regarding their views on physical education. The participants advocated for increased physical education (PE) time during the school day, citing that it would increase attention span and academic achievement (Larouche, Laurencelle, Shephard, & Trudeau, 2015). Assertions regarding the benefits of physical activity and recess are based on research. Aerobic fitness is inversely associated with anxiety and depression (Deuster & Silverman, 2013). In addition, physical fitness is related to higher cognitive performance and executive function (Barenburg, Derse, & Dutke, 2011; Hillman, Buck, Themanson, Pontifex, & Castelli, 2009). Executive function refers to the processes that occur in the brain that are needed to select, organize, and initiate goal-directed actions (Tomporowski, Davis, Miller & Naglieri, 2008). Physical activity is also related to improved

working memory (Kamijo, Pontifex, O'Leary, Scudder, Wu, Castelli, & Hilman, 2011) and an increase in academic achievement (Chomitz, Slining, McGowan, Mitchell, Dawson, & Hacker, 2009; Van Dusen, Kelder, Kohl, Ranjit, & Perry, 2011).

Many adults and children do not acquire adequate amounts of physical activity throughout the day. Over the past 30 years, physical activity levels of children have been steadily declining (Kohl & Cook, 2013b). One study found that only 15% of Canadian adults met the recommendation of 150 minutes of moderate-to-vigorous physical activity per week (Garriguet, & Colley, 2012). Further, Kohl and Cook (2013b) reported that less than half of the children in the United States accrue the recommended 60 minutes of physical activity each day.

One way to increase elementary students' physical activity is through recess (CDCP, 2016). The Parent Teacher Association (2018) advocates for daily recess for all elementary students, referencing that recess benefits students' physical, social, behavioral, and cognitive skills. Aside from recess providing a time within the school day for students to be physically active, it provides numerous other benefits such as improving the child's social and emotional skills (CDCP, 2016). This time of day is being reduced or removed in numerous schools for multiple reasons: (a) policymakers and educators cite an increased focus on academic outcomes (Lorenz, Stylianou, Moore, & Kulinna, 2017), (b) the desire to provide more instructional time (Brusseau & Hannon, 2015; Pellegrini & Bohn-Gettler, 2013), and (c) safety concerns (Kieff, 2001; Rink, Hall, & Williams, 2010). Further, recess is often withheld from individual students as a form of punishment (Adams, 2011) or due to unfinished school work (Woods, Graber, Daum, & Gentry, 2015).

The need for taking breaks is understood and accepted in American society. Adults use breaks, often mandatory, and strategic scheduling to maintain mental alertness during the work

day (Jarrett, 2013). Students also need breaks (Bjorklund & Brown, 1998). Within the school day, recess is beneficial because it provides students with a break from school work (Pellegrini, 2005).

Recess is an important part of the elementary school day in which students are able to take a break from the cognitive demands of academic learning. As the cognitive immaturity hypothesis asserts, taking breaks is crucial in order to maximize student learning. There is evidence that recess has positive effects on student academic achievement and social competence (Pellegrini, 2005). Further, the brain-based learning theory promotes not only taking a break, but also being physically active in order to maximize cognitive gains. There is evidence that physical activity prior to academic instruction is associated with increased academic progress for elementary students (Everhart, Dimon, Stone, Desmond, & Casilio, 2012; Fedewa et al., 2015; Phillips et al., 2015; Pontifex, Saliba, Raine, Picchietti, & Hillman, 2013). Further research is needed regarding the potential benefits of physical activity breaks (Fedewa et al., 2015) and how breaks, routinely scheduled over the course of a school year prior to instruction, can impact academic achievement (Howie et al., 2015).

Problem Statement

Recess, a period of the elementary school day where students can play freely, positively impacts students' creative, social, and emotional development (CDCP, 2016; Ramstetter et al., 2010). During recess, students often participate in physical activity (CDCP, 2016; Erwin, Abel, Beighle, Noland, Worley, & Riggs, 2012; Hall-López, Ochoa-Martínez, Burruel, Ortiz, & Buñuel, 2017), which has been shown to increase participants' memory and executive function (Becker, McClelland, Loprinzi, & Tros, 2014). Despite these benefits, recess time is often removed, reduced, or moved to the end of the school day. The prolonged expectation for

students to engage and process new academic information, while staying seated, is a direct result of high stakes testing and accountability (Adams, 2011; Medina, 2014). Policy makers and educators are continuously looking for ways to increase students' academic achievement as measured by standardized assessments. The problem is, rather than strategically scheduling recess prior to instruction, recess is often not prioritized and is being removed, or reduced in length, from elementary schools.

Purpose Statement

The purpose of this causal comparative study is to test the theory of the impact of recess in elementary school that relates the scheduling of mathematics directly after recess time to achievement on standardized mathematics assessments, controlling for grade level and assessment type, for third grade students attending elementary schools located in Central Virginia. The independent variables were generally defined as the timing of mathematics instruction in relation to recess, either mathematics instruction directly after recess, or mathematics instruction that does not occur directly after recess, and gender, either male or female. The dependent variable, student achievement on the Third Grade Mathematics Standards of Learning Assessment, were generally defined as the percentage of students passing this summative assessment, controlling for school location and grade level of students.

Significance of the Study

The findings from this research study will contribute to the existing body of research regarding the impact of physical activity and recess on elementary students. Some research indicated that physical activity breaks can increase academic performance in students (Fedewa et al., 2015; Harveson et al., 2016). The proposed research expanded upon the current body of literature by providing insight into the significance of scheduling recess directly prior to the

academic subject of mathematics and the impact it could have on third grade students' academic achievement in the subject of mathematics. These findings could support school board office personnel, principals, counselors, and teachers as they work to create master schedules that optimize student learning opportunities.

With mounting pressure to perform well on standardized assessments, there is an increase in schools reducing time spent on breaks (Brusseau & Hannon, 2015; Jensen, 2008b; Pellegrini, 2005; Pellegrini, 2008; Pellegrini & Bohn-Gettler, 2013; Yesil Dagli, 2012). Furthermore, over 50% of children in the United States get less than the recommended 60 minutes of exercise per day (Kohl & Cook, 2013a). One study including 786 students in the southwestern United States showed that only 61% of students meet the minimum number of recommended steps per day (Brusseau et al., 2013). Since physical activity and physical fitness are linked to executive functioning and academic achievement, while also providing numerous other benefits (CDCP, 2016), this is cause for concern. If teachers and administrators realize the cognitive benefits of physical activity and recess breaks, they may be more likely to give students strategically scheduled recess breaks, which would support the development of the whole child. Finally, with an increasing body of literature supporting the correlation between physical activity and academic achievement, and the importance of taking regular breaks, education leaders and education policy makers should consider taking steps to use recess as a means to improve academic achievement in elementary age students.

Research Question

RQ: Is there a significant difference between the Third Grade Mathematics Standards of Learning Assessment scores of male and female third grade students who do not take

mathematics class directly after an unstructured recess break with those students who do take mathematics class directly after an unstructured recess break?

Hypotheses

$H_0$1: There is no significant difference between the mathematics achievement scores of male and female third grade students.

$H_0$2: There is no significant difference between the mathematics achievement scores of third grade students who did not take mathematics class directly after an unstructured recess break and those students who did take mathematics class directly after an unstructured recess break.

$H_0$3: There is no significant difference between the mathematics achievement scores of third grade male students who did not take mathematics class directly after an unstructured recess break and third grade male students who did take mathematics class directly after an unstructured recess break.

$H_0$4: There is no significant difference between the mathematics achievement scores of third grade female students who did not take mathematics class directly after an unstructured recess break and third grade female students who did take mathematics class directly after an unstructured recess break.

Definitions

1. *Academic achievement* - performance on school related tasks (Watson, Timperio, Brown, Best, & Hesketh, 2017).
2. *Acute physical activity* - a single session of physical activity (Harveson et al, 2016).

3. *Cognitive performance* - abstract and verbal reasoning, non-verbal and verbal ability, spatial ability, and numerical ability (Ardoy, Fernández-Rodríguez, Jiménez-Pavón, Castillo, Ruiz, & Ortega, 2014).
4. *Executive functions* - processes that occur in the brain that are needed to select, organize, and initiate goal-directed actions (Tomporowski et al., 2008).
5. *Physical activity* - bodily movements that result in an expenditure of energy (Byrd, 2007).
6. *Recess* - regularly scheduled period in the school day for students to participate in physical activity and free play (CDCP, 2016).

CHAPTER TWO: LITERATURE REVIEW

Overview

In this chapter, the need for this study will be established through theoretical frameworks and related literature. How brain-based learning theory and the cognitive immaturity hypothesis support having recess prior to academic classes will be discussed. Current research regarding breaks from cognitive demands and physical activity will be expanded upon. Finally, the need for this study, in light of previous research, will be explained.

Theoretical Framework

This research study drew upon the brain-based learning theory and the cognitive immaturity hypothesis. Both assert that taking breaks from learning is critical to the learning process. Brain-based research and the brain-based learning theory suggest that educators should understand how the brain works and teach in light of this understanding. This theory promotes the importance of physical activity, social interactions, and periods of cognitive rest (Jensen, 2016b). The cognitive immaturity hypothesis also states that it is imperative for young students to have frequent breaks while learning. This hypothesis asserts that young students are more capable of being attentive after having taken a break (Bjorklund & Greene, 1992). Providing time for students to have recess allows students to maintain their physical health and gives them time to cognitively rest, both of which have positive impacts on academic achievement. Further, in order to optimize learning for students, recess should be strategically scheduled within the school day.

Brain-based Learning Theory

Brain-based learning theory suggests that brain health is an integral part of the learning process. In order to learn effectively, a healthy brain must be well-maintained. Further, it is

important for teachers to understand how the body and brain work together (Wilson & Coyers, 2013). "Brain-based education is the engagement of strategies based on principles derived from an understanding of the brain" (Jensen, 2008a, p. 4). When educators understand how the brain works, they are better equipped to help their students learn.

A multitude of factors other than academic lessons are impacting students' brains and learning while at school. Some of these factors include nutrition, stress, social context, and physical activity (Jensen, 2008b). While many of these components can be addressed by educators within the school day, some are a result of a student's home environment. Educators can help reduce learning distractions by reducing perceived threats, interacting with each student daily, playing music in the classroom, and optimizing many other stress relieving activities and practices. Other building blocks for learning require home support, such as getting enough sleep and the and having emotional stability. Getting adequate sleep is key to learning (Jensen, 2008a). Attention, executive functioning, quantitative skills, logical reasoning, and working memory are all negatively impacted when adequate sleep is not attained. Students' stress derived from situations at home often directly influence and present themselves in the student's' ability to learn within the classroom (Medina, 2014).

One assertion of brain-based learning theory is that physical activity improves brain health, which, in response, improves cognitive function and academic achievement. Researchers in this field emphasized the interconnectedness of physical activity and brain health (Ratey, 2008; Medina, 2014; Wilson & Coyers, 2013). Physical activity produces physiological changes in the brain, including solidifying neuron connections (Jensen, 2017; Medina, 2014; Ratey, 2008), which enhance the brain's ability to learn (Wilson & Conyers, 2013). Voluntary gross motor activity grows new neurons, which is correlated with memory, mood, and learning

(Jensen, 2016b). Physical activity is strongly correlated with improved cognition (Jensen, 2008b). Further, it helps students refocus attention and reduces stress (Jensen, 2008a). Jensen (2017) described including physical activity and recess as a principal strategy of brain-based learning, saying that physical activity and recess raise noradrenaline, dopamine, and cortisol levels, which helps students in their ability to learn.

Since there are many cognitive benefits to physical activity, it is recommended that students should participate in physical activity during the school day (Jensen, 2008a; Jensen, 2016b). Students can be provided opportunities to be physically active through physical education classes. However, according to Jensen, (2008b), only 36% of school children in the United States receive a daily physical education period. Not even a decade later, this percentage had fallen to only 29% of students being scheduled into daily physical education classes (Society of Health and Physical Educators, 2016). Jensen (2005) goes as far as to say the limited amount of physical education classes in the United States is "educational malpractice." Another way to allot for physical activity within the elementary school day is through recess. During recess students have the opportunity to take a break from cognitive demands while playing and engaging in physical activity.

Regardless if students participate in physical activity, brain-based research supports the importance of taking breaks from learning. Students need time for information to settle (Jensen, 2016a) and breaks are necessary in order for the brain to transfer learning to long-term memory. Further, learning becomes more inefficient as the time between breaks increases (Jensen, 2008a). However, instead of increasing the amount of time students spend participating in physical activity, many schools are reducing or eliminating recess in efforts to improve academic achievement (Medina, 2014). Even though many educators know that learning and movement

are connected, most ignore this knowledge once students are in upper elementary school (Jensen, 2005).

While brain-based learning is a relatively new theory in education (Jensen, 2008b), the idea that physical activity impacts the mind is not. The ancient philosopher Plato stated, "In order for man to succeed in life, God provided him with two means, education and physical activity. Not separately, one for the soul and the other for the body, but the two together" (as cited in Ratey, 2008, para. 1). Literature shows that allowing physical activity in elementary school promotes brain health and has physiological outcomes that then impact students' classroom behaviors and their ability to learn. In this research study, the researcher tested the effects of having an unstructured recess break prior to mathematics and its potential impact on students' academic achievement in mathematics.

Cognitive Immaturity Hypothesis

The cognitive immaturity hypothesis also supports scheduling recess prior to academic instruction in order to support academic achievement and learning. This hypothesis, which is associated with Anthony Pellegrini and David Bjorklund, asserts that taking a break from high demand tasks is not only beneficial but is necessary for young children (Bjorklund & Brown, 1998). Further, young children learn differently than adults, need breaks from cognitive tasks more frequently, and are more attentive to classwork after receiving a break from cognitively demanding tasks (Pellegrini & Blatchford, 2002).

The cognitive immaturity hypothesis asserts that young children think differently and do not process information as well as older children and adults (Pellegrini & Bjorklund, 1997; Pellegrini, 2005). Younger students have a lower level of educability due to the immaturity of their nervous systems and their lack of experiences (Pellegrini, 2005). Therefore, young children

must apply greater cognitive effort to their studies, and thus are in greater need of recess breaks as compared to older students (Pellegrini & Bjorklund, 1997). After recess, young students are more attentive to cognitive tasks (Pellegrini & Bohn, 2005). In one study, observers tracked the behavior of students before, during, and after recess by noting student behavior every thirty seconds. The researchers found that second and fourth grade students' inattentiveness was significantly higher prior to recess than directly after recess (Pellegrini, Huberty, & Jones, 1995).

Related Literature

In this section, current literature related to physical activity, recess, and class scheduling in the context of brain function and academic achievement, will be reviewed. Four closely related, yet separate, topics within physical activity will be discussed. These topics include long-term effects of regular physical activity on the way the brain functions, effects of regular physical activity on academic achievement, effects on brain functioning immediately following physical activity, and changes in academic achievement when assessment of learning directly follows physical activity.

Physical Activity

Physical activity refers to an activity that requires the expenditure of energy (Byrd, 2007). According to the physical activity guidelines put in place by the CDCP (2015), adolescents and children should obtain over 60 minutes of physical activity each day. The majority of this time should be comprised of aerobic exercise with some muscle and bone strengthening activities included at least three times per week (CDCP, 2015). According to Kohl and Cook (2013b), fewer than 51% of students in the United States acquire the recommended 60 minutes. In a Canadian study, researchers found that less than 10% of school age children met the benchmark of 60 minutes of physical activity per day (Garriguet & Colley, 2012). One study

involving elementary students in Qatar found that only 39% of students reached 30 minutes spent in moderate to vigorous physical activity during the school day (Zimmo, Farooq, Almudahka, Ibrahim, & Al-Kuwari, 2017).

Research shows that upper elementary female students are often less active than males, thus promoting physical activity in school for female students may be especially important. One study found that while five-year-old male and female students had similar levels of physical activity within the school day, nine-year-old female students were far less active than their male peers during the school day (Zimmo et al., 2017). Another study spanning 57 primary schools and 1,299 students and their parents, found that between the first year of school and a student's fourth year of school, the amount of physical activity per day for female students significantly declines. This decline is not attributed to home factors, as no significant difference was found in the activity level of parents over this time period (Jago, Solomon-Moore, Macdonald-Wallis, Sebire, Thompson, & Lawlor, 2017). Finally, over the course of a voluntary walk/run program, third through fifth grade male participants averaged 28.5 miles, while third through fifth grade female participants averaged 13.2 miles (Garnett, Becker, Vierling, Gleason, DiCenzo, & Mongeon, 2017).

Physical activity has many advantages, including emotional, physical, and cognitive benefits (Kohl & Cook, 2013b). Among other things, physical activity reduces stress, improves mood, lowers blood pressure, and prevents bone loss (American Heart Association, 2016). Physical activity improves brain function (Ratey, 2008) and is directly linked with cognition (Jensen, 2008b). Physical activity, regular or acute, enhances memory, inhibitory control, and executive functions (Kamijo et al., 2011). Physical activity can also positively impact student academic achievement (Byrd, 2007; Chomitz et al., 2009; Lorenz et al., 2017; Van Dusen et al.,

2011). Regular and routine physical activity, as well as single short bouts of physical activity, have positive effects on academic achievement (Kohl & Cook, 2013b).

Regular physical activity. There are multiple benefits to regular physical activity. Physical activity helps with weight control, reduces the risk of cardiovascular disease, diabetes, and some cancers, strengthens bones and muscles, and improves mental health (CDCP, 2015). In an analysis of 54 countries, researchers found that sitting for longer than three hours per day contributed to about 433,000 deaths per year, or 3.8% of all-cause mortality (Rezende, Sa, Mielke, Viscondim Rey-Lopez, & Garcia, 2016). Conversely, when compared with those who participate in little to no physical activity, people who participate in about seven hours of physical activity per week have a forty percent lower risk of dying (CDCP, 2015). Further, there is also a positive association between physical fitness and intelligence (Douw, Nieboer, Van Dijk, Stam, & Twisk, 2014). Regular physical activity has been found to relate to higher cognitive functioning and performance (Chapman, Aslan, Spence, Defina, Keebler, Didenhbani, & Lu, 2013; Hillman et al., 2009; Kamegaya et al., 2012) and higher levels of student academic achievement (Andersen, Mortensen, Vardinghus-Nielsen, Franch, Torp-Pedersen, & Boggild, 2016; Byrd, 2007; Coe, Peterson, Blair, Schutten, & Peddie, 2013; Van Dusen et al., 2011).

Regular physical activity and the brain. Physical activity has physiological impacts on the brain. Ratey (2008) cites Carl Cotmon, who found a direct biological link between movement and the cognitive functioning of the brain in the 1990s. Since then, neuroscientists have been studying the effects that physical activity has on the brain itself. According to Barenburg et al. (2011), there is considerable evidence that long-term physical activity strengthens executive functioning. Further, aerobic exercise increases the volume of the

hippocampus (Erickson et al., 2011), a structure within the brain that gathers stimuli and is necessary for learning and memory (Ratey, 2008).

In studies conducted with adult participants, results showed that physical activity has many positive effects on cognition. Consistently, adults who exercised regularly, over an extended period of time, demonstrated increased cognitive function compared to those who were not physically active. One study, comparing a sedentary control group of adults with a group of adults who participated in an hour of aerobic exercise three times per week for a span of three months, found a significant difference in improvements in cognitive health of those completing the aerobic exercise over that time period (Chapman et al., 2013). Conversely, adults with sedentary lifestyles demonstrate lower fluid intelligence, which is related to problem solving capabilities (Medina, 2014).

Like adults, physical activity is critical for children's overall brain health and executive function (Tomporowski et al., 2008). In children, factors such as attention, memory, and academic performance are all used as indicators of brain health (Kohl & Cook, 2013b). One study, conducted with nine and 10-year-olds, found that higher levels of physical fitness were associated with decreased gray matter thickness in the superior frontal cortex, superior temporal areas, and lateral occipital cortex, which is associated with improved academic performance, as compared to less physically fit students (Chaddock-Heyman et. al., 2015). In another study, eight and nine-year-old students participated in a nine-month physical activity program in which they exercised at least 60 minutes, five times per week. Using functional magnetic resonance imaging (fMRI), the researchers found positive impacts on the elements of prefrontal cortex function involved in cognitive control (Chaddock-Heyman et al., 2013). Another study found that overweight children showed significantly higher executive functioning after they had

participated in a 15 week exercise program as compared to their overweight, sedentary peers (Davis, Tomporowski, Boyle, Waller, Miller, Naglieri, & Gregoski, 2007).

More physically fit elementary children demonstrate better cognitive control as compared to their less fit peers (Chaddock et al., 2012; Scudder, Lambourne, Drollette, Herrmann, Washburn, Donnelly, & Hillman, 2014). In one study, observers used magnetic resonance imaging (MRI) to watch the nine and 10-year-old participants' brain function while completing a modified flanker task, a task in which participants attended to the centrally located stimuli among a group of stimuli presented horizontally. The participants with higher levels of fitness were better at meeting and maintaining the goals of the task (Chaddock et al., 2012). Further, exercise capacity is associated with improved working memory (Geertsen et al., 2016). Another study, which utilized the flanker, also found that cognitive performance on an executive control task was associated with physical fitness levels in preadolescent children (Hillman et al. 2009). Efficient and effective executive functions are necessary for academic achievement, especially in mathematics class (Kohl & Cook, 2013b).

Results of one study, in which participants were 48 nine and 10-year-old students divided into two groups: higher fit and lower fit, showed that higher levels of fitness in elementary children were positively related to memory and learning (Raine, Lee, Saliba, Chaddock-Heyman, Hillman, & Kramer, 2014). Students who are more physically fit appear to concentrate better than their peers (Medina, 2014). Lower levels of physical fitness in nine and 10-year-old students are related to lower abilities to sustain focus and attention to cognitive tasks (Pontifex, Scudder, Drollette, & Hillman, 2012). In preadolescent students, improvement in cardiorespiratory fitness is associated with improvement in working memory (Kamijo et al., 2011). Research regarding the relationship between exercise, emotional distress, and memory,

found that exercise habit strength, as self-reported by the 165 10 and 11-year-old Malaysian participants, was positively associated with cognitive ability (Zainol & Hashim, 2015). Exercise habit strength collectively refers to factors such as routinely planning exercise, feeling guilty if exercise is skipped, mental ease of exercise involvement, and the desire to exercise (Hashim, Grove, & Whipp, 2008).

In summary, executive function, which is imperative in mathematics, is the foundation for academic performance (Kohl & Cook, 2013a). Further, there is a correlation between cognitive function and academic achievement (Geersteen et al., 2016). Regular physical activity is necessary for students because it improves brain health, which improves executive and cognitive functions, which can lead to improved academic achievement.

Regular physical activity and academic achievement. Academic achievement refers to attaining educational goals. It can be measured in a variety of ways, but most commonly is measured by classroom grades and scores on standardized assessments. Students who are more physically active earn higher grades and appear to learn faster than their peers who are less physically active (Byrd, 2007).

Regular physical activity is positively associated with academic achievement. In one longitudinal study in Sweden, student participants were tracked over the course of nine years. Students remained in two separate cohorts over this time. The control group had physical education class twice a week and the experimental group had physical education class five times per week. Both groups had this class for a period of 45 minutes. While there was not a significant difference in the grades of female students, male students in the group who participated in physical education class five times per week had significantly higher grades than the males in the group with physical education only twice per week (Ericsson & Karlson, 2014).

As measured by standardized assessments, physical fitness is associated with higher academic achievement for middle and high school students (Coe et al., 2013). The California Department of Education consistently shows that students with higher fitness scores also have comparatively higher scores on academic assessments (Ratey, 2008). In Texas, a convenience sample of 254,743 students, from grades three through eleven, was used to analyze physical fitness in relation with standardized assessments (Van Dusen et al., 2011). The results showed a significant relationship between students' physical fitness performance and their academic achievement (Van Dusen et al., 2011).

There is a direct association between physical fitness levels and academic achievement in teenagers (Van Dusen et al., 2011). In a German study of 1,011 teenage students, students' physical fitness level and academic achievement were assessed twice, with a span of one school year in between (Suchert, Hanewinkel, & Isensee, 2016). Both times, high levels of physical fitness were associated with better grades for the teenage students. In addition, students who improved their fitness level over the course of the year, also saw improved grades as compared with students who maintained low fitness levels (Suchert et al., 2016). A study of high school students from Spain found similar results (Ardoy et al., 2014). In this study, students' academic and cognitive performance was measured and analyzed in context of the frequency and intensity of physical education classes. Academic performance was measured by classroom grades. Cognitive performance was measured using a questionnaire assessing overall cognition as well as specific dimensions of cognition such as nonverbal and verbal abilities, verbal reasoning, spatial ability, abstract reasoning, and numerical ability. Results from this four month long, randomized control trial, showed that students participating in four days per week of intense physical education classes made greater gains in both academic achievement and cognitive

performance when compared with their peers in a control group who participated in a typical physical education class two days per week (Ardoy et al., 2014). In another study, at the college level, researchers compared students' grade point average (GPA) with the frequency of campus recreation facility visits (Roddy, Pohle-Krauza, & Geltz, 2017). The researchers found a significant difference in the number of campus recreation facility visits by GPA range (Roddy et al., 2017). Students with a GPA greater than 3.45 visited the campus recreation facility an average of 25 times over the course of the semester. Students with a GPA between a 2.95 and 3.45 visited the campus recreation facility an average of 20 times over the course of the semester (Roddy et al., 2017).

Physically fit teenagers also perform better on assessment measures. A Danish study, conducted with 542 female and 577 male students ranging in age from 13 to 15 years old, evaluated student physical fitness through the use of a watt-max cycle ergometer test (Andersen et al., 2016). To complete the watt-max cycle ergometer test, participants cycle at a constant rate while the workload is increased by 25 watts every three minutes until the participant reaches exhaustion. The study measured academic achievement of students, one year later, with a series of mandatory exams in several content areas. The researchers found a significant positive association between physical fitness and academic achievement (Andersen et al., 2016). Additionally, in a study of 669 seventh through ninth grade Taiwanese students, cardiovascular fitness was positively associated with academic achievement (Chen, Fox, Ku, & Taun, 2013).

Aerobically fit preteens have significantly better chances of having high academic achievement (Sardinha, Marques, Martins, Palmeira, & Minderico, 2014). In a longitudinal study following students from fifth through seventh grade, students who were classified as fit, based on cardiorespiratory measures, academically outperformed their peers who were

categorized by the researchers as unfit (Sardinha, Marques, Minderico, Palmeira, Martins, Santos, & Ekelund, 2016). In a separate study, with 1,531 seventh grade students, researchers found that students who were classified as fit based on cardiorespiratory measures, academically outperformed their peers who were categorized by the researchers as unfit, as measured by end of the year marks in mathematics, language, foreign language, and science (Sardinha et al., 2014).

Both middle school boys and girls with higher levels of physical fitness achieve higher scores on mathematics and reading standardized assessments. In one study of 838 middle school students, there was a significant correlation between increased physical fitness levels and higher academic achievement on the Illinois Standards Achievement Test for mathematics and reading. Student physical fitness was measured using the FITNESSGRAM (Bass, Brown, Laurson, & Coleman, 2013) test battery which assessed health-related components such as aerobic capacity, body composition, and muscular strength, endurance, and flexibility (The Cooper Institute, 2014). The researchers found that boys categorized as being healthy and fit were two and a half to three times more likely to pass their mathematics or reading standardized assessments. Further, girls who were categorized as being aerobically fit were two to four times more likely to pass their reading or mathematics standardized state assessments than their peers (Bass et al., 2013). A similar longitudinal study found that students who were consistently fit over a two-year period, from fifth to seventh grade, showed significantly higher achievement test scores than their peers who consistently fell in the needs improvement category of fitness (Wittberg, Northrup, & Cottrell, 2012).

As with secondary students, regular physical fitness also positively impacts academic achievement for elementary school students. One study showed that there was a positive

association between aerobic fitness and teacher assigned grades in reading, writing, mathematics, and science for fourth grade students (Lorenz et al., 2017). Another study, conducted in Spain and including 893 students, ages nine to 11, found that higher grades in core subject areas were associated with higher levels of physical fitness (Torrijos-Nin˜o, Martinez-Vizcarno, Pardo-Guijarro, Garcia-Prieto, Arias-Palencia, & Sanchez-Lopez, 2014). Further, results from this study showed that a larger effect size was seen for male students (Torrijos-Ninõ et al., 2014).

High physical fitness levels of elementary students are not only positively associated with classroom grades but are also positively associated with standardized assessment scores. One Swedish study found that in schools giving students two additional 30-45 minute physical activity sessions per week, fifth grade students had a higher chance of achieving the national learning goals set in that country when compared to students not getting the extra physical activity session (Käll, Nilsson, & Lindén, 2014). In an Australian study of 29 schools and 757 students, researchers collected data on the physical fitness level of students and their performance on standardized assessments. The researchers found that there was a positive correlation between schools in which elementary students were in better physical shape, and higher academic achievement, as measured by a standardized assessment, in literacy and numeracy (Telford, Cunningham, Telford, & Abhayaratna, 2012).

The correlation between physical fitness and academic achievement seems to be especially true for mathematics. Nine and 10-year-old students who are considered more physically fit demonstrated higher levels of mathematics achievement than their peers who were considered less fit (Chaddock-Heyman et al., 2015). In one study, participants with four physical education classes of high intensity level**s** per week, showed significantly higher mathematics achievement than their peers with fewer or less intense physical education classes (Ardoy et al.,

2014). Regardless of socioeconomic status, results from one study found a positive link between cardiovascular fitness and mathematics achievement of upper elementary students (n=544), but found no association between physical fitness and reading achievement (de Greeff, Hartman, Mullender-Wijnsma, Bosker, Doolaard, & Visscher, 2014). In another study, the researchers found that fitness achievement, measured by passing physical fitness tests, directly correlated with mathematics achievement, as measured by the Massachusetts Comprehensive Assessment System, for fourth, sixth, and eighth graders. For the 1,103 student participants, the odds of passing the mathematics assessment significantly increased with the number of fitness tests passed (Chomitz et al., 2009).

Further, regularly participating in physical activity is associated with an increase in students' individual mathematics achievement. In one study, third through fifth grade elementary students had the opportunity to participate in a voluntary, before school running/walking club (Garnett et al., 2017). Researchers found a significant positive association between the number of miles students accrued during the program and student scores on the mathematics portion of the New England Common Assessment Program. Researchers did not find a significant positive association between miles accrued during the program and student scores on the reading portion of this assessment (Garnett et al., 2017). In conclusion, regardless of age, socioeconomic status, or nationality, physical fitness appears to be positively associated with academic achievement.

Immediate effects of physical activity. In addition to the positive effects of long term physical activity, there are immediate benefits to being physically active. These benefits include improved mood and decreased stress levels (Basso & Suzuki, 2017; Jensen, 2008a). Further, like

regular physical activity, acute bouts of physical activity can have positive impacts on brain function and academic achievement (Kohl & Cook, 2013b).

Acute bouts of physical activity and the brain. Participation in physical activity not only has long term positive effects when performed routinely, but also increases executive function immediately (Barenburg et al., 2011). Optimum brain functioning occurs directly after participation in physical activity (Ratey, 2008). In adults, positive results for executive functions occur after both aerobic and muscular physical activity. Researchers divided 42 adult women into two groups. One group participated in sedentary and stretching activities for 30 minutes. The other group participated in both aerobic and strength exercises over the same time period. The group who participated in the acute bouts of aerobic and strength exercises showed significantly improved executive functioning when compared with the control group (Alves, Gualano, Takao, Avakian, Fernandes, Morine, Takito, 2012). In another study, acute resistance exercise improved cognitive performance of the 30 adult participants (Chang, Tsai, Huang, Wang, & Chu, 2014).

Similar results have been found in studies in which the participants were students. Singular events of aerobic exercise positively influence cognitive performance in students (Drollette et al., 2012). High school students who participated in resistance and aerobic exercises and then took an assessment showed significantly higher measures of cognition when compared with their peers who did not exercise prior to taking assessments to measure cognition (Harveson et al., 2016). Further, frequent short periods of physical activity throughout the day have short-term effects on cognition (Kohl & Cook, 2013b). Acute bouts of physical activity also increase students' attention spans directly following the activity. Using an experimental design, Tine & Butler (2012) found that twelve minutes of exercise improved the selective

attention of sixth and seventh grade students from both lower and higher income families. Following an acute bout of physical activity, upper elementary students showed an increase in executive functioning (Chen, Yan, Yin, Pan, & Chang, 2014). Preadolescent children showed greater response accuracy and stimulus-related processing following 20 minutes of physical activity when compared with their own performance following a sedentary reading activity (Pontifex et al., 2013).

Acute bouts of physical activity and academic achievement. Participating in physical activity directly prior to academic learning is associated with an increase in on-task behaviors (Miramontez & Schwartz, 2016) and students' academic progress and performance (Everhart et al., 2012; Fedewa et al., 2015). At Central High School in Chicago, Illinois, students who had a physical education class before school showed a 17% gain in literacy comprehension when compared to their peers who did not begin their day participating in a physical education class. After learning of these results, the guidance department at this school began recommending the scheduling of students in their most difficult classes after their physical education classes (Ratey, 2008). Findings from another study indicated that preadolescent students performed better on mathematics and reading assessments after a single bout of moderately intense aerobic physical activity (Pontifex et al., 2013).

Again, this seems to be especially true of mathematics. Students in classrooms that received more physical activity breaks throughout the day performed higher in mathematics (Fedewa et al., 2015). Furthermore, when these breaks occur may be critical to effectiveness. Directly following 20 minutes of physical activity, students show greater academic performance in mathematics (Pontifex et al., 2013). One study showed that for fourth and fifth grade students, there was a significant positive difference in scores on a mathematics achievement test when

students were given a 10 or 20 minute break prior to taking the assessment, as compared to students who took the assessment after a sedentary activity. Further, female students' scores showed a greater variance than male students' scores (Howie et al., 2015). These findings were remarkably similar to that of another study in which eighth grade students who took a mathematics standardized achievement test within 30 minutes of exercise scored between 11% and 22% higher on the assessment, as compared to their peers who took the assessment after being sedentary or who had not participated in physical activity for the last 45 minutes prior to the assessment. Again, female students' scores were impacted more significantly than their male classmates' scores when the mathematics assessment occurred after physical activity (Phillips et al., 2015).

While there is research supporting the positive relationship between physical activity and academic achievement, not all studies show this correlation. In one study, researchers compared the standardized assessment scores of fourth grade students in two separate schools with varying amounts of time spent on physical activity each week (Tremarche, Robinson, & Graham, 2007). Researchers found that students attending the school spending greater amounts of time on physical activity showed significantly higher scores on an English language arts standardized assessment, but found no significant difference in mathematics achievement, as measured by a standardized assessment, between the two schools (Tremarche et al., 2007). In another study, researchers found that while there was a positive association between physical activity and mathematics performance of ninth grade students, there was a negative association between physical activity and mathematics performance of seventh grade students (Van Dijk, De Groot, Savelberg, Van Acker, & Kirschner, 2014). A third study, conducted with 1,701 students from across five school divisions, found that higher levels of physical fitness were positively

associated with academic achievement on standardized mathematics assessments for sixth and ninth grade students, but not for third grade students (Coe et al., 2013).

Recess Breaks

Recess is a time within the school day for students to participate in free play and physically activity (Brusseau & Hannon, 2015; CDCP, 2016). Recess benefits children in multiple ways, but most importantly, it serves as a break from academic tasks and challenges (Council on School Health, 2013; Ramstetter et al., 2010). Recess improves students' concentration, memory, and attention, and promotes social and emotional development (CDCP, 2016; Rink et al., 2010). Furthermore, it helps students learn how to cooperate and compromise with one another (Pellegrini, 2005).

Despite these benefits, not all elementary school students have recess built into their daily schedule. In Virginia, 73% of school districts report having a policy regarding elementary school recess requirements (Smith, Wilburn, & Estabrooks, 2015). One survey, conducted by the CDCP, reported that only 79% of American elementary schools provide recess (Adams, 2011). In a survey conducted in the late 1990s, 8% of American kindergarten classrooms reported not having recess at all (Pellegrini, 2005).

The average amount of time per day allocated to recess in the United States is relatively low in comparison to that of other countries. On average, the United States only appropriates 27 minutes a day for recess in elementary schools (Cha, 2015). In Finland, elementary students receive 75 minutes of recess per day (Chang & Coward, 2015). In Uganda, elementary students spend half of their school day at recess, lunch, or their choice of sports, arts, music, or play activities. This time is strategically split throughout the school day (Jarrett, 2013). In China, elementary students receive ten minutes of recess for every 40 minutes of class time, and in

Shanghai, specifically, the total recess time for an elementary student is approximately 40% of the school day (Chang & Coward, 2015). Similar to China, Japan gives students a 10 to 15 minute break after every hour of instruction (Cha, 2015).

The additional time spent at recess is not hurting these countries' academic performance. Students in Finland consistently are among the highest scorers on international achievement assessments. As measured by the Programme for International Student Assessment (PISA), Finland's students not only receive one of the highest scores in all subject areas, but students in this country reported relatively no schoolwork-related anxiety, while students in the United States reported high schoolwork-related anxiety (Organisation for Economic Co-operation and Development, 2017). Like Finland, China and Japan both outperform the United States on the academic portions of this measure (Organisation for Economic Co-operation and Development, 2017).

Many schools in the United States have been eliminating or reducing recess and physical activity breaks in order to increase time spent on core academic content (Brusseau & Hannon, 2015; Pellegrini, 2005; Pellegrini, 2008; Pellegrini & Bohn-Gettler, 2013; Yesil Dagli, 2012). According to Jensen, (2008b), this is due to an emphasis on high stakes assessments. While increasing time spent receiving instruction does increase learning, educators misuse and misapply this principle when they apply it to hours of uninterrupted instruction without giving students adequate breaks (Pellegrini, 2005).

Educational policy makers also cite safety concerns (Kieff, 2001) and fear that recess increases behavioral problems such as bullying (Pellegrini, 2005; Yesil Dagli, 2012), as reasons for the removal of recess. Further, some educators report withholding recess as a form of punishment (Adams, 2011; Council of School Health, 2013). A recent study, involving

elementary schools from across the nation, showed that only 28% of those surveyed reported the removal of recess as punishment as not being allowed, and even less, only 26%, reported not being allowed to withhold recess from students who needed to finish school work (Turner, Chriqui, & Chaloupka, 2013).

Reducing or removing recess may be counterproductive for increasing students' academic performance. While there are finite hours within the school day, the benefits of recess outweigh the loss of instruction time (Kieff, 2001). Research shows that recess has a multitude of benefits including a positive impact on academics (Pellegrini, 2008; Ramstetter et al., 2010; Pellegrini & Bohn, 2005; Yesil Dagli, 2012). Further, taking a break from high demand cognitive tasks is necessary for young children (Bjorklund & Brown, 1998), and recess provides this break.

Recess has a direct impact on academic achievement for students (Pellegrini, 2008). Regardless if students participate in physical or sedentary activities during recess, the break that it provides from academics benefits the cognitive abilities of the students following recess (Council on School Health, 2013; Ramstetter et al., 2010). Unstructured breaks, such as recess, facilitate students' ability to learn (Pellegrini & Bohn, 2005) and improve students' memory, attention, and concentration (CDCP, 2016).

Moyer (2014), surveyed fourth grade students in regards to recess. Of students surveyed, 84% reported looking forward to daily recess. These responses indicated that fourth grade students not only enjoyed recess time, but 74% of the students also reported that they felt it helped them pay better attention in class (Moyer, 2014). Taking unstructured breaks helps students stay on-task and minimizes disruptions in the classroom (CDCP, 2016). Kindergarten and first grade students who were provided 45 minutes per day of recess, as compared with their

peers receiving only 15 minutes, showed significant reductions in off task behaviors (Rhea, Rivchun, & Pennings, 2016).

While a recess break in itself is advantageous, another benefit of this time is the fact that many students are often physically active (CDCP, 2016). By providing recess regularly, educators allow time for students to obtain part of the recommended 60 minutes of physical activity per day (Rink et al., 2010). One research study conducted on third, fourth, and fifth grade students, reported that while a 15 minute unstructured recess break only accounted for 4% of the students' daily time in school, students accumulated approximately one-third of their school day steps during this time (Erwin et al., 2012). Further, on average, male students are known to be more physically active during recess (Baquet,Ridgers, Blaes, Aucouturier, Van Praagh, & Berthoin, 2014; Frago-Calvo, Murillo, García-González, Aibar, & Zaragoza, 2017; Gutierrez, Williams, Coleman, Garrahy, & Laurson, 2016; Jaunzarins, Gauthier, King, Larivière, & Dorman, 2014; Kobel, Kettner, Erkelenz, Kesztyüs, & Steinacker, 2015; Roberts, Fairclough, Ridgers, & Porteous, 2013; Shervey & DiPerna, 2017; Springer, Tanguturi, Ranjit, Skala, & Kelder, 2013; Woods et al., 2015) and accumulate more steps than their female peers (Dias, Lemes, Brand, Mello, Gaya, & Gaya, 2017; Erwin et al., 2012).

Some research shows that students accumulate more steps and are more physically active during recess than they are during physical education class. In a study that compared first and second grade students' physical activity levels during recess, exergaming classes, and physical education classes, researchers found that students spent significantly more time in moderate-to-vigorous physical activity during both recess and while exergaming when compared with physical education class (Gao, Chen, & Stodden, 2015). Results from another study, with 1,765 fourth, fifth, and sixth grade student participants, indicated significantly higher levels of physical

activity among students during unstructured recess times as compared to levels of physical activity during teacher led physical education class times (Hall-López et al., 2017). In a similar study with only sixth grade students, researchers found that both male and female students accumulated significantly more steps while at recess than during physical education classes (Gutierrez et al., 2016).

When students participate in activities such as running, jumping, hopping, or skipping, they are utilizing the large muscles in their bodies, which is referred to as gross motor skills (Your Therapy Source, 2016). Recess provides students a time to practice these gross motor skills (Council on School Health, 2013; Rink et al., 2010). Further, because the gross motor activity that occurs during recess is voluntary, it improves memory, mood, and the ability to learn (Jensen, 2016b). Improving gross motor skills may also improve academic performance. Geertsen et al. (2016) conducted a study with a sample of 423 third grade Danish students in order to see if there were associations between fine and gross motor skills, exercise capacity, and cognitive capacity as it relates to academic achievement. This study found a significant association between fine and gross motor skills with multiple cognitive domains: working memory, episodic memory, semantic memory, sustained attention, and processing speed (Geertsen et al., 2016).

Finally, the positive academic benefits of recess may be greater for students who are physically active during recess. A study of first grade students, found an association between higher levels of physical activity at recess and reading ability (Haapala et al., 2014). Another study, in which the participants were prekindergarten students, found that higher levels of active play were associated with better self-regulation and higher scores on mathematics and reading assessments (Becker et al., 2014). Further, since research has shown a positive correlation

between physical activity and increased academic achievement (Byrd, 2007; Coe et al., 2013; Everhart et al., 2012; Fedewa et al., 2015; Käll et al., 2014; Telford et al., 2012; Van Dusen et al., 2011; Wittberg et al., 2012), recess should be incorporated into the daily school schedule of all students.

Strategic Scheduling of the School Day

The daily school schedule is an important piece of students' school experiences. Policy makers, administrators, and teachers are tasked with creating a schedule that optimizes student learning while accounting for all of the moving pieces that influence decisions such as time of day, length of day requirements, and availability of support staff such as special education teachers, librarians, speech language pathologists, and other specialized individuals. Another consideration while scheduling the elementary school day is availability of playground space (Rink et al., 2010).

Educational research regarding scheduling in order to optimize specific outcomes includes topics such as improving academic achievement and the well-being of students. One focus of research surrounding school schedules includes length of the school day in relation to student academic achievement (Keller, Smith, Gilbert, Bi, Haak, & Buckhalt, 2015; Roda, 2017). Another focus of research is in regard to what time of day students take classes. In one study, conducted with secondary female students, academic performance of students who attended class in the morning was compared with the academic performance of students who attended class in the afternoon. No significant difference in academic performance of the two groups was observed by the researchers (Mulenga & Mukuka, 2016). In addition to morning and afternoon considerations, researchers also consider students' individual cycles. Jensen's (2005) *Teaching with the Brain in Mind* purports the need for block scheduling in high school due to brain cycles

and in order to provide enough time for teachers to provide breaks within the class period. However, one study found that neither circadian rhythms nor time of day impacted academic achievement of kindergarten students (Fernandes Cruz, Gomes, Martin, Leitao, Clarisse, LeFloch, da Silva, 2016).

There is also research concerning the scheduling of recess and physical activity within the school day both for academic gains and the development of the whole child. One study found that students who participated in recess directly prior to lunch consumed more calcium when compared with peers who did not have recess directly prior to lunch (Hunsberger, McGinnis, Smith, Beamer, & O'Malley, 2014). Further, German researchers found that elementary students receiving two recess breaks per day, spent significantly more time engaging in moderate-to-vigorous physical activity when compared with students participating in only one recess break per day (Kobel et al., 2015). Finally, a daily schedule with a balance of instruction time and frequent recess breaks yields higher reading scores for kindergarten students (Yesil Dagli, 2012).

One recent research study showed that while physical activity prior to mathematics instruction was beneficial, recess breaks prior to mathematics instruction had adverse effects on student engagement (Owen, Parker, Astell-Burt, & Lonsdale, 2018). In this study conducted with 2,194 teenage students in Australia, researchers sought to determine if physical activity prior to mathematics class had a positive relationship with school engagement. Results showed that physical activity bouts for 10-20 minutes prior to mathematics instruction were most beneficial for higher attention scores, and physical activity bouts for greater than 20 minutes prior to mathematics instruction were most beneficial for cognitive performance (Owen et al., 2018). In addition to studying the amount of physical activity accrued in the hour prior to

mathematics, researchers also analyzed the period prior. Periods included were before school, recess breaks, lunch breaks, classroom lessons and Physical Education lessons. Results showed that students were less engaged when they had mathematics class after a recess break as compared to students who had mathematics after another period (Owen et al., 2018).

One concern educators have in regards to providing time for physical activity within the school day is meeting the required daily hours of instruction time. In Virginia, the minimum number of instructional hours per day is five and a half, excluding recess and lunch (Farbman, Davis, Goldberg, Rowland, 2015). While there is a minimum weekly amount of physical activity time available for elementary school students in Virginia, which can include both physical education class and recess, there is no legislation protecting students from having recess withheld for punitive reasons (American Alliance for Health, P.E., 2012). The Council on School Health (2013) implores educators not to use limiting recess time as punishment. Further, since the recommended number of steps per day for school aged children ranges from 10,000 to 16,500 (Brusseau, Tudor-Locke, & Kulinna, 2013), schools should be careful not to inhibit students from reaching this target amount by purposefully limiting their time to be active.

Physical activity can be regularly incorporated in the form of classroom activities, gym class, and recess (Brusseau & Hannon, 2015). Strategically scheduling structured physical activity directly prior to academic instruction has been related to consistent academic progress in reading and mathematics for intermediate elementary students with intellectual disabilities (Everhart et al., 2012). Further, a study conducted with 1,780 school age youth, found that time spent on physical activity within the school day does not detract from student academic achievement (Esteban-Cornejo, Martinez-Gomez, Garcia-Cervantes, Ortega, Delgado-Alfonso, Castro-Pinero, & Veiga, 2017).

Elementary teachers can provide time for physical activity for students by incorporating movement into academic concepts (Snyder, Dinkel, Schaffer, Hiveley, & Colpitts, 2017). Jensen (2008b) suggested integrating movement throughout the learning process. One study found that incorporating physical activity into academic content significantly improved students' attention to task directly following the physical activity (Mahar, 2011). A study of third grade students who either participated in a traditional mathematics class or one which incorporated movement had similar results (Snyder et al., 2017). This study found that students who participated in movement activities during mathematics class demonstrated more on-task behaviors (Snyder et al., 2017). In one study, 35 upper elementary students completed two sessions of mathematics practices (Vazou & Smiley-Oyen, 2014). One session was of seated mathematics practice and the other 10 minute session included mathematics practice in which physical activity was integrated. Results showed that students' performance on mathematics problems was higher after the session of mathematics integrated with physical activity (Vazou & Smiley-Oyen, 2014). Further, students reported enjoying the mathematics practice integrated with physical activity more than seated mathematics practice (Vazou & Smiley-Oyen, 2014).

While some research studies show positive associations between lessons in which movement is incorporated, other studies either do not show these same results or show results that vary based on the grade level. In one study, second and third grade students either participated in traditional mathematics and reading lessons, or they participated in 10-15 minute mathematics and reading lessons which incorporated physical activity. For example, students completed activities that involved things such as jumping while giving the answer to a mathematics problem. Results showed that second grade students who participated in the sedentary mathematics lessons scored higher on the posttest than the second grade students who

participated in mathematics lessons incorporating physical activity. Results for third grade students showed an opposite effect. Third grade students who participated in the physical activity mathematics group scored significantly higher than students in the control group on the mathematics posttest than third grade students in the control group (Mullender-Wijnsma, Hartman, de Greeff, Bosker, Doolaard, & Visscher, 2015). In another study, in which the 499 participants were also second and third grade students, one group of students participated in three physical activity integration lessons per week, such as squatting while spelling words and doing jumping jacks while repeating multiplication facts, over the span of two school years. No significant difference in the executive functions of this group, as compared with the control group of students, were found (de Greeff, Hartman, Mullender-Wijnsma, Bosker, Doolaard, & Visscher, 2016).

Another way teachers can provide physical activity to students, while maintaining the required amount of daily instructional time, is allowing students breaks to move and stretch in the classroom. In one study, fourth grade students were given one to three 10 minute physical activity breaks throughout the day (Bershwinger & Brusseau, 2013). These breaks were teacher led and consisted of activities such as indoor and outdoor games, jumping jacks, and walking breaks. Participating in these breaks significantly increased the total number of steps of students in these classes, as compared to peers in classrooms not utilizing physical activity breaks (Bershwinger & Brusseau, 2013). Scheduling short durations of physical activity throughout the school day can positively impact student academic performance (Howie et al., 2015; Phillips et al., 2015). In one study, 97% of 116 Oregon teachers surveyed agreed that physical activity breaks during the school day were important, and 91% felt that five to seven minutes of physical activity improved their students' concentration (Perera, Frei, Frei, & Bobe, 2015). Results from

a study in which 460 upper elementary students either participated in a typical schedule, or one that incorporated four different five minute activity breaks throughout the day, showed that participating in physical activity breaks improved achievement in mathematics and reading (Fedewa et al., 2015).

While these classroom activity breaks prove to be beneficial, time may be a barrier to implementation. In one qualitative study, upper elementary classes participated in five, ten, and twenty minute breaks. Students and teachers in these classes were surveyed in regards to their participation in these breaks. Students reported that they enjoyed the breaks and found them beneficial. Teachers also reported that the breaks were beneficial to students but reported concerns implementing these types of breaks regularly due to lack of time within the school day (Howie, Newman-Norlund, & Pate, 2014).

Since the benefits of acute physical activity and recess are numerous, physical activity and recess should be scheduled strategically within and throughout the school day (Mahar, 2011), and breaks should be given frequently (Kohl & Cook, 2013a). While both physical education classes and recess provide students with the opportunity to be physically active, physical education classes are not the same as providing students with a recess break, even though they are sometimes treated as such by educators and policy makers. One study, with a sample size of 1,761 schools across 47 of the states within the United States, found that there was an inverse relationship between the amount of time schools provided for recess and the amount of time schools provided for physical education class (Slater, Nicholson, Chriqui, Turner, & Chaloupka, 2012). Research suggests that physical activity during unstructured breaks may have a greater impact, due to the voluntary nature of participation, in comparison to forced physical activity (Jensen, 2016b; Jensen, 2017; Ratey, 2008). Further, while physical

activity can occur at recess, much like it does in physical education class, the two are not synonymous, nor do they serve the same purpose. Rather than providing students with a cognitive break, physical education classes, like core content areas, have standards that are designed to place rigorous demands on students (Pellegrini, 2005).

In order to maximize the benefits of recess, breaks should be scheduled at regular intervals throughout the day. Doing this will help students focus better during instruction (Ramstetter et al., 2010). Since young children are more attentive to cognitive tasks after receiving a break (Bjorklund & Greene, 1992; Pellegrini & Bohn, 2005), educators should schedule recess prior to core academic content.

Summary

Brain-based learning theory and the cognitive immaturity hypothesis support the importance of recess in elementary schools in regards to academic achievement, particularly in the area of mathematics. Recess provides the opportunity for elementary students to take a break from the sedentary tasks in the classroom and participate in physical activity. Among the many benefits of physical activity are increases in cognitive function and academic performance for school age children.

Few studies have looked at the effect recess has on academic achievement in mathematics. Furthermore, no study has examined the effect on third grade students' academic achievement in mathematics in relation to scheduling mathematics class after an unstructured recess break. To help fill this gap in the literature, the study sought to compare student achievement on the Third Grade Mathematics Standard of Learning Assessment, which is mandatory in Virginia, for third grade students in classes where mathematics class is scheduled directly after recess, with students in classes in which mathematics class is not scheduled directly

after recess. The study will also analyze whether there are significant differences between the assessment scores of male and female students.

Third grade is the grade in which many states start taking high stakes, cumulative assessments (Byrd, 2007). Therefore, this study was conducted with third grade students. Due to these assessments, and the pressure on students, teachers, and schools to achieve academically, opportunities for recess time are often being reduced (Pellegrini & Bohn, 2005). Knowing the benefits of physical activity and recess breaks on student cognition, attention, and academic achievement could help elementary administrators and teachers make scheduling decisions that strategically promote mathematics achievement.

Chapter Three will begin with a discussion of the research design and statement of the research questions and null hypotheses. Next, a detailed description of the participants, setting, instrumentation, and procedures will be provided. The chapter will conclude with an explanation of the data analysis.

CHAPTER THREE: METHODS

Overview

In this chapter, the researcher will discuss the research design, research question, and null hypotheses for the study regarding the scheduling of third grade mathematics in relation to an unstructured recess break for male and female students. The participants, setting, instrumentation, and procedures will be described. Finally, the researcher will explain the data analysis that was used.

Design

This research study used a causal-comparative research design since the data was collected after the fact, and the researcher was seeking to ascertain if there is a cause and effect relationship between the groups determined by the independent variables and the dependent variable (Gall, Gall, & Borg, 2007). The data the researcher collected were archived student scores on the Third Grade Mathematics Standards of Learning Assessment (an end of year state-required assessment in Virginia) and the archived class schedules. The researcher investigated if there was a relationship between the students' schedule, specifically looking at when mathematics class occurs in relation to recess, and the students' Third Grade Mathematics Standards of Learning Assessment scores. This research design is appropriate because the researcher did not manipulate any groups.

The data analysis utilized a two-way analysis of variance (ANOVA) as there were two independent variables, the timing of mathematics instruction in relation to recess and gender, and one dependent variable, the Third Grade Mathematics Standard of Learning Assessment scores. The researcher included the second independent variable, gender, because research results are mixed in this regard. While some research suggests that physical activity may have a more

substantial positive effect on academic achievement for male students (Ericsson & Karlsson, 2014; Harveson et al., 2016; Torrijos-Nino et al., 2014), other research suggests that physical activity breaks have a more significant impact on the mathematics achievement of female students (Howie et al., 2015; Phillips et al., 2015).

In order to study the impact that recess may have on third grade students' mathematics achievement, the researcher collected data from the Third Grade Mathematics Standards of Learning Assessment and the class schedules for participating schools. The researcher looked for differences among scores of students who received mathematics instructions directly after an unstructured recess break as opposed to students who did not have an unstructured recess break directly prior to mathematics instruction. Furthermore, the researcher looked for differences in the scores on the Third Grade Mathematics Standards of Learning Assessment for male and female students.

Research Question

RQ: Is there a significant difference between the Third Grade Mathematics Standards of Learning Assessment scores of male and female third grade students who do not take mathematics class directly after an unstructured recess break with those students who do take mathematics class directly after an unstructured recess break?

Hypotheses

$H_0$1: There is no significant difference between the mathematics achievement scores of male and female third grade students.

$H_0$2: There is no significant difference between the mathematics achievement scores of third grade students who did not take mathematics class directly after an unstructured recess

break and those students who did take mathematics class directly after an unstructured recess break.

$H_0$3: There is no significant difference between the mathematics achievement scores of third grade male students who did not take mathematics class directly after an unstructured recess break and third grade male students who did take mathematics class directly after an unstructured recess break.

$H_0$4: There is no significant difference between the mathematics achievement scores of third grade female students who did not take mathematics class directly after an unstructured recess break and third grade female students who did take mathematics class directly after an unstructured recess break.

Participants and Setting

The participants for this study were drawn from a convenience sample of elementary school students in one school division in Region 5 of Virginia during the 2016-2017 school year. This is a convenience sample because the researcher lives and works in close proximity to the school division in which the research took place. Of the 9,707 students, 0.2% are American Indian; 1.9% are Asian; 7.4% students are Black; 3.5% students are Hispanic; 0.1% are Native Hawaiian; 82.4% students are White; and 4.4% are two or more races (Virginia Department of Education School Quality Profiles, 2016). More diverse than skin color is the socioeconomic status of students. The elementary schools in this school division are located in a region containing low, middle, and high socioeconomic statuses, as well as students from rural and suburban areas. The school division is categorized into three different zones. One of the three zones consists of predominantly middle class and affluent families. In the other two zones, all of

the elementary schools are classified as Title I schools, meaning that at least 40% of the student population comes from low-income families (Virginia Department of Education, 2017b).

The researcher purposefully used the data, conveniently obtained, for students who fell into the two mathematics instruction timing groups. Using a statistical power of 0.7 and alpha at the .05 level of significance, the sample size (*N*) for a medium effect size is 144 (Gall et al., 2007). Participants were third grade students. During the 2016-2017 school year there were 689 third grade students in this school division (Virginia Department of Education School Quality Profiles, 2016). In this school division there are 13 elementary schools, 12 of which include students in the third grade. The size of the schools vary. Three schools have five third grade classes; three schools have three third grade classes; and the remaining six schools have two third grade classes each. While physical education courses are only scheduled once or twice per week for elementary students in this school division, all elementary schools are required to schedule daily recess. Per the school board policy and associated rule, all elementary students in this school division receive at least 10 minutes of recess per day (School Division A, 2001).

The researcher chose to conduct this study using third grade participants as high stakes assessment and accountability often begins in third grade (Byrd, 2007). This is true in Virginia, as third grade is the first year that students take a Standards of Learning Assessment (Virginia Department of Education, 2017a). Further, previous studies have discussed the impact that recess has on academic achievement of students in the primary grades (Becker et al., 2014; Haapala et al., 2014; Rhea et al., 2016) and in the fourth and fifth grades (Howie et al., 2015; Moyer, 2014).

Instrumentation

The Virginia Third Grade Mathematics Standards of Learning Assessment was used as the instrument in this research. This assessment was 28 questions in length and included questions pulled from any standard within the written third grade curriculum, as provided by the Virginia Department of Education (VDOE). Assessment items varied in formats including multiple choice, fill in the blank, drag and drop, and select all. The Standards of Learning Assessment scores were broken into categories on a scale from 0 to 600. Students must have attained a minimun score of 400 to have passed. To meet state accreditation standards, schools were required to meet the benchmark of at least 70% or have maintained a three-year average of 70% or higher of students have passed this assessment (Virginia Department of Education, 2016a).

The Third Grade Mathematics Standards of Learning Assessment was first given in 1998. The purpose of the assessment was to monitor students' progress and academic achievement (Virginia Department of Education, 2016a). Since that time, the content of the Standards of Learning and the Standards of Learning Assessment has been revised several times. The measurement was valid and reliable. There were two core versions of the assessment, both of which assessed the same content and were identical in number of questions. In the technical reports provided by the VDOE, both core versions of the assessment had a Cronbach's alpha of 0.87 and 0.89, respectively (Virginia Department of Education, 2017a).

The Third Grade Mathematics Standards of Learning Assessment was appropriate to use for this research because it measured third grade students' academic achievement of the third grade Standards of Learning. The Standards of Learning curriculum is required of all public elementary schools in Virginia. Further, the Third Grade Mathematics Standards of Learning

Assessment was taken at the same time of the year under controlled conditions for students regardless of elementary school or school division. The examiners manual provided step by step instructions for the administration of the assessment, a script of what should be read to the students, and the type of scratch paper and writing utensils the students used. Guidelines for the physical space in which the test was administered included requirements such as the removal of curriculum materials, an area that is well lit and had minimum crowding, and having ensured the students' workspaces were void of any unauthorized materials (Virginia Department of Education, 2018). Finally, the use of a Standards of Learning Assessment was appropriate because these assessments have been used as an instrument in other recent research studies regarding student academic achievement (Fox, 2014; Lewis, 2013; Linehan, 2012).

Procedures

The researcher began by contacting the superintendent of the school division in which the researcher conducted this study by written letter. This letter contained pertinent information about the research and asked permission for the researcher to conduct research within the school division. The researcher then sought approval from Liberty University's Institutional Review Board (IRB) (see Appendix A). Once the researcher received approval from the division superintendent and Liberty University's IRB, the researcher asked the responsible school board office personnel for copies of the third grade master schedules for the 2016-2017 school year. Next, the researcher contacted the division testing office to acquire the archived Third Grade Mathematics Standards of Learning Assessment results for the 2016-2017 school year. This data included student assessment scores, school, teacher, and gender. In order to ensure student anonymity, student names were not included in the data file. Upon acquiring all data, the researcher stored the information on a password protected laptop.

The researcher used the school schedules to sort the third grade students into the independent variable categories of mathematics class occurring directly after an unstructured recess break, and students in mathematics classes not occurring directly after an unstructured recess break. The researcher conducted data analysis during the 2017-2018 school year. The researcher was unable to use the data collected from one of the 12 elementary schools. In this school, some students received mathematics class directly after an unstructured recess period and other students did not receive mathematics class directly after an unstructured recess break. Based on the assessment data and the master schedule provided, it was impossible for the researcher to determine which students fell into which group.

Data Analysis

This causal comparative study had two independent variables. These variables were gender and the scheduling of mathematics class in relation to recess. Within each independent variable there were two groups. Student gender was reported as either male or female, and scheduling of mathematics class in relation to recess was separated into mathematics class directly after an unstructured recess break or mathematics class not occurring directly after an unstructured recess break. A two-way ANOVA was used to analyze the data. Using an ANOVA was appropriate because there is one continuous dependent variable and the researcher wanted to compare the means across two groups (Warner, 2013). Specifically, a two-way ANOVA was appropriate due to the fact that the researcher wanted to compare the means across the two groups and among gender subgroups. Once the researcher collected the data, it was sorted and screened for inconsistencies and outliers using a box and whisker plot (Warner, 2013).

In order to conduct a two-way ANOVA, certain assumptions need to be met. The first assumption is the Assumption of Normality. The researcher used the Kolmogorov-Smirnov, a

test used to determine whether or not the sample distribution differs significantly from a normal distribution, because the sample is greater than 50. Next, the researcher used Levene's Test of Equality of Error Variance to test the Assumption of Equal Variance, which assumes that the population distributions have the same variances. Finally, the observations, gender, and the timing of mathematics in relation to unstructured recess, were each independent, and the level of measurement for the dependent variable was on a continuous scale (0-600). The researcher reported eta squared, η2, a description of the proportion of variance (Warner, 2013). If the null had been found significant, using the *F* statistic, which conveyed overall significant differences in group means, then the researcher would proceed with the post hoc analysis and conduct a Tukey, to see which means differed significantly (Warner, 2013). The results of the data analysis will be presented in Chapter Four.

CHAPTER FOUR: FINDINGS

Overview

In this chapter the research question and null hypotheses will be provided. An overview of the findings will be presented. Lastly, the results of the data analysis will be discussed.

Research Question

RQ: Is there a significant difference between the Third Grade Mathematics Standards of Learning Assessment scores of male and female third grade students who do not take mathematics class directly after an unstructured recess break with those students who do take mathematics class directly after an unstructured recess break?

Null Hypotheses

$H_0$1: There is no significant difference between the mathematics achievement scores of male and female third grade students.

$H_0$2: There is no significant difference between the mathematics achievement scores of third grade students who did not take mathematics class directly after an unstructured recess break and those students who did take mathematics class directly after an unstructured recess break.

$H_0$3: There is no significant difference between the mathematics achievement scores of third grade male students who did not take mathematics class directly after an unstructured recess break and third grade male students who did take mathematics class directly after an unstructured recess break.

$H_0$4: There is no significant difference between the mathematics achievement scores of third grade female students who did not take mathematics class directly after an unstructured

recess break and third grade female students who did take mathematics class directly after an unstructured recess break.

Descriptive Statistics

There were 610 third grade student participants in this study (*N*=610). Student assessment scores fell on a continuous scale ranging from a score of 207 to a score of 600. The table below includes number of participants, mean scores, and median scores for the total sample and for each of the sub groups.

Table 1
Descriptive Statistics

	Participants	Mean Score	Median Score
Female	299	408	411
Male	311	427	433
Recess	95	420	417
Not Recess	515	418	423
All Participants	610	418	422

Results

A two-way ANOVA was conducted to examine the effects of gender and timing of an unstructured recess period in relation to mathematics class on the Third Grade Mathematics Standards of Learning assessment. The assumption testing and the results from the two-way ANOVA are described in the following sections.

Assumption Tests

The dependent variable, the Third Grade Mathematics Standards of Learning Assessment scores, was measured on a continuous scale (0-600). The two independent variables, the timing

of mathematics instruction in relation to an unstructured recess period and gender, were categorically independent of one another. Further, no student fell in more than one of the four independent categories: female with mathematics directly after an unstructured recess period, female with mathematics not directly after an unstructured recess period, male with mathematics directly after an unstructured recess period, or male with mathematics not directly after an unstructured recess period.

A box-and-whisker plot was utilized to determine extreme outliers in the data. Three extreme outliers were removed from the data set. The first data point excluded was an assessment score of 964. The highest possible score on this assessment is 600, indicating an error with this data entry. Two data points of assessment scores listed as zero were also excluded from this study, because scores of zero indicated that the student did not take the assessment. After the removal of these three data points, another box-and-whisker plot was generated (see Figure 1). Additional outliers were not removed as they were viable scores on this assessment.

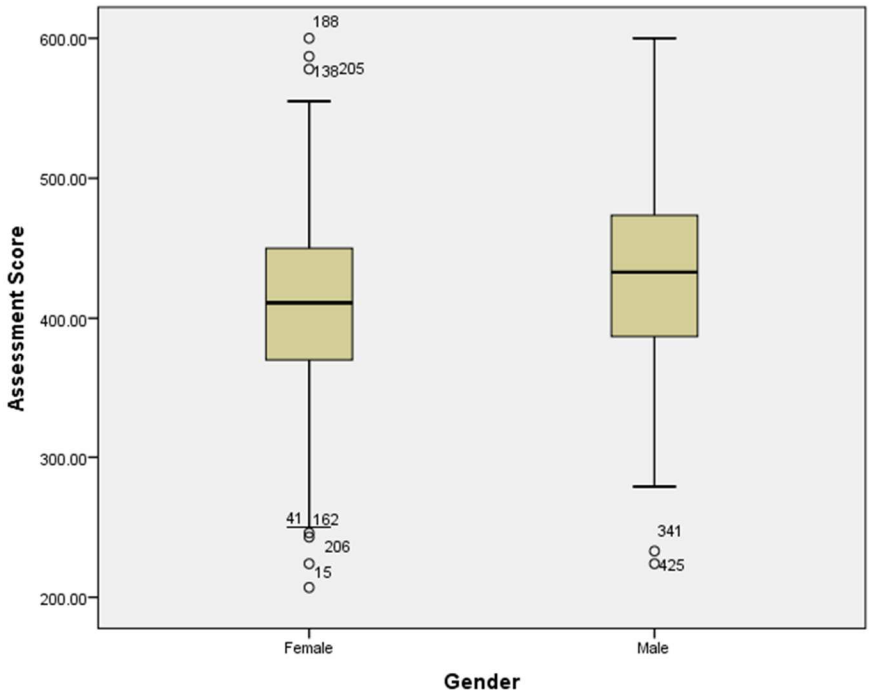

Figure 1. Box-and whisker plot of Third Grade Mathematics Standards of Learning Assessment scores

A Kolmogorov-Smirnov was used to test the Assumption of Normality. The results showed $p = .173$ indicating that the data was normally distributed. There was homogeneity of variance, as assessed by Levene's Test of Equality of Error Variance, $p = .223$.

Hypotheses

After study of the outliers, normality, and variance, a two-way ANOVA was utilized to study the research question. The criteria for rejection of the null hypotheses was a significance level of $p < .05$. The following sections discuss the results of the two-way ANOVA and the decisions regarding the rejection, or acceptance, of each null hypothesis.

Results for Null Hypothesis One. $H_0$1: There is no significant difference between the mathematics achievement scores of male and female third grade students.

There was a statistically significant main effect of gender, $F(1, 606) = 10.515$, p = .001, partial $\eta^2 = .017$. The means for the Third Grade Mathematics Standards of Learning Assessment were 406.751 (SE= 5.220) for female students and 429.776 (SE = 4.813) for male students, a statistically significant mean difference of 23.025, 95% CI [9.080, 36.969], $p = .001$. As a result of this data analysis, the null hypothesis was rejected. There was a significant difference between the mathematics achievement scores of male and female third grade students.

Results for Null Hypothesis Two. $H_0$2: There is no significant difference between the mathematics achievement scores of third grade students who did not take mathematics class directly after an unstructured recess break and those students who did take mathematics class directly after an unstructured recess break.

The null hypothesis was retained. There was no statistically significant difference in assessment scores for students receiving mathematics class directly after an unstructured recess break and students who did not receive mathematics class directly after an unstructured recess break, $F(1, 606) = .051$, $p = .822$, partial $\eta^2 < .001$.

Results for Null Hypothesis Three. $H_0$3: There is no significant difference between the mathematics achievement scores of third grade male students who did not take mathematics class directly after an unstructured recess break and third grade male students who did take mathematics class directly after an unstructured recess break.

The interaction effect between gender and timing of mathematics class in relation to an unstructured recess period was not statistically significant $F(1, 606) = .452$, $p = .502$, partial $\eta^2 = .00$. Therefore, the null hypothesis was retained.

Results for Null Hypothesis Four. $H_0$4: There is no significant difference between the mathematics achievement scores of third grade female students who did not take mathematics class directly after an unstructured recess break and third grade female students who did take mathematics class directly after an unstructured recess break.

The interaction effect between gender and timing of mathematics class in relation to an unstructured recess period was not statistically significant $F(1, 606) = .452$, $p = .502$, partial $\eta^2 = .00$. There is not enough evidence to reject the null hypothesis.

In Chapter Five, the researcher will discuss the results of this causal comparative study, as well as implications and limitations. The researcher will also make recommendations for future research on the topic of unstructured recess breaks and academic achievement.

CHAPTER FIVE: CONCLUSIONS

Overview

In this chapter the purpose of the study will be reviewed. The results of this study, in context of recent literature, will be discussed. Implications and limitations of this study will be provided. Finally, the researcher will make recommendations for future research related to the topic of unstructured recess breaks and academic achievement.

Discussion

The purpose of this causal comparative study was to test the theory of the impact of recess in elementary school that relates the scheduling of mathematics directly after recess time to achievement on standardized mathematics assessments, controlling for grade level and assessment type, for third grade students attending elementary schools located in Central Virginia. Archived Third Grade Mathematics Standards of Learning Assessment scores and master schedules for all elementary schools in one school division were collected for the 2016-2017 school year. The master schedules were used to sort the students into two categories: students in mathematics classes occurring directly after an unstructured recess break and students in mathematics classes not occurring directly after an unstructured recess break. The research used a two-way ANOVA to analyze the data.

This study sought to address the following research question: Is there a significant difference between the Third Grade Mathematics Standards of Learning Assessment scores of male and female third grade students who do not take mathematics class directly after an unstructured recess break with those students who do take mathematics class directly after an unstructured recess break? While the researcher predicted that an unstructured recess break directly prior to a mathematics class would improve students' mathematics academic

achievement, the results of the data analysis indicated that there was not a significant difference in the mean assessment scores.

Null Hypothesis One

$H_0$1: There is no significant difference between the mathematics achievement scores of male and female third grade students. Results of this study showed that there was a significant difference between the mathematics achievement scores of male and female third grade students. Male students scored significantly higher than female students. This unanticipated finding is supported by previous studies whose results showed that male students have significantly higher mathematics achievement than female students (Cheema, & Galluzzo, 2013; Lonnemann, Linkersdörfer, Hasselhorn, & Lindberg, 2013; Wei, Liu, & Barnard-Brak, 2015). However, one study found no significant difference in mathematics achievement of male and female students (Scheiber, Reynolds, Hajovsky, & Kaufman, 2015).

Null Hypothesis Two

$H_0$2: There is no significant difference between the mathematics achievement scores of third grade students who did not take mathematics class directly after an unstructured recess break and those students who did take mathematics class directly after an unstructured recess break. This study did not find a significant difference in the mean scores based on timing of mathematics class in relation to an unstructured recess.

The cognitive immaturity hypothesis emphasizes the importance of young students taking breaks from cognitive tasks (Pellegrini & Bohn, 2005). Further, the brain-based learning theory purports the academic benefits of breaks, but also emphasizes the academic benefits of physical activity (Jensen, 2017). In light of this theoretical framework, the researcher predicted that an

unstructured recess break, which provides the opportunity for both a break from cognitive demands and a chance to be physically active, would increase the mean scores of students.

Despite no significant differences in the mean score of students taking mathematics directly after an unstructured recess and the mean score of students not taking mathematics directly after an unstructured recess period, current research suggests that strategically timed breaks from academic content are beneficial to students (Howie et al., 2015; Phillips et al., 2015). One of the benefits of recess is gains in academic achievement (Council on School Health, 2013; Pellegrini, 2008; Pellegrini & Bohn, 2005; Ramstetter et al., 2010; Yesil Dagli, 2012). Previous studies reported academic benefits of both regular physical activity (Andersen et al., 2016; Coe et al., 2013; Lorenz et al., 2017) and directly after acute bouts of physical activity (Everhart et al., 2012; Fedewa et al., 2015; Pontifex et al., 2013). Multiple recent studies showed that students were more physically active during recess than in physical education classes (Gao et al., 2015; Gutierrez et al., 2016; Hall-López et al., 2017).

However, similar to the findings of this research, one recent study did not find positive mathematics achievement gains directly following a recess period. This study found that high school students who participated in physical activity directly prior to mathematics class saw academic gains, but students who participated in recess directly prior to mathematics class were significantly less engaged than students who had mathematics after another period (Owen et al., 2018).

Null Hypothesis Three

$H_0$3: There is no significant difference between the mathematics achievement scores of third grade male students who did not take mathematics class directly after an unstructured recess break and third grade male students who did take mathematics class directly after an

unstructured recess break. While the mean score of male students who had mathematics directly after an unstructured recess break was higher than male students who did not have mathematics directly after an unstructured recess break, it was not a significant difference.

Current research suggests that male students are more active than female students during unstructured recess periods (Baquet et al., 2014; Frago-Calvo et al., 2017; Gutierrez et al., 2016; Jaunzarins et al., 2014; Kobel et al., 2015; Roberts et al., 2013; Shervey & DiPerna, 2017; Springer et al., 2013; Woods et al., 2015). Further, research supports that there are cognitive benefits of acute bouts of physical activity (Alves, et al., 2012; Chang, et al., 2014; Kohl & Cook, 2013b). Thus, the researcher expected male students who participated in mathematics class directly after an unstructured recess break to have higher mathematics achievement scores than their male peers who did not have mathematics class directly after an unstructured recess break.

Null Hypothesis Four

$H_0$4: There is no significant difference between the mathematics achievement scores of third grade female students who did not take mathematics class directly after an unstructured recess break and third grade female students who did take mathematics class directly after an unstructured recess break. This study did not find significant differences in the mean scores of female students. This was somewhat contrary to current research findings, which indicated that female students benefited more academically from physical activity breaks than male students (Howie et al., 2015; Phillips et al., 2015).

Conclusions

Findings from this study did not indicate that unstructured recess breaks had a significant impact on the mathematics achievement of third grade students of either gender. These findings

are contrary to the researcher's initial expectations and much of the current literature on the topic. This research did not attempt to study any other dependent variables, aside from mathematics achievement on a standardized assessment, and cannot account for the possibility of other benefits of unstructured recess breaks. Current literature, however, indicated numerous benefits directly after acute bouts of physical activity including increased attention span (Miramontez & Schwartz, 2016; Tine & Butler, 2012), improved executive function (Chen et al., 2014), and improved performance in mathematics (Pontifex et al., 2013). Unstructured recess breaks provide elementary students with a break from the academic challenges of the school day, allow for time to participate in physical activity, and contribute to the overall health and well-being of the child.

Implications

While there was no significant difference between the Third Grade Mathematics Standards of Learning assessment scores for students who had mathematics class directly after an unstructured recess break and students who did not have mathematics class directly after an unstructured recess break, these findings contributed to the existing body of literature. Educators should consider many factors, both academic and non-academic, when creating school day schedules. Results of this research showed that male students scored significantly higher than female students on the Third Grade Mathematics Standards of Learning Assessment. In light of this finding, educators should be intentional in providing an equitable mathematics education to all students. Equity in mathematics includes providing all students access to appropriate and quality math programs and offerings that maximize the students potential while providing necessary supports and addressing individual student needs. Further, student engagement, through instructional strategies that promote critical thinking and the use tasks that are relevant

to the students is essential to promoting an equitable mathematics education (Virginia Department of Education, 2016b).

Limitations

This study examined the impact that the timing of unstructured recess breaks in relation to mathematics class had on student achievement on a standardized mathematics assessment. When interpreting the results, it should be noted that this study utilized a causal-comparative design and archived data. There are several limitations that are important to consider when interpreting the results of this study.

The first limitation is that the researcher had no control over adherence to the daily school schedule or teaching practices. Teachers may have chosen to vary their class's schedule periodically. In addition, teachers may have withheld recess from students as a form of punishment or to have the students finish school work. The frequency of such instances was unknown to the researcher and may have impacted the results. Further, this research did not account for other variables such as, but not limited to, teaching practices, student-teacher ratio, and curriculum resources.

A second limitation to consider when applying the results of this study is that this study only took into consideration the timing of recess, not the physical activity that students may or may not have participated in during the unstructured recess break. Additionally, other schedule considerations, such as whether mathematics class was early or late in the school day, after another core subject, or after a non-academic time such as lunch, were not taken into account in this research study.

Another limitation to this study was that only one assessment measure was used. Standardized assessment measures do not always accurately measure students' ability or

knowledge, as variables such as test anxiety may influence outcomes. Further, assessments such as this do not account for individual student growth.

Recommendations for Future Research

This research focused on how the timing of unstructured recess breaks in relation to mathematics class impacted the mathematics achievement of students on the Third Grade Mathematics Standards of Learning Assessment. More research is needed in regards to the impact that strategically scheduling breaks within the school day could have on student academic achievement. Recommendations include:

1. Future research should utilize different methods of assessment. The assessment measure in this study was a one-time assessment given at the end of the year. Future studies could utilize multiple measures to show student growth.
2. Future research could examine the effects of recess, controlling for teacher, by using departmentalized schools in which one group of students had mathematics directly after recess and one or more classes did not, but were taught by the same teacher.
3. Another suggestion for future research would be to examine the amount of time, both length of period and number of periods, students participated in unstructured recess breaks and the potential impact on mathematics achievement.
4. Future research could focus on the effects of having mathematics class after a structured physical activity break, such as a daily physical education class.
5. Finally, further research in regards to gender differences in elementary mathematics should be explored in light of unstructured recess breaks and physical activity.

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APPENDIX

Appendix A: IRB Approval

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

February 22, 2018

Sarah Danaher

IRB Application 3182: Scheduling of Recess before Mathematics and Third Grade Students' Mathematics Achievement in Virginia: A Causal Comparative Study

Dear Sarah Danaher,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study does not classify as human subjects research. This means you may begin your research with the data safeguarding methods mentioned in your IRB application.

Your study does not classify as human subjects research because it will not involve the collection of identifiable, private information.

Please note that this decision only applies to your current research application, and any changes to your protocol must be reported to the Liberty IRB for verification of continued

non-human subjects research status. You may report these changes by submitting a new application to the IRB and referencing the above IRB Application number.

If you have any questions about this determination or need assistance in identifying whether possible changes to your protocol would change your application's status, please email us at irb@liberty.edu.

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