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## The Effect of Classroom Physical Activity Breaks on Students' Academic Performance and Executive Functioning Skills

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THE EFFECT OF CLASSROOM PHYSICAL ACTIVITY BREAKS ON STUDENTS'  
ACADEMIC PERFORMANCE AND EXECUTIVE FUNCTIONING SKILLS

A MASTER'S THESIS  
SUBMITTED TO THE FACULTY  
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BY  
BARB DIEMER

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS  
FOR THE DEGREE OF  
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THE EFFECT OF CLASSROOM PHYSICAL ACTIVITY BREAKS ON STUDENTS'  
ACADEMIC PERFORMANCE AND EXECUTIVE FUNCTIONING SKILLS

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APPROVED

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## Abstract

Classroom-based Physical Activity (PA) has gained attention among teachers and schools due to the potential to enhance learning while also providing the opportunity for children to increase their physical activity level. Children are not meeting the recommended amount of daily physical exercise and the increase in obesity is alarming. Implementation of PA breaks at school has been identified as a way to address the need for more physical activity as well as providing an intervention to target learning. Classroom breaks that have been studied include active learning, which takes place by combining PA with academic material or breaks that are solely exercised in nature, free from academic content. Positive relationships have been seen with the implementation of classroom breaks on academic performance and executive functioning skills. The increased diagnosis of Attention Deficit Hyperactivity Disorder (ADHD) among children and adolescents has also received attention as teachers face the challenge of meeting the needs of students struggling with executive functioning deficits related to ADHD as well as other diagnosed disabilities. Teachers are faced with time constraints of providing the opportunity for movement while also being under pressure to dedicate the prescribed amount of time towards core content such as English, math, and science. This literature review looks at studies that have investigated the effects of classroom-based PA breaks on academic performance, executive functioning skills, and the impact on students with disabilities. Results have shown a positive relationship between physical activity and academic performance. These promising findings also show a noticeable impact on the lowest level learners and students with a diagnosed disability.

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## CHAPTER I: INTRODUCTION

More than 200 years ago, Thomas Jefferson provided a message of advice in a letter to his nephew. The message had a heavy focus on education and exercise. Along with urging diligent studying, Jefferson specifically addressed the necessity of taking breaks from academic efforts to exercise. The letter stated “health must not be sacrificed to learning. A strong body makes the mind strong.” (Mullins et al., 2019, 140). This is good advice to live by, but with the way education has changed over the years, there is limited time for exercise in the school setting.

### **No Child Left Behind Legislation**

In 2001, the No Child Left Behind Act (NCLB) was enacted to close the achievement gap and hold schools accountable for the achievement of all students (Mullins et al., 2019). The federal government mandated numerous accountability measures, but for the purpose of this research, the measure highlighted is standardized testing. This law put into place the mandate for all states to have proficiency tests in place to measure student achievement. With standardized testing, the focus became academic core subjects like English, math, and science. More time was allocated for these subjects and the reduction in support for school for physical education classes occurred in part to the No NCLB Act of 2001. Since the passage of the NCLB in 2001, 44% of elementary schools in the United States have reduced physical education and recess time (Savina et al., 2016).

### **Centers for Disease Control and Prevention Recommendations**

The Centers for Disease Control and Prevention (CDC) recommends that children engage in 60-minutes a day of moderate to vigorous exercise; however, many children



are falling well short of this recommended amount of activity (Stoepker et al., 2018).

With the increased pressure placed on academic achievement, opportunities for students to be physically active at school have declined. Stoepker et al. (2018) reported that since 1980, childhood obesity rates have tripled, with rates of obesity among 6 to 11-year-old children doubling from 7% to 17.5% and rates of obesity among teens quadrupling from 5% to 20.5%. This alarming trend has led researchers to investigate what interventions can take place to increase children's physical activity (PA) levels. Schools have been identified as a primary source for promoting physical activity, given the amount of time in a child's day is spent at school. Finding ways to replace some of the sedentary time that occurs during traditional instruction is the challenge. Methods of increasing school day PA such as classroom physical activity, brain breaks, brain booster, or active learning involves taking a short pause in the standard lesson to be physically active or to integrate PA into the lesson. There is promise for these types of intervention, but the thought remains among educators and school leaders that increasing time spent on PA will threaten academic achievement (Ma et al., 2014).

### **Executive Functioning Deficits**

This researcher sees a large number of students that have executive functioning deficits. Deficits across many different disability labels are noted and when special education evaluations take place, a large portion of information gathered through interviews, surveys, and observation surrounds executive functioning and the impact on school performance. The classroom setting can present many challenges to students, especially those diagnosed with Attention Deficit Hyperactivity Disorder (ADHD). Educators are continually looking for strategies and interventions to meet the needs of

students and foster their academic achievement. Research teams have found that children's executive functioning skills predict academic achievement over the early elementary years and through adolescence (Raver & Blair, 2016).

### **Research Questions**

This paper will address the following questions: How does physical activity influence executive functioning skills among children in the classroom setting? What are executive functioning skills? What does physical activity look like within the classroom, and what is its impact on academic achievement?

### **Key Terms**

A common term that is so often heard in the education field is executive functioning. What is executive functioning? Researchers generally characterize executive functioning as a specific set of attention regulation skills involved in conscious goal directed problem solving (Zelazo et al., 2016). Consider a typical school day and the many demands placed on students. There are numerous expectations such as being on time, keeping an organized locker, paying attention, completing work on time, recalling information learned, avoiding distractions, regulating reactions to situations, and the list goes on. Executive functioning skills make it possible to meet these challenges and sustain attention, keep goals and information in mind, refrain from responding immediately, resist distraction, tolerate frustration, consider the consequences of different behaviors, reflect on past experiences, and plan for the future (Zelazo et al, 2016). Three executive functioning skills that are the foundation of both children's and adults' abilities to carry out daily responsibilities include cognitive flexibility, working memory, and inhibitory control (Raver & Blair, 2016).

Cognitive flexibility involves thinking about something in multiple ways.

Examples include considering someone else's perspective or thinking of multiple ways to solve a math problem (Zelazo et al., 2016). Many students have difficulty coming up with a solution when schedules change or when something they plan for does not fit their expectation. Working memory involves both keeping information in mind and manipulating it in some way. An example of the use of working memory would be a reader taking information after reading a passage and integrating several key ideas to explain or summarize what was in the passage (Zelazo et al., 2016). Inhibitory control is the process of deliberately suppressing attention, and subsequently responding to something. This involves ignoring a distraction, stopping an impulse, or overcoming a highly learned response (Zelazo et al., 2016).

Difficulties with executive functioning are associated with learning challenges and a greater likelihood of behavior problems. Deficits with these skills are a prominent feature of emotional behavioral disorder (EBD), neurodevelopmental disorders (e.g., attention deficit hyperactivity disorder (ADHD); autism spectrum disorder (ASD), and specific learning disabilities (SLD's) that interfere with children's education (Zelazo et al., 2016).

### **Benefits of Physical Activity**

Physical activity has not only been associated with increased physical and mental health but also with beneficial effects on cognitive functions such as attention, inhibition, and cognitive flexibility (Tilp, 2019). Active play and regular physical activity have a positive effect on student achievement, cognition skills, and classroom behavior. (Conyers & Wilson, 2015). Neuroscience research suggests that exercise powers up brain

areas associated with executive functioning that support higher order thinking, and with learning and memory, one can incorporate play, physical activity, and movement in meeting academic demands. Recent advances have shown that one of the most remarkable features of the brain is that it is plastic, meaning it has the capacity to reorganize itself, create new neurons, and new synapses across the lifespan (Moreau, 2015). There is the potential to mediate important changes in cognition, particularly in children whose nervous system is highly malleable. One of the most effective ways to trigger neurogenesis appears to be physical exercise (Moreau, 2015).

Evidence suggests that motor activity may, in some instances, be a necessary compensatory mechanism that facilitates cognitive functioning by greater performance on working memory tasks in ADHD individuals (Moreau, 2015). Researchers and educators have an interest in the link between doses of physical activity and cognitive function because it relates to both health and academic performance (Calvert, 2019). Research teams have found that children's executive functioning skills predict academic achievement over the early elementary years and through adolescence (Raver & Blair, 2016). Researchers and educators continue to raise concerns about how schools can balance physical activity with academic instruction (Hall et al., 2015). Students have prolonged periods of sitting and curriculum developed to meet these standards. The relationship between executive function and physical activity is in need of further research. There are increased academic demands placed on students. Given increased knowledge about the relationship between executive functioning and academic achievement, the education field would benefit from further research.

Among the most important challenges in this field is the question of which specific type and dose of exercise is more versus less likely to unfold beneficial effects and on which facet of cognition. Previous studies have found a positive relationship between diverse parameters of cognition and aerobic fitness tests (Verret et al., 2012). Previous research done by Verret et al. (2012) suggested that despite positive results, conclusions must be considered exploratory. Nevertheless, results suggested that a physical activity program may be beneficial for children with ADHD. In order to add support to these outcomes, future research should include greater executive functions assessment.

## CHAPTER II: LITERATURE REVIEW

### Literature Search Procedures

The purpose of this chapter is to review the literature on implementing movement or physical activity breaks in the school setting and the impact on cognition and academic performance, on-task behavior, and the outcomes of the most vulnerable learners, those with intellectual disabilities. The literature for this thesis was located by searching ERIC, Google Scholar, EBSCO, and Academic Search Premier with publication dates of 2010-2021. The key words that were used in conducting these searches included “movement interventions in the classroom,” “movement and executive function benefits,” “physical activity and on-task behavior,” and “physical activity impact on academic performance.”

### Physical Activity Breaks in the Classroom

There is no question that physical activity is beneficial to children’s health, however, in many schools, students are not receiving the daily recommended time for physical exercise. “Experts recommend that children engage in 60 minutes or more of moderate to vigorous PA (physical activity) per day, yet studies have found that only 42% of children 6-11 years obtain this goal” (Erwin et al., 2012, 474). Children are more sedentary with less time spent on physical activity at school, along with increased time playing video games and accessing technology. Erwin et al. (2012) noted that the *No Child Left Behind* legislation led to budget cuts and increased pressure for schools to increase standardized test scores. The perception is that incorporating more time for physical activity will take away time from the core subjects such as math and reading. PA breaks in the classroom differ from other environments like recess and physical education class due to the size of the room. Classroom-based physical activity can be classified into

(1) physical activity breaks consisting of short bouts of physical activity between the delivery of academic lessons and (2) integrated physical activity during academic lessons (Schmidt et al., 2019). This research will discuss the implementation of classroom physical activity breaks and the impact on children's academic performance, executive function, and the impact on students with disabilities.

### **Academic Achievement**

In the study by Vazou and Smiley-Oyen (2014), cognitive function was referred to as a broad category of mental operations, which includes the process by which sensory data are interpreted, stored, and retrieved, and used in forming verbal and nonverbal responses, reasoning, and behavioral decisions. The study by Mullender-Wijnsma et al. (2014) explored physical activity breaks within the classroom by providing outcomes of an intervention that combined physical activity with learning activities. The study was based upon evidence for the positive effects of moderate to vigorous physical activity (MVPA) on academic achievement. Building on previous findings that combining learning activities with physical activities may lead to favorable academic outcomes as well as health improvements led the team to develop Fit en Vaardig Op School, which stands for academically proficient at school. The inspiration for this intervention was the Physical Activity Across Curriculum (PAAC) and Take10, a learning program for elementary students that introduces physical activity into learning activities and was found to be implemented with success (2014). The first aim of the study was to describe the implementation of the program and the second aim was to investigate the effects of the program on mathematics and reading outcomes after a year. For the purpose of this

research for this thesis, the focus will be on the effects the program had on academic performance after one year.

The study done by Mullender-Wijnsma et al. (2014) included 228 children in second and third grade from six elementary schools in the Netherlands. Three classes participated in the F&V intervention, while the other three classes comprised the control group. In the schools where second grade students participated in the intervention, third grade students made up the control group for their grade and in the schools where grade two formed the control group, grade three students made up the intervention group. The intervention took place three times a week for 21 weeks and consisted of 63 physically academic active lessons of moderate to vigorous intensity but relatively easy to perform (2014). Each F&V lesson was 10-15 minutes in length, one lesson focused on solving math problems, followed by another lesson on solving language problems. The exercises were performed when the children solved a problem, with an example being jumping in place for each letter when spelling a word. Other examples of physical activity included marching, jogging, and hopping in place. The interactive white board provided a visual presentation of the mathematical and language tasks.

The measurements of intensity in the study incorporated the use of heart rate during the F&V lessons. The use of heart rate monitors was a strength as previous studies involved the use of pedometers to track activity. The monitors averaged and stored heart rate every second throughout the lesson (Mullender-Wijnsma et al., 2014). Prior to the intervention, a maximum endurance test was done during physical education class in which the children participated in a shuttle run test. Academic achievement was measured by standardized tests. In the area of mathematics, children were assessed by



participating in a speed test in which they solved arithmetic problems as fast as they could. To assess reading performance, children read aloud as many words as possible in a minute, with another test given with a new set of words (Mullender-Wijnsma et al., 2014).

The data from Mullender-Wijnsma et al. (2014) showed that third grade students in the intervention group scored significantly higher on both math and reading in comparison to the control group. Mullender-Wijnsma et al. concluded that the F&V intervention can be implemented with success in elementary classrooms and the physically active lessons improved academic achievement for third grade students. There is an opportunity for future studies to build on this information and investigate how the intervention can be improved.

The decline in children's physical activity levels is not only alarming in terms of physical health, but also in terms of cognitive development. This concern comes from knowing that motor and cognitive abilities are strongly interrelated and together predict academic achievement in young people (Schmidt et al., 2019). Besides enhancing physical activity levels, classroom-based physical activity interventions appear to be effective at influencing academic related outcomes (Schmidt et al., 2019). What makes the study of integrating physical activity in the classroom so interesting is the varying studies and research on this topic. Different theories and approaches, different backgrounds of the researchers, such as exercise scientists or educational psychologists, influence the direction of the study. For example, the study of Schmidt et al. (2019) included some background in the concept of embodied cognition theory. It is argued that embodying knowledge through motor actions contributed to the construction of higher-

quality mental representations, facilitating recall, and enhancing memory and learning (Schmidt et al., 2019). The study of Schmidt et al. investigated the effects of specifically designed physical activities on primary school children's foreign language vocabulary learning and attentional performance after acute bouts of embodied learning.

Participants in the study were 104 children in the third grade from six elementary schools in Switzerland. Classes were randomly assigned to the experimental conditions, which resulted in two classes in the embodied learning condition consisting of task-related physical activities, two in the physical activity condition involving task-unrelated physical activities, and two in the control condition consisting of a sedentary teaching style (Schmidt et al., 2019). There were three phases that were part of the experiment: pre-test, instruction, and a testing phase. Children were asked to translate 38 exotic animal names from French to German during the pre-test. From the pre-test, 20 animal names unknown to all the children were selected for the instruction phase. The instruction phase lasted two weeks and consisted of one 10-minute session two days per week, which compared to other studies is a relatively short intervention period. The learning sessions were conducted by a trained research student, accompanied by a video played on a big screen to ensure that all learning sessions were identical in terms of the sequencing of the words, numbers of repetition, and duration (Schmidt et al., 2019).

As previously mentioned, embodied learning is a theory that has been proposed to enhance memory and learning. The embodied learning component in the Schmidt et al. (2019) study involved students enacting the movements of the animal name to be learned. For example, for the "short-tailed kangaroo," the children hopped like a kangaroo and positioned their angled arms in front of their torso (Schmidt et al., 2019). For the physical

activity condition, children had to perform movements of the same intensity, but without being related to the animal, for example, running in place. In the control condition, children repeated the animal names as often as the other two conditions, but while being seated at their desks.

The study by Schmidt et al. (2019) shed light on a few areas that have implications for educators. First, children of both the embodied learning and the physical activity condition enjoyed the lessons more than children in the sedentary condition. This finding is in alignment with previous studies comparing embodied learning or integrated physical activity lessons to traditional sedentary teaching instruction with children showing positive reactions. Positively influencing children's enjoyment through classroom-based physical activity is relevant for cognition, since changes in positive affect have been found to mediate the relationship between cognitive engaging activities and children's attentional performance (Schmidt et al., 2019). When looking at the data analysis of the Schmidt et al. (2019) study, the linear mixed model controlling for age and step counts showed that there was a significant difference between the conditions in children's memory performance with the comparisons revealing both embodied learning and the physical activity conditions as being more effective in teaching children new words than the control condition. Children's focused attention, however, did not differ between the three conditions (Schmidt et al., 2019). A couple of things to take note of during this study that differed from other research is the fact that the children only wore accelerometers during one session. Additional days and times of accelerometer use would provide more data in terms of physical activity in comparison to the intervention. Also, the dose response was rather low and may not have reached a threshold to evoke

physiological effects on attentional performance that has been seen to be exercise dependent. Future studies should design and compare specific physical activities at different intensity levels to test this assumption (Schmidt et al., 2019).

Given the modernized environment, children have become increasingly more sedentary. The decrease in physical activity along with increased pressure for high stakes testing shows that considerable evidence is needed to demonstrate the effectiveness of classroom-based interventions that promote PA during the school day (Erwin et al., 2012). The study of Erwin et al. set out to determine the effect of a classroom PA intervention on students' academic performance in the areas of mathematics and reading. Along with the need to establish effective PA interventions, Erwin et al. highlighted the importance of using measures of assessment that are sensitive to incremental changes in students' growth in academics. Most of the research incorporated the use of standardized tests to assess the long-term effects of PA interventions on children's cognitive outcomes; these types of measurements are not useful in assessing short-term gains of the intervention (Erwin et al., 2012). A common tool that educators use in assessing academic growth more frequently and over shorter periods of time is through the use of Curriculum-Based Measurements (CBMs). While this assessment model changes in academic growth, it may be possible to more accurately detect whether PA is exerting a positive effect on children's rate of learning or ability to retain the material. The research of Erwin et al. (2012) aimed to evaluate whether implementing curricular PA positively influenced children's reading and mathematics achievement.

The study took place in an elementary school and included 29 third grade classrooms (Erwin et al., 2012). This was a relatively small sample size compared to

other studies measuring the effects of PA in the classroom. The intervention lasted 20 weeks with one classroom serving as the treatment group, while the other classroom took part as the control group. In an effort to measure small progress over time, curriculum-based reading and mathematics fluency assessments were administered to all students to record baseline data with a follow-up every two weeks using different reading passages and math worksheets (Erwin et al., 2012). With the purpose of the study to measure the effect of physical activity, there also needed to be a tool to track the activity and correlate that to the assessment data. Pedometers were used for the duration of the intervention and students wore these instruments for the entire school day. Children are explorers and fascinated by new objects presented to them, so the use of pedometers was well thought out with the children having the opportunity to handle the pedometers and get some practice wearing them prior to the intervention starting. The PA intervention was organized and structured with training provided before implementation and activity break cards were provided. The PA break was integrated into the curriculum, with the activities related to the math and reading content that was being taught (Erwin et al., 2012).

The findings of Erwin et al. (2012) suggest that PA can positively affect children's reading and mathematics scores as their progress was monitored through the use of curriculum-based measures as well as standardized test scores. There is validity to using the standardized measurements as this form of assessment can track growth and cognitive development over longer periods of time, however, the significance of being able to see short-term gains from the use of CBM's was found in this study. Erwin et al. (2012) discovered that the students in the treatment group had significantly higher scores in math and reading and the difference did not reach that level of significance when

comparing standardized test scores. The promising findings of allocating 20 minutes a day of PA activity is that the intervention did not take away from students' learning and in fact increased the outcome in this area as well as increasing PA, which is beneficial for children's health.

Shoval et al. (2018) set out to explore the impact of integrated physical activity into the learning environment for kindergarteners with a notion that it would contribute to their academic achievement. Similar to the study of Schmidt et al. (2012), different physical activity interventions were implemented. The three groups that were part of this study included mindful movement, which integrated movement in a purposeful way for academic learning, a movement group allowing children to move around the classroom unrelated to any curriculum task, and the control condition where children continued with their regular schedule with no additional PA breaks. The study was of good size and length, with 160 kindergarten students participating for 145 days. Teachers were interested in this concept as the two intervention teachers voluntarily participated in training, 60 hours total, prior to the study. The setup and structure of kindergarten classrooms are typically organized in a way to allow students to move about the class with the learning environment set apart from the area where students engage in free play. Research has shown that learning can benefit from movement and Shoval et al. (2018) wanted to show the effects of both mindful integrated movement and movement not related to a specific learning task. The learning environment for the mindful movement was set up in a way to promote learning through activities such as balancing on blocks that were built in the shape of letters or writing numbers on shelves of climbing equipment. For the second learning environment where students participated in

movement for the purpose of being active, participated in using the playground equipment outside or when indoors, used balls, rings, or other small objects.

The findings of Shoval et al. (2018) showed that the children that had the opportunity to learn in the mindful movement environment attained a higher level of academic achievement. It was also found that the kinesthetic component played a large part in the learning. There has been literature published on learning processes related to motor skills and the study of Shoval et al. (2018) revealed that kinesthetic perception is activated through movement. This process enables learning and leads to a higher level of academic achievement. When kindergarten students engage in mindful movement, they have the opportunity to demonstrate kinesthetically what they have learned in areas such as language skills. For example, vocabulary like “catching” or “throwing” a ball or “rise” compared to “raise” can be demonstrated in the mindful learning environment. These are just some examples of mindful movement and the effect of the kinesthetic process on learning. Shoval et al. (2018) recommended that a follow-up study be conducted to determine if a mindful movement learning environment could enhance kindergarten students’ motor skills.

Tilp et al. (2019) also investigated the effects of motor and coordination-orientated exercises on the academic achievement of school-age children. The study started with 69 students being recruited but given the requirement of having to participate in a certain percentage of test sessions, the number of participants was reduced to 35 students between the age of 11 and 14. A four-week intervention of embedding 30 minutes of motor/fitness exercise five days a week during a morning school break was implemented as the intervention. Basic reading and math skills were assessed to evaluate

the potential effects of the intervention on academic performance (Tilp et al., 2019). The findings of Tilp et al. ((2019) showed a positive effect on arithmetic competence, attention, and a facet of creative potential. This is a promising finding and implication for the education field. The question still remains as to what type of activity and level of vigor has the most potential. More specific exercises may be needed to obtain an effect on the demands of higher-level cognition.

Resaland et al. (2016) used a randomized control trial to determine the effects of a seven-month physical activity intervention on the academic performance of fifth-grade students in Norway. The study was comprised of a large sample size of 1129 children from 57 schools with the criteria being that students were able to participate in daily PA and complete academic performance tasks. Teachers were supported with pre-intervention training, refresher courses during the intervention, help via email or phone, as well as information and videos for approximately 100 PA lessons to carry out the intervention. The PA intervention included three components; 90 minutes a week of physically active lessons that took place on the playground, five minutes a day of physical activity breaks during classroom lessons, and 10 minutes of daily physical activity homework prepared by the teacher (Resaland et al., 2016). The activities were selected for all children in the intervention group to participate and were activities of vigorous intensity as measured by an accelerometer that the children wore for seven consecutive days.

The results of the intervention showed no significant overall effect on academic performance; however, some promising results were found with the lowest level performers in the area of numeracy. There was an increase for those students that



performed the lowest at baseline and it was suggested that the combined approach of integrating the physical activity in curricular content impacted those children more than the amount of PA (Resaland et al., 2016). Positive findings came out of the study, which showed enhanced learning with some school children, but more evidence is needed to show increased academic achievement in all children.

A consideration in the implementation of movement breaks is the activity itself as the type of break may have different outcomes for children's achievement. Fedewa et al. (2018) sought to explore more of the type of PA used and what will have the greatest impact on academic achievement. To accomplish this, they investigated the effects of an aerobic only PA break compared to an aerobic PA break that was combined with academic content. The study included 460 children grades three through five from four elementary schools in the southeastern part of the U.S. The schools were matched on demographic characteristics with 47% qualifying for free and reduced lunch. A random assignment of schools was done with 176 students assigned to academic breaks and 284 students engaged in aerobic only breaks only (Fedewa et al., 2018).

The instrument of measurement completed before and after the intervention included math and reading assessments along with step counts. Fedewa et al. (2018) utilized standard assessments in the fall and spring with the use of Fast-Bridge Learning for math and reading. Pedometers, which are an established measurement, were used to measure student PA. The aerobic intervention classes were given a list of aerobic only movements, whereas Go Noodle movement breaks were used in the aerobic breaks with academic content incorporated into the activity for the other classes. Despite findings that support the integration of movement breaks in the classroom, research to date has not

differentiated between aerobic movement breaks with a focus on academic content and movement breaks that are purely aerobic in nature (Fedewa et al., 2018).

The findings of Fedewa et al. (2018) showed greater academic achievement in reading and provided some evidence that aerobic only movement breaks could support academic achievement gains more than academic based breaks. Another positive finding was the loss of instruction time for the aerobic only group did not show a detrimental effect on learning. The researchers noted some uncontrollable factors in the implementation of the intervention. Teachers may have incorporated academic material that was not present in the standardized tests, which could have affected the outcome. Also, teachers may not have selected the most appropriate break to achieve the greatest amount of success. Steps were greater in aerobic only PA, but there were some variables that were not quantifiable (Fedewa et al., 2018). The enjoyment factor of the breaks and teacher motivation to provide the PA are unknown but could have had an impact on the results. Overall, Fedewa et al. (2018) provided some positive findings in support of implementing movement breaks in the classroom setting.

Embodied cognition is the idea that the mind and body work are connected in the learning process. One example would be in language development that the brain activity not only occurs in the classic language areas but also the areas of the body that control movement. (McClelland et al., 2015). McClelland et al. stated that this could prove to be beneficial to schools as the concept of embodied cognition could improve children's physical understanding. It was also presented that bodily awareness needs to be developed before intellectual reasoning. McClelland et al. (2015) implemented the Move4words intervention based on the belief that academic achievement can be

enhanced by improving attention and self-control through physical and visual bodily activities. Neuroscientific and psychological advancements showed that the experience from learning muscle control to achieve physical tasks leads to a better understanding of achieving more abstract goals (McClelland et al., 2015).

There were three controlled trials within the study, which included a typical mix of ability, gender, and diverse ethnic background along with 20 percent of the students having special needs. The study was easily implemented without any severe change in teaching strategies. A unique component of the study was the length, as student's academic performance was followed for three years before the start and one year after the intervention. The measurement of achievement was the percentage of students who achieved or excelled at the threshold of level four in English and Math on the National examinations taken at the end of primary school (McClelland et al., 2015).

The first trial was comprised of whole classes of children 10-11 years old in eight matched pairs of schools. The study looked at performance for three years before the intervention as well as the intervention year. The second trial tracked individual performance for three years prior to the start of the intervention and one year after. The third trial consisted of a two-group controlled trial of reading performance for 51 pupils from the second study (McClelland et al., 2015). The results of the McClelland et al. (2015) study showed that there was significantly enhanced academic performance for the students who participated in the Move4words compared to those in the control group. The greatest impact was seen for those students performing below the twentieth percentile. The data also showed that the gains were maintained for at least a year. (McClelland et al., 2015).

There is evidence showing that PA breaks benefit children's cognitive function, but it has not been determined what method has the greatest impact. Egger et al. (2019) investigated the effects of three different PA interventions with varying degrees of cognitive engagement and physical exertion on children's executive function skills and academic achievement. Cognitive functions, in particular, EF's are viewed as a component that predicts academic achievement (Egger et al., 2019). It was noted in the study of Egger et al. that several physiological mechanisms suggested the positive effect to show the positive effect that PA has on EF and academic achievement.

The study involved 142 participants age seven through nine from Switzerland, with exclusion criteria being no formal diagnosis of ADHD, dyslexia, dyscalculia, or colorblindness. There were 12 classes randomly assigned to one of the three intervention groups. The intervention groups consisted of (1) combo group, which involved high levels of both cognitive and physical exertion, (2) aerobic group with low cognitive engagement and high physical exertion to promote aerobic fitness with little cognitive demand, and (3) cognitive group with high cognitive engagement with low physical exertion (Egger et al., 2019). Classroom teachers carried out the interventions, which involved two 10-minute sessions a day for a duration of 20 weeks, which was based on the recommendation that the longer the intervention, the greater effect on cognitive performance (Egger et al., 2019). The teachers were unaware of the hypotheses of the study to keep the study uniform and unbiased. The results of Egger et al. (2019) confirmed previous studies showing positive effects of acute and long-term PA breaks on children's mathematical performance. The interventions involving cognitively

challenging breaks showed to enhance mathematical performance more than the aerobic intervention (Egger et. al, 2019).

The study of Hill et al. (2010) aimed to investigate the effects of physical exercise during the school day on cognitive performance in the classroom. The intervention was relatively short with a cross-over design model incorporating PA activity one week and no exercise the second week. There were 1224 students ages 8-11 from six mainstream schools that participated in the study. The cross-over design consisted of two classes from each school, a group A and B. During the first week, group A participated in the PA activity breaks with the intervention switching to group B for the second week. The classes were randomized, with demographics comparable between groups (Hill et al., 2010).

Teachers delivered the PA break for 15 minutes each day to the intervention group. The exercise used in the Hill et al. (2010) study was chosen from the Classroom Exercise Program (CEP), which was curriculum developed by a physical education team. Activities were completed within the classroom environment with students performing the exercises while standing behind their desks. Exercises were intended to be moderately intensive for the average student and they included stretching, aerobic exercises, running in place, and hopping to music (Hill et al., 2010). Children were assessed using an age-appropriate cognitive measure. Hill et al. concluded children's performance improved on the set of standard-based cognitive tests as a result of a classroom-based exercise program. These results are consistent with previous finding showing physical activity between lessons is beneficial for academic as well as physical development (Hill et al., 2010).

Positive effects have been seen with PA breaks on academic performance and executive function, however, questions still remain as to what amount and type of PA has the greatest impact. Considering the structure of the school day and how much material needs to be covered, it is important to maximize efficiency when implementing PA breaks. Howie et al. (2015) set out to determine the different effects that a 5-minute, 10-minute, and 20-minute classroom exercise breaks had on math performance for children 9-12 years old compared to 10 minutes of sedentary activity. The intervention was delivered to 96 students in five fourth and fifth grade classrooms in an elementary school in South Carolina. The study was randomized with each student assigned to one of the four interventions.

The exercise durations were based on previous research that showed improvement in executive function and academic performance with at least 10 minutes of exercise. The classroom intervention developed for this study was Better Ideas Through Exercise, an exercise program designed to maintain moderate to vigorous aerobic activity (Howie et al., 2015). The intervention was delivered at a consistent time each day and used minimal space in the classroom. The activities were similar for the 5-minute, 10-minute, and 20-minute exercise interventions and the only thing that varied was the duration (Howie et al., 2015). Howie et al. (2015) objectively measured intervention fidelity by videotaping the exercise sessions and coding the intensity through the measure of System for Observing Fitness Instruction Time (SOFIT). There was not a difference in intensity observed between the three conditions.

Howie et al. (2015) showed that the 10 minute and 20-minute exercise intervention produced higher math scores, with no effect from the 5-minute intervention

on cognitive improvement. The study suggested that students may react differently to classroom exercise breaks. The participants with lower IQ, higher aerobic fitness, or lower school engagement had a higher level of improvement with the intervention. Additionally, girls had greater improvements in the area of math performance. Howie et al. (2015) noted that the cumulative effect on academic performance over time was not addressed but it would be valuable for further research to look at long term results for the ultimate value on student outcomes.

Calvert et al. (2019) also investigated the dose response relationship between PA and improvement in cognition from a sample of fifth and sixth-grade students. There was interest among researchers and educators as it pertained to student's academic performance and health. The four conditions included in the study were sedentary, light, moderate, and vigorous. The use of videos to lead the movements and accelerometers to measure PA contributed to standardizing the conditions and providing validity to the study. The study was comprised of 156 participants from eight classrooms in a middle school in Idaho (Calvert et al., 2019).

To measure cognitive functioning, assessments were selected from the National Institute of Health (NIH) Toolbox Cognition Battery. The assessments were completed on iPads and scored automatically by the NIH Toolbox software. Video modules were selected from Go Noodle, which is an online resource providing activity focused content to children. Each PA session was 10 minutes in length and included two videos that were accompanied by music. The children participating in the control condition viewed social studies and reading/grammar lessons while seated at their desks. Exercise videos were

selected for the other participants and were low to moderate and high intensity (Calvert et al., 2019).

Calvert et al. (2019) did not find any effect of the exercise conditions on cognitive performance. The scores from participants pre and post-tests did not show any significant difference. There is a limitation as to what can be controlled in the classroom setting. Participation in the exercise movements was encouraged but could not be required so not all children completed the activities. Even though the outcomes regarding PA were not substantiated, Calvert et al. (2019) suggested that the relationship between classroom PA and academic performance warrants further research.

### **Executive Functioning**

Aadland et al. (2019) noted that executive functions (inhibition, working memory, cognitive flexibility) play an important role in the learning process and are essential for academic performance. With limited research in this area, Aadland et al. (2019) set out to examine the effects of a curriculum prescribed PA intervention (The Active Smarter Kids) on executive functions of 10-year-old children from Norway. The randomized control trial included 1,145 children from 57 schools.

The intervention was led by classroom teachers and consisted of an additional 165 minutes a week of PA. There were three components to the trial (1) physically active educational lessons, (2) PA breaks during classroom lessons, and (3) PA homework. Academic learning tasks were incorporated into the PA educational lessons and homework, which added a cognitive element to the activity (Aadland et al., 2019). The intervention was created by collaborating with teachers with the intent of activities being carried out in small groups in an enjoyable matter.



The results of the intent to treat analyses did not reveal any effect of the ASK intervention on executive function, however, the per protocol analyses showed small effects of the intervention on cognitive flexibility (Aadland et al., 2019). Unlike research with prescribed activities that are consistent among intervention groups, the teachers had the freedom to choose activities, which could have resulted in variation related to engagement in the activity (Aadland et al., 2019). Another limitation of the study was the lack of direct observation and measurement of elements of executive function. Despite the limitations and small effect on cognitive flexibility, the findings of Aadland et al. (2019) supported further research to explore broader aspects of both qualitative and quantitative measures on the contribution that PA has on executive function.

There has been research suggesting that executive function (EF) improves with vigorous exercise but Gatz et al. (2019) stated that few studies have provided evidence showing the correlation between improved cognition and specific academic domains. Gatz et al. (2019) explained that EF is an umbrella term for higher order cognitive processes including working memory, inhibition, shifting, and the ability to plan, monitor, and carry out goal-directed actions. Gatz et al. (2019) explored the effects of a physical activity intervention for adolescent girls that were at risk for low self-esteem, sedentary lifestyle, and being overweight. The study included a total of 59 girls (29 for the intervention and 30 for the control group) in grades six through eight who were selected from school social workers, teachers, and support staff with eligibility criteria of struggling socially and/or academically. Science skills related to EF involve observation, thinking and problem-solving, experimenting, providing evidence for conclusions, and evaluating the process (Gatz et al., 2019).

The PA intervention in the study done by Gatz et al. (2019) was implemented three times per week and included running, swimming, biking, and yoga activities. There was pre-planning that the girls needed to take part in, which consisted of setting goals, determining physical activities, and self-regulating to meet the desired outcomes. Measurements used in the study included a 15 question pre and post-test for science, the Behavior Rating Inventory of Executive Function (BRIEF), and a Physical Activity Questionnaire (PAQ-C).

The results of Gatz et al. (2019) showed that the intervention group had statistically higher science achievement along with a significant improvement in the areas of inhibition, metacognition, and cognitive regulation. The study provided evidence that chronic physical activity can enhance cognitive control abilities such as increased attention span, concentration, and improved memory (Gatz et al. 2019). These findings provided promise for improving EF and achievement in related academic domains. The intervention was conducted outside of the school day but Gatz et al. (2019) noted that the intervention can be modified to use methods for increasing the amount of PA during the school day.

The aim of classroom-based PA is to improve both physical activity levels and academic achievement. Recent suggestions have shifted focus to the qualitative characteristics of PA in the area of executive function (Vazou et al. 2014). It was noted in Vazou et al. (2014) that integrating PA with academic subjects is a unique type of PA that includes the physiological demands of aerobic PA and the cognitive demands of academic practice. Building on the notion that there is a greater improvement in executive function tasks with integrated physical activity, Vazou et al. (2014) examined

the acute effects of a session integrating physical activity with math practice compared to seated math practice on executive function and enjoyment. The study was designed to engage the child cognitively while incorporating a moderate level of physical activity.

The participants for the study were 35 children in grades three through five from 12 elementary schools in a Midwestern state. Unlike other interventions that took place in the main classroom, this experiment was carried out in a controlled laboratory environment. The first day in the lab was an introduction session to become familiar with the environment and procedures. A with-in subjects design was implemented with two days of seated math practice and one day 10 minutes of PA integrated with math practice. The participants heart rate was recorded using a heart rate monitor to measure the level of PA. The intensity of the PA was moderate to vigorous, which was viewed as a strength of the study (Vazou et al. 2014). The assessments used to measure executive function components of inhibition, working memory, shifting, and attention were the Standard Flanker, Reverse Flanker, and Mixed Flanker tasks. The math check was done by students providing answers to sets of flashcards. Enjoyment was assessed with the 16-item version of the Physical Activity Enjoyment Scale adapted for use with children (Vazou et al., 2014).

The results of Vazou et al. (2014) showed that the response time in an executive function task emphasizing inhibitory control within the Standard Flanker test improved more after a single bout of aerobic physical activity than the seated math practice. These findings suggested that executive function can be enhanced by promoting PA by integrating it into academic instruction. After the physical activity condition, participants

had significantly higher scores in the area of enjoyment (Vazou et al., 2014). It can be suggested that a higher level of enjoyment will produce more engagement with the task.

There is much to be learned regarding the role of PA on cognitive engagement. Studies comparing different types of physical activities have reported varying results. The aim of the study by Egger et al. (2018) was to sort through the effects of physical exertion and cognitive engagement induced by classroom-based PA on children's EF. The study was comprised of 216 second grade students from 19 different elementary schools in Switzerland were randomly assigned to one of four conditions of an intervention varying in both physical exertion and cognitive engagement. The conditions of the experiment included (1) combo group with high CE high PE, (2) cognition group with high CE low PE, (3) aerobic group with low CE high PE, and (4) control group with low CE low PE. Each intervention took place in an unused classroom and consisted of three different games, lasting six min each, and included short breaks in between activities (Egger et al., 2018). Methods of measurement included a heart rate monitor to assess physical exertion, and the Self-Assessment Manikin in which students rated themselves for cognitive engagement.

Egger et al. (2018) found no significant effects for either the PE factor or interaction of PE and CE in any of the executive functions. Only the factor CE affected children's shifting performance while core EF's of updating and inhibition remained unaffected (Egger et al., 2018). There are a few factors that could have contributed to these findings that contradict previous research showing large improvements in EF's through acute cognitively engaging PA interventions in the classroom. First, the duration of the break was different than other studies. The duration of 20 minutes may be too long

compared to findings that 10-15 produces gains in EF. Another factor when considering the results is that positive effects on cognitive function seem harder to obtain in younger children (Egger et al., 2018). These results would be in line with previous studies showing no effect in younger children because the cognitive demand may have been too high. It is speculated that younger children may benefit from a less cognitive engaging exercise, whereas older children may benefit from more complex exercises. The intensity measured by heart rate monitors only reached a level of 67%, whereas 70-85% indicating moderate to vigorous level has been seen to benefit cognitive performance the most. Egger et al. (2018) also noted that research still lacks a reliable and sensitive instrument to measure CE.

The aim of the research done by Hall et al. (2015) was to explore the relationship of the Build Our Kids' Success (BOKS) PA program with executive functioning skills such as working memory and the ability to shift between tasks. The research was based on the theory that when given the opportunity for moderate to vigorous PA, children will be ready and alert for learning, which will lead to improved academic performance. Five elementary schools in Natick, Massachusetts took part in the three-year study. The total number of participants over the three years was 1,536 students, which was a large sample size for this study. The length of the study was a strength as researchers were able to follow students to the next grade level and measure long term effects. Participants had to be in grades K-2 or years one and two of the study and grades one through three for year three (Hall et al., 2015).

The experimental group included students that participated in the before school physical activity program whereas the students that did not participate in this program

were designated as the control group. Instruments of measure to evaluate outcomes for each of the three years included surveys that parents and teachers completed at the beginning and end of each year as well as a Behavior Rating Inventory of Executive Function (BRIEF). In addition, during the first year, parents completed the Social Skills Rating System (SSRS), and teachers completed the Survey of Academic and Youth Outcomes (SAYO) (Hall et al., 2015).

Research done by Hall et al. (2015) shed light on how participation in PA over time may be linked to improved executive functions. Significant results on the effect of the BOKS intervention were found on Working Memory and Shift, which are two BRIEF subscales. Working memory is the ability to remember and manage information whereas shift is the ability to transition from one situation, activity, or aspect of a problem to another (Hall et al., 2015). Both of these areas have an effect on educational outcomes for students. The findings from the three-year study of the BOKS intervention strengthened the argument that PA can position children to be more ready and alert for learning experiences. The children benefited not only from the skills related to academic achievement but also the opportunity to improve physical fitness by completing moderate-to-vigorous exercises (Hall et al., 2015).

Executive functioning is related to behavioral control and one's ability to attend in the classroom. Students have a greater opportunity to learn and achieve academically when they are more engaged in the classroom (Maykel et al., 2018). Students disrupt the learning of their peers along with their own learning when they are off task. A positive student-teacher relationship is related to a higher level of engagement in class (Maykel et

al., 2018). Maykel et al. (2018) set out to extend the literature showing brief PA breaks during the school day can lead to improvement in Time on Task (TOT).

The study consisted of a single subject design where students served as their own control group. The participants for the study were a classroom of 23 third grade students from a school in rural New England (Maykel et al., 2018). The intervention was low cost and easy for the teacher to implement, with the teacher only needing some brief training. The PA break was led by the classroom teacher immediately prior to the observation period on intervention days. The intervention included one to two minutes of warm-up, six to eight minutes of moderate PA followed by a cool-down period of another one to two minutes. The activities were whole body movements not integrated into the curriculum (Maykel et al., 2018). Systematic direct observations of individual students were conducted by using momentary time sampling and estimating the rates of on task behavior for the class. The observations were conducted in a 45-minute period, which was broken down into three 15-minute blocks. Previous studies included observation times ranging from 10-minutes to 30-minutes, but research showed a need to look at longer observation periods. Maykel et al. (2018) responded to this need by providing information on the duration effects of PA on TOT by conducting 45-minute observation periods.

Maykel et al. (2018) concluded that PA breaks positively impacted TOT rates. The TOT rates were both higher and more consistent during intervention phases than baseline. It was noted that there was some variability among some of the data points at baseline, but it was determined that overall, the high rates of TOT would not have occurred without the PA break intervention. The positive effect of the intervention was

even seen after 30-45 minutes of the PA break. The findings of Maykel et al. (2018) provided valuable information to educators as the classroom intervention showed to be a simple way to increase TOT and also helped to meet the recommended amount of daily PA. However, additional studies are recommended to gather more information on the relationship between PA breaks and TOT.

Along with strong evidence supporting enhanced academic outcomes with PA, there is also support that student focus is improved with acute bouts of PA (Bartholomew et al., 2018). The study done by Bartholomew et al. (2018) consisted of a large and diverse cluster randomized control trial in which accelerometer-based PA was assessed in conjunction with active learning to determine the impact on student attention or time on task (TOT). The study included 149 teachers and 28 schools (19 intervention, 9 control) that were randomly assigned to one of three conditions. The three conditions of the study were intervention language arts, intervention math, and a control group. Participants were divided up into sets of three schools based on demographics with an average of 21% of students eligible for free and reduced lunch (Bartholomew et al., 2018). The aim of Bartholomew et al. (2018) was to examine the impact of active lessons on TOT compared to traditional lessons and also build on the previous research that had limitations on observation time.

The intervention was based on the I-CAN program, also known as the Texas Initiatives for Children Activity and Nutrition. This program focuses on implementing active daily lessons in the classroom for 10-15 minutes. Games, such as tag and relay races are incorporated into the academic material for math and language arts and are designed to engage students in moderate intensity aerobic PA (Bartholomew et al., 2018).



The lessons were implemented by the teacher with the intensity of the PA being dependent on the activity chosen. Activity was measured through the use of accelerometers, which the students wore Monday through Friday for an average of six hours a day. Bartholomew et al. (2018) noted that steps were recorded in the control, sedentary position but it did not come as a surprise to researchers because fidgeting or small movements could have been counted as steps.

The findings of Bartholomew et al. (2018) showed a positive relationship between TOT and the number of steps recorded. There was improved attention across groups which strengthens the argument for the implementation of active PA breaks and active learning in schools. The results were not dependent on the curricular content as there was no difference between intervention schools for math and spelling so information was combined for these areas when looking at the overall effect. The results of Bartholomew et al. (2018) supported the initiative of incorporating more opportunity for PA during the school day.

Incorporating ways to increase engagement and on task behavior within the classroom is valuable to educators. As referenced in Ma et al. (2014), there is an association between academic performance and classroom behavior with increased time on task contributing to overall success. Studies have suggested that PA can improve classroom behavior and with more time spent on learning, there is a direct impact on academic achievement. The purpose of the research done by Ma et al. (2014) was to examine the effect of brief, high-intensity interval exercise on classroom off-task behavior in primary school students. The intervention was easy to implement as no

equipment was needed and training was minimal, however, the study was small in size and lacked a diverse population.

Two schools, a fourth-grade class and a second-grade class from eastern Ontario participated in the three-week program. The activities that were put in place for the PA break consisted of FUNtervals, which are classified as brief high intensity interval protocol (Ma et al., 2014). Examples of these activities include squats, jogging, jumping, and running in place and are intended to be completed in the classroom as quickly as possible within a four-minute timeframe. The schedule that the students followed was a day with a FUNterval break followed by a day of no PA break for the course of the three-week intervention. The alternating schedule was a single group crossover design in which each student's off-task behavior on no activity days was compared with the FUNterval days. A strength of the study was the time allotted for observation. Following the intervention activity, the research team observed student behavior for 50 minutes of additional classroom instruction time (Ma et al., 2014). This allowed the research team the opportunity to see longer term effects of the intervention whereas other studies have included only a 10-15 minutes observation period.

Though the study done by Ma et al. (2014) was limited in size, the analyses of the classrooms included in the research demonstrated that brief, high-intensity interval exercise can decrease off-task behavior. The benefit of the intervention was most apparent in those students with the greatest off task behavior on no activity days. The results of Ma et al. (2014) also supported research that decreased off-task behavior may contribute to the well documented link between physical activity and academic performance.

In the research done by Stoepker, et al. (2018), the team took a further look into previous findings that classroom breaks contribute meaningful amounts of PA, which students are lacking, as well as improve student on-task behavior and academic skills while decreasing classroom behavior issues. Stoepker, et al. (2018) noted that off task behavior is perceived to be problematic in a school setting because of the potential to limit learning opportunities, which could negatively affect student's performance in the area of academics. The study involved one fourth-grade class from a school in the western United States. Research was done to determine the effects of The Weekly Classroom (TWC) walking program that was provided as a PA break. The purpose was to look at three outcomes: explore the differences in PA accrual on the day of implementation, determine the effect on student on-task behavior, and develop a deeper understanding of student teacher experience (Stoepker et al., 2018).

The limited size of the study was due to the fact that the school selected had access to a classroom set of TWC equipment as part of the district's wellness program. With the walking program, students listened to a kid-friendly podcast on the Walk Kit audio device while walking for 20 minutes. The intervention allowed the students to listen to academic content aligned with common core standards while increasing their physical activity. A mixed methods design was used with quantitative data collected through the use of pedometers and systemic observation and qualitative data on participants experiences with the program. Students wore the pedometers for the entire school day with steps being recorded at the end of each day. The TWC program was implemented two days a week for 12 weeks with students participating in recess on non TWC days. Observations were systematically put in place for 10 weeks with five-second

interval recordings done approximately 30 minutes before and after the PA break. To put in perspective the number of observations completed, each student was observed approximately 12 times during each observation period resulting in 6,529 individual studies (Stoepker et al., 2018).

Stoepker et al. (2018) found no effect on student PA, however, there was an increase in on-task behavior, which as cited in previous studies, had an impact on overall student performance. With the students having recess on non-TWC days, the effect on PA accrual was washed out. The intervention did have challenges in terms of technology. The biggest problem noted was the battery life of the audio kit with teachers noting that the podcast would shut down without warning. Students enjoyed the activity break, but along with the teacher, desired more interactive content. The research by Stoepker et al. (2018) contributed to the growing body of knowledge of the effectiveness of classroom PA integration strategies. It can also be concluded that children are more likely to participate in PA when they perceive it to be enjoyable (Stoepker et al., 2018).

It is well known that sitting still for long periods of time can be a challenge for young children. When thinking about the demands put on kindergarten students and the amount of time there are asked to sit still throughout the school day while engaging in whole group instruction, there are challenges that arise. Having children sit for extended periods of time can contribute to behavior issues in the classroom and impact academic performance (Wiebelhaus et al., 2016). The purpose of Wiebelhaus et al. (2016) was to determine if classroom based physical activities would affect student behavior during instruction and increase time on task. Wiebelhaus et al. (2016) also looked at student's perceptions of ability to focus. This, however, was looked at with caution as five-year

old's, in general, have a difficult time answering questions, and if they really understand the question being asked is hard to know.

The intervention implemented was an eight-week program for students attending full day kindergarten at a Title 1 public elementary school in the upper Midwest with 84.2% of students being eligible for free or reduced meals. The study was narrowed down to three students due to some of the children receiving EL service and not being able to respond to the questions in regard to the qualitative part of the study. The PA breaks that were implemented included activities such as jumping on the trampolines, walking balance beams, and hopscotch. The stations provided the participants an opportunity to work on academic skills as well as exert energy while engaged in the activities (Wiebelhaus et al., 2016). The observation time was not as extensive as previous studies mentioned. Frequency charts were completed during whole group instruction for five minutes before the stations began and then for five minutes of instruction following the activity stations. The researchers also videotaped the lessons and activities so they could refer back if needed.

The results of Wiebelhaus et al. (2016) showed that overall, all three participants were more attentive during instruction. Outside influences such as inside recess, party day, or a day before a break, are situations that would need to be taken into consideration when interpreting results of active breaks. The study done by Wiebelhaus et al. (2016) provided some evidence that young children benefit from PA breaks built into their school day. It was recommended that future studies add a control group as well along with participants diagnosed with ADHD.

Kerpan et al. (2019) set out to examine the effect that movement integration has on on-task behavior, which is known to be a facet of self-regulation. For the purpose of the study, movement integration is defined as the opportunity for children to receive increased physical activity during classroom time (Kerpan et al.,2019). The study involved kindergarten and grade one students in a reserve school in Canada with a total of 14 students participating in the intervention, however, only nine parents/guardians gave consent for the measurement component. The study was described as Participatory Action Research, which involves building on strengths of the community, problem-solving, and empowering parents and community members. The aim of this type of study was to engage community partners in the research process to enact change, action, and reflection (Kerpan et al., 2019). Even though the study was small in nature, the implications hold great value as Kerpan et al. (2019) stated that early learning experiences for Indigenous children hold educational, social, health, and economic potential. Indigenous is an inclusive term that globally represents descendants of those who inhabited a geographical region prior to colonization (Kerpan et al. 2019). It is important to take into account cultural beliefs and behaviors and how to integrate that into the educational setting. The main strength of Kerpan et al. (2019) was that relationships were built within the community and there was collaboration between the research team, school leaders, and teachers in the Indigenous community on gaining input as to what outcomes they wanted to measure.

Prior to the intervention, data were collected for one week for on-task behavior. This was followed by two weeks of active lessons. In the middle of the active lessons, the students participated in a five-minute physical activity game that incorporated curricular

content that was relevant to the lesson. Pre and post data for on task behavior was compared from the first week of non-active lessons and the weeks where active lessons took place. The findings of Kerpan et al. (2019) showed that children's ability to stay on task during a 45- minute lesson dropped significantly when they did not receive a PA break during the lesson. Students were 15.7% more off task without the PA intervention. The results are consistent with previous studies of non-Indigenous students that revealed on task behavior improves with physical activity. Kerpan et al. (2019) provided further evidence to support the link between movement and self-regulation for young children.

Despite the health and academic benefits of physical activity, barriers still remain that prevent teachers from implementing classroom PA to the degree they would like to (Snyder et al., 2017). Incorporating PA into academic instruction provides a possible solution to decreasing sedentary time in the classroom but the lack of time and resources have contributed to the low priority put on the implementation of PA in the classroom. Snyder et al. (2017) sought to evaluate the effectiveness of a purposeful movement teaching strategy on PA, on task behavior, and academic achievement that was unique in its nature of being developed by teachers. The study was also guided by the Self-Determination Theory (SDT), which discerns motivation as either autonomous or controlled (Snyder et al., 2017). Snyder et al. (2017) described autonomous as motivation being intrinsic and decisions made out of personal interest, whereas controlled motivation involves external factors such as pressure or demand. The principle behind the study was that the teacher developed program was autonomous motivation and that giving them control over the implementation could fulfill their basic psychological and improve sustainability (Snyder et al., 2017).

The study done by Snyder et al. (2017) involved 24 third grade students with one classroom assigned as the intervention group and the other class using standard teaching strategies as the control group. The intervention consisted of activities that were developed by the teacher with collaboration from the physical education teacher. Materials that were already available in the classroom such as white boards, markers, dice, and blocks were used with the exercises incorporated into the mathematics lesson. The physical education teacher was not present during the lessons, but had a role of fitness liaison, helping with the creation and implementation of the activities (Snyder et al., 2017).

In terms of data collection, the design of the study was based on direct observation to look at on-task behavior, academic achievement measured through assessments and student perception evaluated through the use of write and draw activities. Pre-data was collected one week prior and post data was collected during the final week of the mathematics unit. Accelerometers were used to measure steps, but this tool did not measure activity levels such as light, moderate, and vigorous. A different instrument could have been selected to provide a more comprehensive analysis however, the use of accelerometers is a cost-effective approach to activity measurement (Snyder et al., 2017).

The study done by Snyder et al. (2017) showed that there was a significant increase in steps during the mathematics unit for the intervention group. It could be predicted that this would be the result as long as students were engaged and participating in the activities. The direct observation time sampling confirmed previous research that integrating movement into academic lessons can improve the level of active engagement



and lead to increased learning. Along with improved on-task behavior, the study also showed that PA during mathematics lessons does not take away from learning and retention (Snyder et al., 2017). The result of the student perception done through a write and draw activity revealed that 100% of the students in the intervention had positive responses and enjoyed the activities. As mentioned previously, when students enjoy the activities, they are more likely to be engaged will increase learning opportunities. There were few concerns in regard to implementation given the activities were created through collaboration between the classroom teacher and physical education teacher. The findings of Snyder et al. (2017) provided justification that PA can be effectively implemented with teacher developed lessons at a minimal cost.

A novel, web-based physically active learning program was investigated as an intervention involving attention and behavioral control in the study completed by Vazou et al. (2020). Walkabouts is an interactive video-based program that incorporates physical activities with the academic content of math and language arts. Vazou et al. (2020) aimed to examine the feasibility and effectiveness of Walkabouts on attention and behavioral control of children. The hypothesis was that integrating movement with an interactive program such as Walkabouts may facilitate learning and academic achievement through increased cognitive and behavioral control.

The participants in the Vazou et al. (2020) study included 245 children with 158 in the intervention group with the Walkabouts program and 87 in the control group with typical teaching strategies. The program took occurred 3 times each week for seven weeks with the activities consisting of hopping, jumping, marching, and stretching. Teacher ratings of students' attention and behavioral control in the classroom were

collected before and after the seven-week intervention for both groups. To begin the activity, teachers log into the online program and choose a video based on the grade, subject, common core standard, and learning objectives (Vazou et al., 2020). This provided an interactive learning platform with sessions selected to best match the content of academic instruction. The activities lasted between 7-10 minutes and were presented on classroom whiteboards. Strength of the study included minimal equipment along with the activities being completed in a small space. Trained observers used the twenty-second interval method in observing the entire class, while the System for Observing Student Movement in Academic Routines and Transitions (SOSMART) was a fidelity measurement to record the level and quality of movement (Vazou et al., 2020).

It was concluded by Vazou et al. (2020) that the implementation of the Walkabouts program is realistic and feasible. These results are in line with previous research showing positive effects on on-task behavior. The intervention group improved significantly more compared to the control group in both attention and behavioral control whereas the control group declined. The most improvement was seen for students in Kindergarten and second grade. When considering these results, it should be noted that the control classes had higher baseline scores on both attention and behavioral control. There was no randomization to the study as teachers were able to choose their participation in the program. Vazou et al. (2020) stated that students with high inattentiveness are those who show the greatest improvements on on-task behavior after physical activities.

### **Impact on students with a diagnosed disability**

The problem of insufficient amount of daily physical activity is seen for typically developing students, but even at a higher rate for the population of students that have intellectual disabilities. Intellectual disability (ID) is a developmental condition represented by significant limitations in intellectual capabilities and adaptive behavior (Mazzoli et al., 2021). The research done by Mazzoli et al. (2021) noted significant data for the population of students with intellectual disabilities with more than half are not meeting the PA guidelines of at least an hour of moderate to vigorous physical activity every day. This concern, along with the growing evidence of cognitive benefits of PA prompted Mazzoli et al. (2021) to take a closer look at the effects of PA on students with intellectual disabilities.

Two schools with mild to moderate intellectual disabilities in the city of Melbourne were selected to participate in a five-week active break intervention. The participants included 24 students ranging from age 8 to 12 years old. One classroom was assigned as the control group and two classrooms were designated as the intervention groups. The teachers were responsible for delivering the intervention activities developed by the research group (Mazzoli et al., 2021). Each teacher had the flexibility of selecting activity breaks that best matched the needs of their students with the option of adapting the activities as needed. Computerized tests were used at baseline and at the end of the trial to measure components of executive function such as response inhibition, lapses of attention, interference, and working memory. Other areas of measurement included inclinometers to assess movement patterns and direct observation to measure on-task behavior (Mazzoli et al., 2021).

The research done by Mazzoli et al. (2021) did not confirm the hypothesis that active breaks positively affect children's cognitive functions, however, there were promising findings in relation to working memory. The intervention group showed an improvement in working memory whereas the control group showed a decline in this area of executive function. Things to take into consideration with the study are the limited amount of time and small number of participants. Also, the teacher perceived some children, particularly those with a disability of Autism Spectrum Disorder, to be over-stimulated by the active breaks. Further research could explore the effects of using active breaks in combination with more calming activities on executive function (Mazzoli et al., 2021). Studies are limited in regard to the effect of PA on executive function for students with intellectual disabilities so additional research is needed for this population of students.

The purpose of the study completed by Everhart et al. (2012) was to discover the impact of an additional segment of PA, outside of the scheduled physical education class time, had on school children with intellectual disabilities. Research has shown a correlation between movement and physical activity on cognitive function and Everhart et al. (2012) wanted to look at the trend within students with intellectual disabilities. For children with problems processing cognitive information, The Cognitive Processing Theory suggests that the focus should be on internal processes and not external conditions that limit learning (Everhart et al., 2012).

The total number of students that participated was 13, with seven students in primary grades (K-2) and six students in intermediate grades (3-5). The study started as a baseline without additional structured PA followed by 16 days of PA lessons directed by

the classroom teacher prior to academic work. Lesson planning was done in collaboration with the physical education teacher. The PA was achieved through aerobic exercise from watching a DVD. The next phase of the lesson involved the students doing academic work for three days before returning to the PA activities. This cycle is different in the studies discussed so far in that there was not a continuum of activity. The researchers wanted more validation to their data by implementing the phases. Formative and summative data were collected to measure the academic effects of the intervention. Activities for math were limited to primarily writing and recognizing numbers for primary students and timed tests involving addition and subtraction for intermediate students. Sight word lists were used for assessment in language arts and the lists would change as students mastered the content.

Everhart et al. (2012) used graphical trend data to summarize results. The data indicated that no consistent trend was found for primary students at any phase, however, the intermediate group showed improved academic performance when the physical activity had just been completed. Anecdotal and informal interviews found that both teachers stated that their students appeared to be more focused on the classwork following the PA lessons. As noted earlier about The Cognition Theory, the findings could add justification that regular patterns of physical activity can be the way for children to focus on internal processes.

Literature suggests that Physical Activity (PA) may provide a variety of positive benefits for children with ASD, such as decreases in maladaptive behaviors, increase in productive academic behavior, and improvements in specific executive functioning skills (Nakutin & Gutierrez, 2019). With limited studies conducted in naturalistic settings, it is

important to investigate the effectiveness and feasibility of PA intervention in the public-school setting. Nakutin and Gutierrez (2019) investigated three research questions: (a) Does PA improve academic engagement in school settings in children with ASD? (b) Does PA improve EF for children with ASD? (c) Do school staff members perceive PA to be a safe and effective intervention?

The study took place at a public elementary school (Kindergarten to Grade 5) in Southern California. Three students (two male and one female, six to seven years old) with a diagnosis of Autism Spectrum Disorder (ASD) and receiving services in both general and special education settings participated in the study. The criteria for inclusion in the study were ASD diagnosis confirmed by school records, ability to complete moderate exercise, and teacher report of low academic engagement in class (Nakutin & Gutierrez, 2019). A single intervention, physical exercise in the form of jogging, was implemented to investigate the effect on classroom behaviors, academic engagement, and EF in students with ASD. Additionally, a social validity measure was adapted and completed. The jogging exercise was completed for 12 minutes, followed by a cool down period of five minutes in which students walked or stretched independently.

Academic Engaged Time (AET) was systematically measured by the Behavioral Observation of Students in Schools (BOSS), which involves direct observation to quantify student AET (Nakutin & Gutierrez, 2019). The BOSS categorizes academic engagement into either engaged time or time off-task. In the study by Nakutin and Gutierrez (2019), two specific EF abilities were measured: inhibition and working memory. Inhibition was measured using an online go/no-go task. Participants were asked to click on a solid green dot (go response) and not click on the distractor of patterned

green dots (no-go response). In completing these tasks, students were instructed to respond as quickly as possible. Working memory was measured by digits forward and backward tasks, which are widely used and validated measures of working memory. The tasks were adapted from the Wechsler Intelligence Scale for Children-Fifth Edition and measured the amount of information children could hold in their working memory and verbally produce (Nakutin & Gutierrez, 2019). An adapted version of the Scale of Treatment Perceptions (STP) determined the social validity of the intervention by measuring staff members' perceptions of the intervention in the school setting. This 20-item questionnaire requires staff members to respond to statements using a five-point scale. This qualitative measure was used to determine perceptions of the intervention.

There was some variability and downward trends during some of the sessions, but overall, the students showed gains from baseline to treatment phase in total AET with the jogging intervention. In the area of digits forward and backward, a standard score was calculated by combining the scores of all participants. Nakutin and Gutierrez (2019) suggests that PA did not have an effect on performance on the digits forward or backward tasks. Also, no effect was found on the go/no go task, which implies that no changes occurred in EF. Previous studies have administered EF tasks directly after completing PA intervention. Digits forward is a measure of a fixed ability; therefore, it may have been a poor EF measure for the study design (Nakutin & Gutierrez, 2019). These considerations along with investigating the minimum length of time required for exercise to effectively increase AET will prove valuable in future research on interventions that have the potential to improve educational outcomes for individuals with ASD.

Berthiaume et al. (2012) investigated the effects of a moderate-to high-intensity physical activity program had on fitness, cognitive functions, and behavior in children with ADHD. There is a growing body of evidence supporting the beneficial effects of physical activity in the improvement of cognitive functions, including positive effects on executive functions for children with ADHD, however, the diversity of the variables assessed as well as methodological issues do not allow for consensus (Berthiaume et al., 2012). There were 21 participants in the study with ages ranging from 7 to 12 years old. The children were recruited from a specialized ADHD clinic and local school. Berthiaume et al. (2012) excluded children who presented an ADHD inattentive subtype, children with a learning disorder, and those who took medication other than the usual ADHD stimulant treatment. The researchers used an experimental design study with the experimental group of 10 children assigned to the PA program and 10 children assigned to the control group. Both groups of children had a diagnosis of ADHD (combined or hyperactive-impulsive ADHD subtypes), with the majority being boys as each group only had one girl.

The students participated in a physical activity program that took place for 10 consecutive weeks in the school gymnasium, three times per week for 45 minutes at lunch time. All sessions were supervised by the physical activity specialist and included warm-up, progressive aerobic, muscular, motor skills exercise, and cool down. The activities that were performed for aerobic exercise included basketball, soccer, exercise stations, tag, and ball games. A heart rate monitor was used once a week for each child and the main objective was to maintain moderate to vigorous intensity in each session. Fitness and motor performance tests were carried out before the training program and



followed up with posttests within a week of program completion. Input was sought from parents and teachers with the completion of the Child Behavior Checklist before and after the physical activity program. Attention functions and response inhibition were measured by the Test of Everyday Attention for Children (Berthiaume et al., 2012).

The researchers concluded that the activity program had a positive impact on children with ADHD. Motor performance was better in the experimental group and the behavior scores reported for total problems, social problems, thought problems, and attention problems showed improvement (Berthiaume et al., 2012). The results suggested that a physical activity program may be beneficial for children with ADHD, however, Berthiaume et al. (2012) pointed out that these findings should be considered exploratory, due to methodological issues. A suggestion for future research is to include greater executive function assessment.

Physical activity has shown positive outcomes on executive function for typically developing children. Protic and Valkora (2018) wanted to expand on these findings to examine the relationship between physical activity and executive functions among children with mild to moderate Intellectual Disabilities (ID). More specifically, Protic and Valkora (2018) wanted to determine what level of PE is most productive and what EF component is impacted. The total participants for the study were 104 children, ranging in age from 7-18 years old. Children excluded from the study were those diagnosed with ADHD, ASD, or Down Syndrome. Due to many theoretical backgrounds, there are different definitions and classifications of EF. For the purpose of this research, EF was defined as a collection of processes that are responsible for guiding, directing, and managing cognitive, emotional, and behavioral control (Protic & Valkora, 2018).

Based on this approach, the components of EF noted for this study were inhibit, shift, emotional control, initiate, working memory, plan organize, monitor, and organizational of materials. The Behavior Rating Inventory of Executive Functions (teacher version) was used to assess executive functions. The levels of PA, classified as light, moderate, vigorous, and moderate to vigorous were assessed through the use of accelerometers that students wore for seven consecutive days.

The findings showed that children with mild ID are more physically active than children with moderate ID, and they spend more time in each PA level. Protic and Valkora (2018) found that Moderate PA and Moderate to Vigorous are significant predictors of executive functioning skills involving initiating tasks, storing and retrieving information, and planning and organizing when assessed with the BRIEF scales. The assumption was made that the reason no significant relationship was found between PA and inhibition and cognitive flexibility is that the activities were comprised of aerobic movements only with no academic component (Protic & Valkora, 2018). The suggestion is that further research regarding the impact of PA on the executive function of students with ID should focus on what type of PA is beneficial for each scale of EF along with duration, frequency, age, and type of ID.

## **CHAPTER III: DISCUSSION AND SUMMARY**

### **Summary of Literature**

The research was done by Egger et al., 2018; Egger et al., 2019; Erwin et al., 2012; Everhart et al. 2012; Fedewa et al., 2018; Gatz et al., 2019; Howie et al., 2015; Mullender-Wijnsma et al. 2014; Shoval et al., 2018; and Tilp et al., 2019, provided evidence that Physical Activity (PA) breaks have a positive effect on academic performance. PA breaks were implemented during traditional sedentary time of classroom instruction. Instruments of measurement in these studies included Curriculum Based Measurement (CBM) and standardized tests. These studies all showed improvement in at least one academic area such as math, reading, or science, with the greatest effect being on mathematic performance. Ma et al., 2014; McClelland & Stein, 2015; Resaland et al., 2016; and Vazou et al., 2020, reported that although improvement was not seen with all students, the largest gains in the areas of academic performance and executive function skills were seen with the lowest level performers.

Egger et al., 2018; and Hill et al., 2010 showed positive results and supported the notion that cognition is improved with exercise interventions. In the findings by Schmidt et al., 2019; Stoepker et al., 2018; and Vazou et al., 2014, children reported that they enjoyed the active learning more than the sedentary activities. Enjoyment is a condition which has shown an impact on the increased potential to learn. The perception has been that any activity or change to the scheduled curriculum time takes away from learning opportunities.

Calvert et al., 2019; McClelland et al., 2015; Schmidt et al., 2019; Snyder et al., 2017; and Vazou et al., 2014 concluded that implementing PA breaks with academic lessons does not distract from learning and academic content is not compromised. The time spent on the PA break allowed students the opportunity to increase their activity level which has been on the decline in schools. The findings of Calvert et al., 2019; McClelland et al., 2015; Schmidt et al., 2019; Snyder et al., 2017; and Vazou et al., 2014 support the movement to integrate PA directly into the teaching and learning process. There is growing research showing neuropsychological benefits arising from regular physical exercise, and more specifically an improvement of specific executive function skills. Executive Function Skills (EF's) have been shown to be a predictor for academic success and with many students showing deficits with EF skills, strategies to improve these skills are sought by educators.

Aadland et al., 2019; Berthiaume et al., Everhart et al., 2012; Kerpan et al., 2019; Maykel et al., 2018; Nakutin & Gutierrez, 2019; and Wielbelhaus et al., 2016 showed the positive relationship between the implementation of PA breaks and engagement in the classroom. There was a decreased time of off-task behaviors in these studies with students being more on task during seatwork as well as whole group instruction. The positive findings of Aadland et al., 2019; Berthiaume et al., 2012; Everhart et al., 2012; Kerpan et al., 2019; Maykel et al. 2018; Nakutin & Gutierrez, 2019; and Wielbelhaus et al., 2016 show that PA helps students' EF skills in the area of inhibitory control and staying focused. When students are ready and alert, the opportunity for learning will increase. Bartholomew et al., 2018; Egger et al., 2018; Hall et al., 2015; Mazzoli et al., 2021; Vazou et al., 2014; and Protic & Valkora, 2018 also showed a positive correlation

between PA breaks and EF skills in the areas of working memory and shift, which is the ability to shift attention between one task and another. The findings of Bartholomew et al., 2018; Egger et al., 2018; Hall et al., 2015; Mazzoli et al., 2021; Vazou et al., 2014; and Protic & Valkora, 2018 are consistent with previous research showing improvement with certain facets of EF skills when given PA breaks are implemented in the classroom.

### **Limitations of the Research**

In conducting research to learn more about the impact of movement and physical activity breaks in the classroom, the findings were limited to studies involving elementary and middle school students, ages 5-14. With executive functioning skills being a predictor for academic success, the scope of research done for students in this age group is more abundant than that for students in their high school years. These are prime years for academic and social growth. The study done by Protic and Valkova (2018) was one exception to the research criteria chosen. There was a benefit to including this study as the focus was on students with intellectual disabilities for students 7-18 years old. This is a population of students in which there is limited research regarding the impact of physical movement breaks so there but yet has great need.

In addition to limiting the research based on student age, the type of movement break was also considered. There has been an increased focus in schools on mindfulness activities and breaks to meet the social and emotional needs of students. However, for the purpose of this literature review, the nature of the break was limited to movement integration that provided opportunities for increased physical activity among children during classroom time. As noted in the research, there are physiological changes within the brain that take place with physical activities, so the type of break was an important

consideration when researching the impact on academic performance, executive function, and effect on the students with disabilities.

### **Implications for Future Research**

The number of students diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) continues to rise. Therefore, it is imperative for schools to integrate interventions that help meet the needs of students that have difficulty paying attention and sitting still for long periods of time. Hill et al. (2010) stated the decrease in physical activity might be a contributing factor in the increased diagnosis of ADHD. There have been promising findings on the effect that PA breaks have on executive function skills as well as academic performance. Further research in these areas could be done using updated technology and resources to study the PA intervention on larger sample sizes of participants over longer periods of time and on diverse populations of students. This area of research would also benefit from studies focusing on the population of students with disabilities.

### **Implications for Professional Application**

The increased time placed on curricular content in the classroom has led to an increased amount of sedentary time at school. Wiebelhaus et al. (2016) noted that today's generation of students has had fewer movement opportunities, resulting in underdeveloped vestibular (balance) systems for some children. The longer instructional time will be difficult for a child who has not developed the core strength to sit upright and maintain control over their movements. In my role as an educator, it will be important to use this information in the expectations I set for my students. I can use the

findings from the literature review to provide opportunities for movement during instruction time which, will benefit students' academic performance and executive functioning skills, but also motor control.

It was found that embedding physical activity breaks within academic content did not distract from learning. This is a key talking point when collaborating with other teachers. Many teachers struggle with the demanding curriculum and perceive time availability as a barrier to implementing any additional activities. I can share the positive effects that physical activity breaks have had on academic achievement, executive function, and increased performance for students with intellectual disabilities. Education is constantly evolving to meet the current needs of students and to prepare for the future. I can use the increased knowledge that I have gained from the literature review in facilitating conversations to direct change in the classroom to provide students the opportunity for movement, not only to increase their learning potential but also to increase their overall health.

### **Conclusion**

There is a positive correlation between PA breaks, academic performance, and components of executive function skills not only on typical performing students but also students with disabilities. Research has shown PA interventions embedded with academic instruction and PA breaks solely exercise in nature to be easily implemented and beneficial to students in the school setting. The findings that PA breaks have not distracted from learning should reassure teachers and school leaders that incorporating PA breaks and active learning as an instructional strategy will not hinder academic progress for students. In conclusion, studies have shown that many students are not

getting the recommended amount of daily exercise. With the significant amount of time students spend at school, implementing PA breaks during the school day could provide the opportunity to meet the need for increased physical activity.



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