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The Effect Of Curriculum- And Classroom-Based Physical Activity Breaks On Academic Performance In Elementary School Children In Southern New Mexico

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Abstract

Research has provided strong evidence for the many health benefits of exercise (e.g. decreased risk of heart disease, diabetes, osteoporosis, sleep apnea, falls). Despite the plethora of evidence, most Americans do not meet the Surgeon General's recommendation of achieving 150 minutes of moderate-to-vigorous physical activity (PA) per week. Compounding the problem for children is the fact that although most American kids are enrolled in school for 30 or more hours per week, making schools a prime location to teach modes of physically active health habits, schools have instead increasingly become places that promote sedentary behavior as greater emphasis has been put on standardized test scores. Advocacy for physical activity in schools must show that including PA programs do not hinder academic performance. The studies included in this review support the idea that PA breaks do not hamper learning, but instead improve it. The research on PA breaks throughout the school day shows significant academic benefits whether the intervention was enacted with only 10 children for one week or with 1500 children for three years. This review focuses specifically on the academic benefits of PA breaks in elementary school children, but similar results have been seen in older children. This review proposes that physical activity breaks which are curriculum-based and take place in the classroom increase academic achievement by (1) improving students' cognitive function, (2) increasing students' positive affect, (3) increasing student engagement, (4) being adaptable, easy to implement, and cost-effective, (5) improving school-based interpersonal relationships, and (6) supporting the success of disadvantaged students.

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1. Introduction

For thousands of years, the benefits of physical activity to health and longevity have been documented. From Huang Ti's *The Yellow Emperor's Classic of Medicine*, written in 3000 BC, to Cristobal Mendez's 1553 book *El Libro del Ejercicio Corporal y Sus Provechos* (The Book of Body Exercise and Its Benefits) to Lavie, Ozemek, Carbone, Katzmaryk, and Blair's 2019 article "Sedentary Behavior, Exercise, and Cardiovascular Health", research findings indicate that people who are least fit and active are at greatest risk for chronic disease, loss of function and all-cause mortality (US Department of Health and Human Services [USDHHS], 1996). This increased risk exists independent of race/ethnicity, income, education, body size, body shape, or age (Haskell, Blair & Hill, 2009).

Physical activity increases physical health by reducing the risk of heart attack, helping manage weight, helping lower blood cholesterol levels, reducing the risk of Type 2 diabetes, reducing the risk of some cancers, helping lower blood pressure, strengthening muscles, bones and joints, and reducing the risk of falls, sleep apnea, and osteoporosis. These benefits apply for both adults and children (Warburton, Nicol & Bredin, 2006).

Despite overwhelming evidence concerning the benefits of physical activity (PA) and the huge PA public awareness campaigns undertaken by the U.S. Department of Health and Human Services, the Centers for Disease Control and Prevention, the National Center for Chronic Disease Prevention and Health Promotion, the President's Council on Physical Fitness and Sports, and hundreds of private institutions and companies, approximately half of U.S. adults do not meet the Surgeon General's recommendations of 150 minutes of moderate-to-vigorous physical activity per week (Blackwell & Clarke, 2018). Rates of inactivity are similar for

children (Kohl & Cook, 2013). Children's after school sedentary time has greatly increased with the availability of computers and computer games (Kohl & Cook, 2013). Compared to children who spend less than two hours of screen time per day, children who spend three to four hours per day of screen time are more likely to be classified as overweight. This likelihood increases significantly among children spending more than four hours per day on screens (Hume, Singh, Brug, Van Mechelen & Chinapaw, 2009).

Hispanic children are more highly affected than their non-Hispanic peers by the conditions contributing to overweight and obesity (Bacardí-Gascón & Jiménez-Cruz, 2013; Centers for Disease Control/National Center for Health Statistics, 2017). According to the National Health and Nutrition Examination Survey (NHNES) (2017), obesity rates are approximately twice as high for Hispanic children age 2-19 years vs their non-Hispanic white counterparts. For boys, 28% of Hispanic children are considered obese, whereas only 14.6% of white children are. For girls, 23.6% of Hispanic children are considered obese, as opposed to 13.5% of white children (Centers for Disease Control/National Center for Health Statistics, 2017; Coleman et al., 2005).

Overweight has further reaching effects than simply negatively impacting physical health. It also affects a child's scholastic experience. Overweight children have 36% more absences from school due to illness than their peers of normal weight (Pan, Sherry, Park & Blanck, 2013). Being absent from school negatively affects academic performance. Children missing three or more days of school in the month before testing scored 0.3 – 0.6 standard deviations lower (depending on the number of days missed) on standardized tests than those students who missed no school days in that month (Garcia & Weiss, 2018).

The 2017 U.S. Census Bureau listed New Mexico as the second poorest state in the nation, with 18.2% of its population below the poverty line. Fifty percent of New Mexicans are on Medicaid or Medicare (U.S. Census Bureau, 2017). In academic literature, the proportion of students on free or reduced-price lunch (FRPL) is also used as a measure of poverty. In New Mexico, approximately 70% of students are eligible for FRPL programs (Duran & Weffer, 1992; Gandara, 2010; Gornick & Jantti, 2012; *Martinez v. State of New Mexico,* 2018; New Mexico Public Education Department, 2017). Poverty levels are correlated with attendance rates in school. In 2015, over 40% of U.S. FRPL students missed more than three days of school, compared to 15.4% of non-FRPL students. FRPL students were more than twice as likely as non-FPRL students to miss more than ten days of school per year (Garcia & Weiss, 2018). Approximately 33% of all New Mexico students miss at least three or more days of school per year. Add in the compounding effects of poverty – missing school hinders academic performance significantly more for poor versus non-poor students – and it is no surprise that this area of the country suffers from academic performance scores much lower than national averages (Garcia & Weiss, 2018). In 2017, the national average for fourth graders for proficiency in math at their grade level was around 40%. In even the highest performing districts in New Mexico, proficiency in math is at about 20% (LESC, 2018; NMPED, 2018; U.S. Department of Education [USDE], 2017). With low health and low academic performance, border communities desperately need school-day interventions that can help meet educational goals on multiple fronts. In a Mortality and Morbidity Weekly Report for the Centers for Disease Control, Berendes, Andujar, Barrios and Hill emphasize this point well. “From a public health perspective, these findings highlight a need for resources, and attention to, preventive measures to keep children in school” (2019).

Complicating efforts to combat child obesity is the fact that the school day has become increasingly focused on core academic subjects like reading and mathematics and less time is being devoted to elective programs like physical education, art, and music. Because of this shift in ideologies, children spend more time at school sedentary than they have in the past (World Health Organization [WHO], 2019). The No Child Left Behind Act of 2001 (NCLB) enforced the use of students' performance on standardized tests as a measure of a school's success. Schools that did not show improvements in student performance over each fiscal year were subject to funding decreases. NCLB also transferred almost exclusive accountability to the schools for students' absolute performance. That meant that schools where students were making progress were still labeled as "failing" because their students had not yet reached a level considered proficient (Carey & Manwaring, 2011). Understandably, this increased emphasis on high standardized test scores and retaining funding pressured administrators to allocate more time to academic subjects rather than maintaining a balance with the "optional" programs.

As most children in the United States are enrolled in school for approximately six hours a day, five days a week, schools are the prime locations for developing strong academic skills and learning healthy physical habits (Rasberry et al., 2011). Such a balanced approach to child education requires financial resources, which are usually limited especially in the public schools (U.S. Census Bureau [USCB], 2015). Considering the combined expense of specially trained instructors, equipment, and extra physical space, physical education programs and other elective classes are more expensive than core subject classes. The average elective class costs $512 per student per year, while English costs $434 and math costs $328 (Hemelt, Stange, Furquim, Simon & Sawyer, 2018; Roza, 2009). Therefore, legislators and administrators may be

pressured to cut physical activity programs in schools despite the well-established benefits of exercise.

In order to campaign for physical activity to be returned to the schools, advocates must show that keeping physical activity programs does not hamper the traditional primary goal of schools, which is the academic education of students. In the current societal context, however, one can argue that the traditional goal of academic preparation is insufficient. Children are unhealthier than they were a generation ago and parents, health professionals, educators, and other decision makers are starting to take notice (Kohl & Cook, 2013; Tomkinson, Leger, Olds & Carzola, 2003). Writers for the Economic Policy Institute Emma Garcia and Elaine Weiss state that, "A broader understanding of the importance of student behaviors and school climate as drivers of academic performance and the wider acceptance that schools have a role in nurturing the "whole child" have increased attention to indicators that go beyond traditional metrics focused on proficiency in math and reading" (2018). The Every Student Succeeds Act (ESSA), passed in 2015, includes the new requirement that states report a nontraditional measure of student progress. The focus of those nontraditional measures can vary, but as evidenced by the research presented in this review, physical health-based programs and measures can enhance the traditional school focus of academic education and also nurture the whole child, thus becoming a valuable component of the scholastic experience.

Physical activity breaks that take place in the classroom and are learning-centered have shown promise as an effective method of meeting multi-tiered goals, such as improving children's physical wellbeing and academic performance (Centers for Disease Control [CDC], 2010; Donnelly et al., 2009; Kibbe et al., 2011; Schmidt, Benzing & Kamer, 2016; Sibley &

Etnier, 2003; Singh, Uijtdewilligen, Twisk, Van Mechelen & Chinapaw, 2012). Although discussing the mechanisms by which physical activity increases physical health is worthwhile, that is not the purpose of this review. The associations between activity and health have been extensively researched and documented in many studies and reviews (e.g. Bailey, 2006; Haskell et al., 2007; Janssen and LeBlanc, 2010; Manley, 1996; Penedo & Dahn, 2005; Warburton et al., 2006).

The purpose of this review is to suggest and support reasons that classroom-based physical activity breaks may increase academic performance. Based on the evidence presented in the articles reviewed here, curriculum- and classroom-based physical activity breaks increase academic achievement by (1) improving students' cognitive function, (2) increasing students' positive affect, (3) increasing student engagement, (4) being adaptable, easy to implement, and cost-effective, (5) improving school-based interpersonal relationships, and (6) supporting the success of disadvantaged students. Although much research has been done on the many types of school-based physical activity (PA) programs, this review focuses specifically on those PA interventions in elementary schools that are curriculum- and classroom-based. This means they take place in a kindergarten - 5th grade classroom under the leadership of the classroom teacher. The children perform basic exercise movements (lunges, squats, jumping jacks, etc.) while relating them to specific academic subjects the students are learning at the time. For example, if the teacher's goal was to have the kids practice division, she could say, "What is 24 divided by 4? Do that many toe touches." For science and nutrition, a teacher could have the kids jump up and down when he reads out the food group that helps build muscle (International Life Sciences Institute Research Foundation [ILSI], n.d.). Comparing standardized test results from before and after the intervention time period will provide data to support or contradict the theory that PA

breaks in elementary school classrooms will increase academic performance, and thus provide support for or against implementation of the intervention.

It is worth noting that often the terms "physical activity" and "exercise" are used interchangeably. Although they have similar connotations, their definitions are not identical. Physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure (WHO, 2018). Physical activity includes exercise but also includes other activities that involve movement, such as cleaning, working and active transport. Exercise is defined specifically as a sub-category of physical activity that is planned, structured, repetitive, and purposefully aimed at improving or maintaining cardiovascular endurance, muscular strength, muscular endurance, flexibility or body composition (WHO, 2018). In relation to programs implemented in elementary schools with the goal of increasing academic performance, the broader term "physical activity" is most often used to describe the intervention. As teachers strive to implement activity breaks into their classrooms, allowing for activities like dancing or marching or Simon Says or other movements that would not traditionally be regarded as "exercise" provides flexibility to the program so that it can be tailored to better fit each individual group of children. In the articles presented in this review, benefits to physical health and academic achievement from physical activity and exercise are discussed. As an individual's physical activity approaches the Surgeon General's suggested minimum of at least 150 minutes per week of moderate-to-vigorous physical activity, they reap the same benefits as someone who is participating in a formal exercise program of the same length and intensity (National Association for Sport and Physical Education [NASPE], 2016). Therefore, for the purposes of this review, we will use the terms "physical activity" and "exercise" interchangeably.

It is also helpful here to provide a definition of the terms “overweight” and “obesity”. A person is considered overweight if they have a body mass index (BMI; a measure derived by dividing an individual’s weight by their height) of 25 to <30, or above the 85th BMI percentile. Obesity is the condition of having a BMI greater than or equal to 30, or above the 95th BMI percentile (CDC, n.d.).

2. School-based physical activity breaks improve cognitive function.

Donnelly et. al.'s (2009) landmark study of approximately 1500 children in the Lawrence, Kansas area set out to implement and measure the success of a curriculum-based physical activity program designed to reduce the typical gains that occur in body mass index (BMI) as children age. In addition to changes in BMI, the authors of the study were interested in determining how the intervention affected children's physical activity levels and their academic achievement. The researchers used a population of 1527 second and third graders from 24 public elementary schools in Kansas. The study followed these students for three years. The children were in the fourth and fifth grades at the conclusion of the study. Eight hundred and fourteen students were exposed to the research intervention. Seven hundred and thirteen students were used as the control. A stratified random sampling strategy in gathering participants was used to account for school size and rural versus urban location. Cluster sampling was then used to assign a classroom to the control or experimental group.

Researchers called their program Physical Activity Across the Curriculum (PAAC). It consisted of 10 minute physically active academic lessons designed to be facilitated by the teacher in the classroom and ideally implemented twice per school day. The researchers partnered with TAKE10, a classroom-based physical activity program developed by the International Life Sciences Institute Research Foundation that combines academic instruction with 10 minute physical activity breaks to encourage children to be physically active without sacrificing time dedicated to academic learning (ILSI, n.d.).

Teachers in the control classrooms continued to teach as normal, with a regular schedule and no extra physical education outside of that already provided by the schools. Teachers who

would be implementing PAAC in their classrooms were trained at the beginning of the three-year period as to how to use the program. Weekly and yearly surveys were then sent to teachers to assess teacher and student commitment, enjoyment, and engagement. Research assistants periodically observed the lessons in each classroom and recorded quantitative and qualitative data using the industry accepted SOFIT protocol (a system of recording effectiveness of physical education lessons).

Before the intervention was implemented, parental consent and student assent were obtained. Having each student wear a standard uniform, researchers gathered measures for each child's height and weight. Each participating child was also issued the Wechsler Individual Achievement Test – 2nd edition (WIAT-II), a widely used test that assesses many areas of learning, such as word reading, writing fluency, and math problem solving.

Throughout the testing period, BMI for each PAAC child was recorded at the beginning and end of all three school years. Each spring semester, approximately 12 children per school (about 290 students) were randomly assigned to wear an accelerometer for four consecutive days, two weekdays and two weekend days. The WIAT-II was only issued once at the beginning of the intervention and once at the end. Once all data was collected, researchers used t-test statistical analyses to analyze their data.

The results were somewhat surprising in that BMI was not significantly impacted by exposure to PAAC. However, students in classrooms that participated in PAAC had significantly higher scores on all areas of the WIAT-II, suggesting improved academic performance. The students in the study group also had significantly higher levels of moderate-to-vigorous physical activity outside of school hours on both weekdays and weekends. These findings were supported

by various meta-analyses done by the CDC (2010), Kibbe et al. (2011), Sibley & Etnier (2003) and Singh et al. (2012) indicating similar results of classroom-based physical activity on academic performance.

These findings can be explained by the fact that exercise has been shown to improve learning and memory by increasing cerebral capillary growth, increasing blood flow and oxygenation to the brain, increasing the production of neurotrophins (proteins that helps improve brain function and neural transmission), increasing growth of nerve cells in the hippocampus (the part of the brain responsible for learning and memory), promoting development of nerve connections, increasing density of the brain's neural network, increasing overall brain tissue volume and increasing amounts of neurotransmitters (chemical signals used to relay messages in the brain) (Camahalan and Ipcok, 2015; Rasberry et al., 2011). One of the most noteworthy chemical messengers is brain-derived neurotrophic factor (BDNF). BDNF improves the function of neurons, encourages their growth, and strengthens and protects them against premature cell death. It also binds to receptors at the synapses, to improve signal strength between neurons, which means the brain is better equipped to efficiently develop cognition, reward, learning and memory (Erickson et al., 2011).

In 2011, Erickson and associates performed a study to explore the relationship between physical activity, brain volume, and BDNF levels. One hundred and twenty adults averaging 66 years of age were randomly assigned to an aerobic exercise test group (n=60) or a stretching and toning control group (n=60). Each group met three times per week for one year and was led by trained fitness professionals. The aerobic test group began by walking for 10 minutes during each session, then increasing the duration by 5-minute increments each week until walking 40

minutes per session during week seven. Using the Karvonen formula, each participant's target heart rate was calculated. Each participant was given a heart rate monitor and encouraged to walk at 50-60% of their maximum heart rate reserve for weeks 1-7 and then 60-75% for the rest of the program. Each control participant kept an exercise log and received written feedback every four weeks to encourage consistency and improvement. The control group classes began and ended with a warmup and cooldown. Then the class participants performed four resistance exercises using resistance bands or dumbbells, two exercises designed to improve balance, one yoga sequence, and one exercise of their choice. By week three, the control group individuals were encouraged to increase intensity by increasing repetitions or using more weight. Like the test group, the control group completed exercise logs and received monthly written feedback.

Before experimentation started, each participant in both groups completed a VO_2 max test, received an MRI of their brain, had blood drawn to measure the amount of BDNF in the serum, and completed a spatial memory assessment. At 6 months into the intervention, each participant received an additional MRI and once again completed the spatial memory task. At the end of 12 months, the complete battery of initial assessments was done again. Using Pearson correlations, t-tests, and ANOVA analyses, the data collected was analyzed.

Results showed that the test group had a 2% increase in the volume of their hippocampus, compared to a 1.4% decline in volume in the control group. Both groups improved in their spatial memory skills, but a larger hippocampus was associated with a higher memory performance. The blood serum levels of BDNF interestingly did not differ significantly between the test and control groups. However, when just the experimental group was considered, higher BDNF levels were associated with a larger hippocampus, which was associated with improved

memory performance. While no research similar to Erickson et al. has been found in children, it is quite reasonable to assume that similar processes take place when children exercise.

The lack of exercise and obesity are clearly related (WHO, 2019), and obesity has been associated with detectable structural brain abnormalities during childhood, specifically with decreases in brain regions that control aspects of executive functioning (Mora-Gonzalez, 2019). (Executive functioning is a term that refers to the cognitive processes responsible for organizing and controlling goal-directed behavior. Executive functioning includes inhibition, updating working memory, and shifting between two cognitive processes (Best, 2010).) These brain regions are also the areas that show the largest gains in functioning with exposure to exercise (Tomporowski, Davis, Miller & Naglieri, 2008).

Consequently, it appears that aerobic exercise helps protect and enhance the function of brain tissue that already exists, can contribute to the genesis of new brain tissue, and can protect against brain volume loss. All of these benefits help explain why implementing regular physical activity into the classroom can help increase academic performance, as academic success depends heavily on a child's ability to learn new material (i.e. developing new neural pathways and increased brain tissue volume) and remembering what they've previously learned. Many other researchers have found similar associations between physical activity and improved brain function (Colcombe et al., 2006; Colcombe and Kramer, 2003; Erickson et al., 2010; Erickson et al., 2011; Hillman, Erickson and Kramer, 2008; Schmidt et al., 2016).

3. School-based physical activity breaks increase positive affect and mood.

Hinton, Miyamoto, and Della-Chiesa (2008) commented on the effects of emotion on learning: "Over 2,000 years ago, Plato declared that all learning has an emotional base and scientific research supports this biological interdependence of learning and emotion. Scientific evidence that emotion is fundamental to learning settles ideological debates concerning whether schools are responsible for emotional development. If schools are involved in intellectual development, they are inherently involved in emotional development. Learning is more likely to be effective if educators help to minimize stress and fear at school, teach students emotional regulation strategies, and provide a positive learning environment that is motivating to students." Clearly, ensuring that students have a positive emotional experience at school helps aid learning and thus academic performance. Physical activity breaks may be one way in which teachers can help facilitate students' positive emotional experiences.

Before discussing how physical activity improves mood, it is appropriate to provide some definitions. The following terms have very similar connotations and for our purposes will be used interchangeably, but from a clinical perspective, it is useful to understand the differences, especially when comparing positive feelings to pathologically negative ones. Mood is defined as a temporary state of mind or feeling. Happiness is the state of feeling or showing pleasure or contentment. Positive affect is the extent to which an individual subjectively experiences positive moods such as joy, interest, and alertness. "Psychological wellbeing" is a catch-all phrase meaning experiencing contentment, self-actualization, peace, happiness, and general satisfaction with all elements of life (Ryff, 2018).

Schmidt, Benzing, and Kamer (2016) designed a study to test the effects of physical activity (PA) and cognitive engagement (CE) on attentional performance in elementary schoolers to determine if these interventions resulted in a change in positive affect. Ninety-two fifth graders in Bern, Switzerland were randomly assigned to one of four groups, – (1) a combo group that would complete a physical activity break that required high cognitive engagement, (2) a cognition group that received a break that was sedentary, but required high cognitive engagement, (3) a physical group that participated in a physical activity that required no cognitive engagement, or (4) a control group that received a break that required low physical exertion and low cognitive engagement. The intervention for each group was designed to last for only 10 minutes. On five separate occasions over a period of three weeks, each group of children participated in a typical language lecture lesson, after which pre-tests were given. These tests consisted of the PANAS-C, a commonly used self-report questionnaire that measures positive and negative affect and has been appropriately formatted for children, and the D2 Test, a pencil-and-paper test designed to assess focused attention by requiring students to mark out specific alphabetic letters and leave others untouched. The students then received the intervention assigned to their group, completed another typical academic lesson, and then completed the post-test PANAS-C and D2 as well as a Borg Rating of Perceived Exertion (RPE) Scale (a measure of how physically challenging the student found a particular activity), and a version of the RPE scale designed to measure how cognitively challenging a student found a particular activity (Rating of Cognitive Exertion or RCE). As each intervention was taking place, each child in all four groups wore a heart rate monitor to validate the results of RPE.

The intervention for the 25 students in the combo group consisted of taking them to the playground. They were instructed to complete a “number connection test”, which consisted of

running to the numbers 1-18 drawn on the ground. For 5 minutes, each child had to run to each number in ascending order then start again after reaching 18. After 5 minutes, the child had to compute their total score. They then had a second 5-minute period to try to improve on their previous score.

The 22 students in the cognitive group were asked to complete the ZVT, a pencil-and-paper trail-making test. Numbers from 1-90 were listed on a sheet of paper. Students had five minutes to connect the numbers in ascending order and then start again after reaching 90. After 5 minutes, the students computed their total score. After determining their scores, they had a second 5-minute period to try to improve their previous score.

The 25 students in the physical group were taken to the playground and simply asked to run around at varying speeds. Occasionally, the investigator would give instructions to "change gears in their car", a fun way to ask the children to change their running speeds. This activity was designed to replicate the physical intensity of the combo group but limit cognitive load.

The 20 children in the control group stayed in their classroom at their desks. The investigator permitted the children to rest their heads on their desks and relax as much as possible, then read a children's book aloud to the students for 10 minutes. This activity was designed to require very little of the students, either physically or mentally.

The analyses revealed that the activities that encouraged cognitive engagement increased positive affect significantly, but surprisingly physical activity did not. The increased positive affect brought about by a mentally challenging activity accounted for the improvement in focused attention and processing seen most significantly in the combo group. At first glance, these results may seem to suggest that in order to enhance students' mood, an interesting puzzle

or trivia game may be more effective than physical activity. However, the authors point out that in this case, it is the combination of PA plus CE that leads to greater attentional performance, possibly suggesting a synergistic effect. As will be discussed in more detail later, physical activity is an effective way of elevating mood, and this study highlights the importance of positive affect on attention and mental processing speed. These attributes contribute strongly to a student's ability to perform well academically. According to this study, affect is arguably the most important component of attentional performance. Therefore, it is very important that researchers take the affective reactions of children into consideration when testing the academic effects of physical activity.

Physical activity appears to increase positive affect by initiating important chemical changes in the brain. As a human body moves at a moderate intensity, neurotransmitters are released in the brain. These chemical messengers have many roles, but one of the most important is to contribute to feelings of happiness and psychological well-being (Szabo et al., 2019). One of these neurotransmitters is dopamine, which increases after exercise and helps promote motivation for reward-seeking behavior. Dopamine is also released when a person enjoys the activity he is doing. Dopamine has been shown to help save information as it is discovered. In other words, if a student has an enjoyable memory associated with the learning of information, that knowledge is more likely to be stored in long-term memory (Wolpert-Gawron, 2017). Another neurotransmitter released during exercise is β-endorphin, which attaches to the brain's opioid receptors and produces feelings of euphoria (Szabo et al., 2019). Serotonin increases during exercise and directly contributes to feelings of happiness (Ploughman, 2008). BDNF was discussed earlier in this review as a major contributor to the health and integrity of neurons. It

helps enhance their function of supplying cognitive processing power, but these strong neural pathways also help efficiently deliver and process emotions (Erickson et al., 2011).

Besides changes in neurotransmitters, regular physical activity also lowers a person's basal heart rate (the speed the heart pumps when activity is not being performed). This is due to increased efficiency of the heart to pump the appropriate volume of blood through the body and increased ability to utilize the oxygen delivered by the blood. This increased efficiency allows for less physiological arousal at rest, which promotes relaxation, tranquility, and positive engagement for the exerciser. This state of lessened arousal encourages habits in the exerciser of utilizing physical activity as a means to deal with stress, as exercise comes to provide a sense of psychological relief (Szabo, Griffiths & Demetrovics, 2019).

Hopkins et al. (2012) examined the effects of an acute bout of exercise versus a longer-term exercise program on mood. They also wanted to find out if an individual's BDNF genotype (the way instructions are coded into a person's DNA as to how to exhibit a specific trait) influences the effects of exercise on that individual.

The authors recruited 54 healthy but sedentary young adults (ages 18-36) from Hanover, New Hampshire. After screenings to ensure participants suffered from no chronic physical or mental illness, participants were randomly assigned to one of four groups: (1) a control group who would remain sedentary for the next 4 weeks (OW-) (n=13), (2) a group who would remain sedentary for 4 weeks, but would undertake one bout of exercise on the day of post-testing (OW+) (n=15), (3) a group that would engage in a treadmill walking/jogging program 4 times per week for at least 30 minutes, but would not exercise the day of the post-test (4W-) (n=14), or

(4) a group that completed the same workout protocol as group 3, but would complete an exercise session the day of post-testing (4W+) (n=12).

Before the intervention began, all participants were given pedometers to track daily activity and completed a health history form, an informed consent form, a physical activity questionnaire, a self-report of body height and weight, an estimate of VO_2 max, a novel object recognition task (a test of visual recognition memory ability), a survey measuring mood and anxiety levels, and provided a saliva sample for genetic testing. Participants wore pedometers at all times for the 4-week duration and had daily email communication with the investigators to ensure participants were correctly following instructions given to their specific test group.

At the end of 4 weeks, each participant of the OW+ and 4W+ groups completed a 30-minute exercise session of treadmill walking or jogging. The exercise session was held at least two hours before post-testing. The OW- and 4W- groups did not exercise at all the day of post-testing. The post-tests consisted of the same number of surveys, forms, and samples as did the pre-tests.

Data analysis showed that the 4W+ group, who participated in a long-term exercise program and an acute bout of exercise on test day, significantly increased their accuracy on the memory test and had significantly decreased levels of perceived stress - perceived stress is defined here as the extent to which an individual finds the demands of their life to be unpredictable, uncontrollable, and in excess of their ability to cope (Phillips, 2013). Interestingly, the 4W- group, who exercised according to a long-term program but did not engage in test day exercise, had significantly decreased accuracy on their memory tests. However, this group showed a significant increase in positive mood.

In the OW+ group, who remained sedentary except for one bout of exercise on test day, memory accuracy didn't change significantly and, interestingly, levels of perceived stress increased. In the OW- group, who remained sedentary for the entire trial period, the only notable change was that their memory test accuracy decreased significantly. Another important result from this study was that both the regularly exercising groups (4W+ and 4W-), reported significantly lower levels of state anxiety and higher positive mood on the days they exercised compared to days they didn't.

The results of the study also showed that the participant's BDNF genotype did not affect levels of perceived stress, mood or anxiety. When considered across all groups, the genotype homogeneity did not affect memory test performance. However, when only the 4W+ group was considered, the participants with homozygotic BDNF allele pairings had significantly higher memory test accuracy than those participants with heterozygotic pairings.

Even though Hopkins et al. (2012) studied young adults, their findings are important in several ways when considering the effects of exercise in children. First, a regular exercise program combined with an acute bout of exercise increases memory accuracy and decreases levels of perceived stress. Moreover, it produces lower state anxiety and increases positive mood on the days that exercise takes place. The findings suggest that implementing a program of regular classroom-based physical activity breaks and ensuring that one of these breaks happens on the day of an important test could be a great way to elevate students' moods and lower their stress levels, which in turn may improve academic performance.

The finding that an individual's genetics influence the effect exercise has on them is interesting, but not surprising. A person's specific cellular makeup and their environment both

vie to most greatly impact how that person will grow, learn, and respond to their life experiences (Hinton et al., 2008). In the case of this study, a person with homozygous BDNF alleles experienced a greater cognitive benefit from regular exercise than a person with heterozygous alleles. Taken in isolation, this could be a discouraging finding for individuals that don't have the specific necessary genetic makeup. Nonetheless, as the brain is repetitively exposed to exercise, BDNF levels increase and every individual, regardless of genetic makeup, becomes better able to utilize the advantages of both long term and acute bouts of exercise. This means that every child, regardless of their genetics, can emotionally, physically and academically benefit from physical activity breaks.

Another important discussion point derived from this study is the mental and emotional effects of stress. Stress is a state of mental or emotional strain or tension that results from adverse or very demanding circumstances (Oxford Online Dictionary, n.d.). In the OW+ group, who remained sedentary for the duration of the study except for one bout of exercise the day of post-testing, significantly higher rates of perceived stress were reported. However, this increased stress did not affect performance on the memory test at all. It is possible that the knowledge that a participant had to perform a fitness test that they had not prepared for contributed to increased stress levels. Whatever the reason, the participants' cognitive processing abilities were not diminished. In this group, increased stress levels also did not affect mood. Although intuitively we might assume that increased stress automatically makes us feel bad, these results indicate that that is not always the case.

It is reasonable to assume that some educators, especially those who do not exercise themselves, may fear that introducing physical activity breaks may cause some children,

especially those who are unfamiliar or uncomfortable with exercise, to become stressed and/or upset (Hinton et al., 2008). Although it is true that chronic stress impairs cognitive processing and abilities and can lead to the development of depressive illnesses, exposure to acute stress facilitates memory formation and consolidation. It does this by releasing helpful hormones, like epinephrine, which help consolidate strong emotional memories and activate important learning centers of the brain, such as regions of the hippocampus (Reagan, Grillo & Piroli, 2008).

Although some children may experience negative feelings associated with physical activity, it is more likely that students will experience an increase in feelings of psychological wellbeing. A study by Morgan and Bath (1998) indicated that physical activity contributes independently to the promotion and maintenance of psychological wellbeing. When physical activity is combined with positive social interaction (like that of exercising with your friends in your classroom), these results improve even more. Better health (like that provided by consistent physical activity) and higher social interaction consistently predict higher levels of subjective wellbeing. What's more, feelings of higher wellbeing benefit children through their lifetime. The best predictor of subjective wellbeing later in life is subjective wellbeing early in life, therefore introducing measures to increase wellbeing early in a child's life (i.e. in elementary school), benefits them later in life (Morgan & Bath, 1998). Based on the volume of research confirming this conclusion, we can confidently state that the positive relationships between social activities, physical wellbeing through exercise, and the long-term stability of psychological wellbeing are strong (Edwards, 2006; Hassmen, Koivula & Uutela, 2000; Morgan & Bath, 1998; Netz, Wu, Becker & Tannenbaum, 2005; Scully, Kremer, Meade, Graham & Dudgeon, 1998).

Implementing programs that help improve students' wellbeing can also increase academic performance. School children who report higher levels of wellbeing are more likely to earn higher grades, even when controlling for IQ, age and previous GPA (Ayyash-Abdo & Sanchez-Ruiz, 2012; Borrello, 2005; Quinn & Duckworth, 2007; van Batenburg-Eddes & Jolles; 2013). PA breaks have been shown to contribute positively to a feeling of well-being, improve mood, and thus should result in improved academic performance (Donnelly et al., 2009).

The neurological processes that link mood to learning occur in three major brain networks – the recognition network, which receives, identifies, and categorizes sensory information and transforms it into learning; the strategic network, which helps plan and coordinate goal-oriented actions; and the affective network, which is involved in the emotional components of learning, such as interest, motivation and stress (Hinton et al., 2008). None of these brain networks work alone; they operate in tandem to provide the signals and directions necessary for proper functioning. Emotion shapes and is shaped by cognitive processing. This explains why negative emotions can disrupt learning, but positive emotions drive it. The brain uses emotion to direct action. Accordingly, motivation is emotionally based. Since emotion is shaped by cognitive processing, students can learn to regulate their emotions and thus potentially increase traits like motivation and interest. Students can use emotional regulation strategies to control negative emotional reactions. Some effective emotional regulation strategies include pausing during the moment of highest negativity, breathing deeply, observing specific thoughts and feelings, practicing mindfulness, finding ways to have fun, and exercising (Rolston & Lloyd-Richardson, 2017). As a student continues to practice emotional regulation strategies, related brain synapses are strengthened in a process called long term potentiation (LTP). This makes it easier for information – academic, emotional, or otherwise – to be transferred at the synapse

(Cooke & Bliss, 2006; Hopkins, Davis, VanTieghem, Whalen & Bucci, 2012). Thus, the ability to regulate emotions is a strong predictor of academic outcomes (Hinton et al., 2008). PA breaks in the classroom have the potential to help students regulate emotions and improve behaviors that benefit academic performance (Hinton et al., 2008).

4. School-based physical activity breaks increase student engagement.

Beginning at birth, physical activity affects how humans learn. Famed psychologist Jean Piaget described the process of cognitive development as taking place in four stages (Fiore, 2018). Piaget's first stage of cognitive development is referred to as the sensorimotor stage and typically takes place between birth and two years of age. In this stage physical activity and the accompanying physical sensations are turned into representative mental symbols and thus help the child collect and interpret information about their environment (Fiore, 2018). From the very beginning, tactile and kinesthetic stimulations are the primary information to which a person reacts (Wigram & DeBacker, 1999).

Sivilotti and Pike (2007) declared that kinesthetic learning is a fundamental, powerful and ubiquitous component of learning, especially in young children. The learning of all children benefits when they can be physically active while learning academic content (Hutton, 2006).

Gardner's Theory of Multiple Intelligences (Gardner & Hatch, 1989) proposes that intelligence is defined as a person's problem-solving skills and use of everyday experiences to inform learning. Gardner's list of intelligences succinctly summarizes a wide range of human cognitive capacities, describing the different processes that people utilize to obtain and use information. Gardner's eight intelligences are linguistic, musical, logical-mathematical, spatial, interpersonal, intrapersonal, naturalist, and bodily-kinesthetic (Gardner & Hatch, 1989).

Felder and Silverman (1988) identified several learning styles in an effort to better educate teachers on effective teaching methods. Felder and Silverman's list of learning styles includes sensing, intuitive, visual/verbal, auditory, inductive, deductive, active, reflective, sequential, kinesthetic, and global (Felder & Silverman, 1988).

Even though the idea that individual learners have unique learning styles has fallen out of favor, Piaget, Gardner, and Felder and Silverman all identified that physical activity is a strong component of learning. Many other studies have confirmed this important relationship (Begel, Garcia, & Wolfman, 2004; Fordyce & Wehner, 1993; Gomez-Panilla, So & Kesslak, 1998; Isaacs, Anderson, Alcantara, Black & Greenough, 1992; Parcel, Simons-Morton, O'Hara, Baranowski & Wilson, 1989; Sivilotti & Pike, 2007; Snyder, 2000; Yaffe, Barnes, Nevitt, Lui & Covinsky, 2001).

Snyder (2000) asked students to pick which of Felder and Silverman's (1988) learning styles (auditory, visual, kinesthetic, etc.) they most closely identified with. Students also chose which of Gardner's Intelligences (linguistic, intrapersonal, kinesthetic, etc.) they believed best describes how they learned. Research assistants gathered the data and obtained each student's grade point average (GPA) and MAT-7 and BSAP standardized test scores. Using the data gathered from the surveys and academic success measures, statistical analyses were conducted to examine the relationship between students' self-reported learning styles and their actual academic achievement.

The results showed that academic achievement was independent of self-reported learning style. However, 81% of students considered themselves tactile/kinesthetic learners. Urval et al. (2014) performed a study that found that 37% of students preferred at least four different methods of teaching be incorporated into their curriculum. These results support the importance of physical activity in learning as a way to effectively support all learners by incorporating variable practice into the classroom.

Different instructional methods (also referred to as variable practice) create different underlying neural pathways to knowledge, leading to a more robust neural encoding of information and thus greater accuracy and transferability than teaching by one method alone (Hinton et al., 2008; Schmidt, 1975). Classroom-based physical activity breaks give students an opportunity to repeat and rehearse the information they have learned in novel settings, which is an important component in consolidating memories and moving them from short-term storage in the brain's hippocampus to longer-term storage in the cortex, the brain's outer layer (Richards, 2008).

The brain develops over time through a continuous and dynamic interaction between biology and experience. This underscores the need for dynamic developmental approaches to teaching. Utilizing strategies like curriculum-based physical activities in addition to traditional "chalk-and-talk" lectures results in a dynamic learning environment and more effective and inclusive instruction, supporting learning subject matter in a greater variety of ways that more widely encompass the needs of all learners (Begel et al., 2004; Hinton et al., 2008).

As students receive instruction in a dynamic learning environment, they are likely to feel more engaged in their classroom and in learning (Gettinger & Seibert, 2002). Student engagement is a very important contributor to student success; students who are engaged with school are more likely to learn, to find the experience rewarding, to graduate, and to pursue higher education (Marks, 2000). Marks argues that student engagement is a clear sign that the child is on its way to achieving and developing optimally as a person. Engagement enhances a child's willingness to work and triggers their ability to connect with the learning. Students who feel engaged in the classroom have greater academic success (Alexander, Entwisle & Olson,

2001; Crosnoe, 2005; Samuels & Turnure, 1974; Skinner, Wellborn & Connell, 1990). Many experienced teachers support the efficacy of physical movement and activity to increase students' engagement in academic lessons (de Frondeville, 2009; Eichholz, 2016; MacMeekin, 2017; Quizalize, 2018; Reading Horizons, 2013; Walpert-Gowan, 2017).

5. School-based physical activity breaks are adaptable, easy to implement, and cost-effective.

Skilled teachers recognize when students can benefit from a PA break, and understand that curriculum-based PA breaks are easily adaptable to almost any classroom setting, enabling teachers to make physical activity and kinesthetic-learning activities accessible to each of their students (Camahalan & Ipock, 2015; Donnelly & Lambourne, 2011). If a teacher wanted to incorporate physical activity into a spelling lesson, she could have the students spell out each word while completing jumping jacks, running in place, or performing frog jumps. If her students are less physically able, they can spell out words while doing low impact exercises like step jacks, high knee marching, or toe touches. If the children are chair-bound they can participate by doing overhead presses, arm circles or biceps curls while they spell out their words (ILSI, n.d.). Children who are non-verbal still benefit from the auditory and kinetic stimuli provided by these activities. Even children who are unable to respond physically or verbally, like those with muscular dystrophy, can benefit from curriculum-based physical activities. The rhythm of the instructor verbally spelling out words and moving in time adds a predictable cadence to the auditory stimulus and reaches a child's innate ability to hear, recognize and remember patterns (Hill-Clarke & Robinson, 2004).

Classroom time is one of the resources that effective teachers are skilled at using (Gettinger & Seibert, 2002; McBer, 2001). These teachers use an appropriate pace throughout the lessons, allocate their time fairly amongst the pupils, and use the available time well without devoting a lot to transitions or distractions. They create maximum opportunities to learn and no time is wasted (Gettinger & Seibert, 2002; McBer, 2001). Classroom- and curriculum-based PA breaks help support these behaviors. No time is spent transitioning to another part of the

building, because the teacher and students remain in the classroom. Many PA breaks, like those included in the TAKE10 program, require no equipment, so no time is needed for set up or clean up. Because they are flexible and easy to implement, these short breaks support increased health and academic performance (Camahalan & Ipock, 2015; Donnelly et al., 2009; Donnelly & Lambourne, 2011; Howie, Schatz and Pate, 2015; Kibbe et al., 2011; Norris, Shelton, Dunsmuir, Duke-Williams & Stamatakis, 2015; Schmidt et al., 2016; Skrade, 2013).

Curriculum-based PA breaks constitute effective, economical interventions that improve students' behavior, attention, and learning. Researchers have found significant positive results with programs that cost very little. Schmidt et al. (2016) asked children to run across a flat outside surface to numbers drawn on the ground with chalk. Bershwinger and Brusseau (2013) utilized equipment-free jumping jacks and walking breaks. Begel, Garcia, and Wolfman (2004) used activities that required only pencils and paper. If instructors find it difficult to create PA programs for their classrooms that are appropriately physically challenging and manageable, excellent commercial curricula are available for only a few hundred dollars (e.g. the TAKE10 and Jump In! programs) (Begel et al., 2004; Donnelly & Lambourne, 2011; Graham, Lucas-Thompson & O'Donnell, 2014; ILSI, n.d.).

Even when physical activity programs require a significantly higher initial financial investment, they produce positive results with costs that are considered reasonable. Australian exercise researcher Rachel Sutherland and associates conducted a large study designed to report the cost and effectiveness of the Physical Activity 4 Everyone (PA4E1) intervention compared to the cost of usual PA practices. PA4E1 was a multi-component intervention implemented in low-income communities.

Ten Australian secondary schools in low-income neighborhoods were recruited for the study. Five schools served as the control group and contributed 505 students to the study. Five schools served as the experimental group and contributed 645 students to the study, for a total population of 1,150. Researchers started tracking the children when they were in 7th grade and followed them for a period of 24 months.

At the beginning of the research period, each child wore an accelerometer for 7 days to gather baseline measures of their typical level of physical activity. Each student was also given an online survey to report health habits and was measured by researchers for height and weight. Height and weight measures were used to calculate a student's body mass index (BMI). The researchers then implemented the intervention, which was large scale and multi-tiered. The PA4E1 program sought to increase physical activity through seven strategies including: (1) more active PE lessons, (2) a 10 week enhanced school sports program, (3) supervised recess with physical activity opportunities, (4) development of personal PA plans for each child in the test group, (5) a supportive school PA policy, (6) increased linking with the community and (7) increased linking with parents. These strategies were strengthened by six levels of support including: (1) an in-school PA consultant, (2) executive support of school leadership and committees, (3) detailed teacher training, (4) equipment and resources including balls, ropes, hoops, pedometers, and PA plan templates, (5) weekly encouraging email prompts to teachers from a study representative, and (6) detailed monitoring reports.

At both 12 and 24 months, students were re-evaluated with accelerometers, online surveys, and anthropometric measures. Financial costs were estimated from a societal perspective and included materials, printing, and personnel costs, like salaries, consultant fees,

substitute teachers to allow regular teachers to attend training, and time spent as staff attended additional meetings about program implementation. Once all these data points were gathered, the authors used the information to calculate incremental cost effectiveness ratios (CER) for changes in moderate-to-vigorous physical activity (MVPA) and BMI. Cost effectiveness ratios help answer questions around the benefits of interventions relative to their cost in order to inform funding decisions (Owens, 1998). Essentially, a higher CER (i.e. a higher dollar amount) means that more effort must be expended for the same health benefit. Incremental CERs were calculated for minutes of MVPA for each child per day, MET hours (A MET represents energy expended divided by resting energy expenditure) gained per person per day, BMI units avoided and 0.1-unit changes in a BMI z-score (the z-score is a numerical representation of a value's relationship to the mean). Calculating MET hours gained accounts for the variety of physical activity measures in use and considers intensity, duration and frequency of physical activity.

At 12 and 24 months, the test group had significantly increased physical activity and reduced weight, BMI and BMI z-score. The overall cost for the PA4E1 intervention was $329,952 over 24 months, or $394 per student in the test group. This investment resulted in a CER of $56 for each additional minute of MVPA per child per day, a CER of $1 for each MET hour gained per person per day, a CER of $1,408 for each BMI unit avoided and a CER of $563 for a 10% reduction in BMI z-score. From these results, the authors concluded that ambitious and wide-reaching programs like PA4E1 are cost effective solutions for increasing physical activity levels and reducing unhealthy weight gain in children. These conclusions mirror those found in similar studies (Barrett et al., 2015; Coleman et al., 2005).

In order for policymakers to allocate scarce resources, economic evaluations of health and academic programs are needed. No single threshold exists to determine the acceptability of

cost effectiveness; it depends on the values, budget, politics, and willingness to spend of the community (Barnsbee, 2018). Research like Sutherland and associates' study helps contribute to a pool of knowledge that helps legislators make well-informed budget decisions. School-based PA interventions are effective and are cheaper on average than estimates for clinical and surgical treatments for obese children, which are estimated in the $1,000-$2,000 per BMI unit change (Barrett et al., 2015). The cost effectiveness of school-based PA interventions increases further when we consider that the authors of the Sutherland study calculated benefits very conservatively. The financial component of the effects on healthcare potentially caused by the intervention were not included, nor were potential effects on other students. Because the intervention involved improving the school environment and parental and community involvement, it is likely that children not included in the test group also received benefits. The Sutherland study also involved hiring an in-school physical activity consultant, a cost that many schools need not absorb, as instructors that are already staff members can be trained to lead implementation of a program at school. When this is the case (like in the TAKE10 program), the CER for each additional minute of MVPA per child per day decreases to about $27 (Sutherland et al., 2016). The adaptability, time- and cost-effectiveness of classroom- and curriculum-based physical activity breaks support the goals of successful educators and schools.

6. School-based physical activity breaks improve school-based interpersonal relationships.

To be most effective and promote maximum academic achievement, educators must help provide students with the skills and strategies needed to meaningfully connect with other people (Murray-Harvey, 2010). Physical activity breaks can be developed to emphasize prosocial behavior and goals. Physical activities can highlight the value of working together and reiterate that working together will help increase personal happiness (Orlick, 1981). Numerous studies have documented the benefits of cooperative PA activities (Barrett, 2005; Dyson, 2005; Goudas & Magotsiou, 2009; Johnson & Ward, 2001). A study by Goudas and Magotsiou (2009) found that students who participated in a cooperative PE learning program showed enhanced social skills and attitudes toward group work. These students, compared to those of the control group, increased their cooperative skills and empathy and decreased their quick-temperedness and their tendency to disrupt. They also increased their preference for working in groups and decreased their discomfort with group work. Activities that combine physical activity and group work have been shown to be so successful at increasing students' social abilities that Goudas and Magotsiou (2009) state that social skills can and should be a valuable curricular target in physical education.

Curriculum-based PA breaks' interactive nature makes them valuable not just for content-related exercises, but also to address social challenges facing any classroom (Begel et al., 2004). For example, the Crab Break 'n' Build activity is an example of a curriculum-based break that encourages physical activity, reinforces academic lessons, and promotes teamwork. In it, students divide into two-person teams and stand at one side of the room, which has a line of plastic cones for each team. The first teammate crabwalks (face up, on hands and heels with hips and bottom off the ground) to each cone and knocks it over while spelling out a word, one letter

for each cone. When they have reached the end, the second teammate crabwalks to each cone and sets it upright while spelling a word, providing one letter for each cone (Adapted Physical Activity, 2018).

Cooperative PA breaks help provide students a safe environment in which to learn how to regulate emotions, refine social skills, and build strong social networks, all of which provide important social capital that helps a student be more successful (Hinton et al., 2008). These cooperative activities also help create an environment in which students perform tasks successfully a higher percentage of the time than they normally would, building a sense of accomplishment and success (Johnson & Ward, 2001). This success reinforces skills, builds confidence, and drives increased success (Iso-Ahola & Dotson, 2014).

PA breaks may especially benefit students who are overweight or obese. Students who are overweight or obese may feel stigmatized or biased against, which can lead to less positive socialization and even decreased academic achievement (Robinson, Bacon & O'Reilly, 1993). Helping these students become physically active, improve their physical fitness levels, self-esteem and positive affect related to exercise may result in feeling more comfortable socializing and reduce the negative stigma and bias they experience, thus improving the quality of their social interactions (Welk et al., 2010).

Teacher-pupil relationships are also very important influencers of a student's academic success but can be described much more simply than can peer-peer relationships. According to the Australian Society for Evidence Based Teaching (ASEBT), students want two basic things from their teachers. First, they want to know that their teacher cares about them. This is demonstrated as teachers develop an environment of warmth and empathy and are physically and

mentally present enough to let the students know they are important. Second, students want teachers who have high expectations of them, and believe and communicate that children are capable of succeeding and expect them to do so. Students want to be challenged and given the tools, materials, time, practice and support needed to meet those challenges (ASEBT, n.d.). Relationships that are comprised of high care plus high expectations are considered high-performance and highly effective. Teachers with high-performance relations with students have a passionate desire to help students learn and improve, which leads them to demand high standards of behavior and effort. They do this while also valuing the children as people and taking an interest in their lives. These teachers provide students with strong academic and behavioral guidance while nurturing personal responsibility and self-regulation (ASEBT, n.d.). Strict leadership plus friendly behavior is positively related to academic achievement (Levy, Wubbels, Brekelmans & Morganfield, 1997). PA breaks can be one tool in the teachers' toolbox to help achieve such a relationship, especially through effective modeling.

Albert Bandura developed social learning theory, which states that people learn by observing the behavior of others and the outcomes of those behaviors (Fiore, 2018). Modeling is an important aspect of this theory. A model is a person whose behavior, example, or success is or can be emulated by others (Bandura & Walters, 1977). Since teachers are entrusted with the safety, discipline and instruction for about half the children's waking hours, the influence that takes place at school can be life changing. Therefore, teachers can serve as role models who teach character, moral virtues, and other positive characteristics including a physically active lifestyle (Lumpkin, 2008).

Physical activity can be used as an excellent medium for teachers to model and teach moral values. Seeing their teacher model good behavior encourages the same behavior in the children (McBer, 2001). Teachers model integrity by teaching fair play and good sportsmanship and by respecting all students and treating everyone with kindness. Teachers demonstrate honesty by telling the truth and acting in an honorable way regardless of the consequences. For example, they can encourage students to be honest about who touched the wall first or who knocked the ball out of bounds even if it means they lose the game. Trust is established by upholding expectations and fulfilling promises and commitments. Trust increases as teachers provide support, feedback and encouragement as a student learns a new skill, and as they explain the activity's rules or guidelines, and then kindly and firmly enforce them. Students learn fairness as a teacher ensures all students have the same opportunity to meet standards or goals and receive support for their unique abilities. For example, if the goal of an activity is to do jacks while spelling out a word, a student could do jumping jacks or step jacks, depending on their physical ability and comfort level. Teachers also demonstrate fairness by exercising self-control and restraint when challenged, as people who are fair and don't bully or shift responsibility for their emotions to others. Respect is learned by having opportunities to be kind to and patient with students of all levels of skill and ability. Responsibility is practiced as students are held morally accountable for their actions and fulfilling their duties (e.g. playing their position correctly in baseball or soccer, contributing to team success in a relay race, etc.). In short, physical activities help children learn respect for the rights and feelings of others and self-discipline through their participation, effort and emotional regulation (Lumpkin, 2008).

Teachers do not only have the opportunity to act as a model for prosocial behaviors, they also are in a prime position to model physical activity. When a teacher encourages and

participates with students in PA breaks, they act as both a role model and mentor for good health and life habits. Effective teachers are very actively involved with their pupils at all times; teachers who are more active and engaged inspire students to be more active and engaged (Cardinal, 2001; Cheung, 2019; Donnelly et al., 2009; Massey, Stellino & Fraser, 2018; McBer, 2001). Teachers with physical limitations may feel intimidated about participating in physical activity, especially if it is new or unfamiliar. Happily, many PA curricula, like TAKE10, include modifications for beginning, intermediate, and advanced exercisers, so it is likely that teachers can find a physical activity that fits their comfort level. As teachers respect their individual limitations and seek to increase their abilities, they encourage their students to do the same (McBer, 2001).

As students participate in physical activities, they can learn prosocial behaviors and increase their social engagement and support (Jarvinen & Nicholls, 1996). This creates a healthy, helpful positive feedback cycle, as increased social support is shown to increase adherence to physical activity programs (Far et al., 2015; Killingback, Tsofliou, & Clark, 2017; Lemstra, Bird, Nwankwo, Rogers & Moraros, 2016; Sasidharan, Payne, Orsega-Smith & Godbey, 2006; Whiteman-Sanland, Hawkins, & Clayton, 2018). Engaging in moral behavior, having better social support, increasing physical health, and developing higher levels of psychological wellbeing all help children perform better academically (Quinn & Duckworth, 2007). It is likely that implementing a PA break intervention in the classroom, if done effectively, will help build an environment of encouragement and achievement school wide. Students with improved social skills mentor and influence other students and the entire community can benefit (Speizer, 1981; Sutherland et al., 2016).

Jarvinen and Nicholls' (1996), study showed that males and females experienced their social relationships differently. Girls felt that they had more supportive relationships with their teachers and had more positive social/emotional and academic experiences than boys. This could be partly due to the fact that girls intuitively view relationships and social wellbeing as a worthy achievement without being a means to an end. This valuing of relationships in and of themselves helps contribute to greater emotional wellbeing (Jarvinen & Nicholls, 1996; Murray-Harvey, 2010), so programs designed to help improve emotional wellbeing should emphasize the rewarding nature of interpersonal relationships (e.g. Exercising is more fun with friends!).

As discussed earlier, curriculum- and classroom-centered physical activity breaks help students improve relationships because these activities encourage moral behaviors, self-discipline and emotional self-regulation, all of which help increase a student's prosocial qualities and positive social skills. These positive social skills contribute significantly to higher academic achievement (Hinton et al., 2008; Jarvinen & Nicholls, 1996; Murray & Malmgren, 2005; Whiteman-Sandland et al., 2018). Adults should encourage youth to participate in activities they find enjoyable, feel competent doing, have chosen to do and that include positive social support. These conditions optimize the student's motivation to sustain physical activity and thus the physical, social, and psychological benefits and increased academic success resulting from such participation (Stuntz & Weiss, 2010).

A conversation about school relationships would not be complete without considering how teachers feel about their occupations, their students, and the institutions at which they teach. Most teachers feel enthusiastic about their jobs, supported by their school's administration, and prepared to meet the challenges that go along with educating America's children (Bill & Melinda

Gates Foundation [BMGF], 2013). In order to do their jobs more effectively, teachers nationwide have asked for two things: more support and more resources. Specifically, teachers need good instructional materials, quality professional development, additional planning time, and opportunities to collaborate in order to ensure continued successful instruction (BMGF, 2013; Legislative Education Study Committee [LESC], 2018). Getting teachers access to quality programs is essential, as teachers who have the time and resources they feel they need to be successful experience less frustration, are more effective, and produce more successful students (Felder & Silverman, 1988; Murray-Harvey, 2010; Ulug, Ozden, & Eryilmaz, 2011). High-quality and evidence-based PA programs, like TAKE10, provide educators with effective materials and the training necessary to successfully utilize them. These programs do not take much time to learn or implement, thus maximizing the preparation time teachers do have. The nature of these PA programs encourages collaboration among teachers as they share printed materials, ideas for fun activities, and feedback about what works well and what does not.

Ultimately, each student's academic achievement is largely affected by the quality of their relationships with their families, peers and teachers. Teachers can use physical activity to help students improve their relationships with their peers and to act as a role model for good health and moral habits. As a child's health, academic, moral reasoning and social skills improve, so does their sense of self-efficacy. Ultimately, it is a child's sense of self that will motivate them to achieve. From a school professional's perspective, students' perceptions of themselves may represent the most important aspect of reality (Rosenfeld, Richman & Bowen, 2000).

7. School-based physical activity breaks support the success of at-risk students.

A large number of children in New Mexico are characterized as at-risk (*Martinez v. State of New Mexico,* 2018). At risk children are those who come from an economically disadvantaged home (approximately 70% of NM students), are English Language Learners (15%), are Native American (11%), or who have a disability (15%) (*Martinez v. State of New Mexico,* 2018). As Hispanic children make up 60% of K-12 students in New Mexico (LESC, 2018; Pew Research Center, 2014), this population warrants particular attention. Sixty-one percent of Hispanic children in New Mexico live in low-income households and 80% of New Mexico's English Language Learners are Hispanic (National Center for Children in Poverty, 2018), giving these children a frighteningly high likelihood for being classified as at risk. As discussed in the introduction, Hispanic children also have higher incidence of obesity and diabetes than their White peers. These statistics highlight the intense need for effective academic and health interventions in this area. In order to best implement programs, a through understand of the peoples living here is essential, particularly those who are Hispanic.

An in-depth analysis of a nationwide health survey revealed four distinct Hispanic student profiles in the United States (Crosnoe, 2005). First were students who were low achieving and weakly school oriented. Boys and children of low socioeconomic status were most likely to fall in this category. These students earned low grades, liked school less and were less involved. Second were students who were still low academic achievers but were moderately school oriented (i.e. they liked school better than the first group). Puerto Ricans often fell into this group. Third were those students who were high achievers and were moderately school oriented. These students got good grades, were engaged in the classroom and felt attached to the school but didn't engage in any extracurriculars. This described many Cuban Americans. Finally,

there were the high-achieving, strongly school-oriented students. These students got high grades and were very involved in extracurricular activities. Students living with two parents or whose parents were more educated were most likely to fall into this category.

Second- and third-generation Mexican Americans were the most likely to be in the low-achieving, weakly-oriented group. This is not an unusual finding. There exists a pattern, known as the immigrant paradox, that Hispanics living in the United States who were born here are much more likely to have general problems (including health, education, and crime) than those born in Latin America (Fuller & Garcia Coll, 2010). These findings underscore the fact that American-born youth of Mexican origins (a population that makes up almost 50% of New Mexico's residents) (ProximityOne, 2019; USCB, 2010) warrant the most immediate and direct school intervention. People living in communities along the U.S.-Mexico border are at risk of experiencing numerous negative health risk conditions, such as poverty, a lack of education, a lack of healthy foods and poor eating habits, and lack of opportunities for safe physical activity.

In 2005, Coleman, et al. designed a study to assess the impact of a national trial program on the health of children living in El Paso, Texas, a primarily low-income, Mexican/Mexican American border community. The authors used the Child and Adolescent Trial for Cardiovascular Health (CATCH) program, which was a multi-tiered program, funded by the National Institutes of Health, that sought to improve the eating and exercise behaviors of United States elementary school students. The program included protocols to improve the quality and nutritional content of school cafeteria meals, to increase physically active time in physical education classes, to incorporate health information and physical movement into the classroom with a high-quality curriculum, and to encourage parent and community participation with a

home program. The authors hypothesized that the use of a flexible, wide-reaching program like this would enable low-income schools to tailor it to their resources and needs, leading to a significant impact on the rates of child risk for overweight.

Elementary schools in the region applied to be part of the CATCH trial and four test schools were randomly selected from the pool of applicants. After matching the test schools for district and geography, the four control schools were also chosen at random, resulting in a total of 896 third graders, 473 of whom were part of the control group and 423 of whom were the test group. The schools included in this test population were 95-99% Hispanic, 82-92% free or reduced-price lunch (FRPL) eligible, and 33-72% limited English proficiency. These percentages are representative of the region. All parents provided consent. All children were in third grade when the trial began, and each child was followed for two years.

At the beginning of the trial and in the fall of each subsequent year, each child was observed to see how many yards they could run in nine minutes. Each student's height, weight, and hip circumference were each recorded. Characteristics and the quality of each school's PE classes and cafeteria meals were also recorded. Control schools were not given any materials but were given $1,000 at the beginning of each school year as an incentive for participation. Test schools were given the CATCH curriculum, consisting of thorough teacher training, accessibility to and interaction with professional physical activity consultants, high quality classroom materials, monitoring of school meals and consulting for cafeteria staff, and an equipment box consisting of PE equipment, training manuals, and pedometers. Due to the frequent presence of consultants and other study representatives in the schools, the implementation of the program

was frequently evaluated, and teachers, students, and staff had regular opportunities to voice questions or concerns.

At the end of two years, results indicated that for girls at control schools the risk of overweight increased by 13%. In test schools, this risk increased only 2%. For boys in control schools the risk of overweight rose 9%, as opposed to only 1% in boys in test schools. Neither group showed a decrease in body mass index. After two years, students in the CATCH program had better aerobic fitness than their control group peers, but this advantage did not last one year post-intervention. CATCH schools' students also, interestingly, had higher amounts of moderate-to-vigorous physical activity in the fall of each school year, but not in the spring. Although none of the test or control schools met CATCH's program recommendations for fat and sodium in their cafeteria meals, meals at test schools increased in nutritional content over the life of the program.

Overall, the El Paso CATCH program was successful at lowering the risk of increased body mass index in elementary school students in a cost-effective way. It was more successful, in fact, than the national measures for the CATCH program. Some of the reasons for this include that the population for this study has some of the worst rates of overweight and inactivity in the nation. These students have a much higher risk of overweight and were likely much more responsive to the intervention in light of limited community and school resources for nutrition and physical activity.

Although the CATCH program is more comprehensive than our test intervention, TAKE10, this study adds to the evidence that well-planned interventions in border communities, whether they be for increased academics or health or both, have been shown to be successful

(Trevino et al., 1998), so we can reasonably hope to achieve academic success with our study. It is well documented that people of low socioeconomic status/high poverty, especially children, benefit more from focused effort and programs for positive change than their low poverty counterparts (Alexander et al., 2001; Barrera et al., 2002; Coleman et al., 2005; Duncombe, 2017; Duran & Weffer, 1992; Gandara, 2010; Hoelscher et al., 2010; Jackson, Johnson & Persico, 2015; Moerman & Jonas, 2002; Murray & Malmgren, 2005).

Coleman's work shows that well organized and supported interventions can have positive impacts in Hispanic border communities. This suggests that fully implemented classroom-based physical activity breaks in the school routines may help children who otherwise are likely to not participate in physical activity outside their physical education classes (Gandara, 2010). By encouraging positive interactions with others and significant personal effort, cooperative physical activities in the classroom support Hispanic students' goal-directed approach to education and traditional work orientation (Duran & Weffer, 1992).

Bringing physical activity into school classrooms helps students that desperately need help and may make them more successful long term (Bunketorp Kall, Malmgren, Olsson, Linden & Nilsson, 2015; Dwyer et al., 2001; Hollar et al., 2010; Lovasi, Hutson, Guerra & Neckerman, 2009; Rutt & Coleman, 2005). Implementing this small school-based intervention, if effective, may contribute to 10% higher individual earnings in adulthood and to a 17% increase in family income in adulthood (Hyman, 2016; Jackson et al., 2015; Jepsen, Troske & Coomes, 2014; Krueger, 1998).

In short, the significance of the extra learning provided by quality school interventions, such as PA breaks, cannot be overemphasized (Duran & Weffer, 1992). Coordinated efforts for

student wellbeing can no longer be considered a luxury. Low-income, primarily Hispanic communities can accomplish significant results with minimal funding and resources. Although the process may be daunting, communities do have the power to directly change children's health, their academic success, and ultimately, their future if they are willing to adopt and commit to more effective approaches to education (Coleman, 2006). Successful change is achieved through accomplishing small goals. Implementing high-quality PA breaks on a consistent basis in the classroom is one small goal that can be easily achieved with the commitment of the classroom teachers and administration of individual schools. The future of Latinos is inextricably bound up with the future of the United States (Gandara, 2010), so programs that benefit the good of these students benefits the good of everyone.

8. Literature Review Conclusions

Despite some grim statistics (LESC, 2018; WHO, 2019), it would be inaccurate and discouraging to assume that America's schools are totally failing (Heick, 2015; Krueger, 1998; Strauss, 2018). The United States has made an admirable commitment to educate every child regardless of background, race, ability, socioeconomic status, or religion. We view education for the 13 years of childhood and adolescence as a right, rather than a privilege. We raise children that grow up to help America teach more, contribute more, and achieve more than any other country in the world (Singer, 2017; United Nations, 2018). Nonetheless, improvements need to be made. There is a need for more comprehensive health- and learning-promoting physical activity policies and programs, especially for the economically and socially disadvantaged members of society (Haskell et al., 2009). Children need more support and more effective curricula to develop their cognitive skills, especially early in their lives (Gandara, 2010; Landale, Oropesa, Noah & Hillemeir, 2016). In order to achieve their best cognitive performance, students must achieve a healthy level of physical activity, ideally reaching a level of fitness that meets the national physical education standards (Castelli & Hillman, 2007).

Curriculum- and classroom-based physical activity curricula, like ILSI's TAKE10 program, help address these issues while fitting seamlessly into the elementary school day. In order for school-based PA interventions to be widely adopted, they must be inexpensive and easy to implement, allow for flexibility, and support local, state and national academic mandates. These programs should include teacher-friendly prepared materials that also appeal to students. They should provide teacher training that is helpful but is not burdensome in terms of time commitment or budget. Lastly, these programs should have been shown to be effective through quality research studies. Franks and associates (2007) state that school-based PA programs

should provide a distinct advantage over the current system, have compatibility with the school's and community's current values, have low complexity, have observable results, and have the flexibility to be tried out on a partial or temporary basis. Based on the literature presented in this review, we can conclude that curriculum- and classroom-based physical activity interventions, like TAKE10, meet these recommended criteria and produce desirable and cost-effective results to students' health, behavior and academic achievement. Trudeau and Shephard (2008) provide an eloquent conclusion to the discussion of this topic: "Given competent providers, physical activity can be added to the school curriculum by taking time from other subjects without risk of hindering student academic achievement. On the other hand, adding time to academic or curricular subjects by taking time from physical education programs does not enhance grades in these subjects and may be detrimental to health".

9. Research Methods

A note on these research methods: this project was greatly interrupted by the unprecedented outbreak of a novel coronavirus and COVID-19. Beginning in March 2020, public and private schools nation- and worldwide were first temporarily closed and then canceled for the remainder of the 2019-20 school year, making the collection of the data originally proposed for this project impossible. Despite the unexpected and widespread effects this global pandemic has had, daily physical activity remains important. Physical activity has been a major coping mechanism for millions of people, including elementary school-aged children, sheltered-in-place in their homes for weeks at a time. If anything, this pandemic has underscored the importance of strategies that enable and encourage people of all ages to work, learn, and be physically active in easy, inexpensive ways. The research methods described here were originally designed under the assumption that the school year would not be drastically interrupted.

9.1 Design and Hypotheses. The research design and methods were developed to answer the following two research questions:

- What is the effect on standardized test performance of curriculum- and classroom-based physical activity breaks implemented in elementary school children in Southern New Mexico?
- What is the teacher-measured effect on student engagement of curriculum- and classroom-based physical activity breaks implemented in elementary school children in Southern New Mexico?

Based on the review of the literature, it was hypothesized that implementing a program of curriculum- and classroom-based physical activity breaks would increase scores on standardized math and reading tests. Furthermore, this program would also lead to teachers observing that their students were more engaged in the classroom.

9.2 Participants. The participants in this study were teachers and elementary school children from a local elementary school. This school was chosen as the site for this intervention as SE, author of the study, had been involved at the school on a volunteer basis for six years and had developed rapport with many teachers and staff members. At the inception of this project, this elementary school was the natural choice for a research site due to longstanding positive relationships with the teachers. Unfortunately, between the birth of the project and day one of the intervention, the school district and the participating school experienced tremendously high staff turnover. The entrance of a new administration at both the district and school levels necessitated renegotiation of personal and professional relationships at the school. Attempting to balance responsibilities as both a parent with children at the school, and a researcher within the same small community proved problematic. As a parent, SE expressed concerns with how her children's education was being handled by the new administration. Because of the project being located at the school, the dual roles of parent and education researcher taken on by the author became an issue. As a consequence of various critical interactions with the new school administration in the role of parent, despite support from UTEP, SE was regarded somewhat suspiciously in her researcher's role, and the new administration was not easy to work with after these interactions.

To deal with the deteriorating relationship, SE attempted to move the project to another elementary school in the district. Unfortunately, during that time the district suffered a technology disaster. All computers in the district were attacked by a catastrophic malware program, necessitating the shutdown of all technology use -- including Internet, email, student grades tracking programs, parent contact programs, and even, briefly, telephone usage -- from

October 2019-February 2020. Communicating remotely with a new elementary became nearly impossible, and requests for face-to-face meetings were ignored.

These conditions necessitated that the original school remained the intervention school. SE initiated the research methods, starting with group selection processes. All teachers and staff members attended weekly staff meetings. With permission of school administration, SE presented a 5-minute verbal overview of the TAKE10 program, a summary handout from the TAKE10 website, and led all staff members through a sample physical activity from the TAKE10 website. After this introduction, all teachers were given the opportunity to volunteer as an intervention classroom. Staff members, such as library and computer lab leaders did not have consistent groups of students they were responsible for on a daily basis, and therefore were not eligible to serve as intervention classrooms. It was the initial intention of the project that in order to keep the workload manageable for SE and to ensure an adequate control group, only two classes per grade would be permitted to volunteer for the intervention, and that these slots would be filled on a first come-first served basis. The remaining classes in each grade would serve as the control group.

Gathering volunteers for the experimental group was a significant challenge. The presentation to the faculty was strictly limited to five minutes, leaving no time for staff to ask questions about the program. SE also was not able to retrieve the volunteer signup sheets that were being distributed to the teachers. When administration returned signup sheets to SE several weeks later, only three teachers had volunteered to serve as experimental classrooms. SE attempted to recruit more teachers as volunteers by putting physical letters in teachers' mailboxes, but with limited success. Through face-to-face conversations, SE was able to recruit four more teachers to be volunteers.

Another significant challenge in establishing the experimental and control classroom groups was getting consent from all students and teachers who could be involved in the study. In this particular study design, all students in the school could have been affected. Therefore, consent forms written in both English and Spanish had to be physically sent home with all 660 students and then retrieved, collected, sorted, and stored. Consent forms were also given to and collected from the teachers who volunteered to be intervention classrooms. With budget and supply shortages plaguing the district, finding a place to make copies of all these consent forms, in addition to sorting, stapling, and organizing them, was an expensive and time-consuming endeavor. It was also a sensitive process; once the forms were returned, they had to be treated as confidential, as they included the names of students, their guardians, and a guardian's signature.

9.3 Experimental Treatment. The TAKE10 program, developed by the ILSI Research Foundation, was the intervention used in this study. This program is designed to combine academic instruction with 10-minute physical activity breaks to get children moving without sacrificing time dedicated to academic learning. Each 10-minute physical activity break takes place in the classroom under instruction of the teacher. The activities require the use of little or no equipment and consist of a brief warmup, a set of exercises that provides an opportunity to practice academic subjects, and a brief cooldown and stretching.

The expectation that the teachers in the intervention classrooms would fully implement the TAKE10 program was overly idealistic. SE observed it in action only twice; once was during a kindergarten dual-language spelling activity, and once was when SE taught the TAKE10 lesson to a first-grade class. Ten minutes seemed to be too long for most teachers. Some decided to make the physical activity break shorter and, in one case, presented a two-minute yoga lesson. Others believed TAKE10 to be too regimented, and let their students go outside for an extra recess. Teachers frequently expressed feeling too overwhelmed to plan 10 minutes of structured physical activity time, even with support from SE and the TAKE10 materials.

The control group continued to receive two weekly 30-minute physical education classes already provided by the school. The intention was that no other intervention would be provided to them. The teachers of control classrooms were specifically asked not to change or add anything extra to their normal school day during the test period. The school's administration agreed to not start any extra programs during the intervention period. Unfortunately, this agreement was not adhered to, and in January 2020, the school began a monthly Walk to School initiative.

9.4 Training. The TAKE10 intervention program was implemented primarily by the teachers of each intervention classroom. SE visited intervention classrooms regularly and occasionally ran activity sessions at the request of the teacher. Training for teachers of intervention classrooms was provided in person by SE at a staff meeting. The in-person training included verbal explanation and rationale for the TAKE10 program, a visual presentation and verbal explanation of TAKE10 curriculum materials, and a physical demonstration and group participation in a sample TAKE10 activity.

After the meeting, the TAKE10 program binders were given to the team of teachers from each grade. The binders included written instructions for the teacher. Teachers were also each provided a folder with ideas for easy, child-friendly physical activities that should have been easily adaptable to a classroom setting.

9.5 Program Implementation Compliance. At the beginning of the intervention, SE hypothesized that program compliance for this particular population would be high because teachers volunteered to be included in the intervention group. SE assumed that those teachers who believed they had the time and physical and mental resources to commit to the program, would be the ones to volunteer. It was assumed that these teachers would likely be more motivated to adhere to program guidelines and instructions, than teachers who had been chosen randomly. After the intervention started, it could be observed that the teachers who volunteered to implement the program were really trying to do so. But despite their best intentions, it became clear that the demands on their physical and mental resources were greater than they anticipated when they initially volunteered. Full participation and implementation of the program was haphazard from the start.

It was hoped that compliance and commitment to full implementation of TAKE10 would be encouraged through the use of weekly evaluations of the intervention provided by the teachers; weekly email contact with teachers, staff and administrators; and in-person visits and observations by SE. These observations had the potential to provide qualitative measures of student engagement in the physical activity, how lesson content was delivered and what content was being delivered, and how the teacher was involved. For example, was the teacher spending most of the activity time modeling the exercise, managing students, providing verbal encouragement, etc.? SE was able to observe three total activities using the SOFIT protocol, but scheduling these observations proved to be anxiety-provoking for the teachers. Even though they volunteered to use the TAKE10 intervention, teachers could not report when during the week they intended to use it and seemed unable to plan its implementation. Three of the seven volunteer teachers asked to not have the pressure of observations and a fourth teacher burst into

tears when asked when a good time would be to come observe her class. Consequently, opportunities for observations were limited, and with the technology shutdown in the school district continuing, communicating with teachers via email for evaluations was impossible.

No enforcement of control conditions was implemented for the participants of the control group. It became apparent early on during this project that it was difficult enough to motivate the volunteer teachers to fully participate in the intervention. It was clear that none of the teachers in the control classes were trying to adopt and implement the program. It appeared that all the teachers were overwhelmed and anxious due to the administrative and technological challenges and had difficulty dealing with the basic responsibilities and bare essentials of their jobs.

9.6 Data Recording & Analysis. In order to answer the research question as to how curriculum-based PA breaks affect standardized test performance, the initial study design included gathering and comparing students' monthly standardized test scores. The outbreak of COVID-19 brought school abruptly to a halt for the remainder of the school year, rendering this type of data collection impossible. The initial study design also included emailing weekly evaluations to teachers and holding a focus group at the end of the intervention period to develop an idea of how curriculum-based physical activity breaks affect student engagement. Unfortunately, first the technology outage and then the pandemic outbreak prevented this data from being collected.

Early on in the intervention, when it was realized that getting into teachers' classrooms was going to be difficult, SE distributed a short survey to all intervention and control teachers. This survey was designed to have teachers indicate how they were using physical activity in their classroom. Of the more than thirty teachers at the school, only eleven surveys were returned. Despite the poor return rate, these surveys became the richest source of information for this project.

The survey first asked teachers: "Think of an average week during fall semester of this school year (August or September 2019 - before the technology outage). How often did you use physical activity (PA) (curriculum-based or not) with your students? What kinds of PA did you use? Please indicate which type(s) of PA you typically used on which day(s) of the week." Options for answers included: TAKE10 activity, activity video, extra recess, activity song, stretching/yoga, other, or none. On each day of the week, between 4 and 6 of the respondents used "other" activities, which included things like non-curriculum-oriented cardio in place (e.g. students doing jumping jacks or running in place by their desks or playing a freeze dance

game). Also, almost twice as many teachers reported using extra recess on Thursdays and Fridays than at the beginning of the week.

The survey then asked teachers: "Think of the last two weeks (Feb 1 - 14, 2020). How often did you use physical activity (PA) (curriculum-based or not) with your students? What kinds of PA did you use? Please indicate which type(s) of PA you typically used on which day(s) of the week." Options for answers for this question were the same as listed for the question above. TAKE10 had been introduced at this point, but despite this extra option for incorporating physical activity, only two of the teachers who responded reported opting for this. "Other" activities and extra recess continued to be the activities most often utilized.

The next question asked teachers to indicate whether they felt the amount of total physical activity their students received between recess, PE classes, and in-class PA, was adequate, insufficient, or excessive. Seventy-three percent of responders felt the amount was insufficient, while 27% felt it was adequate. No teachers felt the amount was excessive.

The survey then asked teachers to identify specific roadblocks they encountered when attempting to incorporate physical activity into their classrooms. Overwhelmingly (9 of 11 respondents), teachers said it was the fact that their classroom schedule felt too full, that they did not have the time to add in something like TAKE10. Over one-third of teachers also indicated that the lack of technology was a major obstacle to consistently offering PA in class to their students.

Finally, the survey asked if there was anything else the teachers wanted researchers to know about their attempts to utilize physical activity. Teachers said that class sizes and behavioral issues affected their ability to use TAKE10, but they thought it was so important

that they would like to see time specifically built into their class schedule for physical activity. One teacher even suggested making the school day longer in order to incorporate it.

Despite the fact that ideal TAKE10 lessons didn't happen often, the incidents when it did provide interesting case study data on how to successfully implement an intervention like TAKE10. Observing the kindergarten dual-language spelling activity was one of the highlights of the research experience. The students appeared highly motivated and engaged, as each of the 22 students in the classroom participated eagerly. The teacher encouraged student input by asking them to decide the next color they were going to spell out, and having the children spell the words out loud in both English and Spanish. The teacher was well organized and offered a good example of health and activity to her students by performing the exercises along with them.

Teaching a TAKE10 lesson to a class of first graders was another high point of the study. As in the kindergarten class, the students were engaged and participating. This activity involved spelling out compound words while doing exercises in place. The teacher did not perform the exercises along with her students in this activity but was supportive of SE being there, and the children seemed to enjoy having a guest in their classroom.

Even observing the less-than-ideal iterations of TAKE10 provided useful information. It was clear from the observations that teachers are incredibly hard workers who are genuinely dedicated to their students' success. They are overwhelmed but doing their best.

10. Project Conclusions & Recommendations

Ultimately, this was a promising project that was conceived at an unfortunate time. In addition to the many unusual roadblocks faced – personnel turnover, technology outage, budget shortages, and conflict with other school programs, much of the trouble seemed to be due to the fact that the project attempted to run the intervention during the Spring semester. Teachers expressed multiple times that they felt less overwhelmed in the Fall. They mentioned the stress of preparing for end-of-year testing on top of trying to teach without technology, without being able to make copies of anything, etc. was more than they felt prepared to adequately handle.

Without conducting head-to-head studies, it is impossible to say for sure whether or not the Fall semester of an average public elementary school runs smoother and is less difficult and tiring for teachers, and is thus a better time to introduce an intervention like TAKE10 than is the Spring semester. Anecdotal evidence seems to support this conclusion, and comparing the success of the program introduced in the Fall versus in the Spring would make for an interesting research study.

Another important outcome of this project is the realization how delicate and difficult the process of choosing a site for educational research can be. Finding a good research site is difficult without having any personal connections to a school. For this project, the school district did not provide any feedback as to at which schools they would like the study to be performed, so it was left to SE to determine the site. Consequently, SE reached out to educators at a school she knew. There was a negative consequence of this strategy however, because personal relationships make being strictly professional quite difficult. People have personal feelings, even when acting as professionals, and that was an issue in this project. In future projects, the

researcher should not have personal relationships with personnel in the school(s) that will be involved in the research project as participants. Asking the school district or UTEP to negotiate the process of finding a project site would make it easier for the researcher to remain strictly a researcher, even if the researcher may have children or family members in one or more of the schools in a district.

Although this research project did not go as anticipated, continued pursuit of answers to the research questions is important. The need for simple, effective, and inexpensive physical activity interventions for elementary school children in New Mexico that are easy to implement has not gone away. The challenges encountered in the research project were unsurmountable and effectively derailed it. This project inadvertently highlights some reasons why children in New Mexico schools may be struggling. Despite teachers' best and admirable efforts, administrative turnover, technology failures, and the expectations heaped upon teachers who are not prepared to handle such disruptions all distract from teaching and learning. Children are struggling academically and struggling to stay healthy, and the circumstances that impeded the carrying out of the TAKE10 program may explain a small part of that struggle. The implementation of TAKE10, which has been utilized successfully elsewhere, went poorly in this case because teachers were overwhelmed by extraneous circumstances to the extent that they could not even develop a plan for the delivery of the TAKE10 sessions or implement short 10-minute physical activity breaks during a school day.

This research project should be repeated because it has the potential to help many children. The future of children in the Southern New Mexico elementary schools is inextricably

connected with the future of the United States (Gandara, 2010), and programs that can show benefit for the good of these students may also result in benefits for the good of everyone.

11. Classroom Physical Activity Teacher Survey

1. Think of an average week during fall semester of this school year (August or September 2019 - before the technology outage). How often did you use physical activity (PA) (curriculum-based or not) with your students? What kinds of PA did you use? Please indicate which type(s) of PA you typically used on which day(s) of the week.
    a. Take10 activity
    b. Activity video (example: GoNoodle)
    c. Extra recess (outdoors or indoors)
    d. Activity song (example: Head, Shoulders, Knees, and Toes)
    e. Stretching/yoga
    f. Other
    g. None
2. If you answered "other" in the question above, please provide a brief explanation of the physical activity utilized.
3. Think of the last two weeks (Feb 1 - 14, 2020). How often did you use physical activity (PA) (curriculum-based or not) with your students? What kinds of PA did you use? Please indicate which type(s) of PA you typically used on which day(s) of the week.
    a. Take10 activity
    b. Activity video (example: GoNoodle)
    c. Extra recess (outdoors or indoors)
    d. Activity song (example: Head, Shoulders, Knees, and Toes)

e. Stretching/yoga

f. Other

g. None

4. If you answered "other" in the question above, please provide a brief explanation of the physical activity utilized.
5. Please indicate which statement best represents your feelings on physical activity during the school week.
    a. I feel the amount of physical activity my students receive during an average school week (between PE, recess, and in the classroom) is adequate.
    b. I feel the amount of physical activity my students receive during an average school week (between PE, recess, and in the classroom) is excessive.
    c. I feel the amount of physical activity my students receive during an average school week (between PE, recess, and in the classroom) is insufficient.
6. Whether you currently use PA in your classroom or not, which, if any, roadblocks or challenges do you encounter in incorporating physical activity into your classroom? Please select as many options as are applicable to you.
    a. No roadblocks. I feel I have everything I need to utilize PA in my classroom as often as I'd like.
    b. Time. Our class's daily schedule is too full to consistently incorporate PA.
    c. Preparation time. I simply do not have time to plan for PA activities in my classroom.
    d. Test preparation. Our primary focus on preparing students for testing precludes PA in our classroom.

e. Technology. We do not have consistent access to the technology necessary to utilize PA in our classroom to the fullest extent.

f. Resources. I don't know where or how to find practical ideas on how to use PA in my classroom, or I don't have consistent access to those resources.

g. Physical resources. I don't have the physical space or equipment necessary in my classroom to easily and consistently incorporate PA.

h. Student interest. My students just don't like physical activities and/or don't want to participate.

i. Other ability/interest. I, personally, am not physically able to participate or am not interested in physical activity at this time.

j. Federal, district, or school policy. Policy I must abide by precludes me from incorporating PA into my classroom as much as I'd like.

7. It is our goal to develop a clear and honest picture of the successes and challenges teachers face as they strive to best serve their students. Is there anything else you'd like researchers to know about your experience with physical activity in the classroom?

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