

The Effect of Time of Day and the Scheduling of Physical Education on Academic Achievement

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Abstract

Education has progressed and continues to develop to meet the needs of all students. An abundance of research has been conducted exploring functional and instructional best practices to maximize academic achievement. Research revealed separately that the time of day affects students' academic performance, and that physical education improves cognitive functioning. Combining these two strategies of purposefully scheduling physical education to affect students' academic achievement should be considered. The purpose of this synthesis is to review the literature on the time of day and the scheduling of physical education on academic achievement. Utilizing the positive effects of physical education and understanding time of day effects, stakeholders can create meaningful policies that have a significant impact on students' academic success.

Chapter 1 – Introduction

Education has progressed and continues to develop to meet the needs of all students. An abundance of research has been conducted exploring functional and instructional best practices to maximize academic achievement (Egger et al., 2019);(Guy et al., 2008); (Labak et al., 2020). The purpose of public education is to ultimately prepare individuals with the necessary skills for either higher education or the workforce (Guy et al., 2008). The end goal is for students to become productive members of society (Guy et al., 2008). Cognitive development is one of the most sensitive phases of human development (Egger et al., 2019). Students are dramatically transforming in cognitive, behavioral, and emotional functioning (Alfonsi et al., 2020). Although schools recognize the benefits of physical education on cognitive function (Donnelly et al., 2016), there has been no consideration of time of day or specific scheduling implementation of physical education to maximize improved cognitive development or academic achievement.

Several studies have investigated the impact of sleep on academic performance and proposed delaying the start of school (Alfonsi et al., 2020). Adolescents compared to children and adults are at a critical stage of life where changes in their circadian rhythm, sleep-wake cycle, are delayed (Alfonsi et al., 2020). It is well known that sleep is important for physical, social and cognitive function, but adolescents are not receiving the appropriate amount of sleep giving rise to many major health concerns (Alfonsi et al., 2020).

Another aspect researched to enhance academic performance is class offerings. High school course offerings and curriculums offer resources for students to develop essential skills needed for college or employment (Guy et al., 2008). School districts emphasize preparing

students for the next step in life by offering a variety of different courses such as advance placement (AP) classes, dual enrollment courses, and vocational classes to ensure that students with a variety of interests can excel (Turnlund, 2019). However, the placement of these types of class offerings in a student's schedule can have a major effect on a student's overall academic achievement. Cognition fluctuates throughout the day, causing an ideal timeframe to learn and acquire new skills (Pope, 2016). The arrangement of students' classes can hinder students' learning ability and affect their academic outcomes (Williams & Shapiro, 2018). Along with the time-of-day courses are offered, studies investigate ideal time spent in class (Labak et al., 2020). Traditional scheduling consists of 45-minute periods, but many schools have implemented block scheduling giving more time to Math, Science and English, otherwise known as "core" classes. The additional time reduces instructional fragmentation and increases opportunities for more enriched learning (Labak et al., 2020).

Similarly, physical education has been found to have a positive impact on students' academic performance (Niedermeier et al., 2020) Specifically, assisting in students' attention, concentration, and time on task. Physical education also affects mental health, students' overall well-being and self-concept (Luan et al., 2022). As a result, schools have incorporated designated physical activity "brain breaks" into the classroom (Egger et al., 2019).

Based on ongoing research, schools have made changes to maximize academic achievement such as delaying the start of school, implementing a variety of class offerings, time of day of courses, block scheduling, and brain breaks but they have not considered how the placement of physical education classes can boost academic performance.

Statement of the Problem

Many strategies have been developed, considered and some even implemented to improve students' academic achievement. These proposed considerations focus on the crucial development period an adolescent goes through. Ultimately, schools want to create a positive environment to maximize student achievement and prepare students for the next stage of their life (Guy et al., 2008).

Physical education, like many other subjects, helps students develop fundamental skills necessary for college, workforce, and life. Students who are physically active benefit not only physically, but cognitively and socially (CDC, 2022). More specifically, physical education has a positive effect on students' academic performance (Bacon & Lord, 2021). Time of day or placement of physical education class requires further investigation to determine the effects they have on cognitive function and academic achievement.

Purpose of the Synthesis

The purpose of this synthesis is to review the literature on the time of day and the scheduling of physical education on academic achievement.

Operational Definitions

1. **Physical Education** - Physical education provides students with a planned, sequential, K-12 standards-based program of curricula and instruction designed to develop motor skills, knowledge and behaviors for active living, physical fitness, sportsmanship, self-efficacy and emotional intelligence (SHAPE America, 2014).
2. **Academic Achievement** –the extent to which a student has achieved their educational goals, commonly measured by examinations or continuous assessments (Time on Task, Examinations and Grade Point Averages). (Donnelly et al., 2016)

Research Questions

1. What is the impact of the time-of-day physical education is scheduled on academic achievement?
2. What is the impact of the amount of time physical education is scheduled on academic achievement?

Delimitations

1. The articles used in the literature review of the synthesis were both peer reviewed and full text.
2. The review included articles between 2007-2022.
3. The ages looked at in this study ranged between 6-19 years old.
4. The articles reviewed for this synthesis were specific to scheduling (time of day and amount of time) of physical education.

Chapter 2 – Methods

The purpose of this synthesis is to review the literature on the effect of time of day and the scheduling of physical education on academic achievement. Furthermore, this paper will also investigate the impact of the amount of time physical education is scheduled on academic achievement. An exhaustive search for previous research on these topics was conducted and analyzed. This chapter specifically details the methods used in obtaining information for the synthesis.

Literature obtained for this project began with the SUNY Brockport Drake Memorial Library. Multiple databases were used to obtain articles, they included EBSCOhost (Academic

Search Complete, Education Source), SportsDiscuss, Gale Academic and Pubmed. For articles to be included in the research process they had to meet certain criteria. Specifically, all articles were peer reviewed and were not published before 2009. Searches in the aforementioned databases returned almost 8,000 articles. To further reduce the number of returned articles, specific keywords were utilized. Keywords fell into three focus areas 1. adaptations made in the school day to improve academic performance (functional and instructional) 2. effects of physical education on cognitive function and academic achievement 3. scheduling/time of day of physical education class. Several keywords were identified as the most important, they were physical education, cognitive function, academics, academic performance/ achievement, scheduling and time of day. The articles selected offer support for improving the relationship between academic scheduling and utilizing the positive effects of physical education on cognitive function.

The first search involved researching functional and instructional strategies to improve academic performance. This assisted in determining proposed considerations that could potentially improve or have improved students' academic achievement. The search yielded approximately 37,000 results. Through the results a theme appeared, and the 5 most common strategies were used in this synthesis. The top five common strategies were delayed start of school, class offerings, time of day of class offerings, block scheduling and brain breaks. Further searches were performed using these specific strategies as key terms along with the phrase "to improve academic performance". This limited the results to 50 for each specific key term used. At least one article was selected for each of the top five common strategies that could potentially improve a student's academic achievement.

The second search focused on the effects of physical education on cognitive function. Although this did not yield as many results as the first search, it yielded approximately 8,000

results. To reduce the number of the results, the key word adolescent was added. Of the 170 articles that were identified, three articles were selected and used in the critical mass for this paper.

Like the second search, the third search included the effects of physical education but instead focused on academic achievement rather than cognitive function. This yielded 3,000 articles and when adolescent was added as a keyword it limited the articles to 900. Out of these results two articles were used in the critical mass of this paper.

The fourth and final search focused on physical education scheduling. The search yielded 1,700 results but when incorporating limiters, it reduced the results to 20 articles. Only one article pertained to the synthesis, and it was added to the critical mass of this paper. The remainder of the articles used in the critical mass of this paper were identified through references contained in the articles that were found through the database searches.

A variety of professional journals were used to obtain the articles that were selected for use in the critical mass of the synthesis. The journals include *BioMed Research International*, *Education Sciences*, *Career Development for Exceptional Individuals*, *Northwest Journal of Teacher Education*, *The Review of Economics and Statistics*, *International Journal of Environmental Research and Public Health*, *American College of Sports Medicine*, *Physical Education, Recreation and Dance*, *National Institutes of Health*, *Physical Activity and Health*, and *Frontiers in Psychology*. Each journal provided useful information and a unique perspective to this paper.

The critical mass for this synthesis paper consists of 10 articles. For nine of the articles, there were a total of 735 participants, 348 participants were nine years of age or younger and 387 were 10 years of age and older. The last article used in the critical mass analyzed data collected

by two investigators who observed a total of 297 classes (three lessons within each unit, for three units for each physical education in the school, in each of the seven schools) over a two-year period.

The data collected in the critical mass articles were gathered in a variety of ways. Both quantitative and qualitative data were measured. Qualitative data included observations, self-reported information through questionnaires and surveys on participants' feelings and activity levels. Quantitative data gathered were academic achievement related such as GPAs and test grades/results. Half the articles used analytics including descriptive analysis, t-tests, analysis of variance (ANOVA), Pearson's Product-Moment correlations, and Cronbach's alpha. The most common ways to analyze data were ANOVA, or ANCOVA. The other half of the articles utilized Independent Models or Structural Equation Modeling for analysis.

The process of locating quality, scholarly research produced the critical mass to understand the effect that physical education has on students' cognitive function and determine class scheduling options to enhance academic performance.

Chapter 3 – Review of Literature

The purpose of this chapter is to present a review of literature on the time of day and the scheduling of physical education on academic achievement. Considerations to maximize academic achievement such as delayed school start, class offerings, time of day, block scheduling and most importantly, utilizing the positive effects of physical education will be discussed.

Education plays a critical role in helping individuals develop the necessary skills to become successful members of society. Different strategies and interventions have been used in schools to maximize student potential, and ultimately their overall achievement. Delaying the

start of the school day is one method schools have used to improve academic achievement and it is the first component that will be discussed in this review.

Schools Considerations to Maximize Academic Achievement

Sleep has a major effect on cognitive function, especially during critical developmental periods that students experience. Students' sleep patterns differ from adults. The American Academy of Sleep as well as other medical associations agree on recommending 8-10 hours of sleep per night for students to achieve optimal performance. Children and adolescent circadian rhythms, wake-sleep cycle, or internal clock, vary due to several environmental and biological factors (Alfonsi et al., 2020). Alfonso et al., (2020) studied the effects of different wake-sleep schedules on academic achievement. Researchers conducted a literature search using PubMed that was narrowed down by utilization of 4 key search terms. The key search term included adolescents with the following: sleep, circadian process, homeostatic process, sleep deprivation, sleepiness, school timing, health, academic performance, and school timing. They grouped articles and focused on three major areas: (1) Sleep in adolescents - how they sleep and how they should sleep, (2) The effects of sleep deprivation on health, performance and behavior, and benefits and (3) challenges of delayed school start time. Each category shed light on different aspects of the impact of sleep in adolescents. In adolescents, circadian shifts from morningness (up to 10 years of age) to eveningness in adolescence and then returns toward morning in advanced ages (after 50 years of age). There are gender, cultural, and habit variations that alter individuals' sleep phases. In the second category it was reported that three main areas of daytime functioning are affected by chronic sleep restrictions: mental and physical health, cognitive and academic performance, and risk-taking behaviors. Lastly, the third category concluded that insufficient sleep and chronic sleep restriction result in adverse consequences. Another related

problem noted in the study was sleepiness and students' tendency to fall asleep and nap during school hours with an obvious negative impact on learning. Results demonstrated that impaired sleep quality and quantity are associated with decreased learning ability and compromised daytime functioning. Thus, delaying the start of school provides students with the opportunity for a greater length of total sleep time which may improve academic outcomes.

The placement of class offerings in a student's schedule is another strategy that has been researched to improve academic achievement. Pope (2016) analyzed how the time of day affects students' productivity and if efficiency gains can be obtained by rearranging the order of tasks they perform throughout the day. Data were gathered from student class schedules (Math and English class periods), California Standard Test (CST) English and Math scores, as well as individual course Grade Point Averages (GPA) of students in sixth through eleventh grade from the Los Angeles Unified School District (LAUSD). Middle schools and high schools in LAUSD have a six- period class schedule and school starts at 8 am with class periods ranging from 50 to 60 minutes. When comparing Math GPAs and Math CST scores of students with Math in period 1 and those in periods 5 and 6, it found some selection of higher-performing students into morning Math. With the full set of variable controls accounted for, the estimate of having a morning instead of an afternoon class increases a students' Math GPA by .068 points and CST scores by .024 standard deviations. The study also recognized that Math classes were more affected by the time of day than English classes. Certain subjects may have similar sensitivity to time of day and may favor strategically placing classes in students' schedules. It could be beneficial to schedule physical education at a specific time of day to increase students' productivity and maximize their academic achievement.

In other findings, Williams and Shapiro (2018), found that the impacts of student fatigue throughout the school day are striking, and shows a decrease in students productivity. The purpose of this study was to expand the link between students' academic achievement and their daily schedules to causally determine precisely how the organization of courses through the school day influences performance. This study utilized over five academic years of data (all students' courses and grades) for nearly 7,000 students from the US Air Force Academy (USAFA). The study compared students who took the same course in the same term on the same schedule day but with different class timing and with different variation in their daily schedules. Other variables were considered as vectors (i.e., fatigue, instructor schedule and time) and were used to accurately exploit variations in students' schedules. Like the previous studies, the analysis focused on a universal test, SAT Verbal and Math scores, as well as individual GPAs. This study found that consecutive classes have a consistently negative impact on performance. Specifically, a student sitting in their second consecutive class is expected to perform .031 standard deviations worse than if they took the same course after a break. In addition, results also supported a delayed school start as it found that students taking 9 am classes or later performed .16 standard deviations better than students taking the same class at 7 am. As hypothesized, a student with a "balanced" schedule, having their breaks spaced throughout the day, earns expected grades 0.035 and 0.018 standard deviations higher than students with consecutive classes. The study suggests that students suffer both from the immediate effects of consecutive classes and the cumulative effect of a heavy course load in a single day. Further evaluation determined that students in the lowest percentile suffer the largest average penalties from taking three or four consecutive classes with a very large -.13 standard deviation. On the other hand, students from the top percentile showed no significant fatigue due to consecutive classes but

were more affected by overall load. It would stand to reason that physical education or motor activity breaks scheduled between core classes may help students overall in their academic achievement.

Not only does the time of day affect academic achievement but the amount of time in class has also been investigated to determine its effect on students' learning. Labak et al., (2020) investigated how block (90 minutes) vs single (45-50 minutes) class scheduling on students' average performance in high school biology courses and students' interactive effect of class scheduling. The study looked at 281 Croatian students who were in grades 1-4. The students were divided into two groups: single scheduled classes and block scheduled classes. The research consisted of three different stages: (1) initial grade appropriate exam, (2) teaching and (3) another grade appropriate exam. The two groups were taught biology the same way before and during the research and were balanced regarding age-appropriate lessons. Also, the same teaching methods and learning outcomes were achieved but splitting topics respectively in the time that was allotted. For example, within block scheduled classes students were simultaneously taught about the difference between prokaryotic and eukaryotic cells, while within single-scheduled classes, each cell type was taught in a separate single class. Both exams meet the same learning outcomes and are linked to concepts. From this, they found that first graders and second graders exposed to a single schedule biology class performed significantly better in the 2nd exam than students attending block schedule classes. Third grade students exposed to block scheduled biology classes performed significantly better. To further assist in analyzing statistical trends, researchers grouped student performances. There were four overall performance categories: low, medium, good, and excellent which were determined by the mean percentage of the students' success on both exams. The 3rd graders who were grouped in medium, good and excellent

performed equally well after the teaching in block- and single scheduled classes. Additionally, 3rd graders who were in the single scheduled class intervention experienced a deteriorating effect on their performance, specifically those who were grouped in the low student performance category. There were no 4th grade students who belonged in the top category (excellent), all students performed equally well on the first and second exams. Low and medium performing 4th grade students improved in their performance on the 2nd exam regardless of the class type. In deduction, certain grade levels could benefit from longer periods of time in engaging learning topics. Although this study examines Biology class, similar results of success could be seen in longer blocks of time in physical education. Also, it was noted that students of lower performance significantly benefited from block scheduling. Students who are of lower performance could benefit in a specific schedule like block schedule to improve academic proficiency.

Schools have also explored the effects of block scheduling, but most have not been focused on its effects on physical education. Haynes-Hunter and Avery (2007) investigated the effects of block scheduling on physical education and examined how students spent total time in (1) instructional episodes, (2) receiving information and (3) engaging in motor activity. Selected for this study were five high schools (four northeast and one west coast of the United States) and two middle schools (one northeast and one west coast of the United States). The data were collected by two investigators that observed a total of 297 classes (3 lessons for each of the 3 units per physical education program in all seven schools) over two years. The two researchers had a .91 reliability when comparing coding results of both live and videotaped recordings. Overall, the observations discovered that students in block scheduled physical education spent more time in management, transition and waiting compared to time spent in activity. More

specifically, the students spent more time during transition periods such as waiting after the completion of a station and during equipment distribution/clear up than in activity. Teacher experience and training of larger blocks of physical education may also alter the success of a class. A 90-minute physical education block schedule class may not produce the same beneficial effects on academic performance as core classes.

A similar Block Scheduling study by Bukowski and Stinson (2020) looked at the effects that this type of scheduling had on physical education learners, teachers, and curriculum in the Midwest. This study examined nine out of 69 public high schools throughout Wisconsin that used block scheduling. In these nine high schools, 31 physical educators participated in seven interview questions about block scheduling. The interview questions were given to participants beforehand to develop thoughtful responses and were recorded for analysis. Their responses fell into three broad categories: positives of block scheduling, negatives of block scheduling and other. The concerns of physical educators regarding block scheduling were that block scheduling denied students access to the whole curriculum, there was a lack of student participation for long periods of time, and student/teacher absences were more costly. Overall, physical educators approved the block scheduling because of their perceived decreased stress, increased time for interaction with students, and student grade improvement. Ideally teachers prefer a longer amount of time for students to develop and practice physical education, but true participation of students and practicality of block schedule classes lead to some concerns. Although many classes are transitioning to a block schedule, students may benefit more from traditional or even short bouts of physical education compared to a block style class.

Many strategies like the above research studies have been developed, considered and some even implemented to improve students' academic achievement. Physical Education is

amongst the many strategies and interventions used by schools to improve student's cognitive function. Physical Education has been found to have a positive impact on students' academic performance.

Positive Impact of Physical Education on Students' Academic Performance

Engagement in daily physical activity or physical education brings multiple benefits including physical and mental health but most importantly cognitive function. Luna et al (2022) examined how subjective well-being (SWB) and general health (GH) mediate the relationship between adolescents' physical activity and cognitive function. For the study it used a 2018 data set called Program for International Student Assessment (PISA). This study utilized the PISA of 15-year-old students in nine different countries (Bulgaria, Georgia, Hong Kong, Ireland, Mexico, Panama, Serbia, Spain, United Arab Emirates). The survey gathered data on the frequency of moderate physical activity, and satisfaction of health, life, and school. To test cognitive function, this study analyzed Reading, Math, and Science achievement tests. Increase in weekly moderate physical activity was positively associated with higher levels of subject wellbeing. Individuals who frequently participated in moderate physical activity displayed large direct effects on cognitive function and indirect effects through improvements in subjective well-being and general health. Overall, students who were generally more physically active were also healthier (GH), had better mental health and performed better cognitively. Students who are healthier and perform better (physically, mentally, and cognitively), can put forth more focus on being successful in school. Schools have the power to create and implement policies that promote physical education, increasing physical activity levels and therefore influence students' academic achievement.

Many schools are focusing their efforts and considering increasing instructional time for classes like Math, Language, and Science in an attempt to improve testing scores. This reduces and eliminates classes such as Art, Music and most importantly Physical Education which is known to improve students' performance in school. Ardoy et al., (2013) research focuses on the improvement of adolescents' cognitive performance and academic achievement through physical education class. This study analyzed the effects of an intervention focused on increasing the time and intensity of physical education on adolescents' cognitive performance and academic achievement. The authors used a four-month, group randomized controlled trial, with 67 adolescents from Southeast Spain. Three classes were randomly allocated into three groups: control group (CG), experimental group 1 (EG1) and experimental group 2 (EG2). Each group was given different interventions. The control group received their normal physical education sessions consisting of 55 minutes twice each week. The EG1 group received a treatment plan of four sessions consisting of 55 minutes each week. The last group EG2 also received four sessions consisting of 55 minutes each week but their sessions were specifically high intensity, having students' heart rates above 120 bpm. Participants were analyzed in three different ways: Cognitive performance (Spanish Overall and Factorial Intelligence Test), Academic Performance (grades in Math, Language, Science) and Physical Fitness Assessment (cardio, muscular and speed-agility). At baseline cognitive performance variables did not differ among the study group except for verbal and numerical ability that were marginally lower in the CG compared to EG2. Adjusted for baseline levels, it was found that all cognitive performance indicators improved in adolescents from EG2 compared to those in CG and EG1. There was no significant difference between CG and EG1. In conclusion, the most improvement was seen in the EG2 group which had the four sessions per week of high intensity physical education. Increasing frequency and

intensity of physical activity produced more desirable effects on academic achievement. Physical education twice a week may not benefit academic performance as much as four physical education classes that specifically focus on increasing students' heart rate above 85% of their max heart rate (high intensity). Thus, the effect of the type of physical activity performed should also be considered in addition to time of day and the amount of time.

Further exploration of high intensity movement was done by Costigan et al (2016). The purpose of this study examined how participation in High Intensity Interval Training (HIIT) was linked to enhanced brain structure and function, cognition and overall academic performance. This study focused on evaluating the efficacy of two high intensity interval training (HIIT) protocols for improving cognitive and mental health outcomes (executive function, psychological well-being, psychological distress, physical self-concept) in adolescents. Executive function refers to mental processes that allows for control and goal directed behaviors and is subdivided into three different aspects. The HIIT session consisted of 8–10-minute sessions of high intensity exercise that increases heart rate (>85% of max heart rate) with little to no rest periods. Participants were randomized to three conditions: aerobic exercise program (AEP), resistance and aerobic (RAP) and control group (CG). AEP group completed HIIT sessions primarily involving gross motor cardiorespiratory exercises (shuttle runs, jumping jacks, and skipping) whereas the RAP group completed HIIT sessions that included a combination of cardiorespiratory and body weight resistance exercises (walking lunges, sprints, push-ups). The control group participated in physical education and usual lunch time activity for the eight-week intervention. The participants were analyzed in three major Mental Health Outcome categories: executive function, psychological well-being, and psychological distress. Executive function utilized the Trail Making Test (TMT) which is a measure of visual attention, speed scanning,

speed processing and mental flexibility. Psychological distress utilized the Kessler Psychological Distress Scale (K10) which is a brief self-reporting questionnaire. Lastly, the Physical Self-Description Questionnaire was used to measure physical self-concept. In changes in executive function, small to moderate intervention effects were found in the RAP condition whereas there was only a small intervention effect in the AEP group. The two results were classified as “possibly beneficial”. The same results were discovered when analyzing changes in psychological well-being. There were no intervention effects for psychological distress from either group. Small changes were reported in self-concept but were not significant. In conclusion, small and moderate improvements in executive (cognitive) function were evident in AEP and RAP groups respectively. It would stand that high intensity interval training is an effective type of physical activity that is successful at improving executive functioning and cognitive function. This supports that in addition to considering the effects of time of day and the amount of time physical education has on academic success, that the type of physical activity should also be considered.

Besides investigating the type of physical activity (HIIT, aerobic, resistance training) such as Costigan et al. (2016) did, perhaps length of time of physical activity should be investigated. Niedermeier et al. (2020) did just that. Their study assessed the impact a single ten-minute physical activity had on the cognitive domain of visual attention compared to sedentary behavior in the population of physically active sport students. Using a randomized controlled design, 51 healthy and physically active sport students were selected for an intervention in the break of a two-hour study course. The 51 participants were randomly assigned to either physically active intervention (run for ten minutes), and the other called a control group (sedentary during break). Detailed information about the study’s procedure was given to

participants and all participants were on a volunteer basis. During initial screening information on self-reported sociodemographic data, physical activity level and self-efficacy students completed a questionnaire of 59 questions. Participants were tested for affective states and perceived attention at three different times: immediately prior (pre), immediately after (post) and 30 minutes after intervention (follow-up). Visual attention and perceived exertion were tested once. The primary outcome was visual attention (visual search, scanning and speed of processing) which was tested by a modified Trail Making Test. The task was a timed event which consisted of a combination of connecting circled numbers in numerical order. Four different sheets were used and the mean scores of the four was considered the outcome. The secondary outcome of this study perceived attention and affective states were collected through a questionnaire. Those who were selected for the physical activity group ran outdoors together for 10 minutes accompanied by an instructor with the intention of an intensity of “somewhat hard” and “hard”. The rating of perceived exertion was used to insure intensity. From this, they found that there was significantly higher visual attention in the physical activity group compared to the sedentary control group. Participants in the active group also reported to have an increase in perceived attention. While changes in the pre and post were evident, pre and follow-up results concluded that there were no significant differences between the two groups. Students may immediately benefit from the effects of short bouts of physical activity especially regarding visual attention (visual search, scanning and speed processing) but the duration of these effects are unclear.

Short bouts of physical activity, even in the form of “brain breaks” are known to help students when learning. Egger et al. (2019) research supports the relationships of physical activity, executive function, and academic achievement. This study examined the effect of

qualitatively different physical activity breaks on children's cognitive outcomes. The first aspect is updating, which is the ability to keep relevant information in working memory. Inhibition, the second aspect, refers to the avoidance of dominant, automatic or prepotent responses. The last aspect, shifting, represents the ability to change among multiple tasks, operations, rules, or perspectives. Egger et al (2019) specifically believes that inhibition is the first EF to be fully developed in children and shifting to be the last. Overall, it's believed by researchers that high levels in EF predict school readiness in young children. Participants included children between the ages of seven and nine who underwent a 20-week classroom based physical activity (PA) intervention. Parents of the children provided consent for the study and all data were treated with strict confidentiality. There were three different types of interventions children were subjected to: high exertion and high cognitive engagement (combo), high physical exertion and low cognitive engagement (aerobic) and low physical exertion and high cognitive engagement (cognition group). For the combo group (high cognitive engagement, high physical exertion) physical activity breaks would consist of movement with cognitive components. For example, students played a game called "Horse Race" where students would quickly run onto spots until the teacher would say a keyword. Keywords were predefined movements that were used to have students adapt and react as quickly as possible. The aerobic group (low cognitive engagement, high physical exertion) played the same game but with the elimination of keywords, so students just performed aerobic movements such as running, and jumping. The cognitive group (high cognitive engagement, low physical exertion) also played another variation of the game "Horse Race" but they sat in a circle and would raise their hand when the teacher used keywords. Two 10-minute interventions per day were carried out in the classroom with their regular class teacher. Teachers were provided training prior to administering intervention including instructing

them on basic principles, aims and the purpose of the intervention as well as demonstrating specific contents. Participants were assessed in cognition and academic achievement. Cognitive assessment included: Updating assessed with Backwards Color Recall task, Inhibition assessed with child adapted version of Eriksen Flanker Task, and Shifting was assessed with an additional “mixed” block within the flanker task. The assessment was conducted using three standardized academic achievement tests in Math, Spelling, and Reading for second graders. The cognition group had significantly lower physical exertion compared to both the combo and the aerobic group but the aerobic and combo group did not differ. Three separate tests revealed that updating and inhibition, effective function, did not differ significantly between the three groups. These researchers found that the combo group profited the most by displaying enhanced “shifting” (represents the ability to change among multiple tasks, operations rules or perspectives). In academic achievement, only mathematics differed significantly between the three groups. The aerobic group did not significantly perform better in Math, when compared to the combo and cognition group. It could be perceived that strategically scheduling physical education or motor activity breaks during or between core classes may help students’ executive function, specifically “shifting” (ability to change among multiple tasks, operations, rules or perspectives).

A similar study by Bacon and Lord (2021) investigated how physically active learning (PAL) (1) contributes to children’s physical activity levels, impacts on academic outcomes and influences children's focus and concentration, specifically Time on Task (TOT). Incorporating physical activities learning increases students' overall physical activity and other beneficial improvement of mechanisms that contribute to improved outcomes, such as better concentration, improved regulation and behavior measured through time on task. Over a two-week period, 38 primary school aged students participated and were exposed to either physically active learning

(PAL) or non-active learning (NAL). Teaching methods for PAL and NAL were led by classroom teachers in their normal classroom space each day of the week. During PAL, learning objectives were delivered in combination with gross and fine motor actions. Each PAL session was 10 minutes within a 20-minute Math lesson which focused on increasing heart rate to elicit high cognitive benefits which included movements like stepping, marching jogging, jumping arm pulsing and some cross lateral arm-leg movement. Three measurements were taken during this study: physiological (heart rate monitors), academic outcomes (four assessments of curricular learning) and TOT (observations). Average intensity measured by heart rate during PAL was 73% heart rate max, which reflects moderate to vigorous activity. As predicted, students who participated in PAL were reported to be more active. Teaching across both groups increased from pre and post intervention. In addition, no differences were observed in test scores at the end of either intervention in both post assessments and no differences in retention of learning assessed seven days later were indicated. Participants of PAL did significantly indicate a greater capacity for physiological demand and spent more time on task than NAL participants. Although students increased their attention and spent more time on learning materials which were hypotheses to improve academic achievement, no significant improvements of academic achievement were reported with physical active learning. Physical education or physical activity may not have a direct impact on academic achievement but directly improve academic achievement because students cognitively function better and spend more time on tasks.

Summary

Schools look for innovations and strategies that increase educational productivity and enhance independent skills, ultimately making students successful members of society. Schools have come a long way throughout the years, but improvement is a continuous process. Based on

research, school districts implement or consider implementing strategies to maximize academic achievement such as delayed school start, class offerings, time of day, brain breaks and block scheduling.

Over the years it has been evident that physical activity contributes to multiple physical and mental health benefits. In schools, physical education plays a critical role in promoting physical activity and improving students' overall educational experience. Physical education contributes to many benefits such as enhanced brain structure, enhanced cognitive function, increased productivity, increased learning ability, improvement of mental health/state and overall self-concept. All of these benefits are critical especially during developmental stages of life.

Schools have recognized these benefits and have implemented strategies like physically active learning (PAL) and brain breaks that are both physically and cognitively stimulating. To further maximize physical education effects, scheduling physical education in students' schedules may offer significant benefits. The review of literature in this chapter illustrates how the time of day and the scheduling of physical education affects academic achievement. Understanding how the time of day affects cognition and utilizing the positive effects of physical education can have a significant impact on students' academic success.

Chapter 4

Results, Discussion and Recommendations for Future Research

The purpose of this chapter is to present the results of the review of literature on the time of day and the scheduling of physical education on academic achievement. In addition, this chapter will explain how these results align with the research questions which guided this syntheses project. Lastly, this chapter will provide recommendations for future research as it relates to the time of day of physical education on academic achievement.

The data reveals that schools are constantly looking for proven strategies and interventions to maximize students' performance. The results of this review of literature suggests that there is an ideal time of day and organization of a school schedule that benefits learning. The literature also demonstrates a positive correlation between physical education/physical activity and cognitive function (executive function), indicating that purposefully scheduling physical education classes to improve academic achievement can be a viable strategy for schools.

Many students have used a strategy or intervention to assist in learning. Since children and adolescents must attend school by law, schools have an opportunity to influence this population. Understanding the potential benefits of purposefully scheduling physical education can enable schools to change policies and increase academic outcomes.

Discussion

Interpretations

As part of this literature review, several research questions were proposed. The first research question examined was “What is the impact of the time-of-day physical education is scheduled on academic achievement?” The results in many of the research studies show that there is an ideal time of day for students to learn and absorb information. For example, in Alfonsi et al. (2020), the researchers found that sleep-wake schedules set in school do not fit with students' biological circadian rhythm. The school examined the transition from an 8:25 am start time (9th grade) to 7:20 am (10th grade), it showed an increase in daytime sleepiness associated with earlier school start times. Giving students greater length of total sleep, time may decrease cognitive fatigue and improve academic outcomes.

Similarly, Pope (2016) reported that moving school start times later increased students' Math GPAs regardless of which period students took Math. It was also concluded that by moving

school start times later and moving Math class earlier, students' Math GPAs increased significantly. Pope indicated that students performed better in the morning classes and Math was more affected by time of day than English. Similarly, certain subjects may have more or less time of day sensitivity. Physical education could be sensitive to time of day, or it could be placed in one's schedule to combine the effects of time of day and physical activity to improve academic achievement.

On the contrary, Williams and Shapiro (2018) suggested that afternoon classes are the best time of day for students' learning, but agreed that there is also an advantage to a delayed school start. Students taking a 9 am class or later performed .16 standard deviations better than students taking the same class at 7 am. Uniquely, Williams and Shapiro (2018) discovered that students who had multiple consecutive classes without a break were put at the greatest disadvantage. Specifically, a student sitting in their second consecutive class was expected to perform .031 standard deviations worse than if they took the same course after a break. It would stand that physical education or motor activity breaks scheduled between classes may assist in students' achievement.

Furthermore, physical education before class or using physical activity during class as a break can improve time on task and cognitive function. Ardoy et al. (2013) incorporated interventions that included: Control Group (CG) with regular scheduled two physical education classes per week, Experimental Group (EG1) with two four physical education classes per week and Experimental Group 2 (EG2) with four high intensity physical education classes per week. The study examined these interventions' effects on academic achievement. The EG2 participants that received four high intensity physical education classes per week significantly improved all cognitive performance indicators where all other groups did not. Increasing just solely the

frequency of physical education is not enough to improve academic achievement but increasing frequency and implementing a high intensity program stand to be beneficial for students.

Comparably, Laun et al. (2022) investigated the effects of moderate physical activity on students' cognitive function. In this study, moderate physical activity was found to have a positive, direct effect on Math performance (.036), Reading (.027) and Science (.034). In addition, moderate physical activity indirectly influenced students' performance academically due to students' perceived well-being and overall improvement of general health. If students are healthy and have a high perceived state of well-being, they can put more energy and focus on learning.

Bacon and Lord (2021) indicated that physically active learning has a statistically significant 10 percent improvement on time-on-task compared to non-physically active learning. Although this study indicated an improvement on students' task attention, no improvement was found on the post-activity assessment and the retention learning assessment that occurred seven days later. Physically active learning improved students time-on-task but these effects did not transfer to students test scores or overall achievement in the class.

It's evident that students are affected by their school schedule. Equally as evident is that physical education can improve cognitive function. Combining the effects of strategic organization of school schedule and physical education can benefit students. Early morning classes between 7 am and 9 am are not conducive to learning. It is also evident that cognitive fatigue or daytime sleepiness occurs during the school day but the time at which this may occur varies in these studies. Consecutive classes pose the greatest harm to students' cognitive function. In addition, specific subjects like Math or possibly physical education are more sensitive to time of day effects. Additionally, the studies prove that physical education not only affects students'

attention (time-on-task), but enhances cognition. Even though the research clearly demonstrates improvements in executive or cognitive function, these findings don't necessarily carry over to students' academic performance. Although the results of these studies do not clearly indicate a direct impact on academic achievement for the time-of-day physical education is scheduled, it does demonstrate some benefits.

In conclusion, based on these results, it is clear that physical education could be used purposefully in students' schedules. Placing physical education at the start of the day or in between consecutive classes can potentially offer students benefits.

The second research question that was examined was “What is the impact of the amount of time physical education is scheduled on academic achievement?” The results revealed that the length of time does alter the effects that physical education has on cognitive and academic performance. Niedermeier et al. (2020) assessed the impact of a single ten minute physical activity on cognitive domain. The study found that cognition, specifically visual attention (visual search, scanning and speed of processing), was significantly higher pre vs. post test in those individuals that participated in 10 minutes of physical activity during their class break. However, these results did not show the same visual attention improvement during follow-up assessment (30 minutes after intervention). Thus, it concludes that short bouts of physical activity, especially in regards to visual attention (visual search, scanning and speed processing), improves but the duration of these effects are unclear.

Opposite of the Niedermeier et al. (2020) study, Labak et al. (2020) looked at block schedule classes, which are typically 90 minutes per class. Although this study specifically analyzed Biology class, it found that the effects of this type of schedule showed improvement only in the 3rd grade. The other three grades showed better performance with traditional 45

minutes class periods. Students of a specific grade level or specific students may need alternate schedules to perform better academically.

Haynes-Hunter and Avery (2007) investigated the effects of block scheduling in secondary physical education classes. The results of this study found that students spent more time in management and waiting and less time receiving information and in activity. This coincides with results from Bukowski and Stimson (2005) which noted concerns of physical educators that students do not participate in physical education for long periods of time. Even though physical educators who participated in this study approved of block scheduling overall, they were concerned that teacher/student absences were costly, students did not have access to the whole curriculum, and students with special needs have difficulty staying engaged for such long periods of time. Theoretically having more time for activity such as a 90-minute physical education block schedule would be beneficial, but may not be practical in improving academic proficiency.

Other research used to examine the impact of the amount of time physical education is scheduled on academic achievement was Egger et al. (2019). This research study investigated the impact of brain breaks that were physically and cognitively engaging on executive functions (cognitive/mental function) and academic achievement. Results showed that the group that profited the most and displayed enhanced shifting (the ability to change among multiple tasks, operations, rules, or perspectives) was the combo group (two ten minutes of high intensity physical activity and high cognitive engagement per day). Physical education or motor activity breaks scheduled during or between core classes may assist in improving students' executive function, specifically "shifting" (ability to change among multiple tasks, operations, rules, or perspectives).

While analyzing these articles a pattern emerged. When considering the time of day and the amount of physical education, consideration should be given to the type of movement being performed. In Costigan et al. (2016), the researchers investigated high intensity interval training (HIIT) for cognitive health. High intensity interval training entails short intervals of intense exercise typically with a heart rate of greater than 85% of maximum heart rate. This study incorporated two HIIT sessions per week in their scheduled physical education lessons. There were three groups who participated in intervention: aerobic exercise program group - AEP (involving gross motor cardiorespiratory exercise such as shuttle runs, jumping jacks, and skipping), resistance and aerobic program - RAP (involving a combination of cardiorespiratory and body weight resistance such as shuttle runs, jumping jacks, and pushups) and the control group (involving normal programmed physical education lesson). Costigan et al. (2016) reported that small to moderate intervention effects on executive function were found in the RAP group and a small intervention on the AEP group which both were classified as “possibly beneficial”.

Arday et al. (2013) also supported the relationship between physical education (PE) and academic achievement and high intensity interval training. This study was randomly assigned into three different groups: control group - CG (usually two PE sessions per week), experimental group 1 -EG1 (four PE sessions per week) and experimental group 2 - EG2 (four high intensity PE sessions per week). Results indicated that all cognitive performance indicators improved significantly in the EG2 group compared to CG and EG1. It was also reported that there was no difference between CG and EG1 in the cognitive performance variables studied.

It's evident that students are affected by the amount of time scheduled for physical education. It is apparent from the research that short bouts are effective in increasing cognitive functioning. This is also supported with the use of physically active “brain breaks” in

classrooms. On the other hand, block scheduling could be beneficial, but lack of student participation in physical education for long periods of time warrants concerns on effectiveness. Equally as evident is the type of physical activity that promotes positive cognitive functioning. High intensity interval training has been shown to improve cognition.

In summary, when creating a student's academic schedule, it is important to consider the research in this synthesis of purposefully placing physical education to improve cognitive and academic achievement.

Implications

There is a lack of research that specifically examines the time of day and the scheduling of physical education on academic achievement. The research utilized in this synthesis all conclude with similar conclusions on how physical education affects cognitive performance. However, conclusions varied on how physical education is administered, the amount of time allotted and time of day. Ultimately, the results of these studies do not clearly indicate a direct impact on academic achievement for the time-of-day physical education is scheduled on, but it does demonstrate some benefits. Further research needs to be conducted specifically to determine the effects on the time of day and the scheduling of physical education on academic achievement. However, from this review of literature, stakeholders can conclude that purposefully placing physical education can improve students cognitive functioning.

In many studies it was noted that the effects of physical education improvement occurred, especially in Math class compared to other subjects. The research also showed that lower performing students were more sensitive to time of day and physical education considerations to improve academic achievement.

Pope (2016) and Williams and Shapiro agree that the structure and organization of a school day schedule can influence academic achievement. They felt that understanding a student's performance throughout the day could lead to a "prime" schedule that could especially be used for students who were underachieving.

Additionally, researchers, Ardoy et al. (2013), Niedermeier et al. (2020) and Luan et al. (2022), all agreed that physical education improves cognitive function. Although the evidence is not overwhelming nor significant, at minimum, they concluded that physical education doesn't harm academic achievement.

Ideally, combining the two considerations, by purposefully scheduling physical education classes into a student's schedule or strategically implementing a designated policy to place physical education classes before an academic class is proven to increase students' cognitive function. Schools are in a unique position as they can implement policies that enhance student performance. Understanding how the time of day affects cognition and utilizing the positive effects of physical education, stakeholders can create meaningful policies that have a significant impact on students' academic success.

Recommendations for Future Research

In reviewing the database of literature on the time of day and the scheduling of physical education on academic achievement, the following limitations were noted regarding the students under review. Differences in sample sizes within each research study was reviewed and the differences in study samples could alter (too small or too large) specific generalizations made. Another limitation to note is that for studies with surveys and questionnaires, participants may

not have always provided truthful information. Similarly, participants' answers, given statements, and behaviors could have also been altered due to participating in a study.

Based on these limitations and other insights related to the literature the following recommendations for future research should be considered:

1. Further research on the effects of the amount of physical education time allotted.
2. Research on the effects of time of day of physical education.
3. Research on the direct effects of physical education on students' academic achievement in the class directly following physical education.
4. Research on the long-term effects on cognitive function and high intensity interval training.

Summary

The purpose of this literature review was to determine if time of day of physical education influences academic achievement. The review consisted of 10 critical mass articles that were specifically chosen for this synthesis. The articles selected were systematically used to support and provide evidence that determined the impact of the time-of-day physical education is scheduled on academic achievement and the amount of time physical education is scheduled on academic achievement.

Research revealed separately that the time of day affects students' academic performance, and that physical education improves cognitive functioning. Combining these two strategies of purposefully scheduling physical education to affect students' academic achievement should be considered especially for individuals who are underachieving.

Further research is needed to definitively determine the benefits of physical activity on cognitive functioning and academic achievement of adolescent students in physical education.

Utilizing the positive effects of physical education, and understanding time of day effects, stakeholders can create meaningful policies that have a significant impact on students' academic success.

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Appendix A

Author	Title	Source	Purpose	Methods and Procedures	Analysis	Findings	Discussion/Recommendations	Research Notes-Commonalities/Differences
Valentina Alfonsi, Serena Scarpelli, Aurora D'Atri, Giacomo Stella and Luigi De Gennaro	Later School Start Time: Impact of Sleep on Academic Performance and Health in the Adolescent Population	International Journal of Environmental Research and Public Health	Intended to propose a direction for future studies targeted to implement prevention or treatment programs by modifying sleep time.	PubMed queries Key Search Terms included: - "Sleep" and Circadian Process" - "Sleep Deprivation" - "Sleepiness and School Time" - "Health and Academic Performance"	Grouped into three different categories. Focused on the effects of adolescent sleep deprivation and the impact of delaying school start time,	Insufficient sleep in adolescents represents a major public health issue. Sleep wake schedules set by schools do not fit with biological circadian and homeostatic processes regulating adolescent sleep patterns.	Applied later start time programs as policy change to reduce the imbalance between early waking time and adolescent sleep phase delay in order to address adverse outcomes intervening on the main external factor of sleep curtailment in this population.	Thus, delaying the start of school provides students with the opportunity for a greater length of total sleep time which may improve academic outcomes.
Kevin M. Williams and Teny Maghakian Shapiro	Academic Achievement Across the Day: Evidence from Randomized Class	Occidental College, Department of Economics, CA	Expand our understanding of how school day schedule	Utilizing data from the United States Air Force Academy The data	Addition to our full sample analysis, focused on the	Consecutive classes have a consistently negative impact	Evidence of cognitive fatigue A decrease in ability to absorb material	-Cognitive Fatigue - Time of day effect -Fatigue and boredom are a

	Schedules		affect achievement	cover five academic years at USAFA which includes nearly 7,000 students and over 200,000 student course observations in core academic fields	subset of fall-semester freshmen. Students are still in their teens, are new to the academy and are enrolled almost entirely in required core courses.	on performance. Students schedule them to sit in ,multiple classes in a row, they perform significantly worse in the latter classes, Students taking a 9am or later are expected to perform .16 standard deviations better than students taking the same class at 7am	Consistently negative effects associated with early morning (7am -8 am) Assigning the worst students to more optimal schedule is a pathway to increasing overall achievement break for a student is around an hour long. (Needed to reset students fatigue against impact of consecutive classes)	persistent issue in education - biological rhythm that governs our sleep wake cycle called circadian rhythms - Circadian timing also affects the times of day when a person is more alert, independent of sleep (Blake1967) "Out of Sync"
Nolan G Pope	How the time of day affects Productivity: Evidence from school schedules	The review of Economics and Statistics Vol. 98 No. 1	The time of day effect may be interpreted as different productivity during different parts of	student-level panel data of students in sixth to eleventh grade from the LA Unified School District.	Math classes are more affected by the time of day than English Classes	Moving Math classes to the morning and other classes like English to	Start times do not meet the circadian rhythm of adolescence Day- time sleepiness	Certain subjects may have similar sensitivity to time of day, and may favor strategically placing classes in

			<p>the day due to Circadian rhythm; stamina effects with decreasing productivity the longer a student is at school or school structure effects</p>	<p>6 period class schedule, typical start time of 8 am, each period about 50 minutes</p> <p>Academic outcome, GPA, and CST score.</p>	<p>Other classes such as Physical Education, also have small time of day effects.</p> <p>Higher productivity is higher in the morning than in the afternoon</p>	<p>afternoon could increase students GPA</p> <p>Understanding how the time day affects students allows schools to change policies to increase academic outcomes.</p>		<p>students' schedules. It could be beneficial to schedule physical education at a specific time of day to increase students' productivity and maximize their academic achievement.</p>
Michael Turnlund	<p>The experiential-learning track: career exploration student interest, and applied classroom-learning in small rural junior-senior high school</p>	<p>northwest journal of teacher education Volume 14 issue 2 article 5</p>	<p>to examine a strategy used by a small school to address budgetary and staff restrictions to offer academic programs and elective offerings.</p>	<p>Budgetary and staff constraints can limit academic programs and elective courses offerings</p> <p>Can reduce elective courses matched to students interest and aligned with their future career or post secondary educational goals.</p>	<p>The experiential-learning track program was developed as a mechanism to overcome educational limitations through "hands on" learning opportunities designed</p>	<p>Increased "hands on" learning opportunities</p> <p>Increased interest, curiosity or exploration or prepare individuals for post-high school careers.</p>	<p>The experiential-Learning Track Program provides an effective and adaptable methodology to meet these students needs and interest.</p> <p>The program engages students and staff members in a meaningful way but</p>	<p>Giving students options - School Strategy to improve academic Achievement</p>

					<p>around student interest.</p> <p>Outdoor Track - outdoor activities and careers</p> <p>Arts and Culture Track - activities and careers in the humanities</p> <p>The Animal Science Track - activities and careers in veterinary medicine</p> <p>The Tech Track - activities and careers in technology and trade</p> <p>Business Track - activities and</p>		<p>also parents, community leaders and other stakeholders</p>	
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					careers in entrepreneurship Independent Track-career in explorations and mentorship program			
Barbara A. Guy, Patricia L. Sitlington, Michael D. Larsen, Alan R. Frank	What are High Schools Offering as Preparation for Employment	Career Development for Exceptional Individuals Volume 32 Number 1	to determine the patterns that existed in employment preparation courses offered by districts across a midwestern state and the primary intent primary method of instruction and location of the classroom-based and work-based components	3 stage process Year 1 - districts were closed from one intermediate education unit to field test study instruments and procedures and determine the initial criteria for employment preparation courses and categories Year 2 - refined instruments and procedures were	On average, high school offered 52.1 courses that were considered to meet the definition of employment preparation 73.5 percent of employment preparation courses were classroom based	Curriculum to be more purposeful in preparing students for post secondary employment Increasing number of courses with work-based components On relevancy of the program, especially in terms of	Alternative strategies to improve student achievement and prepare students higher education and employment	College Entry Enter Employment

			nts of these courses	posted in three different districts Year 3 - data were collected from the statewide sample.	only.	employment emphasis		
Irena Labak, Mirela Sertic Peric, and Ines Radanovic	Effects of Block vs. Traditional Scheduling on High School Science Success - Lessons from Biology Classes	Education Sciences	How block vs. single class scheduling, students average performance and their interaction affect students success in high school biology course	The study included 281 high school students' participation in first written exam conducted to evaluate students' initial knowledge; teaching in block vs single scheduled classes, second written exam conducted to assess students' achievement after block vs single scheduled classes.	Block scheduled classes did not affect students' success equally across all student performance categories When estimating effects of class scheduling on students' success students age prior knowledge overall performance and complex	Significant two way interaction effect of grade and class scheduling on the students final exam performance, after adjusting for students overall performance The one-way Ancona applied on the 2nd written exam scores confirmed a statistically significant	Due to their longer duration, block scheduled classes enable successful building and connection of concepts which is usually facilitated by employing teaching methods requiring active cognitive student engagement. Studying concepts and laboratories Considering the issue of students interest and their attention span for certain	Students who are of lower performance could benefit in a specific schedule like block schedule to improve academic proficiency.

					ity of educational topics should be considered.	difference in students success between single vs block scheduled biology classes within 1st 2nd 3rd grade whereas in the 4th grade, the statistically significant differences was not confirmed	topics some learning topics and outcomes might be accepted and chive Ed better if a topic is covered small "single" increments instead of a few large blocks	
Francis M. Kozub & Timothy A. Brusseau	Powerlifting: A Suitable High School Elective and After School Intramural Program)	Journal of Physical Education, Recreation and Dance	how to safely integrate the sport-related aspects of powerlifting into a curricular offering that addresses the national standards	10 week unit that focuses on developing skills, proper lifting form and spotting practices to help encourage students to view lifting as a lifetime activity.	Learning lifts early is important for later success and offering lifting as a physical education elective may help stimulate interest in	Powerlifting is one of the fastest growing sports for young and older adults. Training is required and there are many areas related to	The focus of a powerlifting unit in physical education should be to help students to understand the basic principles of the three lifts, the rules for a meet and safe spotting techniques as well as to	The physical education curriculum should focus on creating lifelong learners and movers based off national standards

					physical activity among students who may not be attracted to traditional games and sports.	nutrition, workout plans and motivation that relate to broader educational standards in both physical education and health	encourage participation in this activity after school and into adulthood.	
Paul Bacon and Rachel N. Lord	The impact of physically active learning during the school day on children's physical activity levels, time on task and learning behaviors and academic outcomes	Health Education Research Vol. 36 No.3	This study investigates how physically active learning (PAL) (1) contributes to children's physical activity levels, (2) impacts on academic outcomes and (3) influences children's focus and concentration, defined as time on task (ToT)	Over a 2 week period, participants were exposed to PAL and non-active learning (NAL) lessons in a counterbalanced design.	Physiological responses and ToT behavior were recorded through out PAL and NAL lessons. Academic outcomes were assessed week before, during and the week after each mode of delivery.	Children are more active during PAL compared to NAL. The physiological demands of PAL were significantly greater. Children's ToT was significantly higher with PAL than NAL. PAL improved ToT behavior indicating that PAL could	Modest levels of PAL increased activity levels. No evidence was found to test PAL had a negative effect on children's academic outcomes and PAL could positively impact on children's concentration. Factors such as increases in neurotransmission chemicals or increased	protective factor for many health conditions and in children Associated with improved academic and mental health and as it contributor to healthy weight status School contributes to child sedentary behavior through desk-based activity Improved cognition and

						have a role in regulating behavior and maximizing concentration. There were no differences in academic outcomes when PAL and NAL were compared	cerebral blood flow and. Oxygen delivery may have impact on concentration or moderated behavior responses	academic outcomes better concentration improved self-regulation and behavior = ToT
Xi Luna, Ji Liu and Xin Lou	Examining the link between Physical Activity and Cognitive Function: A Parallel Mediation Model of Health and Well-being Among Adolescents	The Journal of Frontiers in Psychology	Examines how subjective wellbeing (SWB) and general health (GH) mediate the relationship between adolescents	Total of 63,228 15 year old subjects in nine countries/economics including Bulgaria, Georgia, Hong Kong, Ireland, Mexico, Panama, Serbia, Spain and United Arab Emirates. Moderate physical activity was reported weekly.	SWB and GH were assessed using an international validated multi-term standardized questionnaire. SWB was measured by students' self-evaluated health satisfaction with their	Finding indicate that increase in weekly (MPA) was positively associated with higher levels of SWB and CF among the study subjects Frequent Weekly MPA had relatively large	Shows positive relationship observed between MPA and CF among adolescents SWB and GH were two critical mediators through which physical activity positively bolster CF MPA is also associated with healthy diet better sleep	CF- Cognitive Function SWB- Subjective Well-being GH- General Health MPA - Moderate Physical Activity) How MPA influences adolescents CF existing evidence has identified

					<p>health, life and schooling. GH was measured by students'</p> <p>physical health and mental health status.</p> <p>CF was modeled as a latent function consisting of plausible values derived using time response theory on Reading, mathematics and Science achievement test</p>	<p>direct effect on CF and indirect effects channeling through improvement in SWB and GH were non trivial</p> <p>Boost to CF associated with MPA were larger for Math and Science than Reading</p>	<p>MPA is related to positive self-image, self-esteem and self efficacy.</p> <p>Effectively reduce depressive symptomatology, psychological stress and anxiety</p>	<p>three lines of potential channels : Physiological factors, executive function and learning disposition.</p> <p>Neurotrophic factors all of which are strong determinants of development of growth, maintenance and plasticity of the brain and related to CF</p> <p>Some MPA are found to increase arousal leading to better attention span.</p>
<p>Martin Niedermeier, Elisabeth Weiss, Lisa Steidl-Muller, Martin</p>	<p>Acute Effects of a Short Bout of Physical Activity on Cognitive Function in Sports</p>	<p>International Journal of Environmental Research and Public</p>	<p>The goal of the study was to assess the impact of a single ten-</p>	<p>Using a randomized controlled design, 51 healthy and physically active sport students were</p>	<p>physical activity resulted in a transient enhancement of</p>	<p>The physical activity group showed significantly higher visual</p>	<p>There are at least four important aspects to consider when focusing on effects of acute</p>	<p>as much as 30 hr a week with sedentary activities such as reading, studying, using the</p>

Brutscher and Martin Kopp	students	Health	minute physical activity on the cognitive domain of visual attention compared to sedentary behaviors in a population of physically active sport students.	<p>allocated to one of the following interventions in the break of a two hour study course: physical activity group (running for ten minutes) and sedentary control group.</p> <p>Visual attention was measured post intervention , and 30 minutes after intervention , perceived attention and affective states were measured.</p>	<p>perceived attention and arousal immediately after the intervention however these effects were not evident anymore at 30 min after the intervention</p> <p>Critical time frame of intervention effect 11 to 20 min after physical activity bout</p>	<p>attention post intervention increase in the physical activity group compared with the sedentary control group.</p> <p>Perceived attention and arousal showed a significantly larger pre and post intervention increase in the physical activity group compared with the sedentary group which was not evident 30 minutes after intervention</p>	<p>physical activity notes on cognitive function(1) CF decreased during activity but increases after(2) intensity of bout might produce different effects(3) Duration of bout(4)effects on those who are used to PA</p>	<p>computer, or watching TV.</p> <p>Intervention - single bout of physical activity</p>
Fabienne Egger,	Boost your brain,	PLOS/ONE	Aim of the study	Children aged	To test the	Results showed	Higher improvement	"Pure" physical

<p>Valentin Benzing, Achim Conzelmann, Mirko Schmidt</p>	<p>while having a break! The effects of long-term cognitively engaging physical activity breaks on children's executive functions and academic achievement</p>		<p>was to examine the effects of qualitatively different PA breaks on children's cognitive outcomes</p>	<p>between 7 to 9 years were allocated to a 20 week classroom based PA program with either high physical exertion. and high cognitive engagement, high physical exertion and low cognitive engagement. Or low physical exertion and high. Cognitive engagement.</p>	<p>main hypotheses of the study, the three groups were compared regarding the three core EF between pre and post test.</p> <p>Post-hoc analysis revealed a significantly greater improvement in shifting performance in the combo group than aerobic</p> <p>For academic achievement only mathematics differed significantly</p>	<p>that the combo group profited the most displaying enhanced shifting and Math performance. The cognition group profited only in terms of enhanced math performance whereas the aerobic group remained unaffected.</p>	<p>nt on EF for those PA interventions with higher amounts of cognitive engagement</p>	<p>PA breaks with little cognitive effort are not able to enhance specific cognitive components</p> <p>Shifting is strongly related to problem solving which is a higher ordered of EF</p>
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					between the groups			
Sarah A. Castigan, Narelle Eather, Ronald C. Plotnkoff, Charles H. Hillman, and David Lubans	High Intensity interval training for Cognitive and Mental Health in Adolescents	evaluate the efficacy of two high intensity interval training (HIIT) protocols for improving cognitive and mental health outcomes	participants were randomized to three conditions: aerobic exercise program, resistance and control HIIT sessions (8-10 min. Per session) were delivered during physical education lesson or at lunchtime three times per week for 8 weeks	assessments were conducted at baseline and immediately post intervention to detect changes in executive function, psychological well being, psychological distress and physical self description by researchers blinded to treatment allocation. Intervention effects were examined using linear mixed	results were not significant, small improvements in executive function and psychological well being were evident in the AEP group; moderate improvements in executive function and small improvements in well being and perceived appearance were observed for the RAP group	Overall, small improvements in executive function and psychological well being were evident in the AEP group, small improvements in executive function well being and perceived appearance were observed for the RAP group Feeling state scores improved from pre workout to post workout in both HIIT groups;	contribute to the understanding how short bouts of intense exercise influence cognitive and mental health outcomes in adolescent population	A HIIT within the school day

						however, significant results were observed only among participants in the AEP group		
Joseph E. Donnelly, Charles H. Hillman, Darla Castelli, Jennifer L. Etnier, Sarah Lee, Phillip Tomporowski, Kate Lanbourne, Amanda Szabo-Reed	Physical Activity, Fitness, Cognitive Function and Academic Achievement in Children: A Systematic Review	American College of Sports Medicine, Position Statement	The purpose of this study was to answer the following questions : 1) among children ages 5-13 yr do Pa and physical fitness influence cognition, learning brain structure and brain function? 2:Among children 5-13 yr, do PA physical education and sports programs influence standardized achievement test	grouped by study design as cross sectional longitudinal acute or intervention trials. Considerable heterogeneity existed for several important study parameters ; therefore results were synthesized and presented by study design	Majority of the research supports the view that physical fitness, single bouts of PA, and PA interventions benefit children's cognitive functioning. Limited evidence was available concerning the effects of PA on learning	positive association among PA, fitness, cognition and academic achievement . Findings are inconsistent and the effects of numerous elements of PA on cognition remain to be explored such a type amount frequency and timing	Questions remain regarding how to best incorporate PA within schools, such as activity breaks versus active lessons in relation to improved academic achievement	

			performance and concentration/attention		Evidence indicates that PA has a relationship to areas of the brain that support complex cognitive process during task			
D.N. Ardoy, J.M. Fernandez - Rodriguez, D. Jimenez-Pavon, R. Castillo, J.Ruiz, F.B Ortega	A physical education trial improves adolescents' cognitive performance and academic achievement: EDUFI T Study	Scandinavian Journal of Medicine & Science in Sports	analyze the effects of an intervention focused on increasing the time and intensity of Physical Education adolescents cognition performances and academic achievement	4-month group-randomized controlled trial was conducted in 67 adolescents from South-East Spain, 2007 3 natural school groups were randomly allocated CG, experimental 1 or experimental 2	Cognitive Performance-Spanish Overall and Factorial Intelligence Test Academic Achievement - Grades Physical Fitness Assessment - Shuttle Run, long jump test,	No significant difference between CG and EG1 in cognitive performance variables studied. Cognitive performance indicators improved in most adolescents belonging to EG2. EG2 had an	Increasing the number and intensity of PE sessions per week has a positive effect on both cognitive performance and academic achievement Double the number of PE sessions not enough stimuli for improving cognitive or academic performance.	No significant differences but amount plus intensity was increased academic achievement and cognitive performance indicators

						improved average academic achievement compared with CG and EG1	“Dose” volume and intensity has a clear and significant effect on cognitive and academic performance - Specifically high intensity exercise	
Joanne Margaret Hynes-Hunter and Sarah Avery	Block Scheduling in Secondary Physical Education: East Coast Compared to West Coast United States of America	The Physical Educator	investigates the effects of block scheduling (90-120 minute periods) on sixth to twelfth grade students attending secondary physical education classes located northeast and west-coast United States	Four high schools and one middle school located in the Northeast and one high school and one middle school on the West Coast. 297 classes observed (3 lessons within each unit, for 3 units for each physical educator in the school in each of the 7 schools)	Quantitative Methods Data were collected and analyzed by two investigators Time in class and “overall use of time in class”	students more time “waiting” and in “management” and less time in “activity” Most of the instructional time was spent in practice, followed by explaining for demonstrating the skill Least amount of time was spent changing	advantages in adopting block scheduling, larger time to carry out standards but concerned about its effectiveness.	Block Schedule PE could be beneficial if structured correctly

						condition s (making a skill easier or more difficult), refining the skill, informati on on how to perform a particula r task, and practicin g skills from a previous lesson.		
Bruce J. Bukowski & Anne D'Antonio Stinson	Physical Educators' Perception s of Block Schedulin g in Secondary Physical Education	The Journal of Physical Educatio n	The study looks at the effects of block schedulin g has had on Wisconsi n physical education learners, teachers and curriculu m	Nine public high school through Wisconsin were chosen from among 69 public schools that used block scheduling 31 physical education teachers at theses 9 high schools agreed 7 interview questions that were recorded	All 31 participa nts complet ed the interview process Respon ses fell into 3 broad categori es: positive s of blocks scheduli ng, negative of block scheduli ng and other	Positive - Reduced levels of stress "ran smoother" Normal "hassles" Less distractio n Increase d time for interactio n with students More one on one time and more student teacher interactio	Even though the teachers have many concerns about block scheduling the program meets with their general approval	The benefits outweigh any concerns

						<p>n better grades More time on fundamentals</p> <p>Negative -</p> <p>Students do not participate in physical education for long periods of time Student/teacher absences are more costly Concerns with special education students</p>		
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