The Impact of Later Secondary School Start Times on Adolescent Academic Achievement and Attendance

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Dedication

This work is the culmination of early mornings, late nights, long weekends, and sacrifices by a lot of people I care about very much. Before this doctoral journey began and even along the way, there were people who doubted, dissuaded, and even disrupted this pursuit. Never let anyone get in the way of your own personal goals or stop you from climbing your mountain.

This dissertation is dedicated to anyone who wants to or has climbed their own personal mountain. Ignore the people yelling at you from the ground or throwing stones from the mountain side. Embrace the people who are willing to hold your safety rope as you make the ascent, and make sure to stop, appreciate the view and the people who helped you get there, when you reach the top.

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Finally, my sincere appreciation and admiration to all the members of Cohort Four. We experienced new life, death, and everything in between during this process. Your friendships through the ups and downs of these last couple years would have been enough of an achievement to make the early mornings, late nights, and weekends all worth it. I can't begin to explain what you all have helped me to achieve during our time together.

Abstract

The American Academy of Pediatrics recommends 8.5 to 9.5 hours of sleep per night for adolescents (Barnes et al., 2016). Additionally, sleep behavior and scientific research about teenagers and young adults, from the late 1990s, showed developmental changes in melatonin release around this age that impacts starting sleep times (Wahlstrom, 2014). Despite the availability of this and other research on adolescent sleep and school start times, over 80% of the secondary school start times across the United States were before the 8:30 a.m. recommended time (National Center for Educational Research, 2017). The purpose of this quantitative study was to build upon the initial research available from the 2019 Pennsylvania Joint State Government Commission report on Secondary School Start Times. The researcher collected gender, grade level, ethnicity, socioeconomic status and special education services data from two suburban school districts in Pennsylvania that had changed their secondary school start times to at least 30 minutes later in the past five years with the hope of identifying the impact of the time change on the academic achievement and attendance data of students in these districts.

TABLE OF CONTENTS

List of Figures

List of Tables

School District #1

School District #2

CHAPTER 1

Introduction

Attaining equity in education is a challenge that has plagued society for decades. There have been some well recognized and frequently studied federal court cases or legislation that have made inroads to level the educational playing field for all students. The Supreme Court ruling in *Brown v. Board of Education of Topeka* mandated districts across the country desegregate their school buildings (Warren & Supreme Court of the United States, 1953), the Individuals with Disabilities Education Act (IDEA) required a free and appropriate public education for all students with disabilities and special education needs (Education for All Handicapped Children Act, 1975), and Title IX of the 1972 Education Amendments legislation made it illegal to exclude a person from participation or deny benefits of an educational program based on gender (Title IX of the Education Amendments Act, 1972). These are all well-known challenges in the fight for equality in education, but work is still being done to identify and provide equal access to educational conditions and resources. Lynch and Baker (2006) define equality in education as an environment for learning with similar conditions, access to resources, distribution of agency, and opportunities for connection to culture. They further explain that creating an equitable education environment does not guarantee equal outcomes. All students should have access to the same opportunities, but their individual agency and how they use those opportunities will determine educational outcomes.

More recently, educational institutions across the country faced the challenge of bringing their facilities into the 21st century with costly upgrades to technology infrastructure and hardware. This capital-intensive process caused a discrepancy in access to technology devices and the internet known as the digital divide. The digital divide measures the number of students

in a classroom or school building compared to the number of devices available or classrooms with access to the internet (Becker, 2007). In a 2001 NAACP Call for Action in Education report, the digital divide is one of the critical areas identified as needing to be addressed to provide greater equity in education. Other areas of the education infrastructure identified in that report as having a significant disparity in access across the country included resources in the classroom and access to college-bound curriculum. In another study, Rees et al. (1996) found that the process of tracking students, or placing them in pre-determined ability groupings, significantly disparaged students of lower socioeconomic status and ethnic minorities. Students identified in these groups had a higher likelihood of placement in the lower academic tracks and a long-term disparity in the quality of their education.

The intent of this study was to provide further research for equity in education as it pertains to the topic of adjusting secondary school start times and the impact that change has on students from different subgroups including ethnic backgrounds, races, socioeconomic status or who receive various special education services. Continuing the pursuit of educational equity requires a constant, reflective perspective to identify areas of study and current trends in education, while recognizing gaps in application and practice. School funding, early childhood education, and teacher vs student-centered instructional practices are all current examples of this disparity between educational equity theory and actual trends in practice (Becker, 2007; Jackson, 2001; Lynch and Baker, 2006; Rees et al., 1996). The study of changing secondary school start times and the impact on students has a significant amount of scientific research informing the potential biological impacts of changing secondary school start times on adolescents, but a minimum amount of this literature specifically identifies and explores the impact on students who identify with the various student subgroups identified earlier. This research contributes to

the body of research around the topic of changing school start times overall and adds an additional lens for school district administrators to consider when making the choice to adjust the start times of schools in their district.

Secondary school day start times are becoming a topic of conversation in school districts across the country. The recent implementation of a California state law mandating an 8:00 a.m. start time for all middle schools and an 8:30 a.m. start time for all high schools, with some exceptions for rural schools, comes on the heels of several research studies outlining the science behind sleep times in adolescents (California Bill 328, 2019). Pennsylvania Senate Resolution 417 of 2018 authorized a case study on sleep deprivation and its connection to secondary school start times (Joint State Government Commission, 2019). Changing the start time for secondary students is not an easy adjustment. School districts need to consider all factors when making decisions that impact the physical, mental, and academic well-being of their students. This can become more difficult with the growing social, economic, and cultural needs and diversity in each of their communities. School district leaders also face political, economic, and school community challenges when making decisions on this topic. Each community must weigh the advantages and disadvantages to come to a decision that is in the best interest of students and families in their own communities.

Adolescents have a predisposition to make choices counter to the suggestions of the adults in their lives. For generations, they intentionally disregarded the preferences of those around them with more life experience when it came to the clothes they wear, the music they listen to, and many other mainstream adolescent choices. Many believed this to also be true about an adolescent's choice of bedtime. Regularly staying up past midnight to watch television or talk on the phone was routine adolescent behavior during the 1980's and 1990's, while more

recently long nights involving video games, texting, and interacting on social media filled their time. In the early 1990's, researchers began to identify biological reasons that helped to explain some of the sleep behavior choices by adolescents (Wolfson and Carskadon, 1998). The naturally occurring change in melatonin release time for adolescents revealed a developmental chemical reason, called sleep phase delay, that explained the desire for later bed times (Carskadon, 1999).

The identification of sleep phase delay led to a cascade of additional research on adolescent sleep and the impacts on other parts of their lives. Starting in 1997, the Minneapolis Public School District adjusted the start time for a group of seven high schools in their system and partnered with researchers from the University of Minnesota, led by Kyla Wahlstrom, to study the impact on attendance, sleeping in class, and student-reported depression (Wahlstrom, 2002). The results of early studies like the one from Wahlstrom led other researchers to study similar start time changes in school districts across the country and expanded the breath of potential connections to adolescent sleep. These topics include academic achievement (Kelley and Lee, 2015; Wheaton et al., 2016), automobile accident risks (Bryant and Gomez, 2015; Luyster et al., 2012), student behavior in school (Bastian and Fuller, 2018; Joint State Government Commission, 2019), career and technology education achievement (Scarpello, 2010), equity (Keyes et al., 2015; McQuiggan and Megra, 2017; Redford and McQuiggan, 2019), student health (Baum et al., 2014; Czeisler, 2009; Kelley et al., 2015; Luyster et al., 2012; Owens et al., 2010; Wahlstrom, 2002; Wahlstrom et al., 2014), and attendance (Balkis et al., 2016; Bastian and Fuller, 2018; Joint State Government Commission, 2019; Marx et al., 2017). While this is not an exhaustive list, the amount and variety of research connecting adolescent sleep to various factors in their lives is in its infancy.

Statement of the Problem

The recommended hours of sleep per night for an adolescent is 8.5 to 9.5 according to the American Academy of Pediatrics (Barnes et al., 2016). Evolving research from the 1990s around adolescent sleep behavior showed a delay in melatonin release and the subsequent inability to consistently fall asleep before 10:30 p.m. Because of this research, some secondary schools across the United States adjusted their start times to allow adolescents the opportunity to obtain closer to the recommended hours of sleep per night (Wahlstrom, 2014). This research supported a start time of 8:30 a.m. or later and coincided with policy statements from the American Academy of Pediatrics to maximize student health. A majority of secondary schools and districts across the country failed to adjust start times that aligned with this research.

An analysis of 2017 education data from the National Center for Educational Research showed approximately 50% of students who attended secondary schools in the United States had a school day that started before 8:00 a.m., while over 80% start before the recommended time of 8:30 a.m. The General Assembly of the Commonwealth of Pennsylvania commissioned a study on sleep deprivation of adolescents in 2018. This study was part of the data cited by a state commission for later school start times at secondary schools. Equally concerning as the national data is a report from this Joint State Government Commission in Pennsylvania that identified 78% of secondary schools in Pennsylvania with start times before 8:00 a.m. Secondary school start times do not align with the research available to provide adolescents with the optimal amount of sleep and the best opportunity to be healthy and academically successful. This study intended to collect data from school districts in the state of Pennsylvania who have adjusted their secondary school start time by at least 30 minutes later in the past four years. The researcher completed a comparative analysis of student academic achievement and attendance records from

before and after the time change to find any positive or negative statistically significant changes in the data that supported or contradicted the findings of prior research. The researcher also considered demographic information including race, ethnicity, socioeconomic status, and eligibility for special education services in the data analysis to review for a greater impact on any of these subgroups.

Research Questions

This study collected data and reported results for the following research questions:

1. How does changing secondary school start times impact student academic achievement?
2. How does changing secondary school start times impact student attendance?

Using information from the Joint State Government Commission report, the researcher identified eleven potential subject districts to participate in the study. Since 2016, each district had adjusted their secondary school start time to be at least 30 minutes later compared to the prior year. The intention of the researcher was to collect academic and attendance data from these districts for the year prior to and immediately following the decision to adjust the secondary school start time. The researcher used this information along with various demographical and educational information representing the subgroup identifiers, to complete the analysis and findings for the research study.

By attempting to provide additional data and analysis around the research questions, the researcher hopes to contribute to the discussion on adolescent sleep and its impact on student academic achievement and attendance. Furthermore, the researcher sought to identify and have a deeper understanding of potential relationships that may exist between school start times, academic achievement, and attendance in the identified subgroups of gender, race, ethnicity,

socioeconomic status, or eligibility for special education services to help promote future discussions on equity in educational environments.

Purpose and Significance of the Study

The purpose of this research study was to understand how the decision by school administrators to adjust secondary school start times impacts adolescent academic achievement and attendance. More specifically, to identify any benefits to adolescents in the areas of academic achievement and attendance in the districts across Pennsylvania that adjusted their secondary school start time by more than 30 minutes later in the past five years. The study also broke down the data from the participating districts by gender, race, ethnicity, socioeconomic status, and eligibility for special education services to look at any underlying trends on the impact of historically underperforming or disadvantaged groups of students.

This study built on the existing research showing the relationship between school start times and academic achievement (Balkis et al., 2016; Barnes et al., 2016; Bastian et al., 2018; Bryant & Gomez, 2015; Gais et al., 2006; Owens et al., 2010; Wahlstrom et al., 2002; Wahlstrom et al., 2014; Wheaton et al., 2016) as well as the connection with school attendance (Bastian et al., 2018; Marx et al., 2017; Owens et al., 2010; Wahlstrom et al., 2002; Wahlstrom et al., 2014). In addition to contributing to the existing research, the study highlights the underlying data representing students in the identified subgroups and hopes to promote a discussion on equity and the impact of changing school start times on these groups of students. Research that promotes a more equitable learning environment could be beneficial in the discussion for some communities to consider adjusting school start times that are more aligned with recommendations from the Centers for Disease Control, National Sleep Foundation, and the American Academy of Pediatrics.

Theoretical Framework

The impetus to conduct this research study started with a general interest of the researcher along with the willingness of a local district to explore the possibility of transitioning the district's secondary school start times to better align with the existing research on requirements for adolescent sleep. Combined with the study completed by the Joint State Government Commission for the General Assembly of the Commonwealth of Pennsylvania in 2019, the researcher sought to identify relationships between delaying secondary school start times and the impact on student academic achievement and attendance in various subgroups through the use of a quantitative research design.

Cognitive Load Theory (CLT) is the primary key theoretical framework for this study; the principal belief being the mind has a limited capacity to store information within short-term memory (Sweller, 1988). When the recommended sleep is not achieved by adolescents, the potential exists to impact an adolescent's environment and their ability to transfer knowledge from working (short-term) to long-term memory. The capacity limitation of short-term memory combined with the impact on knowledge transfer from working to long-term memory could have adverse effects on academic achievement over a period of time, because it can impact an adolescent's ability to be prepared to learn.

There are three different forms of cognitive load identified within CLT that can impact student learning (Sweller et al., 1998). Intrinsic cognitive load represents the expectation that is found within each learning process, individual activity or area of study (Chandler and Sweller, 1991). Alternatively, extraneous cognitive load is the concept used to identify and measure an individual's ability to learn, based on factors within the control of the instructor. Finally, germane cognitive load describes the work done by an instructor to design learning opportunities

that intentionally promote the development of long-term memory. While the ability of an instructor to control the level of intrinsic cognitive load that exists in every learning opportunity is minimal, they do have a significant amount of control over the level of extraneous and germane cognitive load within their instruction and design of the learning process (Sweller et al., 1998).

Given that it is impossible to replicate a learning opportunity with the exact same conditions twice, for the purposes of this study, weighted grade point average was used as the constant to measure learning across the data sets. Although the researcher did not identify and measure the various types or levels of cognitive load that existed within each learning opportunity, it was assumed for the purposes of this study, that the expectations of cognitive load remained, on average, similar given a comparable representation of instructors between the constant and the experimental year of each school districts' data. Therefore, the variable of secondary school start time and its connection to adolescent sleep becomes a potential factor that could impact learning, as measured by weighted grade point average, and attendance.

Limitations of the Study

The limitations of this study are as follows:

1. Only Pennsylvania public secondary schools identified by the report from the Joint State Government Commission were included.
2. The researcher was dependent on the willingness of districts that are contacted to participate in the study.

3. The study was dependent upon the academic achievement and attendance data received from each district being maintained for accuracy during the transition from the student information system to the researcher.
4. The study was dependent on the best efforts to use weighted Grade Point Average (GPA) as a consistent measurement for comparison of academic achievement on data from various secondary schools governed by different, independent local boards of education and their guidelines for evaluating academic courses identified as honors or general education classes.
5. The data collected for one participant was from academic school terms prior to the COVID-19 global pandemic, however the collection of data from a second school district did occur during school terms impacted by the historical event.
6. The data collected from one participant will be split between a term that was not impacted by the COVID-19 global pandemic and one term that was impacted by it. Every effort was made to use comparative data sets from these two terms that limited the variables that would have an effect on the data, except for the variables identified as part of the study.

Background and Role of Researcher

The researcher has worked in the field of education for 11 years, five years as an instructor in the classroom at a mid-sized urban/suburban district and six years in administrative roles at a suburban/rural mid-sized district, both in South-Central Pennsylvania. Both districts serve communities with student populations that have above state average rates for low socioeconomic status and student special education service needs. Prior to their time in education, the researcher spent eight years in various roles within the business and finance

industry. The researcher's professional background in education includes a B.S in Finance, a B.S. in Marketing, a K-12 Information Technology and Business Education certification, a Masters in Educational Leadership, and a Pennsylvania Superintendent's Letter of Eligibility.

Definition of Key Terms

The following terms are relevant to the study. They are defined to provide context along with consistent understanding and application throughout the study:

Academic Achievement – The measurement of academic achievement in this study uses weighted Grade Point Average (GPA) that is generally accepted in most high schools across the United States.

Adolescent – Adolescent means a student between the ages of 12 and 18, who would attend school in grades 7-12.

Attendance Percentage – The attendance percentage calculated in this study used the total number of days a student was considered present in school divided by the total number of possible days a student could attend school in a specific school year.

Control Year – The school year prior to the change of the school start time.

Ethnicity – The connection or belonging to a specific group with a similar cultural tradition or national heritage (National Center for Educational Statistics, 2002).

Experimental Year – The school year immediately after the change of the school start time.

Grade Point Average (GPA) – The formula used by educational institutions to report academic performance of students based on their grades.

Race – The physical, cultural, and behavioral attributes that connect an individual to a specific group of people (National Center for Educational Statistics, 2002).

Secondary School – An educational building or group of students in grades 7-12.

Socioeconomic Status – Social standing or classification of individuals measured in education by their eligibility and participation in either the free or reduced cost meals program. This program is offered by the National School Lunch Program and funded by the United States Department of Agriculture (USDA).

Special Education – Students who receive specially designed instruction, at no additional cost to the parents, to meet the unique learning needs of students with a disability. Students with disabilities can have an individualized education plan (IEP) to outline the student's disability and the specially designed instruction used to support the student in accessing a similar education to their peers.

Tardy – Arriving to school after the official start time of the school day. All schools track the number of days a student shows up late to school. Some count the number of accumulated minutes students miss due to their late arrival.

Weighted Grade Point Average - The weighted GPA scale takes into consideration the type of courses a student completes with 5.0 points being awarded for receiving the highest academic achievement in honors or Advanced Placement (AP) courses as recognized by The College Board.

504 Plan – Section 504 of the Rehabilitation Act of 1973 requires schools to provide supports for any student diagnosed with a disability that restricts their capability to access, participate, or learn in a classroom or school sponsored activity.

Summary

This study adds to the body of research that exists on changing the school start time for adolescents and how it may or may not impact their academic achievement and attendance. Using data from schools across the state of Pennsylvania that recently made this change, the researcher sought to understand if any change exists in a student's academic achievement and attendance compared to their school experience prior to the change in start time. Chapter Two of this dissertation provides a review of the literature on adolescent sleep relative to the different components of the research questions in this study.

CHAPTER 2

Review of the Literature

This literature review outlines the history across the United States education system for establishing secondary school start times, how start times influence adolescent sleep, and the research completed during the last 40 years that explains the impact of sleep or lack thereof on adolescent brain, physical, and emotional development. It also includes an explanation of the current challenges school districts face when making the decision to adjust secondary school start times. Finally, this literature review will define low socioeconomic status and provide an overview of poverty in the education setting as it relates to this study.

Theoretical Framework

In the late 1980's, researcher John Sweller published his work on the effects of learning for individuals during the problem-solving process. Based on the results, he drew a conclusion that explained the impact of problem-solving expertise on schema acquisition (Sweller, 1988). Sweller showed through his research that the effort required to understand what is being asked of a learner during the problem-solving process may not contribute to schema acquisition. Without the appropriate schema acquisition, Sweller concluded development of problem-solving expertise was negatively impacted. This research became the early building blocks for the theoretical development of Cognitive Load Theory (CLT).

Cognitive Load Theory is the intentional organization and presentation of information that provides learners with the best opportunity to achieve a high-level of performance and knowledge retention (Sweller et al., 1998). CLT is a framework outlining the capacity of an individual during the learning process by establishing a theory on the ability to store around

seven different elements in a learner's working memory, but only having the ability to apply two to four of those elements at any given time (Sweller et al., 2005). Additionally, Sweller et al. explains the limitations on working memory and its capacity are directly related to new information presented to the learner and not information accessed from long-term memory. Research has shown that information retrieved from long-term memory does not impede the functionality of the brain's working memory (Ericsson and Kintsch, 1995). The process of taking short-term working memory and storing those experiences, long-term memory formation, happens during sleep in both the slow wave and REM sleep stages, which are the latter two phases of the 75-90-minute sleep cycle (Buzsaki, 1998).

The theoretical framework for this study combines CLT with the research of what happens during the sleep cycle. The researcher sought to understand if there is an impact on academic achievement and attendance when secondary school start times disrupt the adolescent sleep cycle. The study considered adolescent sleep research, the process of long-term memory development during the later stages of the sleep cycle, and the impact it could have on student academic achievement and attendance.

School Day Start Time: A Historical Perspective

The structure for the comprehensive secondary school in the United States dates back to the implementation of vocational education as a separate opportunity from the traditional high school curriculum with the passage of the Smith-Hughes Act of 1917. In conjunction with this legislation, the Bureau of Education and Department of the Interior commissioned a study on the reorganization of secondary education in the mid-1910's, which resulted in the Cardinal Principles of Secondary Education in 1918. The principles recommended by the commission established the framework for an educational system that greatly resembles the one that

continues to exist today. Their recommendations included separating elementary and secondary students, developing compulsory school requirements for all youth, establishing the comprehensive secondary high school, creating and adhering to a standardized curriculum, and structuring the articulation of students from one education level to the next.

School start times during this time period through the late 1950's varied across the United States with some starting around 7:30-8:00 a.m., to meet the childcare needs of a predominantly factory-worker community, while other agrarian-based school communities started between 8:30 and 9:00 a.m. Research by Dr. Diana Zuckerman from the National Center for Health Research found that by the early 1960's, most schools across the United States started school between 8:30 and 9:00 a.m. (Zuckerman, n.d.). However, the trend to start school earlier began in the late 1960's and continues through today. O'Malley and O'Malley (2008) cite research that identifies factors including overall population growth, geographic population expansion, the need for staggering times of class and building schedules, and social or economic pressures as reasons for the move to earlier start times, especially for older students. Additionally, national energy costs and energy supply pressures during the 1970's pushed educational systems to again review their practice of running a larger number of buses at the same time, and instead consider a tiered transportation system with multiple bus runs that would require less overall energy consumption.

The present-day average secondary school start time for public schools across the United States is 8:02 a.m. with over 40% indicating a start time before 7:59 a.m. (National Center for Education Statistics, 2017). A more in-depth analysis of the data from the National Center for Education Statistics shows that 11.9 million (46.1%) of the 25.8 million students across the United States attend a secondary school that has a start time before 8:00 a.m. Among 500 school districts in the Commonwealth of Pennsylvania, 307 of the districts start their secondary

school(s) between 7:30 and 7:59 a.m., with an additional 77 starting before 7:29 a.m. The final 116 have a secondary school start time after 8:00 a.m. In total, over 78% of the school districts in Pennsylvania have a secondary school start time before 8:00 a.m. (Joint State Government Commission, 2019). Considering morning routines and transportation time for these students to get to school, a daily wake-up time before 7:00 a.m. is not an unreasonable assumption. This is the equivalent to asking an adult to wake up around 4:00 a.m. every day and be at their best to perform daily expectations for their job. (Kelley & Lee, 2015).

Adolescent Sleep

Sleep is an essential function of life. Like eating or breathing, the human body requires sleep to maintain good physical and mental health (Ohayon et al., 2017). There are several factors that can interfere with good sleep habits in adolescents. Unawareness or poor decision making around the quantity and quality of sleep needed; over scheduling their lives with social, extra-curricular, academic, or employment activities; or access to technology are just some examples of factors that can impact the amount of sleep an adolescent gets on any given night (Wheaton et al., 2016). While adolescents and their parents/guardians have a level of control over the factors previously named, there are other, naturally developing, biological changes that occur during the adolescent stage of life, which impact the optimal timing for an individual to fall asleep and wake up.

The amount of sleep a child needs during their middle-childhood years (8-12 years old) and the adolescent stage of their life (12-18 years old) is not different (Owens, Belon, and Moss, 2010). The recommended amount of sleep time for children during both these stages of life is about eight and a half to nine and a half hours per night. Based on research by Keyes et al. (2014), between 1991 and 2012 the percentage of adolescents who self-reported averaging at

least seven hours or more of sleep per night gradually decreased from approximately 64% of adolescents at age 12 to about 34% of adolescents at age 18. In the same study over the same period of time, the researchers also found the number of adolescents who self-reported getting regular, adequate sleep went from 42% of children age 12 down to 22% of teenagers age 18. This data was consistent across all subgroups and cultural backgrounds with the only exception being a slightly lower percentage of females regularly reported getting seven hours or more of sleep per night.

The human body, like most other life on this planet, exists with a naturally occurring 24-hour cycle or rhythm. This circadian rhythm follows a similar pattern to the light-dark cycle of Earth through photoreceptors found in the eyes (Foster, 2007). The suprachiasmatic nuclei in the brain take the lead in regulating the cycles of the circadian rhythm, and along with other regions of the brain and hormones, control the human body stages of sleep (Kelley et al., 2015). Another component of the sleep cycle is the 'wake maintenance zone'. This time period, that happens naturally in the early to mid-evening of a day in children up to age 12, is when the body's natural Melatonin hormone secretion starts to increase at a rate that gradually initiates the start of a sleep cycle. In adolescents, the hormone secretion cycle of the circadian rhythm delays release until later in the evening, creating a later wake maintenance zone, and coinciding with a sleep cycle that starts closer to 11:00 p.m. (Kelley et al., 2015). The biological delay in falling asleep and a before 8:00 a.m. school start time combine to form one set of factors that limit the average amount of sleep most adolescents can get nightly (Foster, 2007; Kelley et al., 2015).

Because of regular, early morning commitments that include the start of the school day during the week, most adolescents attempt to use weekends as a time to make up for missed sleep (Keyes et al., 2015). Unfortunately, this pattern can cause more damage than benefits to

adolescents and their circadian sleep cycle. Wake and sleep times that are consistent across the seven-day week, support better sleep patterns. Research results of adolescents showed that postponement of sleep on the first two nights of a weekend resulted in a delayed melatonin release of up to 90 minutes on the next night (Bryant & Gomez, 2015). The attempt by adolescents to recover lost sleep time by extending the amount of time they sleep on the weekend, also contributed to lower levels of alertness during the daytime (Owens et al., 2010).

Understanding the human bodies' developmental changes in sleep patterns as a person enters the adolescent stage of their life is an important factor in meeting their needs. Within the research outlined in this literature review, a lack of consistent, adequate sleep during the adolescent stage of development could have a direct impact on the well-being of their physical and mental health.

Adolescent Sleep and Physical Health

The amount of sleep an individual gets has a direct impact on their physical health. Adolescents, who require a greater number of sleep hours per day compared to an adult, can see a lack of sleep have an exponential impact on their physical health (Carpenter, 2001). Carpenter (2001) also reports that regular occurrences of less than seven hours of sleep can result in negative outcomes for adolescents' physical appearance, functional alertness, and driving awareness. All of these can have both short and long-term implications for the health and well-being of adolescents and those around them.

A required daily routine that includes starting school before 8:00 a.m. makes it difficult for adolescents to get the suggested eight and a half to nine and a half hours of sleep per night, as currently recommended by the National Sleep Foundation and American Academy of Pediatrics (2019). This consistent and chronic lack of sleep can result in additional challenges to an

adolescent's physical health and appearance. These challenges include hypertension, diabetes, metabolic disorders, impaired immune responses, and obesity (Luyster et al., 2012). Moller-Levet et al. (2013) found similar results in their research when they studied the negative effects on the human body after a week of averaging just over five and a half hours of sleep per night. They identified 711 different genes that have an influence on the body's circadian profile and observed a significant negative impact. Marx et al. (2017) included study results from Brandalize (2011) in their research synthesis that shows a growth over time of almost two percentage points in body fat of a student group with an earlier school start time versus a later start time. Additionally, in November of 2016, the Journal of Clinical Sleep Medicine provided a consensus statement and recommendations that included a sleep time of 9-12 hours for teenagers age 13-18. They reported this would lead to improved quality of life and physical health.

Along with physical health, getting or not getting an appropriate amount of sleep can have an impact on the functional alertness of adolescents. When experiencing an average of six and a half hours of sleep per night compared to the recommended amount, adolescents report feeling less efficient, less alert, and more forgetful (Baum et al., 2014). In addition to these symptoms, teenagers also identify themselves as sleepier and having lower levels of concentration compared to when they get more than eight and a half hours of sleep (Carpenter, 2001). Sleep study research with adults as well as adolescents show an overwhelming reduction or impairment in numerous functional human behaviors including productivity, memory, decision-making, concentration, performance, and communication (Baum et al., 2014; Carpenter, 2001; Kelley & Lee, 2015; Kelley et al., 2015). While these should be concerning results for anyone, they are particularly alarming for career and technology education students, who could be learning and working with dangerous tools and equipment. Along with impaired functional

alertness, an adolescent should be aware that sleep deprivation elevates the willingness of individuals to engage in questionable behavior like taking drugs and consuming alcohol (Kelley & Lee, 2015).

The functional alertness of adolescents has a direct connection to their ability to operate motor vehicles. The combination of a newly licensed drivers lack of experience with a chronic lack of sleep has the potential for devastating results. Young drivers are responsible for over half of the 100,000 accidents each year that result from fatigue (Carpenter, 2001). Also, peak accident rates for adolescent drivers occur in the morning hours (Czeisler, 2009). However, research collected by Wahlstrom et al. (2014), showed mixed results on this topic. When participating schools adjusted their secondary start time to 8:30 AM, some of the participating districts reported a decrease of 65-70% in accidents for students age 16-18, but other districts participating in the study reported a decrease of 6% and an increase of 9%, so these results showed no clear research-based conclusion. Wheaton et al. (2016) conducted similar studies to Wahlstrom, using schools in Kentucky and Virginia. Their research showed a decrease in accident rates across counties that had later school start times; however, Wheaton et al. (2016) did not have a statistically significant difference between rates in these counties and ones that did not change school start times, when considering crash rates among all 16-18-year-old drivers.

The literature reviewed reveals the impact a lack of sleep can have on adolescents and their long-term physical health. Aligning secondary school start times with current recommendations for adolescent sleep might help to address the research on adolescent physical health concerns outlined in this section.

Adolescent Sleep and Mental Health

The quality and quantity of sleep every individual gets not only impacts his or her physical health, but plays a vital role in their mental health as well. While eight and a half hours is the minimum recommended amount of sleep per night for teenagers, restricting that amount to approximately six and a half hours or less of sleep per night can have an impact on mental health. Research shows that repetitive or frequent nights with six and a half hours or less of sleep can cause increased occurrences of mental health challenges in teenagers that include irritability, anxiety, and depression, while also impacting their decision making and ability to control anger (Kelley et al, 2015). This same research also states these types of sleep patterns can contribute to more severe mood fluctuations and higher levels of frustration compared to a teenager who regularly gets closer to eight and a half hours of sleep per night.

Challenges with mental health are not uncommon for teenagers and their parents. The frequency and severity of these types of challenges in a teenager's life have a direct relationship to the average amount of sleep a teenager gets nightly (Owens et al., 2010). The evidence of this chronic sleep loss can manifest itself in both external and internal symptoms. The external signs of a potential psychiatric illness can include frequent or uncharacteristic and sudden aggressive behavior, repetitive conflicts with teachers or peers, and increased irritability (Marx et al., 2017). Irritability from a chronic lack of sleep can be mistaken for opposition disorders, which can lead to misdiagnosis and the unnecessary use of prescription medications on teenagers (Baum et al., 2014). In a study completed by Owens et al. (2010) of almost 300 students who experienced a change in school start time, 84% of the students reported incidents connected to irritability or annoyance prior to a change in school start time, while only 63% reported these types of incidents after the change in school start time. Although external symptoms of irritability and

frustration are concerning, these signs can be indicators of more severe internal factors impacting the mental health of teenagers.

Internal factors that impact a teenager's mental health can have as much or more devastating effects than the external ones. Research synthesized by Marx et al. (2017) showed internal symptoms from getting less than the recommended amount of sleep to include dysfunction of the pre-frontal cortex, which already has delayed development in teenagers. This area of the brain supports creative thinking and behavioral responses, so the delayed development can lead to violent outbursts and over-reaction to situations compared to their peers. This same research also found that teenagers experiencing regular sleep patterns of less than eight and a half hours per night exhibited higher rates of poor self-esteem, anxiety, and depression compared to their peers who did attain an amount of sleep closer to that currently recommended by the American Academy of Pediatrics. The situations of students who were sleep deprived also included a higher frequency of feeling like they were in a bad mood and unable to control their emotions, which can increase the risk of aggravating any pre-existing mental health conditions (Baum et al., 2014).

A regular reduction in the hours of sleep received compared to the recommended amount for teenagers can have an impact on the mental health of teenagers and manifest itself through both external and internal symptoms. These symptoms can impact the quality of life for teenagers and those around them. Research completed by Owens et al. (2010) showed a statistically significant increase in personal depression scores among 11^{th} and 12^{th} graders as well as in girls versus boys for students who average less than eight and a half hours of sleep per night. However, students who received at least eight and a half hours of sleep per night, showed no statistically significant difference in their personal depression scores across various grade

levels or between genders. This research adds to the growing body of evidence showing the impact on a teenager's mental health when they regularly receive an amount of sleep below the recommended amount.

As outlined in the research presented over the previous couple sections of this literature review, the lack of regular sleep can have an impact on the physical and emotional well-being of an adolescent. There are also potential impacts to other aspects of their life including attendance and academic achievement in school.

Adolescent Sleep and Learning

Unlike the clear scientific evidence demonstrating the impact of irregular or insufficient adolescent sleep on their physical and emotional health, the research is not as consistent when it comes to the connections between nightly amounts of sleep and a student's academic outcomes or attendance. The multiple variables that impact student attendance and academic achievement results could explain the division in these research results. Student attitudes toward teachers and school, self-confidence in academic abilities, goal setting, parent educational levels, and family income can all impact absenteeism (Balkis, Arsian, & Duru, 2016). Some of the factors impacting educational outcomes include socioeconomic status, school systems, student/teacher relationships, and prior academic achievement or content exposure (Sanders, Wright, & Horn, 1997). These factors, combined with the variety of ways to measure academic outcomes like grade point average (GPA), state standardized tests, Scholastic Assessment Test (SAT)/American College Testing (ACT) cumulative and content specific results, or other national and international exams, all contribute to inconsistent research results when measuring academic outcomes and their relationship to adolescent sleep.

There are multiple variables that can influence and impact the academic performance of students, how those results are tracked, and the data that is used when completing an analysis for research studies. In a research report completed by Wahlstrom et al. (2014), called *Examining the Impact of Later High School Start Times on the Health and Academic Performance of High School Students: A Multi-Site Study*, the team highlighted the following facts when studying academic performance of students:

> It is known that people who consider themselves as "morning people" show their best performance earlier in the day, with performance decreasing as the day continues. On the other hand, evening types tend to show greater performance throughout the day (Anderson et al., 1991). One possible explanation for the lack of academic effects found in some studies is that most adolescents tend to shift towards being evening types (Randler & French, 2009) and tend to show optimal performance on tasks later in the day (Hansen et al., 2005; Kirby, Maggi, & D'Angiulli, 2011). Therefore, studies which look at differences in academic tests such as the ACT which are typically given in the morning (e.g., Hinrichs, 2011) may not be controlling for the confounding factor of the time of day that the assessment is given. (p. 7)

Reviewing research connecting student academic performance and sleep through this lens helps explain the mixed results. While Wahlstrom (2002) found no significant relationship between the average amount of sleep a student received per night and their GPA, research completed by Gais, Lucas, and Born (2016) showed a detrimental relationship between sleep deprivation and its effects on memory. The effect on memory is even more significant if it follows a night where the student is attempting to make-up for a lack of sleep (Gais et al., 2016). Along with memory, later bed times or irregular sleep can have a negative impact on school achievement (Wolfson & Carskadon, 1998). The researchers also found that students who had academic performances consistent with C's, D's, and F's averaged 25 minutes less sleep per night compared to their peers who are averaging A's and B's.

Adolescent Sleep and Attendance

In addition to academic performance, the amount of sleep a student gets has a mixed impact on their attendance record. Research in the Minneapolis Public School District by Wahlstrom in 2002 showed a decrease in the number of students who were tardy to first period when the district adjusted their secondary school start time from 7:15 a.m. to 8:40 a.m. However, more recent research by Wahlstrom (2014) and Hinrichs (2011) revealed a mix of statistically significant and statistically insignificant findings in a more comprehensive review of the correlation between school start time and student attendance rates. One significant piece of data demonstrated a positive impact on student attendance. Schools with a start time after 8:30 a.m. resulted in students being less likely to get suspended, which directly impacts attendance rates (Bastian & Fuller, 2018).

Attendance and academic achievement are important parts of the adolescent experience in school. There is a body of evidence that makes a reasonable argument that these different factors could have a relationship. Being in class is an important part of the learning process and learning can have an impact on a student's near-term and long-term goals in life.

Low Socioeconomic Status and Ethnicity in Education

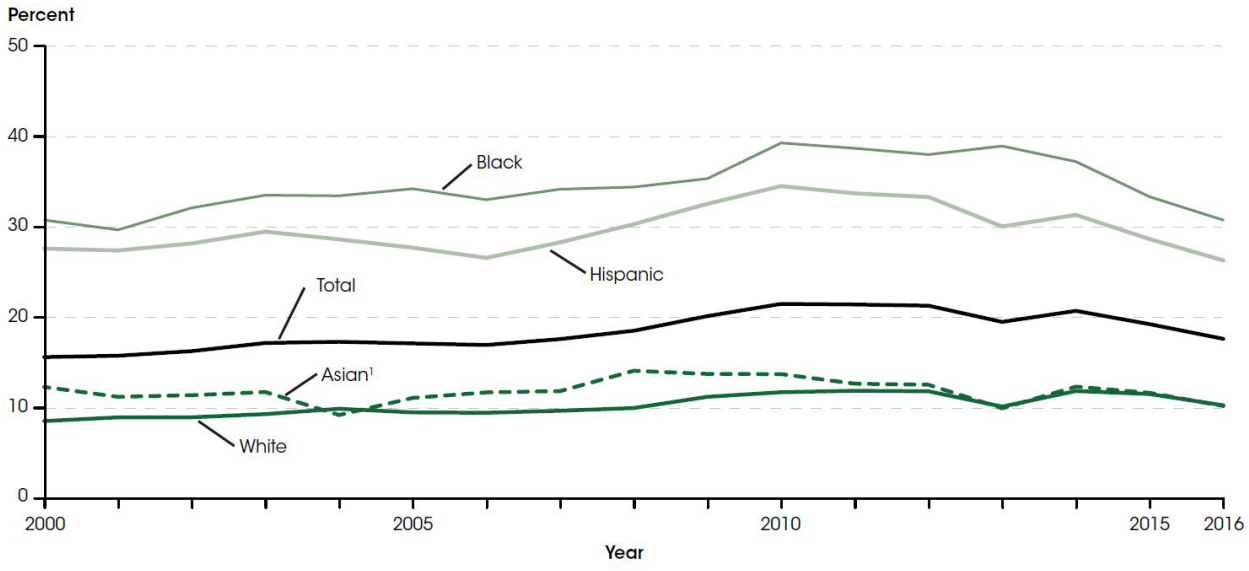
The United States Census Bureau defines poverty based on the amount of qualifying income a family receives in relation to the number of family members in the household and compares it with pre-determined income thresholds. Although adjusted for inflation every year, the income thresholds for poverty data identification do not take into consideration geographical location. This lack of adjustment could cause some to challenge the accuracy of the poverty data given the differences in cost of living between place in the Mid-West compared to the East or West coastline or urban versus rural locales, while others could argue that the differences are accounted for in the earned median wage discrepancy between the various locations. The U.S.

Census Bureau considers all income as part of the calculation with the exception of capital gains/losses, food stamps, housing subsidies, and tax credits. If the total household income divided by the Census Bureau's family size income poverty threshold amount is less than one, then every member of the family is determined to be living in poverty for government statistical calculation purposes.

Economic factors at home can have an impact on a child's learning potential. Research connections show early-childhood exposure to poverty conditions at home have an adverse impact on learning and academic performance in a student's early learning years (Mulligan, Hastedt, and McCarroll, 2012). Currently, 26% of students with a Hispanic heritage and 31% of black students come from families that are living in poverty (de Brey et al., 2019). The trend of these percentages over the past 20 years can be seen in Figure 1 retrieved from The United States Department of Education's Status and Trends in the Education of Racial and Ethnic Groups 2018 report.

Figure 1.

Racial/ethnicity percentages of children living in poverty from 2000-2016. Retrieved from https://nces.ed.gov/pubsearch/.



Attempts by the federal government to account for these financial challenges and give every student a chance to receive a quality education include programs like Title I. This program, which was originally authorized with the passage of the Elementary and Secondary Education Act (1965), and later renewed and amended by the Every Student Succeeds Act (2015), provides multiple tiers of federal grants to state and local education agencies with a high percentage or high number of students that come from low-income families (U.S. Department of Education, 2018). In 2016, about 25% or roughly $14 billion dollars of the federal education revenue distributed to states and local education agencies had a Title I allocation. Even with this assistance and other support programs, the average low-poverty district (bottom 25% of low-income families) across the United States had 3.5% more revenue per pupil than the highest poverty districts (Corman et al, 2019).

A low socioeconomic status does not only impact student education outcomes. Research shows that families identified as poor by government statistical standards have parents with additional barriers to involvement at their child's school. These could include having parents who are unable to get off work to participate in events at school (59%), having two full-time working parents (68%), or having a single parent household employed full time (73%) (Redford, Huo, and McQuiggan, 2019). Parents in this study also identified inconvenient meeting times, lack of child care, problems with transportation, and lack of knowledge or communication about events at school as other reasons for not participating in school-based activities. In another study, families with a poverty status of poor only volunteered or served on a school committee 27% of the time (McQuiggan and Megra, 2017). Breaking down the same parent sample data from this study, the demographic group of families with parents/guardians that had less than or only a high school degree or equivalent volunteered for school committees 25-27% of the time.

Challenges of Changing School Day Start Time

The idea of a later secondary school start time is a complex adjustment to scheduling that involves a broad range of stakeholders to review and support the change for adolescent students. If it were as simple as reading, understanding, and putting into practice the results of adolescent sleep study research, many more school districts would have already considered and adhered to the available research information. The challenge lies with the modification of current practice and societal structures that exist to support an education and economic system as it currently functions. Some of these potential adjustments exist in the homes of students outside of the school setting, while others are directly impacted by and in the control of the school district. These challenges could cause any district considering a change in school start time to work directly with their immediate community, as well as the surrounding schools and districts, to implement a plan that allows for a later secondary school start time.

School districts must consider challenges that occur in the home and are not in the immediate control of the school district. Challenges must be identified and factored into the decision-making process when considering a change in secondary school start times. These can include established start and end times of parental employment, student opportunities for employment during after-school hours, and dismissal times of secondary students so they can be used for household childcare of younger school-age students (Joint State Government Commission, 2019). These are all reasons to involve a district's community in the decision-making process. According to data from the United States Bureau of Labor Statistics, as of July 2019 over 56% of youth ages 16 to 24 maintained some form of employment. The percentage of students who work and the number of hours they work per week increases as students progress through high school (Keister & Hall, 2010). Providing a reasonable amount of notice to the

community about the expected time changes would give adequate time for families to adjust their current schedules and make changes to accommodate the new start times.

The changes outside of the school district's control are not numerous, but they could have a lasting impact to the family structure of households in the community. However, the changes that are directly controlled by the school district present significant hurdles to accomplishing the goal of adjusting secondary school start times. School districts must consider the impact to meeting annual required instructional hours for students, the timing of after-school activities and extra-curricular programs, district bus transportation schedules and budgets, start times for elementary students, and the impact on contractual negotiations of employment start and end times with staff (Barnes et al., 2016; Joint State Governance Commission, 2019). For example, the Pennsylvania Department of Education School Code Basic Education Circular (2001) outlines the requirements of instructional hours for students to be "at least 450 for half-time pre-K and kindergarten, 900 for full-time pre-K and kindergarten and elementary, and 990 for secondary." If a district must move their secondary start time by 45 minutes from 7:30 a.m. to 8:15 a.m. to better align with adolescent sleep research, a corresponding change may be needed at the end of the day to account for the instructional hours requirement. This time shift could have an impact on district transportation schedules or start times of after school activities for students including extra-curricular sports or clubs, employment, childcare of younger siblings, and other demands of student time at the end of the school day.

Some of these challenges are assuming a significant change to elementary student or district staff times is necessary and that an adjustment to transportation and/or student and staff schedules will not yield similar results. Both the Pennsylvania Joint State Government

Commission (2019) and the National Sleep Foundation's Barriers and Solutions research address these concerns and propose some solutions that may prove effective in some communities.

Summary

The research and understanding of the impact sleep has on our daily lives and the importance to people of all ages, but especially adolescents, is growing every year. It is the responsibility of each school district to make sure it is providing an optimal learning environment and creating conditions that give every student a chance to succeed. The research on school start times shows some districts are unaware of or are ignoring the growing research on the impacts of adolescent sleep time and not considering the opportunity to improve conditions for student success.

A review of the literature reveals a significant amount of information promoting a secondary school start time of 8:30 a.m. or later (Joint State Government Commission, 2019; National Center for Educational Statistics, 2007; O'Malley and O'Malley, 2008). This specific time may not be attainable by some districts for a variety of reasons, but can be used as a starting point in discussions to adjust secondary school start times. Additionally, the process districts use to support administrators and involve their community in school or district-wide decisions should be inclusive of the diversity represented in each district with a continuous focus on factors that impact ongoing success of these relationships including direct partnership assistance, family and community involvement, and helpful district to school leader relationships (Epstein et al., 2011). Creating and following a process that gives all impacted community members the opportunity to participate in the conversation can be part of the plan's development. The research that currently exists on changing school start times shows little consideration for or study to understand the

impact of this type of change on students based on various subgroup identities including gender, ethnicity, race, socioeconomic status, or receipt of special education services.

Chapter Three (Method) provides the research design and procedures followed to collect and analyze the data. It identifies the parameters used to identify potential participants, the process followed to contact and engage with potential participants, and the procedures executed to collect and analyze the data.

CHAPTER 3

Method

The purpose of this study is to determine if the available data shows a statistically significant relationship between later secondary school start times, student academic achievement and attendance. The study focused on students in grades 7-12 at school districts across the Commonwealth of Pennsylvania that self-identified as having adjusted later their secondary student start times by at least 30 minutes in the past 4 years. The researcher served as an independent, objective observer and the data collected was used to determine if a statistically significant relationship existed between secondary school start times and the factors of weighted grade point average, attendance rate, and tardy percentage that were identified in different gender, race, ethnicity, socioeconomic status, and eligibility for special education subgroups. A quantitative research design was employed by applying descriptive and inferential statistics to the data sets to determine statistical significance.

Research Questions

This study gathered data relative to the following research questions:

1. How does changing secondary school start times impact student academic achievement?
2. How does changing secondary school start times impact student attendance?

By collecting and reviewing data around these two questions, the researcher is providing additional research on the topic of adolescent sleep and its impact on students' academic achievement and attendance. The researcher specifically focused on school districts in Pennsylvania as a follow up to the release of the Joint State Government Commission report in October of 2019 titled "Sleep Deprivation in Adolescents: The Case for Delaying Secondary

School Start Times." Additionally, the researcher used the subgroup demographics of gender, race, ethnicity, socioeconomic status, and special education services to identify the impact on any of these groups of students.

Research Design

A quantitative approach was applied due to the availability of pretest and posttest research data and the attempt to measure the impact of an independent variable, secondary school start times, on a variety of dependent variables including gender, grade, race, ethnicity, socioeconomic status, and special education eligibility (Creswell, 2014). This study sought to collect data from school districts in Pennsylvania that met the research study parameters in an effort to determine if secondary schools that move their start time to at least 30 minutes later create a statistically significant change in student weighted grade point average, number of days absent, or number of student tardy instances.

The researcher took a postpositivism theoretical approach to the framework for this study. In the postpositivist worldview, the various effects on the participant group have a correlated cause that need researched and understood for a better comprehension of the laws and theories that impact behaviors in the world (Creswell, 2014).The postpositivism approach has a quantitative research design and seeks to evaluate or review the existing variables in the available research and identify the correlated variables that produce the most advantageous outcome for the participant group (Butin, 2010). A postpositivist worldview assumes that in this study a quantitative research approach could measure secondary school start times and the impact on student weighted grade point average and attendance factors.

Data Collection

The process of data collection for this research started with a review of the Pennsylvania Joint State Government Commission report (2019). The report contained a section on the current status of secondary school start times in Pennsylvania. The researcher identified eleven school districts from this section of the report in the state that had adjusted later their secondary school start times by at least 30 minutes in the past four years. Using the internet to identify names and contact information for the current Superintendent of each school district, an email was sent to invite participation in the study (Appendix A). After confirming participation in the study, a follow-up email was sent to the Superintendent with an Informed Consent Form (Appendix B). If no response was received from the initial inquiry within two weeks, a follow-up email was sent and a phone call made to confirm interest in the study.

After receiving a response and signed Informed Consent Form from each potential district Superintendent, an email was sent to the district contact for student information management confirming participation in the study and outlining the requested information as well as the process, format, and timeline to submit the student data. Student data from the control year and experimental year were collected on two separate spreadsheets. The researcher provided a spreadsheet template with columns for each of the following data points from both the control year and the experimental year (see Appendix C and D).

1. Grade Level
2. Gender
3. Race
4. Ethnicity
5. Socioeconomic Status
6. Special Education Y/N

7. If Special Education (#6) is Yes, IEP or 504
8. # of student days in Marking Period 1
9. # of student absences in Marking Period 1
10. # of student tardies in Marking Period 1
11. # of student days in school year
12. # of student absences in school year
13. # of student tardies in school year
14. Weighted grade point average in Marking Period 1
15. Weighted grade point average in school year

The data submitted on the template included a single line for each student in grades 7-11 of the control year, the year prior to the start time change, with an enrollment record at the school during marking period 1 of both school years contained in the study and a weighted grade point average calculation. The data collected from the experimental year, the year after the time change start, included all students in grades 8-12 who had a complete data set in the control year.

The template submission did not include any personal student information (name, address, phone number, school identification number, or state identification number) that would allow the researcher to identify a specific student and connect them to information inside the data set. The demographical information that was requested for the student data set matched the data submitted to the Pennsylvania Information Management System (PIMS) for the October 1 student enrollment snapshot. All districts must submit this data collection to the Pennsylvania Department of Education annually and this provided a common and existing reference point that each district could use to submit data for the study.

Data Analysis

After collecting the data from each participating school district, the researcher first reviewed all data to ensure no identifying information was included within the submission from each district. Additionally, the researcher checked the data to ensure all submissions met the research criteria and included the required information. Any data records that did not have a complete record of requested data from marking period one of each school year were attempted to be resolved through further contact with the district. If the data inaccuracy couldn't be resolved, it was removed from the data sample before the data analysis process began.

Once the non-qualifying data was purged from the data set submitted by each school district, the researcher began the process by calculating the mean and standard deviation of the control and experimental year for weighted GPA, numbers of days absent, attendance rate and number of tardy instances for the overall student sample from each school as well as each grade level, gender, race, ethnicity, socio-economic status, and special education population. The mean shows the average value for each data set and is one of the best ways to represent a large group of values (Salkind, 2014). Along with the mean, the standard deviation shows the average variation of the data from the mean for both the control and experimental years. This outcome, along with additional calculations, helps contribute to the evidence and discussion of any statistically significant results.

The researcher then conducted t-tests of dependent samples to identify the significance of the change between the control and experimental school years for weighted GPA, number of days absent, and attendance rate, for all students and each identified sub-group. These tests were conducted on data where the change in mean and/or standard deviation between the control and experimental years represented a benefit for the student. The purpose of using this test was to determine whether the change in means for each of the calculations was statistically significant

based on the data from the control and experimental year, or due to other factors including variance of the student population or a sampling error based on the student data set (Salkind, 2014). The researcher completed all statistical analysis based on the knowledge that each school or district did not make any changes to their grade scale between the control year and the experimental year of the data set.

Ethical Considerations

Ensuring a research process meets and maintains all the established regulations to uphold the privacy of data for all participants is the responsibility of the Institutional Review Board (IRB) at each institution in conjunction with the researcher for each proposal (Butin, 2010). Because of this expectation every university has a standard set of guidelines and expectations for ethical behavior when completing research that involves or has data about human subjects. This group and the process for approval of a research opportunity is essential to protect the health and well-being of all parties involved. It was important to work in collaboration with the IRB at Shippensburg University and my dissertation chairperson to identify and mitigate any potential ethical issues within my research and data reporting process.

Given the information that is available in the research report, a motivated individual could potentially identify the group of school districts contacted by the researcher for data in this study. Further data provided by the researcher could also lead an individual to identify a specific school or district that a certain data set may belong to in the study. Because of this situation, the researcher used pseudonyms for all participating school districts and did not include additional demographical information about the district in the research report, beyond the reportable data, to avoid confirmation of the participation by a school district. The researcher also took significant efforts to report data by groups of students and have any individual identifying

information removed before the data was transferred and made available to the researcher for statistical analysis.

In an effort to limit individual student data from being identifiable and related to the specific student, all participating districts were asked to submit their data absent of student names, addresses, phone numbers, social security numbers, and local or state identification numbers. Once the district completed the data template, they were given instructions to place the file inside their own cloud-based password protected storage drive and provide the researcher with a viewable link to the file. The researcher accessed the file via this link and downloaded a copy to two separate password protected external storage drives. Once downloaded, the file went through an additional review process to remove any student identification information. One external drive was used as the researcher's primary storage tool and the other was maintained as a backup. The researcher stored both drives in a locked cabinet inside an office with a locked door.

Summary

The researcher used a statistical significance research design to collect and review existing data from school districts in the Commonwealth of Pennsylvania who adjusted their secondary school start times later by at least 30 minutes. The intention of the quantitative study was to determine any potential significant differences between the change in start time and academic achievement, attendance frequency, or occurrence of tardies. The researcher also used specific subgroup identification methods including gender, grade-level, race, ethnicity, socioeconomic status, and special education identification to determine if any of these groups were impacted by the change in secondary school start times.

The researcher collected data from each district and stored it in a secure environment. The collected data was then run through a series of statistical analyses including calculation of mean, calculation of standard deviation, and the t-test for dependent samples; with the results maintained separately by district for pre-and post- secondary school start time change comparisons. After completing the individual district comparisons, the researcher reviewed the data across districts to identify any potential trends that existed. The results showed how the change in secondary school start times impacted or did not impact the various dependent variables identified in the study and whether any subgroups of students were impacted by the changes made in each district or potentially overall.

Chapter Four presents the breakdown of academic achievement and attendance data from each district for both years of the study, and report on the quantitative analysis results. Chapter Four of the research report is divided into three separate sections. The initial section contains demographical information about each participant district, details about the data requested as part of the study, an explanation of the problem of practice, the research questions, and a summary of the research procedures. The second section contains the results of the data analysis, separated by district, and include the various subgroup results. The final section merges data from the various participating districts into a single, visual representation and presents the analysis of the data for each of the research questions.

CHAPTER 4

Findings

This study analyzed the impact of changing secondary school start times on student academic achievement, as measured by weighted GPA and student attendance. The data represents a contribution to the research on later school start times and the effect on students, while providing a more detailed analysis and breakdown of the collected data by including the various sub-group information. As the attention on social-emotional well-being has increased in recent years, research on factors that impact this part of students' development and how they relate to school and district decisions has been under a microscope. Education leaders must consider a wide range of variables with every choice they make. The findings from this study could help to inform school leaders and communities around the decision on secondary school start times and provide data towards a more equitable educational experience for all students.

This chapter contains the findings from the data collection of two different school districts in Pennsylvania who adjusted their secondary school start times by at least 30 minutes to answer the research questions:

1. How does changing secondary school start times impact student academic achievement?
2. How does changing secondary school start times impact student attendance?

In addition to an overview of the demographics for each of the participating school districts, this chapter contains full year weighted GPA and attendance data for school district #1 during the control and experimental years. Additionally, it has marking period 1 and full year weighted GPA and attendance data for school district #2. Finally, the full year data from both school districts was combined to provide an analysis of the cumulative data.

All data contained within the results was compared according to the subgroups identified in the study, using the mean and standard deviation between the control year and the experimental year in each school district and in the overall cumulative data analysis. An additional test for statistical significance was performed on each instance in the data, where the specific subgroup data had two or more data points showing a beneficial outcome for the student group. Statistical significance was based on the directional dependent samples *t*-tests with the error probability set at .05 and at 95% confidence intervals. All data calculations were completed in Microsoft Excel using the data spreadsheets provided by each school district and the pivot tables or formulas built into the program.

Participants

The participants in this study were school districts with secondary schools that adjusted their school start time by at least 30 minutes later as identified in the Pennsylvania Joint State Government Commission report (2019). These districts agreed to submit the requested data for students in grades 7 through 11 during the school year prior to the change in school start time. The information requested included academic achievement and attendance data for the 1st marking period and full school year before as well as immediately after the change in school start time. Only students who had enrollment records in both school years were part of the data collection. Demographic and descriptive statistics of student populations in each of the district profiles were drawn from the submitted data. All data was requested and received absent any individual student identifying information. The requested data matches the demographical information provided to the Pennsylvania Department of Education during the October 1 Student Enrollment Reporting Snapshot of the corresponding school years. This ensured that all districts who participated in the research submitted statistical data for student enrollment, demographics,

socioeconomic status, and special education from a similar reference point in their respective school years.

School District #1

School District #1 is a suburban-rural school district in Pennsylvania with over 6,000 students, who adjusted their secondary school start time within the last five years. Both the middle and high school buildings in School District #1 changed their start time from 8:10 to 8:40. Their data submission as a participant in this study consisted of year-end data for both the control and experimental years. Because School District #1 does not normally calculate weighted GPA for a single marking period and the time involved to validate the accuracy of a weighted GPA calculation for a specific marking period, School District #1 chose not to submit data for a single marking period as part of the study. Table 1 shows the demographical information of each subgroup represented in the study for School District #1 during the experimental year.

Table 1

Demographics and Descriptive Statistics for School District #1 - Experimental Year

Grade	Gender		Socioeconomic Status		Special Ed Eligible	
	Male	Female	Free/Reduced	Pay	Yes	No
8	269	238	100	407	69	438
9	223	246	83	386	72	397
10	254	267	96	425	67	454
11	234	252	106	380	63	423
12	253	238	81	410	52	439

	Race						
Grade	African-American	American Indian	Asian	Hispanic	Multi-Racial	Pacific Islander	White
8	9	0	23	21	31	0	423
9	10	1	40	13	41	0	364
10	13	1	43	19	18	0	427
11	23	4	26	15	15	0	403

12	10	1	42	15	12	1	410

Academic Achievement

When evaluating for the first research question, School District #1's academic achievement data shows a number of mixed results depending on how the results are reviewed across the various subgroups in the study. Table 2 provides weighted GPA (WGPA) data within the student population when it is broken down by gender and receipt of special education services. The mean WGPA of female students in the 10^{th} – 11^{th} and 11^{th} – 12^{th} grade levels showed a minimal improvement between the control and experimental years, while the range of standard deviations across this set of the data points decreased. However, the male population of all grade levels did not show any statistical improvement in weighted GPA or standard deviation when considering gender and special education services. Finally, the *n* count of the 504 subgroups in each grade level was 13 or less students, accounting for the larger variance in mean and standard deviation of WGPA compared to the other subgroups.

Table 2

Weighted GPA by Grade Level and Special Education Services

Grade	Female				Male			
	Control		Experimental		Control		Experimental	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
7th – 8th								
504	4.00	0.30	3.83	0.14	3.83	0.36	3.06	0.66
IEP	3.81	0.30	3.51	0.40	3.67	0.46	3.23	0.62
None	3.94	0.35	3.86	0.40	3.88	0.41	3.70	0.53
8th – 9th								
504	3.90	0.15	3.20	0.37	3.84	0.50	3.16	0.66
IEP	3.89	0.16	3.10	0.90	3.78	0.42	2.85	0.82
None	3.94	0.35	3.85	0.71	3.88	0.36	3.58	0.82
9th – 10th								
504	3.13	0.48	2.89	0.11	3.41	0.87	3.38	1.03
IEP	3.05	0.63	2.69	0.66	3.05	0.67	3.00	0.71
None	3.83	0.60	**3.87**	0.60	3.56	0.77	**3.58**	0.76
10th – 11th								
504	4.00	N/A	4.00	N/A	3.38	0.86	3.35	0.62
IEP	3.16	0.76	**3.17**	0.72	3.03	0.55	**3.05**	0.52
None	3.80	0.62	**3.81**	0.62	3.51	0.73	3.51	0.74
11th – 12th								
504	2.37	N/A	2.32	N/A	3.37	0.63	**3.38**	0.62
IEP	3.18	0.37	**3.21**	0.37	3.01	0.53	3.00	0.52
None	3.81	0.58	**3.83**	0.57	3.56	0.67	3.55	0.67

After comparing the mean and standard deviations between the control and the experimental years, the bolded data points in Table 2 were then analyzed further for statistical significance. The results for each of the *t-tests* are found in Table 3.

Table 3

Statistical Significance of Weighted GPA by Grade Level and Special Education Services

Data Set	*N count*	P(T<=t) two tail	Statistically Significant
Female			
9th - 10th and No Spec Ed	246	0.000801	**Statistically Significant**
10th – 11th and IEP	21	0.795603	Not Statistically Significant
10th – 11th and No Spec Ed	230	0.228821	Not Statistically Significant
11th – 12th and IEP	15	0.457999	Not Statistically Significant
11th – 12th and No Spec Ed	222	0.003200	**Statistically Significant**
Male			
9th-10th and No Spec Ed	208	0.281145	Not Statistically Significant
10th – 11th and IEP	37	0.598144	Not Statistically Significant

The data shows that the 9th-10th grade and 11th -12th grade student groups who did not receive any special education services showed a statistically significant improvement in their weighted GPA that could potentially be attributed to the change in secondary school start time. All other special education subgroups did not have an increased weighted GPA, nor did they show a statistically significant improvement in their weighted GPA.

When breaking down the data by ethnicity, School District #1 only had two subgroups that contained an *n* count of greater than 20 students, or at least 5% of the student population, in all grade levels. The ethnicity data for each of these subgroups, Asian and White, are represented in Table 4 along with their gender demographics and mean weighted GPA for each grade level.

Table 4

Weighted GPA by Grade Level and Ethnicity

Grade	Female				Male			
	Control		Experimental		Control		Experimental	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
$7^{th} – 8^{th}$								
Asian	3.93	0.37	**4.10**	0.34	4.06	0.29	3.88	0.44
White	3.94	0.36	3.87	0.37	3.85	0.43	3.64	0.53
$8^{th} – 9^{th}$								
Asian	4.05	0.28	**4.07**	0.65	3.84	0.53	**4.31**	0.65
White	3.92	0.35	3.76	0.75	3.88	0.36	3.50	0.77
$9^{th} – 10^{th}$								
Asian	4.21	0.49	**4.28**	0.45	4.00	0.87	3.97	0.90
White	3.74	0.63	**3.77**	0.64	3.43	0.72	3.43	0.73
$10^{th} – 11^{th}$								
Asian	4.29	0.42	**4.33**	0.45	3.64	0.73	**3.68**	0.73
White	3.73	0.65	**3.74**	0.64	3.53	0.66	3.53	0.65
$11^{th} – 12^{th}$								
Asian	4.01	0.67	4.00	0.68	4.00	0.71	3.96	0.69
White	3.78	0.56	**3.80**	0.55	3.45	0.64	3.44	0.64

Similar to the data on students who receive special education services, the data on ethnicity and weighted GPA was analyzed further for statistical significance, if the mean of any subgroup showed an improvement from the control year to the experimental year in the study. A majority of the female Asian and White ethnic subgroups showed an increase in the mean weighted GPA, along with the 8^{th}-9^{th} and 10^{th}-11^{th} grade male Asian ethnic subgroups.

Table 5

Statistical Significance of Weighted GPA by Grade Level and Ethnicity

Data Set	*N count*	P(T<=t) two tail	Statistically Significant
Female			
7^{th} - 8^{th} and Asian	12	0.383231	Not Statistically Significant
8^{th} – 9^{th} and Asian	25	0.842402	Not Statistically Significant
9^{th} – 10^{th} and Asian	21	0.048488	**Statistically Significant**
9^{th} – 10^{th} and White	221	0.064092	Not Statistically Significant
10^{th} – 11^{th} and Asian	14	0.013078	**Statistically Significant**
10^{th} – 11^{th} and White	215	0.249976	Not Statistically Significant
11^{th} – 12^{th} and White	202	0.001246	**Statistically Significant**
Male			
8^{th} – 9^{th} and Asian	14	0.022307	**Statistically Significant**
10^{th} – 11^{th} and Asian	12	0.493211	Not Statistically Significant

The lack of consistency in the results from the students with special education services subgroup continued in the data results when broken down by ethnicity. While the Asian female 9^{th}-10^{th} and 10^{th}-11^{th} grade groups, along with the White female 11^{th}-12^{th} and Asian male 8^{th}-9^{th} all showed statistically significant results in the difference between their control and experimental year mean weighted GPA calculations; the other gender and ethnicity subgroups either showed no statistical significance in the growth of their mean weighted GPA or no improvement from the control to the experimental years of the study.

Finally, when looking at the academic achievement results for School District #1 by gender and socioeconomic status, the only growth in weighted GPA is present with students in grades 10-12. The mean weighted GPA and standard deviation by socioeconomic status for students in these grade levels is shown in Table 6.

Table 6

Weighted GPA by Grade Level and Socioeconomic Status

Grade	Female				Male			
	Control		Experimental		Control		Experimental	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
$9^{th} – 10^{th}$								
Free	3.42	0.59	3.36	0.72	3.21	0.79	3.15	0.83
Reduced	3.14	0.67	3.09	0.81	3.10	0.60	3.08	0.64
Full Pay	3.83	0.62	**3.85**	0.64	3.72	0.67	**3.74**	0.68
$10^{th} – 11^{th}$								
Free	3.21	0.72	**3.23**	0.69	2.99	0.74	**3.01**	0.73
Reduced	3.35	0.60	3.33	0.57	3.12	0.68	3.09	0.68
Full Pay	3.89	0.56	**3.89**	0.57	3.76	0.61	**3.76**	0.61
$11^{th} – 12^{th}$								
Free	3.33	0.58	**3.35**	0.56	3.27	0.60	**3.29**	0.58
Reduced	3.37	0.46	**3.39**	0.47	3.38	0.51	3.37	0.53
Full Pay	3.84	0.58	**3.86**	0.56	3.69	0.65	**3.69**	0.65

Within the grade levels and socioeconomic statuses that showed growth in the mean weighted GPA, there is a more balanced sample of improvement data between the genders. Each of the three categories of socioeconomic status showed an improvement in the mean calculation of weighted GPA across one of the three grade level groups shown on Table 6. However, when this data was analyzed for statistical significance, the results in Table 7 show that only one of the data sets had a statistically significant result.

Table 7

Statistical Significance of Weighted GPA by Grade Level and Socioeconomic Status

Data Set	*N count*	P(T<=t) two tail	Statistically Significant
Female			
9^{th} – 10^{th} and Full Pay	228	0.100481	Not Statistically Significant
10^{th} – 11^{th} and Free	46	0.482743	Not Statistically Significant
10^{th} – 11^{th} and Full Pay	197	0.261764	Not Statistically Significant
11^{th} – 12^{th} and Free	29	0.246470	Not Statistically Significant
11^{th} – 12^{th} and Reduced	6	0.255891	Not Statistically Significant
11^{th} – 12^{th} and Full Pay	203	0.007638	**Statistically Significant**
Male			
9^{th} – 10^{th} and Full Pay	197	0.201622	Not Statistically Significant
10^{th} – 11^{th} and Free	45	0.508196	Not Statistically Significant
10^{th} – 11^{th} and Full Pay	183	0.892360	Not Statistically Significant
11^{th} – 12^{th} and Free	39	0.387507	Not Statistically Significant

The female and full pay socioeconomic status subgroup showed a statistically significant change in the weighted GPA from the control year (M = 3.8401) to the experimental year (M = 3.8571). Unfortunately, although statistically significant, the change of 0.017 in mean of the weighted GPA for this subgroup represents less than a 0.25% change on a five-point, weighted GPA scale.

Attendance

The data at School District #1 for the second research question of how the change in secondary school start time impacts student attendance showed similar mixed results to the question of academics. The difference with the attendance data is the groups that showed a reduction in the mean number of absences, a positive change for students, were mainly from the 7^{th} – 8^{th} and 8^{th} – 9^{th} grade groups compared to the academic results, where the 9^{th}- 10^{th}, 10^{th} – 11^{th}, and 11^{th} – 12^{th} grade groups showed the positive difference by improving their average weighted GPA. Table 8 compares the mean numbers of absences between the control and

experimental years for students who receive special education services by grade level and gender.

Table 8

Number of Absences by Grade Level and Special Education Services

Grade	Female				Male			
	Control		Experimental		Control		Experimental	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
7th – 8th								
504	10.25	5.85	**9.18**	5.95	6.77	6.00	**6.50**	4.07
IEP	15.35	10.31	**9.69**	4.68	9.63	8.87	**8.68**	6.55
None	7.75	6.04	**7.72**	6.10	8.32	6.93	**7.34**	6.50
8th – 9th								
504	13.45	9.77	16.09	14.71	12.45	6.84	**6.19**	4.54
IEP	11.11	6.01	12.94	10.26	11.82	15.95	**9.91**	9.84
None	9.01	7.69	**8.54**	6.38	7.49	5.90	7.65	5.77
9th – 10th								
504	8.00	3.75	17.88	11.56	3.58	2.81	10.69	15.74
IEP	7.95	5.57	12.12	9.35	10.16	8.03	12.84	8.51
None	7.06	6.09	10.17	8.29	6.06	5.22	8.67	6.22
10th – 11th								
504	3.00	N/A	10.00	N/A	4.86	1.79	5.88	2.70
IEP	10.47	7.55	14.49	0.35	7.45	7.03	9.93	8.83
None	7.60	6.10	10.89	7.51	7.74	6.59	10.17	8.23
11th – 12th								
504	17.35	N/A	14.60	N/A	7.72	9.47	**4.22**	0.38
IEP	10.48	9.16	16.34	12.21	11.95	12.29	14.66	13.19
None	8.78	6.48	12.43	10.06	7.49	6.52	11.56	10.66

Some data in Table 8 for School District #1 has a large variance between the control and experimental year, because of the small sample size within the group. The female 504 and IEP subgroups have less than 21 students at every grade level, which means a substantial change in absences for a couple students between the control and experimental years can have a significant

impact on the overall data results. Table 9 shows the results of the statistical significance tests for the change in mean number of absences of both the male and female groups bolded in Table 8, except for the 11th - 12th grade 504 male subgroup which had an *n*-count of only 3.

Table 9

Statistical Significance of Absences by Grade Level and Special Education Services

Data Set	*N count*	P(T<=t) two tail	Statistically Significant
Female			
7th – 8th and 504	6	0.565685	Not Statistically Significant
7th – 8th and IEP	12	0.020241	**Statistically Significant**
7th – 8th and No Spec Ed	220	0.942154	Not Statistically Significant
8th – 9th and No Spec Ed	221	0.238140	Not Statistically Significant
Male			
7th – 8th and 504	14	0.958000	Not Statistically Significant
7th – 8th and IEP	38	0.410335	Not Statistically Significant
7th – 8th and No Spec Ed	218	0.017564	**Statistically Significant**
8th – 9th and 504	11	0.000355	**Statistically Significant**
8th – 9th and IEP	36	0.353138	Not Statistically Significant

With $p \leq .05$ as the factor determining statistical significance of the t-test paired samples for mean analysis, the female 7th – 8th with IEP, the male 7th – 8th No Special Ed, and the 8th – 9th with 504 groups all showed statistical significance in their decrease of absences between the control and experimental years. The other five subgroups identified with a decrease in their mean number of absences were all not statistically significant. This result is like the other results in the study by finding a smaller subset of the subgroup data set that showed a benefit from the time change, but no consistent evidence to extrapolate a conclusion within an entire subgroup of students.

The data on student absences by ethnicity in Table 10 shows most of the 7th – 8th and 8th – 9th grade student groups across most ethnicities had a decrease in the mean number of absences between the control and experimental years of the study, meanwhile when looking at the

ethnicity data for the other secondary student groups, not one ethnicity subgroup showed a decrease in the number of mean absences. The statistical significance results of the attendance data from Table 10 is shown in Table 11. Although 15 subgroup data sets show a decrease in the number of mean absences, the statistical significance of those results is limited to the 7th – 8th grade White females and 7th – 8th Asian males.

Table 10

Absences by Grade Level and Ethnicity

Grade	Female				Male			
	Control		Experimental		Control		Experimental	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
7th – 8th								
Hispanic	7.82	6.60	9.57	5.95	8.86	4.61	**8.14**	3.10
Asian	4.27	3.22	**4.10**	4.09	7.36	6.96	**2.65**	2.34
Black	3.88	2.53	4.05	3.47	4.80	4.32	**3.74**	1.34
White	8.61	6.73	**7.73**	5.59	8.16	6.87	**7.62**	6.44
2 or more	8.14	5.33	13.51	10.95	12.80	10.47	**9.37**	7.85
8th – 9th								
Hispanic	9.71	13.95	**8.41**	6.67	10.33	7.88	**9.13**	6.87
Am Indian	N/A	N/A	N/A	N/A	12.00	N/A	15.00	N/A
Asian	6.82	6.82	**5.60**	5.47	4.29	4.42	**3.58**	4.71
Black	9.63	11.48	**8.81**	9.43	26.25	34.75	**13.08**	12.45
White	9.38	7.33	9.59	7.04	8.05	6.18	**7.88**	6.41
2 or more	11.68	9.02	**9.48**	10.90	8.57	6.09	9.19	5.76

Table 11

Statistical Significance of Attendance by Grade Level and Ethnicity

Data Set	*N count*	P(T<=t) two tail	Statistically Significant
Female			
7^{th} – 8^{th} and Asian	12	0.929561	Not Statistically Significant
7^{th} – 8^{th} and White	197	0.019819	**Statistically Significant**
8^{th} – 9^{th} and Hispanic	7	0.732418	Not Statistically Significant
8^{th} – 9^{th} and Asian	25	0.123662	Not Statistically Significant
8^{th} – 9^{th} and Black	4	0.506580	Not Statistically Significant
8^{th} – 9^{th} and 2 or more	19	0.251963	Not Statistically Significant
Male			
7^{th} – 8^{th} and Hispanic	7	0.630334	Not Statistically Significant
7^{th} – 8^{th} and Asian	11	0.040671	**Statistically Significant**
7^{th} – 8^{th} and Black	5	0.585667	Not Statistically Significant
7^{th} – 8^{th} and White	226	0.150383	Not Statistically Significant
7^{th} – 8^{th} and 2 or more	20	0.143053	Not Statistically Significant
8^{th} – 9^{th} and Hispanic	6	0.621065	Not Statistically Significant
8^{th} – 9^{th} and Asian	14	0.341873	Not Statistically Significant
8^{th} – 9^{th} and Black	6	0.246295	Not Statistically Significant
8^{th} – 9^{th} and White	174	0.714896	Not Statistically Significant

The final data set for School District #1 is the attendance information based on socioeconomic subgroups. The initial analysis on this set of data also showed a decrease in the mean number of absences across almost every subgroup for the younger secondary grade levels, except the 7^{th} – 8^{th} grade female reduced lunch, 8^{th} – 9^{th} grade female free lunch, and 8^{th} – 9^{th} grade male free lunch groups. Table 12 shows the mean and standard deviation data for all socioeconomic subgroups in the 7^{th} – 8^{th} and 8^{th} – 9^{th} student populations. The bolded data points represent decreases in absences from the control to the experimental years.

Table 12

Attendance by Grade Level and Socioeconomic Status

Grade	Female				Male			
	Control		Experimental		Control		Experimental	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
7th - 8th								
Free	10.08	8.69	**7.22**	4.49	11.09	9.33	**8.97**	9.00
Reduced	7.81	6.07	**7.63**	5.82	7.96	6.64	**7.25**	5.74
Full Pay	10.27	6.81	13.68	10.10	6.27	4.64	**5.95**	5.45
8th – 9th								
Free	11.82	8.13	13.48	7.41	10.14	7.04	10.27	8.11
Reduced	8.85	7.67	**8.58**	7.07	7.94	8.79	**7.34**	6.03
Full Pay	10.95	6.66	**7.21**	8.27	16.00	5.57	**14.67**	8.80

While nine of the twelve data points within the socioeconomic status breakdown had an improvement in the student results by decreasing the mean number of absences, the data results for significance in Table 13 were similar to the other data sets for School District #1 by showing mixed results when determining statistically significant data sets.

Table 13

Statistical Significance of Absences by Grade Level and Socioeconomic Status

Data Set	*N count*	P(T<=t) two tail	Statistically Significant
Female			
7th – 8th and Free	32	0.019840	**Statistically Significant**
7th – 8th and Full Pay	195	0.610925	Not Statistically Significant
8th – 9th and Full Pay	204	0.578302	Not Statistically Significant
8th – 9th and Reduced	11	0.039564	**Statistically Significant**
Male			
7th – 8th and Free	46	0.049310	**Statistically Significant**
7th – 8th and Full Pay	212	0.078357	Not Statistically Significant
7th – 8th and Reduced	11	0.830703	Not Statistically Significant
8th – 9th and Full Pay	181	0.265251	Not Statistically Significant

School District #2

School District #2 is a suburban-rural school district in Pennsylvania with approximately 4,200 students, who made the decision to adjust their secondary school start times by at least 30 minutes in the past three years. The high school adjusted their start time from 7:30 to 8:10, while the middle school changed from 7:27 to 8:05. The district agreed to consider participation, based on the final guidelines after IRB approval of the study, as they were planning for what would be the experimental year of the study for the district. In March of 2020, the control year of the study for School District #2, the COVID-19 global pandemic forced school districts across the state of Pennsylvania to adjust their mode of instruction from in-person to virtual for the remainder of the school year. Like other school districts across the state, School District #2 also had to consider the impacts of COVID-19 and make decisions about how best to meet the needs of their student population during the 2020-2021 school year, which was the first year of the adjusted school start times at their secondary schools.

After receiving IRB approval, the researcher re-engaged with the leadership of School District #2 to see if there was an opportunity to collect data on the adjustments of their secondary school start times, while accounting for the health, safety, and learning accommodations made by the district because of COVID-19. The school district had made the following adjustments that the researcher had to take into consideration when determining the validity of the data collected for the study:

1. Except two weeks at the end of March 2020, School District #2 continued to deliver instruction with a modified form of learning evidence collection to students through a virtual platform. The district made additional accommodations on 4th marking period and final grade reporting of the school year that would result in challenges for the researcher

to authentically compare full year data on weighted GPA between the control and experimental year of the study.

2. For the 2020-21 school year, School District #2 gave secondary students the choice of attending classes physically in the building or through a live streaming platform from home.

Given this information, the researcher made the following adjustments to the data request from School District #2:

1. The researcher only collected data on students who attended classes physically during the 2020-21 school year. This meant they had a modified, but similar learning location between the control and experimental years of the study. They also had to arrive to school by a required time and were measured on similar attendance expectations.
2. While the entire data set for School District #2 has a limitation based on COVID-19, the district could calculate marking period weighted GPA, so a comparison of marking period 1 academic achievement was completed for the study.

Table 14 shows the demographical data for students who were included in the study from School District #2. On average, this information represents about 72% of the entire student population in each grade level.

Table 14

Demographics and Descriptive Statistics for School District #2 - Experimental Year

Grade	Gender		Socioeconomic Status		Special Ed Eligible	
	Male	Female	Free/Reduced	Pay	Yes	No
8	148	95	101	142	53	190
9	132	117	98	151	52	197
10	118	102	80	140	42	178
11	109	113	86	136	38	184
12	105	111	83	133	40	176

	Race						
Grade	African-American	American Indian	Asian	Hispanic	Multi-Racial	Pacific Islander	White
8	5	0	3	24	12	0	199
9	5	0	8	18	5	0	213
10	6	1	4	27	5	0	177
11	6	0	4	23	6	0	183
12	9	1	5	18	3	0	180

Note: Only includes students who attended in the building during the 2020-21 school year

Academic Achievement – Marking Period

The academic achievement data for School District #2 allowed the researcher to compare marking period 1 results between the control and experimental years when evaluating the first research question. Given the timing of COVID-19 on the data collected from School District #2, the marking period data is potentially a more accurate snapshot of changing secondary school start times positive or negative impact on academic achievement. Any full year data should be reviewed while taking into consideration the conditions outlined as part of the introduction for School District #2. The improvement of mean weighted GPA was not as concentrated at School District #2 for both the marking period and full year data when evaluating across the various subgroups in the study. Also, a factor at School District #2 was the *n* count for some of the

subgroups, especially with over one quarter of the total student population excluded from the study data.

Table 15

Weighted GPA by Grade Level and Special Education Services – Marking Period 1

Grade	Female				Male			
	Control		Experimental		Control		Experimental	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
7th – 8th								
504	2.67	0.95	2.67*	2.10	1.94	0.24	1.56*	0.85
IEP	3.03	0.86	**3.06**	0.59	2.28	0.76	**2.61**	0.80
None	3.32	0.73	**3.38**	0.98	2.91	0.97	**2.96**	1.03
8th – 9th								
504	3.25	0.66	3.20*	1.47	3.02	0.70	**3.20**	0.61
IEP	2.50	0.52	2.18	0.94	2.68	0.65	1.99	1.12
None	3.26	0.76	**3.42**	0.90	3.10	0.85	3.10	1.10
9th – 10th								
504	3.00	N/A	**3.50***	N/A	2.86	N/A	1.86*	N/A
IEP	2.47	0.98	1.95	1.36	2.49	0.83	1.95	1.14
None	3.48	0.80	3.41	0.95	3.20	0.88	2.92	1.14
10th – 11th								
504	N/A	N/A	N/A	N/A	3.15	0.56	2.51	1.39
IEP	2.61	0.68	2.13	1.21	2.34	0.91	**2.39**	1.14
None	3.48	0.67	3.33	1.00	3.07	0.90	2.90	1.26
11th – 12th								
504	2.74	1.19	**3.42***	0.44	2.56	1.08	**2.58**	1.39
IEP	2.24	0.96	**3.32**	0.50	2.34	1.06	**2.62**	1.13
None	3.38	0.77	**3.50**	1.02	3.33	0.87	3.19	1.21

Note: * - subgroup had an *n* count of less than 5

A *t*-test for statistical significance was completed on each of the marking period 1 weighted GPA results at School District #2, where the experimental marking period 1 value was greater than the control year and the *n* count of the subgroup was greater than five students. Table 16 represents the results from the *t-tests* for statistical significance.

Table 16

Statistical Significance of Weighted GPA by Grade Level and Special Education Services

Data Set	*N count*	P(T<=t) two tail	Statistically Significant
Female			
7th – 8th and IEP	7	0.627890	Not Statistically Significant
7th – 8th and No Spec Ed	80	0.562612	Not Statistically Significant
8th – 9th and No Spec Ed	95	0.000446	**Statistically Significant**
11th – 12th and IEP	9	0.012788	**Statistically Significant**
11th – 12th and No Spec Ed	88	0.199757	Not Statistically Significant
Male			
7th – 8th and IEP	40	0.035486	**Statistically Significant**
7th – 8th and No Spec Ed	103	0.723323	Not Statistically Significant
8th – 9th and 504	5	0.249022	Not Statistically Significant
10th – 11th and IEP	15	0.690675	Not Statistically Significant
11th – 12th and 504	5	0.565310	Not Statistically Significant
11th – 12th and IEP	16	0.617912	Not Statistically Significant

The results in Table 16 show no consistent results of the student subgroups that benefitted from the changes in secondary school start times. When reviewing the groups of students who receive special education services, only the 11th – 12th with IEP females and the 7th – 8th with IEP males showed statistical significance in their results, along with 8th – 9th grade females with no special education services. All other male and female subgroups had no improvement or no statistical significance in the improvement of their mean weighted GPA during the first marking period, between the control and experimental years.

The ethnicity information within School District #2's results also produced a limited number of data points to evaluate for statistical significance when using the same threshold of 5% of student population that was used for School District #1. Also limiting the ethnicity data is that over 90% of School District #2 is either White (79.1%) or Hispanic (11.9%). Table 17 contains the mean weighted GPA and standard deviation for both female and male groups by

ethnicity when the *n* count for students in the subgroup was greater than 5, since the average student *n* count in the study is slightly greater than 100 per grade level by gender.

Table 17

Weighted GPA by Grade Level and Ethnicity – Marking Period 1

Grade	Female				Male			
	Control		Experimental		Control		Experimental	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
$7^{th} – 8^{th}$								
Hispanic	N/A	N/A	N/A	N/A	2.33	0.81	**2.53**	0.79
White	3.32	0.75	**3.39**	0.90	2.77	0.97	**2.89**	1.03
$8^{th} – 9^{th}$								
Asian	3.21	0.77	**3.58**	0.45	N/A	N/A	N/A	N/A
Hispanic	2.66	0.67	**2.89**	0.88	N/A	N/A	N/A	N/A
White	3.21	0.78	**3.31**	0.96	N/A	N/A	N/A	N/A
$11^{th} – 12^{th}$								
Hispanic	2.38	0.85	**2.63**	1.15	1.73	1.01	**1.89**	1.06
White	3.23	0.85	**3.57**	0.93	N/A	N/A	N/A	N/A

Note: N/A means subgroup data had an *n* count of less than 5 or did not increase weighted GPA

After identifying the ethnicity subgroups by gender at School District #2 with improvements in mean weighted GPA, *t-tests* for statistical significance were completed on each data set. The results of the tests for statistical significance to the $p \leq .05$ level and the *n* count of each group are in Table 18. They show there is no statistical significance to any of the results for these subgroups except for the $11^{th} – 12^{th}$ grade White and female group.

Table 18

Statistical Significance of Weighted GPA by Grade Level and Ethnicity – Marking Period 1

Data Set	*N count*	P(T<=t) two tail	Statistically Significant
Female			
7^{th} - 8^{th} and White	83	0.281059	Not Statistically Significant
8^{th} – 9^{th} and Asian	6	0.193121	Not Statistically Significant
8^{th} – 9^{th} and Hispanic	7	0.513500	Not Statistically Significant
8^{th} – 9^{th} and White	94	0.060992	Not Statistically Significant
11^{th} – 12^{th} and Hispanic	7	0.973795	Not Statistically Significant
11^{th} – 12^{th} and White	88	0.013203	**Statistically Significant**
Male			
7^{th} – 8^{th} and Hispanic	18	0.221850	Not Statistically Significant
7^{th} – 8^{th} and White	113	0.166876	Not Statistically Significant
11^{th} – 12^{th} and Hispanic	7	0.870915	Not Statistically Significant

The final comparison of the marking period 1 academic achievement data from School District #2 is the socioeconomic subgroups. The difference in this data set is the combination of the Free and Reduced lunch groups compared to the data from School District #1 where those two socioeconomic statuses are reported and analyzed as two separate subgroups. The results of the socioeconomic status subgroup data are found in Table 19 with bolded data points for increases in weighted GPA during the experimental year.

Table 19

Weighted GPA by Grade Level and Socioeconomic Status – Marking Period 1

Grade	Female				Male			
	Control		Experimental		Control		Experimental	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
7th – 8th								
Free/Reduced	2.83	0.80	2.70	1.32	2.37	0.93	**2.47**	0.96
Full Pay	3.51	0.62	**3.71**	0.44	2.97	0.89	**3.11**	0.94
8th – 9th								
Free/Reduced	2.80	0.84	2.68	1.18	2.80	0.82	2.46	1.21
Full Pay	3.32	0.69	**3.53**	0.76	3.12	0.79	**3.17**	1.07
9th – 10th								
Free/Reduced	2.91	1.13	2.77	1.18	2.61	1.05	2.27	1.19
Full Pay	3.59	0.60	3.52	0.93	3.17	0.81	2.92	1.16
10th – 11th								
Free/Reduced	3.08	0.69	2.77	1.05	2.69	0.88	**2.71**	1.28
Full Pay	3.54	0.71	3.50	1.02	3.07	0.92	2.82	1.24
11th – 12th								
Free/Reduced	2.83	0.87	**2.95**	1.03	2.90	0.88	2.63	1.24
Full Pay	3.39	0.85	**3.75**	0.80	3.24	1.03	**3.35**	1.14

As with the previous data sets, this set of subgroup data was also evaluated for statistical significance, if the mean weighted GPA showed an increase between the control and experimental marking periods. The results of the statistical significance tests are found in Table 20.

Table 20

Statistical Significance of Weighted GPA by Grade Level and Socioeconomic Status

Data Set	*N count*	P(T<=t) two tail	Statistically Significant
Female			
7^{th} – 8^{th} and Full Pay	56	0.014314	**Statistically Significant**
8^{th} – 9^{th} and Full Pay	75	0.006606	**Statistically Significant**
11^{th} – 12^{th} and Free/Reduced	28	0.905552	Not Statistically Significant
11^{th} – 12^{th} and Full Pay	66	0.001366	**Statistically Significant**
Male			
7^{th} – 8^{th} and Full Pay	81	0.134978	Not Statistically Significant
7^{th} – 8^{th} and Free/Reduced	61	0.492230	Not Statistically Significant
8^{th} – 9^{th} and Full Pay	69	0.947849	Not Statistically Significant
10^{th} – 11^{th} and Free/Reduced	24	0.781207	Not Statistically Significant
11^{th} – 12^{th} and Full Pay	58	0.890946	Not Statistically Significant

The results of the statistical significance *t-tests* for the female full pay subgroups strongly implied a change in secondary school start times was a benefit to their academic achievement during the first marking period. The 7^{th} – 8^{th}, 8^{th} – 9^{th}, and 11^{th} – 12^{th} subgroups all had p-value results less than 0.015, while all the male socioeconomic status subgroups, that had an improvement in the mean value of their weighted GPA, showed no statistical significance in the results. This division in the significance of the results by gender is not a data trend that appeared in any of the other subgroup results for academic achievement by marking period from School District #2.

Academic Achievement – Full Year

The academic achievement results and analysis of the full year data for the combined data set from both school districts will be explored in its own results section. However, there were some data points from School District #2's full year results that the researcher wanted to highlight. A reminder that the data from marking period 4 of the control year as well as all the

data from the experimental year for School District #2 occurred during the COVID-19 global pandemic.

The weighted GPA by grade level and special education services for the full year only showed improvements in the mean calculation for subgroups of students in the 7th – 8th and 11th – 12th grade groups. The data for the control and experimental years of these subgroups is found in Table 21 with the bolded text highlighting improvements between the two years.

Table 21

Weighted GPA by Grade Level and Special Education Services – Full Year

Grade	Female				Male			
	Control		Experimental		Control		Experimental	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
7th – 8th								
504	2.83	1.01	2.42*	1.94	2.13	0.32	1.50*	1.25
IEP	3.22	0.76	**3.30**	0.46	2.51	0.78	**2.58**	0.69
None	3.50	0.72	3.20	1.07	3.07	0.99	2.77	1.09
11th – 12th								
504	2.96	0.29	2.90*	0.43	2.74	1.28	**2.90**	0.78
IEP	2.45	0.90	**3.05**	0.56	2.37	0.79	**2.54**	0.97
None	3.37	0.90	**3.38**	1.03	3.28	0.95	3.22	1.02

Note: * - subgroup had an *n* count of less than 5

While the number of subgroups that showed improvement in the mean weighted GPA between the control and experimental years is minimal, there is some noticeable increases of the mean standard deviations between the two years within these subgroups. Eight of the twelve subgroups represented in Table 21 have an increased mean standard deviation. Meanwhile, when evaluating the results of the mean weighted GPA by special education services in Table 21 for statistical significance, there is only one subgroup, 11th – 12th grade females with IEPs, that

showed statistical significance in their data. The results for all of the *t-tests* are represented in Table 22.

Table 22

Statistical Significance of Weighted GPA by Grade Level and Special Education Services

Data Set	*N count*	P(T<=t) two tail	Statistically Significant
Female			
7^{th} – 8^{th} and IEP	7	0.385282	Not Statistically Significant
11^{th} – 12^{th} and IEP	13	0.017211	**Statistically Significant**
11^{th} – 12^{th} and No Spec Ed	93	0.981454	Not Statistically Significant
Male			
7^{th} – 8^{th} and IEP	40	0.604156	Not Statistically Significant
11^{th} – 12^{th} and 504	5	0.339093	Not Statistically Significant
11^{th} – 12^{th} and IEP	17	0.683105	Not Statistically Significant

The data for improvement of the mean weighted GPA by ethnicity was also limited in the number of results that showed a positive increase, between the control and the experimental year. The only three subgroups with an *n* count above five that had an increase were the 8^{th} – 9^{th} grade Hispanic females, the 11^{th} – 12^{th} grade Hispanic females, and the 11^{th} – 12^{th} grade White females. The complete set of data for School District #2 by grade level and ethnicity subgroups is available in Table 23, including statistical significance. Using a $p \leq .05$ as the determination for statistical significance, none of the three subgroups showed a statistical significance in their change of mean weighted GPA data.

Table 23

Weighted GPA and Statistical Significance by Grade Level and Ethnicity – Full Year

Grade	Female					
		Control		Experimental		
	n	*M*	*SD*	*M*	*SD*	P(T<=t) two tail
8th – 9th						
Hispanic	7	2.60	0.62	2.69	1.08	0.765832
11th – 12th						
Hispanic	11	2.17	1.06	2.58	0.93	0.435429
White	92	3.36	0.85	3.43	0.96	0.661575

Finally, the data showing an improvement in the mean weighted GPA for students by the socioeconomic and gender subgroup breakdown is only found within one student grade level group. The only grade level that showed an improvement in the mean weighted GPA is the 11th – 12th grade students. However, their statistical significance *t*-tests showed no significance in the results, which is similar to the ethnicity subgroup results. The mean weighted GPA, standard deviation, and the statistical significance of the results for the 11th – 12th grade subgroups are available in Table 24.

Table 24

Weighted GPA/Statistical Significance by Grade Level and Socioeconomic Status – Full Year

Grade	Control			Experimental		
	n	*M*	*SD*	*M*	*SD*	P(T<=t) two tail
11th – 12th Females						
Free/Reduced	34	2.76	0.93	2.85	0.90	0.929319
Full Pay	69	3.47	0.85	3.60	0.91	0.266379
11th – 12th Males						
Full Pay	61	3.30	1.04	3.33	0.96	0.394617

Attendance – Marking Period

School District #2 provided data on both absences from and tardies to school. For this study, the researcher used each instance of a tardy as a data point and did not consider the number of minutes a student was tardy to school. The data for the comparison of the marking period in the control and experimental year showed only three groups of students within the gender and special education services subgroup breakdown that had a decrease in the mean number of absences. However, the mean number of tardies showed a reduction in 14 of the 30 subgroups across the female and male data. The absence data is shown in Table 25, while the tardy data is available in Table 26.

Table 25

Number of Absences by Grade Level and Special Education Service – Marking Period

Grade	Female				Male			
	Control		Experimental		Control		Experimental	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
$11^{th} – 12^{th}$								
IEP	2.00	1.75	**1.82**	3.60	3.21	4.26	**2.67**	3.14
None	1.81	2.04	2.11	4.07	2.00	2.38	**1.71**	3.12

Table 26

Number of Tardies by Grade Level and Special Education Service – Marking Period

Grade	Female				Male			
	Control		Experimental		Control		Experimental	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
7th – 8th								
504	2.00	3.46	2.33*	2.52	0.25	0.50	0.75*	1.50
IEP	0.63	1.41	**0.00**	0.00	0.83	1.85	1.13	2.26
None	0.13	0.40	0.40	0.92	0.45	1.28	0.57	1.20
8th – 9th								
504	1.00	1.73	**0.67***	1.15	0.00	0.00	0.00	0.00
IEP	0.23	0.60	1.13	2.29	0.74	1.67	**0.70**	1.84
None	0.39	1.38	**0.23**	0.64	0.09	0.32	0.18	0.48
9th – 10th								
504	0.00	N/A	0.00*	N/A	0.00	N/A	0.00*	N/A
IEP	0.38	0.65	**0.23**	0.44	0.81	2.17	**0.75**	1.65
None	0.84	2.33	**0.23**	0.50	0.33	1.37	**0.21**	0.53
10th – 11th								
504	N/A	N/A	N/A	N/A	0.00	0.00	0.33	0.52
IEP	1.53	3.31	**0.53**	1.13	2.78	3.96	**1.26**	4.13
None	0.46	0.92	**0.45**	1.38	0.75	1.84	**0.14**	0.54
11th – 12th								
504	1.75	2.36	**0.00***	0.00	0.83	2.04	0.00	0.00
IEP	2.36	5.21	**0.00**	0.00	1.63	3.06	**0.33**	0.69
None	0.54	1.33	0.16	0.47	0.90	1.88	**0.21**	0.54

Note: * - subgroup had an *n* count of less than 5

The tardy data by students who receive special education services was analyzed further to determine how many of the results were statistically significant. The breakdown of the *t*-test results is found in Table 27. They show that all but two of the subgroup data sets are not statistically significant. The only two that have significance are the 10th – 11th and 11th – 12th grade male groups with no special education services.

Table 27

Statistical Significance of Tardies by Grade Level and Special Education Services

Data Set	*N count*	P(T<=t) two tail	Statistically Significant
Female			
7^{th} – 8^{th} and IEP	7	0.253373	Not Statistically Significant
8^{th} – 9^{th} and No Spec Ed	96	0.327183	Not Statistically Significant
9^{th} – 10^{th} and IEP	12	0.438205	Not Statistically Significant
9^{th} – 10^{th} and No Spec Ed	88	0.055209	Not Statistically Significant
10^{th} – 11^{th} and IEP	15	0.290482	Not Statistically Significant
10^{th} – 11^{th} and No Spec Ed	95	0.896350	Not Statistically Significant
11^{th} – 12^{th} and IEP	11	0.243160	Not Statistically Significant
Male			
8^{th} – 9^{th} and IEP	30	0.926279	Not Statistically Significant
9^{th} – 10^{th} and IEP	28	1	Not Statistically Significant
9^{th} – 10^{th} and No Spec Ed	84	0.371568	Not Statistically Significant
10^{th} – 11^{th} and IEP	18	0.271585	Not Statistically Significant
10^{th} – 11^{th} and No Spec Ed	83	0.000926	**Statistically Significant**
11^{th} – 12^{th} and IEP	17	0.128744	Not Statistically Significant
11^{th} – 12^{th} and No Spec Ed	81	0.001212	**Statistically Significant**

The marking period attendance data for absences and tardies was additionally broken down by ethnicity among the School District #2 students. The mean number of absences data showed only two subgroups that had a decrease between the control and experimental years of the study. The Hispanic male grade 12 subgroup of six students had 4.44 mean absences in the control year and 1.14 mean absences in the experimental year. Additionally, the White male grade 12 subgroup of 90 students showed a decrease from 2.06 to 1.90. However, neither of these results were statistically significant. The mean number of tardies remained consistent or showed a decrease in 19 of the 24 female ethnicity subgroups and 19 of the 26 male subgroups. Of these results, subgroups with an *n* count of at least five were further analyzed with a *t*-test for statistical significance. Only two, the 11^{th} – 12^{th} grade White male and female subgroups had statistically significant results. The results for all those tests can be found in Table 28.

Table 28

Statistical Significance of Tardies by Grade Level and Ethnicity – Marking Period

Data Set	*N count*	P(T<=t) two tail	Statistically Significant
Female			
7th – 8th and Hispanic	6	0.896875	Not Statistically Significant
8th – 9th and Asian	6	0.610881	Not Statistically Significant
8th – 9th and Hispanic	7	0.355917	Not Statistically Significant
9th – 10th and Hispanic	14	0.145743	Not Statistically Significant
9th – 10th and White	82	0.167186	Not Statistically Significant
10th – 11th and Hispanic	12	0.239009	Not Statistically Significant
11th – 12th and Hispanic	10	0.123529	Not Statistically Significant
11th – 12th and White	90	0.004099	**Statistically Significant**
Male			
7th – 8th and 2 or More	9	0.16902	Not Statistically Significant
9th – 10th and Hispanic	11	0.607638	Not Statistically Significant
9th – 10th and White	93	0.940566	Not Statistically Significant
10th – 11th and Hispanic	8	0.296432	Not Statistically Significant
10th – 11th and White	92	0.079663	Not Statistically Significant
11th – 12th and Hispanic	7	0.366296	Not Statistically Significant
11th – 12th and White	86	0.000369	**Statistically Significant**

The last marking period subgroup attendance data set was divided into free/reduced and full pay socioeconomic status. Like the special education services and ethnicity subgroup breakdowns, there were only two data points that showed a reduction in the mean number of absences. The 11th – 12th grade full pay female mean number of absences went from 1.60 to 1.55 and the 11th – 12th grade full pay male mean number of absences were 1.83 during the control year and 1.18 in the experimental year. Neither of the mean absence results showed statistical significance, but the mean number of tardies was lower in 14 of a possible 20 socioeconomic subgroups. Table 29 shows the results of the *t*-tests for statistical significance in those subgroups.

Table 29

Statistical Significance of Tardies by Grade Level and Socioeconomic Status – Marking Period

Data Set	*N count*	P(T<=t) two tail	Statistically Significant
Female			
7^{th} – 8^{th} and Full Pay	59	0.698404	Not Statistically Significant
8^{th} – 9^{th} and Free/Reduced	32	0.230813	Not Statistically Significant
9^{th} – 10^{th} and Free/Reduced	34	0.090932	Not Statistically Significant
9^{th} -10^{th} and Full Pay	64	0.450399	Not Statistically Significant
10^{th} – 11^{th} and Free/Reduced	39	0.673730	Not Statistically Significant
10^{th} – 11^{th} and Full Pay	64	0.101851	Not Statistically Significant
11^{th} – 12^{th} and Free/Reduced	34	0.009436	**Statistically Significant**
11^{th} – 12^{th} and Full Pay	68	0.038400	**Statistically Significant**
Male			
8^{th} – 9^{th} and Full Pay	72	0.798292	Not Statistically Significant
9^{th} – 10^{th} and Full Pay	74	0.102597	Not Statistically Significant
10^{th} – 11^{th} and Free/Reduced	29	0.856988	Not Statistically Significant
10^{th} – 11^{th} and Full Pay	70	0.004413	**Statistically Significant**
11^{th} – 12^{th} and Free/Reduced	36	0.007103	**Statistically Significant**
11^{th} – 12^{th} and Full Pay	61	0.033863	**Statistically Significant**

Attendance – Full Year

Due to the COVID-19 global pandemic School District #2 experienced an increase in mean absences across all grade levels represented in the research study. While some of the increased days absent can be attributed to health and safety guidelines or students participating in school from home, the study removed all students from School District #2 who participated in 100% remote learning during the experimental year of the study from the data. Even when considering only students who attended in-person during the experimental year of the study, just one subgroup within all the subgroups studied for this research showed a decrease in the mean number of days absent. The 11^{th} – 12^{th} grade female students with an IEP had a mean of 9.57 absences during the control year and 7.38 absences during the experimental year. The overall mean number of absences by gender and grade level are represented in Table 30.

Table 30

Mean Absences by Gender and Grade Level – Full Year

Grade	Female				Male			
	Control		Experimental		Control		Experimental	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
$7^{th} – 8^{th}$	5.13	4.49	8.86	10.53	5.82	5.56	12.19	13.14
$8^{th} – 9^{th}$	4.77	4.41	13.87	17.89	5.03	4.71	12.58	14.73
$9^{th} – 10^{th}$	8.19	11.94	13.65	13.02	6.57	13.47	13.31	14.05
$10^{th} – 11^{th}$	5.25	4.61	12.35	12.66	5.67	5.55	12.66	14.26
$11^{th} – 12^{th}$	7.18	5.57	9.92	13.16	6.78	6.16	10.13	15.12

While the absence data went in a direction that did not benefit students during the two years of the study, a different trend emerged from the tardy data. There were student groups in each of the subgroups, special education services, ethnicity and socioeconomic status, that showed a decrease in the mean number of tardies from the control to the experimental year. The special education services breakdown had 11 subgroups with a decrease in the mean number of tardies during the experimental year. These subgroup comparisons and their statistical significance are shown in Table 31.

Table 31

Tardies/Statistical Significance by Grade Level and Special Education Services – Full year

Grade	Control			Experimental		
	n	*M*	*SD*	*M*	*SD*	P(T<=t) two tail
Females						
8th – 9th No Spec Ed	96	1.81	4.84	1.62	3.70	0.650347
9th – 10th IEP	13	1.08	1.71	0.92	1.12	0.746321
9th – 10th No Spec Ed	88	2.56	7.14	1.59	3.48	0.511703
10th – 11th IEP	11	4.87	12.43	2.85	3.85	0.262170
11th – 12th IEP	12	6.50	13.33	0.23	0.44	0.140615
11th – 12th No Spec Ed	94	2.13	5.32	1.21	4.46	**0.025932**
Males						
9th – 10th IEP	27	5.32	8.87	4.26	10.83	0.773855
10th – 11th IEP	17	9.83	15.36	5.68	13.54	0.784925
10th – 11th No Spec Ed	82	2.55	7.04	1.74	3.44	0.642914
11th – 12th IEP	18	5.11	8.92	2.17	5.69	0.219333
11th – 12th No Spec Ed	81	3.75	6.31	2.29	3.99	0.107780

Note: $p \leq .05$ is the statistical significance for the mean analysis of the t-test paired samples

The demographics for School District #2 show almost 90% of the student data in the study comes from Hispanic or White students. The full year tardy data, represented by ethnicity, had only five female subgroups and four male subgroups with a decrease in tardies out of a possible 46 groups. Hispanic and White students made up all the groups with a decrease in tardies. The mean and standard deviation from the control and experimental years, along with the statistical significance calculation are found in Table 32.

Table 32

Tardies/Statistical Significance by Grade Level and Ethnicity – Full year

Grade	Control			Experimental		
	n	*M*	*SD*	*M*	*SD*	P(T<=t) two tail
Females						
8th – 9th Hispanic	7	3.43	5.53	2.43	3.91	0.632889
9th – 10th Hispanic	14	5.53	11.99	2.43	4.22	0.382547
10th – 11th Hispanic	11	7.25	13.42	3.46	3.86	0.222000
11th – 12th Hispanic	10	8.18	14.06	4.18	11.57	0.257532
11th – 12th White	92	1.93	5.19	0.74	2.11	**0.048194**
Males						
9th – 10th Hispanic	11	8.50	13.50	7.54	11.80	0.985734
10th – 11th White	91	3.56	9.65	1.95	6.46	0.738717
11th – 12th Hispanic	7	11.33	14.50	1.00	1.53	0.186274
11th – 12th White	86	2.85	4.89	2.28	4.42	0.437051

Note: $p \leq .05$ is the statistical significance for the mean analysis of the t-test paired samples

The tardy data for School District #2 showed mixed results when comparing the mean number of tardies from the control and experimental years of the study. 10 out of the 20 subgroup data points had a reduction in the mean number of tardies with six from the female and four from the male groups. Seven out of ten came from the 10th – 11th and 11th – 12th grade groups. A full breakdown of the statistical data for each subgroup that showed a decrease in the mean number of tardies is in Table 33.

Table 33

Tardies/Statistical Significance by Grade Level and Socioeconomic Status – Full year

Grade		Control		Experimental		
	n	*M*	*SD*	*M*	*SD*	P(T<=t) two tail
Females						
8th – 9th Free/Reduced	30	3.72	7.01	3.10	5.33	0.917755
9th – 10th Free/Reduced	32	3.21	8.10	1.65	1.77	0.801901
9th – 10th Full Pay	65	1.88	5.80	1.40	3.87	0.772724
10th – 11th Full Pay	64	1.40	2.63	1.33	2.49	0.968815
11th – 12th Free/Reduced	37	4.03	2.05	1.35	6.15	**0.010023**
11th – 12th Full Pay	70	2.05	5.71	0.90	2.36	0.170142
Males						
10th – 11th Free/Reduced	28	7.45	14.91	4.41	10.52	0.969333
10th – 11th Full Pay	70	2.00	4.18	1.38	2.16	0.850690
11th – 12th Free/Reduced	36	6.23	9.26	3.16	5.58	0.117967
11th – 12th Full Pay	62	2.57	4.33	1.50	2.82	0.206305

Note: $p \leq .05$ is the statistical significance for the mean analysis of the t-test paired samples

A final note about the full year attendance data for School District #2. The total number of potential days a student could have been tardy to school during the control year was 123, because for part of the 3rd marking period and the entire 4th marking period, all school districts were on remote learning due to COVID-19. The district continued to take daily attendance during remote learning, measured by factors other than physically showing up to school, however this means all subgroups that showed a decrease in the mean number of tardies during the experimental year of the study did it while school was in session for 60 more days than the control year. While this is not part of the calculation for statistical significance, it is a factor the researcher thought was important to consider when looking at the data.

Combined Data School District #1 and #2 – Full Year

A final analysis of the data was completed by merging the full year data from the control and experimental years of each school district to form one combined data set from each year.

Using the combined data created a larger representation of students in each subgroup and allowed the researcher to identify areas of statistical significance, where it was not identified in the separate sets of data from each individual district. The adjustments and limitations identified in the School District #2 section of the results are maintained in the merged data set for the school districts. Given the results calculated by analyzing each district separately, the researcher was able to identify some additional areas of significance among the 3,625 students, despite the impacts of COVID-19 on the School District #2 data.

Academic Achievement

The combined results of the weighted GPA for School District # 1 and #2 did not provide a greater number of increased mean results between the two school years when dividing the data for special education services. The combined results had five student subgroups with an improved weighted GPA, compared to seven for School District #1 and six for School District #2 in their individual results. Four of the five improved mean weighted GPAs were in the 11^{th} -12^{th} grade student population with the remainder in the 10^{th} – 11^{th} grade student group. The increased mean and statistical significance results for the control and experimental years are found in Table 34. Only the 11^{th} – 12^{th} female IEP group had a statistically significant result.

Table 34

Weighted GPA/Statistical Significance by Grade Level and Special Education Services

Grade	Control			Experimental		
	n	*M*	*SD*	*M*	*SD*	P(T<=t) two tail
Females						
10th – 11th IEP	32	2.97	0.72	3.00	0.78	0.675535
11th – 12th IEP	28	2.83	0.76	3.13	0.47	**0.002115**
11th – 12th No Spec Ed	315	3.68	0.72	3.70	0.76	0.528481
Males						
11th – 12th 504	8	2.95	1.11	3.08	0.72	0.326949
11th – 12th IEP	49	2.78	0.70	2.84	0.74	0.907547

Note: $p \leq .05$ is the statistical significance for the mean analysis of the t-test paired samples

The mean combined school district weighted GPA data showed an increase in the number of ethnicity subgroups with an improved value when comparing the control and experimental years. There were 11 ethnicity subgroups with an increased weighted GPA compared to nine for School District #1 and three from School District #2 when reviewed individually. However, the number of data points that were statistically significant did not improve compared to the individual school district data. Zero out of 11 subgroups were statistically significant, while four out of nine were significant from School District #1 and zero out of three were significant from School District #2. The results of the mean and standard deviation comparisons, along with the statistical significance values, can be found in Table 35.

Table 35

Weighted GPA/Statistical Significance by Grade Level and Ethnicity

Grade	Control			Experimental		
	n	*M*	*SD*	*M*	*SD*	P(T<=t) two tail
Females						
7th – 8th Asian	13	3.83	0.52	3.92	0.73	0.674105
9th – 10th Asian	23	4.18	0.49	4.21	0.51	0.460843
9th – 10th Black	9	3.15	1.36	3.33	1.04	0.587915
10th – 11th Asian	17	4.22	0.42	4.25	0.46	0.108388
11th – 12th Hispanic	17	2.67	1.10	2.91	0.92	0.485755
11th – 12th White	294	3.65	0.69	3.68	0.72	0.221037
Males						
8th – 9th Black	8	3.63	0.56	4.24	0.65	0.057656
10th – 11th Asian	13	3.70	0.73	3.76	0.76	0.292178
11th – 12th Black	12	3.04	1.08	3.17	0.91	0.671104
11th – 12th Hispanic	15	2.58	1.01	2.63	1.08	0.189563
11th – 12th 2 or More	10	3.35	0.83	3.41	0.69	0.539637

Note: $p \leq .05$ is the statistical significance for the mean analysis of the t-test paired samples

The final academic achievement subgroup breakdown was the socioeconomic status. Out of a possible 20 subgroup data points that could have shown an increased mean weighted GPA between the control and the experimental years, only three female groups and no male groups had an improvement. The individual data for School District #1 had 10 subgroups with an increase in mean weighted GPA, although no subgroup had more than a 0.03 improvement; while School District #2 had 3 with an improved mean weighted GPA. Two of the three groups that showed an improvement in the full year individual data for School District #2, also was represented in the combine data. The mean weighted GPA, standard deviation, and statistical significance is shown in Table 36.

Table 36

Weighted GPA/Statistical Significance by Grade Level and Socioeconomic Status

Grade	Control			Experimental		
	n	*M*	*SD*	*M*	*SD*	P(T<=t) two tail
9th – 10th Females						
Full Pay	292	3.75	0.68	3.77	0.71	0.920447
11th – 12th Females						
Free/Reduced	69	3.04	0.82	3.09	0.79	0.801987
Full Pay	273	3.74	0.68	3.79	0.68	0.169694

Note: $p \leq .05$ is the statistical significance for the mean analysis of the t-test paired samples

Attendance

The combined attendance data for School District #1 and School District #2 included only absence information. School District #1 did not submit tardy data. Additionally, the absence data from School District #2 was negatively impacted by the COVID-19 global pandemic and the health and safety guidelines required of schools by the Pennsylvania Department of Health and Center for Disease Control. These factors contributed to a result where only ten data points out of a possible 100 showed a benefit to the student between the control and experimental years of the study.

The mean number of absences decreased in three different subgroups when considering students who receive special education services. Table 37 shows the data for the three groups. The 7th – 8th grade female student group with IEPs, the 8th – 9th grade male student group with 504s, and the 11th -12th grade student group with 504s all showed a reduction in mean absences, however only one of the three, 8th – 9th grade males with 504s, was statistically significant.

Table 37

Absences/Statistical Significance by Grade Level and Special Education Services

Grade		Control		Experimental		
	n	*M*	*SD*	*M*	*SD*	P(T<=t) two tail
Females						
7th – 8th IEP	19	11.02	9.88	8.96	6.25	0.269277
Males						
8th – 9th 504	16	10.44	6.78	6.82	3.97	**0.018408**
11th – 12th 504	8	8.57	7.70	3.96	4.37	0.221315

Note: p≤.05 is the statistical significance for the mean analysis of the t-test paired samples

The data for mean absences by ethnicity group had seven subgroups with a decrease in absences. The results were divided among four different grade level groups, with only the 11th – 12th grade group not represented. Additionally, the mean absence decreases were spread across three out of the six ethnic subgroups represented in the study. The American Indian, Black and White subgroups were not represented in the mean absences decrease data. The results for the decreases in mean absences by ethnicity are in Table 38.

Table 38

Absences/Statistical Significance by Grade Level and Ethnicity

Grade		Control		Experimental		
	n	*M*	*SD*	*M*	*SD*	P(T<=t) two tail
Females						
7th – 8th Asian	13	5.89	6.82	5.10	5.30	0.491032
8th – 9th Hispanic	14	7.57	10.25	6.78	6.51	0.679361
Males						
7th – 8th Asian	13	6.69	6.58	2.78	2.39	**0.048144**
7th – 8th 2 or More	29	10.69	10.27	9.19	7.99	0.388572
8th – 9th Asian	16	3.81	4.32	3.38	4.43	0.527235
9th – 10th 2 or More	16	12.04	29.08	10.73	9.90	**0.004944**
10th – 11th Asian	13	5.60	6.31	5.58	5.40	0.992018

Note: p≤.05 is the statistical significance for the mean analysis of the t-test paired samples

The final subgroup breakdown in the study was socioeconomic status from the combined school districts data. Unfortunately, there were no female or male groups that showed a decrease

in the mean number of absences by socioeconomic status. The increase in mean number of absences between the control and experimental years of the combine school district data could be attributed to the impact COVID-19 had on the number of student absences for School District #2 during the experimental year of data from the study.

Summary

Chapter 4 contained a comprehensive presentation of the findings from the data collection for this quantitative study. Comparisons of means and standard deviations as well as calculations of statistical significance using a paired samples t-test to compare the means were completed on any data that showed a benefit to students through an increase in weighted GPA or a decrease in attendance factors. Additionally, the data was organized by subgroups to review the potential effects of the adjusted school start time on students of different genders, grade levels, ethnicities, socioeconomic status, and special education status. Chapter 5 identifies the findings within each of the research questions, reviews the limitations of the data collection, and discusses the potential opportunities for school district secondary school start time changes and future research.

Chapter 5

The purpose of this dissertation was to evaluate the impact of changing secondary school start times on students in different educational subgroups including gender, grade level, ethnicity, socioeconomic status, and receipt of special education services. School districts were approached for participation based on information provided in the report from the Joint State Government Commission for the General Assembly of the Commonwealth of Pennsylvania in 2019. The districts that agreed to participate were asked to provide weighted GPA and attendance data for the school year prior and the school year following the decision to change secondary school start times.

The study is based on the theoretical framework of Cognitive Load Theory (Sweller, 1988) and the negative impact of an inadequate amount of daily sleep for adolescents on a student's ability to transfer knowledge from short-term to long-term working memory. Application of the theory to secondary school start time implies that a combination of the delayed melatonin release in adolescents and earlier secondary school start times impedes an adolescent's ability to obtain the nightly required amount of sleep. The lack of required sleep to maximize academic performance and social-emotional health has the potential for adverse effects on a student's attention and performance in the classroom, as well as overall attendance in school. Over time, the negative impact on student academic performance and attendance could have a compounding effect that delays a student's cognitive load ability compared to their peers and have a longer-term negative impact on a student's academic achievement and attendance.

The measurement of academic achievement in this study is based on weighted GPA, a generally accepted measurement across most secondary schools in the United States, and adds to existing research on the relationship between school start times and academic achievement

(Balkis et al., 2016; Barnes et al., 2016; Bastian et al., 2018; Bryant & Gomez, 2015; Gais et al., 2006; Owens et al., 2010; Wahlstrom et al., 2002; Wahlstrom et al., 2014; Wheaton et al., 2016). The study also contributes to prior research around the impact of changing secondary school start times on attendance (Bastian et al., 2018; Marx et al., 2017; Owens et al., 2010; Wahlstrom et al., 2002; Wahlstrom et al., 2014).

Key Findings

Research Question #1

The first research question emphasized the impact of changing secondary school start times on student academic achievement. In the study, 330 data points could have shown an increase in weighted GPA when considering gender, grade level, ethnicity, socioeconomic status, and receipt of special education services subgroups. This included marking period and full year academic achievement data for both participant school districts. The results showed 67 different instances had a benefit on students' weighted GPA when comparing the control and experimental year data. Out of the 67 data points that showed an increase in weighted GPA, 15, or 22.3%, were statistically significant. These 15 statistically significant data points represent 4.5% of the total available subgroup data. These rates of significance are less than the 70.3% rate shown in the study completed by Wahlstrom, et al. (2014). The primary differences in the results analysis between the two studies was Wahlstrom had six different participant districts and used only grade levels to group students for reporting purposes.

An analysis of the 67 data points that showed an increase in weighted GPA across the different subgroups revealed 21 ethnicity, 22 socioeconomic status, and 24 special education data points among the 67. Additionally, the gender breakdown was 41 female groups to 26 male

groups and the grade level data showed 13 instances from 7^{th} - 8^{th}, 10 from 8^{th} – 9^{th}, 6 from 9^{th} – 10^{th}, 12 from 10^{th} – 11^{th}, and 26 from 11^{th} – 12^{th}. Aside from making a general observation that an 11^{th} – 12^{th} grade female had the best probability of having an improved weighted GPA after the secondary time change, no other significant conclusions about secondary school start time change and academic achievement can be drawn from the study results. The overall data suggests that along with the lower percentage of statistical significance for data points in this study compared to previous research, the spread of data shows very little academic achievement benefit to any specific gender, grade level, ethnicity, socioeconomic, or special education status subgroup.

Research Question #2

The second research question explores the idea of changing secondary school start times and the impact on students' attendance. In the study, the researcher found 112 data points that showed a decrease in the mean number of absences or tardies out of a possible 430 instances among the grade levels and subgroups represented. Although 270, or 62.8%, of the 430 total attendance data points represented absences, they only made up 39, or 34.8%, of the 112 data points that showed a decrease in the mean. A decrease in the mean number of tardies for all grade levels and subgroups represented 73 out of a possible 112 data points, or 65.2% of the instances. The rate of statistical significance within the data for the attendance research question was similar to the outcome from the academic achievement research question. In the attendance data, only 20 out of a possible 112 data points were statistically significant, representing 17.8% of the data. In addition, those 20 statistically significant data points represented only 4.7% of the 430 total data points collected on attendance from both school districts for the research.

A comparison of the 112 data points that showed a decrease in the mean number of absences or tardy instances also showed similar results to the academic achievement research question. The research data showed no distinct positive impact on secondary students from any specific grade level, gender, ethnicity, socioeconomic status, or special education services subgroup. The 11^{th} - 12^{th} grade subgroup had 30 data points within the attendance data, while the other four grade level subgroups had between 18 and 23. The difference between female and male subgroups with a reduction in the mean number of attendance data points was split evenly at 56. Additionally, there were 41 instances of an ethnicity subgroup, 37 instances of a special education services subgroup, and 34 instances of a socioeconomic subgroup that had a decrease in the mean value of their attendance data, but these were all spread among the different categories inside each of the subgroups. Finally, while certain ethnicity subgroups were not represented in the number of times they showed a decrease in the mean value of their attendance data, they were also underrepresented in the overall demographics of the study, as shown in Tables 1 and 14.

Limitations of Findings

Several limitations occurred as part of this dissertation research, largely due to the timing and design of the study related to the COVID-19 global pandemic and the sample size of districts available to participate. In March of 2020, school districts across the United States were forced to stop in-person learning and transition to virtual instruction for the remainder of the school year due to the outbreak, infection rate, and illness severity of COVID-19. The immediate effect of this shift in learning was potentially impacted by factors that included student age, teacher training, access to high-speed internet, electronic devices, and digital academic resources that allowed or prevented the continuation of learning in a virtual environment. Districts and

communities that lacked adequate resources, both technological and financial, faced the greatest impediment to learning under these conditions. The global pandemic and the challenges that came with it continued into the 2020-21 school year, forcing districts to adjust instructional models and learning expectations, because of health and safety guidelines as well as potential learning loss connected to how the previous school year ended. The data collection for this study occurred during the COVID-19 pandemic and this had an impact on the number of districts willing to participate in the study.

In addition to the impact of COVID-19, the number of districts eligible to participate in the study was limited. The researcher used the 2019 report from the Joint State Government Commission for the General Assembly of the Commonwealth of Pennsylvania to identify school districts that had recently or at the time were considering an adjustment to their secondary school start times. This was the only recent and publicly available data on districts in the state of Pennsylvania that met the research criteria. With only 2.2% of districts in Pennsylvania eligible to participate in the study and the ongoing COVID-19 global pandemic, the results available from this study are limited by the subgroup demographics of the two districts who agreed to participate and submit data.

Recommendations for School Districts

The data that was made available for this research study did not provide enough evidence to make any conclusive decisions about secondary school start times and their positive impact on student academic achievement or attendance. Although this is the case, the research process for this study had limitations and the literature supports additional studies on changing secondary school start times. School districts and future researchers should continue pursuing an environment that promotes academic growth and social-emotional well-being for all students.

A daily recommended amount of sleep is essential to maintaining proper physical and mental health (Ohayon et al., 2017). The trend of starting school earlier than 8:30 a.m. started in the 1960s and has progressed to today, where over 46.1% of students across the United States start school before 8:00 a.m. (National Center for Education Statistics, 2017). This trend has potentially contributed to only about 34% of students age 18 self-reporting they get more than seven hours of sleep per night (Keyes et al., 2014). This is a disturbing trend given the American Academy of Pediatrics suggestion of eight and half to nine and a half hours of sleep per night for adolescents (2019). Given the research, the impact of sleep on adolescent physical and mental health should be enough for any school district to consider adjusting their secondary school start times, but the additional research, although inconclusive, around the academic achievement and attendance benefits, could be enough for more districts to consider the investment of time and resources around investigating the implications of pushing later their secondary school start times.

The transition to later secondary school start times does not happen without a potential negative impact to other parts of the school system or community. For this reason, the decision cannot be made in haste or without thoughtful consideration and participation from a variety of stakeholders. Districts are encouraged to engage with health professionals in their community and provide informational sessions on the sleep research benefits to adolescents. The conversations should include community members to understand how these changes can affect schedules for childcare, adult and student employment, clubs, sports, and other extra-curricular activities. Finally, the discussions to change secondary school start times should include district and school leaders from elementary and secondary levels, as these changes will most likely have

an impact on a variety of factors, including transportation, instructional time, and contractual time for staff across the school district.

Implications for Future Research

The research in this dissertation should contribute to a growing conversation on a variety of factors that potentially impact each individual student's academic achievement and social-emotional well-being. Students across the various educational subgroups that are represented in this study need the collective effort of the adults in their lives to regularly review and consider the learning environment established by the community. The learning environment should primarily focus on research-based decisions that are best for student development, while also considering the needs and input from the local community. Results from this study could lead to further research in the area of adolescent sleep, the impacts of school start time changes, and the mental health of adolescents. Additionally, more multi-year longitudinal studies on adolescent sleep and the positive impacts on all students, including a data analysis of the educational subgroups identified in this study, could benefit the educational community. The limitation of the demographics in the sample of this study necessitates further research on the topic of adolescent sleep and its impacts within urban communities and on students from various ethnic backgrounds.

Although this dissertation research contributed to the collection of data on adolescent sleep and its impact on various educational subgroups, it also raised additional questions for the researcher. Qualitative studies on changing secondary school start times could explore the social-emotional well-being of students from the student and teacher view-point. Further research should also explore the impact of school start times on attendance with students who use district transportation versus those who are regularly self-transported. Another area of investigation

could be the potential benefit of changing secondary school start times on the cumulative minutes of instructional time a student experiences before and after the change.

While the researcher focused on secondary school start times and the positive impact on academic achievement and attendance for this study, there existed within the data from these school districts additional trends worth mentioning as items for potential future research. The researcher noticed the consistent disparity between the weighted GPA of students on free/reduced lunch status and those who were identified as full pay. There also existed in the data a disproportionate *n*-count of males to females with IEPs when compared to the overall gender demographics of the school district. Finally, because of the timing of the data collection for this study, there exists the possibility to utilize the information as a contribution to the research around the impact of COVID-19 on student academic achievement and attendance.

Conclusion

The goal of this research was to contribute additional evidence around the study of changing secondary school start times and the impact on academic achievement and attendance. The researcher hoped to promote awareness and expand the data analysis of potential benefits on changing secondary school start times to various educational subgroups. While the study did not provide any conclusive results around benefits to students based on gender, grade level, ethnicity, socioeconomic status, or special education services, it does add to the existing research and encourages both future research on the topic and discussions by educational leaders within their communities.

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APPENDIX A

SUPERINTENDENT EMAIL

Dear Superintendent's Name,

Please consider this formal request to engage in a research study for the purpose of completing my doctoral dissertation with Millersville and Shippensburg University. I am studying secondary school start times and their potential impact on a student's academic achievement and attendance. Given the ongoing research on adolescent sleep, a student's social-emotional needs and the connections to academic and attendance data, I believe the findings of this study may provide administrators and other school district decision makers with additional research regarding the effect of adjusting secondary school start times to benefit adolescent students.

For the purpose of this study, I hereby request permission to:

1. Work directly with your information technology department, student information system administrator, and/or PIMS reporting contact to collect data about each student's gender, grade level, race, ethnicity, socio-economic status, special education eligibility, weighted grade point average, absences, and tardies during the first marking period of the school year prior to and immediately after SCHOOL DISTRICT NAME adjusted the start time of their secondary schools.

In the collection and reporting of this data, the school district and all students will remain anonymous and confidential. The data collection and transfer process will ***not*** include student names, district student numbers, or state identification numbers that would potentially allow for the specific identification of an individual student and their data.

Prior to beginning, the entire study will be reviewed and approved by the Institutional Review Board (IRB) of Shippensburg University. Your written approval using the attached consent form and confirming participation in the study is a necessary component of the review board process. When responding to confirm participation, please provide the name, phone number, and email address of the person in your district that I should contact to obtain the requested data. If necessary, I would be happy to meet or speak with you to further discuss details of this request. Please contact myself, my dissertation chair, or the IRB chair at the phone number or email below with any additional questions, before agreeing to participate and share data for this study. I thank you in advance for your consideration.

Sincerely,

Gregg R. Shulenberger, gshulenberger@gmail.com or (717) 945-9908

Dr. Alan Vandrew, Dissertation Chair, Associate Professor, Shippensburg University, ATVandrew@ship.edu or (717) 554-7181

Dr. Todd Whitman, IRB Chair, Shippensburg University, IRB@ship.edu or (717) 477-1654

APPENDIX B

SUPERINTENDENT CONSENT FORM

Informed Consent for School District

Title of project/study: The Impact of Later School Start Times on Adolescent Academic Achievement and Attendance

Principal Investigator's (PI) Name: Gregg Shulenberger

PI's University Affiliation and Title: Graduate Student, Doctoral Program in Educational Leadership

1. **Purpose of the research/study:** The purpose of this study is to understand how the decision by school administrators to adjust secondary school start times impacts adolescent academic achievement and attendance. The data will be analyzed for statistically significant changes among the whole student body as well as within subgroups including gender, race, ethnicity, socioeconomic status, and special education eligibility.

2. **Procedures to be followed:** Once consent to participate is signed and returned, the investigator will reach out to the primary data contact for the school district to discuss the data transfer. The school district will export gender, race, ethnicity, lunch status, eligibility for special education, IEP or 504, weighted GPA, number of days absent, number of days tardy, and total minutes tardy data of students in 7^{th}-11^{th} grade for the first marking period in the school year prior to the time change and the same data for all students in 8^{th}-12^{th} grade in the first marking period immediately following the secondary school start time change. Students who do not have a record in the first marking period of both school years should be removed. All identifying information including name and student ID number should be removed from the data file before being shared with the investigator. This information will be placed on two separate spreadsheets, one for each school year, and shared with the investigator using the templates provided.

3. **Potential risks or discomforts to participants:** Names of school districts will be changed to limit identification of specific district data. All data published will be organized by groups of students. No individual student identification information will be shared with the investigator.

4. **Potential benefits to participants:** Any district that agrees to participate will receive the statistical analysis of their data shared with the investigator. This will include calculation of statistical significance for changes of weighted GPA, number of days absent, number of days tardy, number of minutes tardy, and a data breakdown by subgroup from before and after the secondary school start time change.

5. **Duration/time requirement for participants:** The investigator estimates it will take approximately 1-2 hours for the data contact to extract, organize, and transfer the data from the district contact to the investigator.

6. **Confidentiality and anonymity protections provided to participants:**
   All data from the school district will be transferred via a shared document that will be copied to a password protected external drive. Once copied, the district can destroy the shared document. The original and backup copies of the external drive with the research data will be password protected and stored in a locked drawer. All data stored on these drives will not have individual student information that would allow for the identification or connection of a specific individual to their data.

7. **Contact information:** Gregg Shulenberger, gshulenberger@gmail.com, phone (717) 945-9908; Dr. Alan Vandrew D.Ed., Dissertation Chair, Associate Professor, Shippensburg University, ATVandrew@ship.edu, phone (717) 554-7181; and Dr. Todd Whitman, IRB Chair, Shippensburg University, IRB@ship.edu, phone (717) 477-1654.

8. **Voluntary Participation:** Participation in the study is voluntary and the Superintendent may choose to withdraw from the study at any time without penalty or continued use of the data supplied by the district.

9. **Eligibility:** As Superintendent, signing below consents to the sharing of the data outlined above with the investigator for the sole purpose outlined in this document.

I consent to participate in this study and may withdraw at any time.

_____ _____

Signature Date

_____

School District

APPENDIX C

CONTROL YEAR DATA TEMPLATE GRADES 7-11

Grade Level	Gender	Race	Ethnicity	Socioeconomic Status	Special Education Y/N	IEP/504	Student Days MP 1	Student Absences MP 1	Student Tardies MP 1	Student Days Year	Student Absences Year	Student Tardies Year	Weighted GPA MP 1	Weighted GPA Year

APPENDIX D

EXPERIMENTAL YEAR DATA TEMPLATE GRADES 8-12

Grade Level	Gender	Race	Ethnicity	Socioeconomic Status	Special Education Y/N	IEP/504	Student Days MP 1	Student Absences MP 1	Student Tardies MP 1	Student Days Year	Student Absences Year	Student Tardies Year	Weighted GPA MP 1	Weighted GPA Year