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# In Desperate Need of Sleep: Teenagers and School Start Times

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# In Desperate Need of Sleep:

# Teenagers and School Start Times

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## Abstract

School start times have the potential to be damaging to students academically. Several studies have linked sleep to the transfer of knowledge into long term memory, while others show how the lack of sleep is disruptive to learning. If school start times truly have an impact on the functionality of the teenage brain, educators should be doing everything in their power to make sure schools begin at a proper hour. The purpose of this study was to extend research done in other parts of the country, traditionally in urban areas, that attempted to show a link between student achievement and school start times. This study aims to compare two different schools, with comparable demographics, in hopes of extending the research to small, rural schools. Data from two rural schools were obtained, organized, and tested to see if there was a statistically significant difference between the average GPA of the two schools for the 2011-2012 school year. Graduation rates, or continuous enrollment, from the 2010-2011 school year were also analyzed in this study. The results showed a trend toward a difference in GPA between both schools, but no statistically significant difference was found. The school that had a later start time, however, did show a statistically significant higher graduation rate than the school that had an earlier start time.

*Keywords:* school start times, student achievement, graduation rate, teenagers, sleep, grade point average

## Introduction

It is no secret that most people find teenagers to be complex creatures. Until recently, parents and educators have believed that hormones and brain connectivity were the major factors in the typically odd adolescent behaviors such as risk taking, depression, indulgence, and selective memory. Within the last decade, several different scientists have begun to study the effects of sleep on student achievement, learning, memory, processing, and functionality. Several studies have, in fact, shown that sleep is a major factor in several aspects of student achievement. Without sleep the brain begins to experience the most critical kinds of stress, making any kind of functionality impossible. This begs the question, are parents and educators doing everything they can to make sure adolescents are getting enough sleep to function optimally? When we think about sleep, we tend think about what time teenagers are getting to bed. However, another crucial aspect of sleep is what time teenagers are expected to rise in the morning. Districts all around the nation are responsible for choosing school start times and bell schedules that make sense for their student population. With the new information surrounding sleep and the teenage brain, it is important to investigate whether schools and districts are really implementing the wisest school start time policies.

### Background and Need

Teenagers all over the United States seem to have more distractions and appear to be getting to bed at a later hour, but are still being expected to rise for school early in the morning. Sports activities, parties, employment, and technology exacerbate the issue of getting to bed at a reasonable hour. Sleep is not a priority, but it should be. Without enough sleep, teenagers have a hard time transferring learning into memory during REM sleep. Without enough sleep, teenagers have a hard time allowing each part of the brain to function with full efficiency.

Stories and studies all over the television and Internet communicate the consequences of inadequate sleep. Sleep deprivation can lead to long term health consequences, fatigue, mood disorders, life expectancy, confusion, and inability to focus (Drummond, 2006). Although most students do not appear to be severely sleep deprived, they still run the risk of functioning below a level of which they are capable. Without enough sleep, students are putting themselves at a real disadvantage when it comes to learning. However, school start times dictate at which hour students need to rise in the morning. In terms of brain functionality, educators should ask if these school start times make sense for our adolescent population.

One significant study in Minnesota, where two Minneapolis-area school districts decided to shift their start times from 7:20 to 8:30 and 7:15 to 8:40 showed significant increases in student achievement (Whalstrom, 2001). In an additional study, sleep expert Robert Vorona, along with several other researchers, Mariana Szklo-Coxe, Andrew Wu, Michael Dubik, Yukin Zhao, and CatesbyWare, (2011) compared high school start times (7:25AM and 8:40AM) to the number of teenage car accidents in two neighboring cities. Vorona found that the latter start time had a 41% lower car accident rate than the earlier. Studies are beginning to show just how critical sleep is for adolescents as related to academic achievement and overall safety.

The goal of educators, as it has been for centuries, is to help guide students into becoming responsible adults who are capable of contributing to society in a meaningful way. The way this 'capability' is measured is through student achievement, which can be measured through grade point average, as well as other factors such as attendance, standardized test score, and graduation. It is now becoming more evident that there are specific ways educators can help guide these students into success; techniques such as brain-based teaching provide one avenue to gear education toward teenage tendencies. Additionally, strategies such as collaboration between teachers and healthy food choices seem to be making a contribution to the academic success of teenagers. Now, with research emerging regarding sleep as a critical factor in academic potential, ensuring that students are getting enough of it has become yet another technique to enhance academic achievement. If sleep does, in fact, play a major role as is being suggested in current research, then there exists the possibility that simply pushing school start times back may help boost student achievement.

**Statement of Problem**

Recent studies have begun to expose exactly how critical sleep is for the brain. Since many researchers believe that the teenage brain is an even more fragile system than a fully developed brain, researchers are just beginning to understand how critical sleep is for the teenage brain. Researchers have started to compare school start times in order to determine whether or not sleep and school start times have a profound impact on student achievement. While some studies have begun to show just how critical sleep is for adolescents, educators need to analyze school start times in their own communities, so specific student needs can be met, and students can achieve at an optimal level.

**Purpose Statement**

The purpose of this study is to compare the school start times of two rural high schools in Northern California to see whether or not school start times actually have a significant impact on grade point average and graduation rates in our local high schools. While it is a reasonable assumption that sleep is critical for the brain to function optimally, scientists are currently arguing whether or not the amount of sleep teenagers are getting actually has a direct effect on student achievement. We know they sleep, we just don't know if they sleep enough, and whether or not that affects academic performance. If sleep does actually have an effect on student achievement, the question remains whether or not the correlation is significant enough for researchers and educators to say with a fair amount of certainty that it is possible to boost student achievement through means such as pushing back school start times.

**Research Question(s) and/ or Hypothesis**

How does school start time impact student grade point average and probability of graduation?

**Theoretical Rationale**

School start times may have a significant impact on student achievement because of the fragility of the teenage brain during adolescence. The brain is not only trying to build more meaningful pathways for the brain to communicate more effectively, it is getting rid of unused pathways, while trying to absorb as much new information as possible. In addition, there has been a relatively recent discovery that shows that adolescents experience a disruption to the normal sleep cycle. A disruption to the normal circadian sleep cycle, known as DSPS (delayed sleep phase syndrome), has caused adolescents to get to bed later (Wolfson & Carskadon, 1998). As a result, they may not be getting enough sleep to function optimally in school. In terms of processing, learning, remembering, and transferring knowledge into long-term memory, the brain is a very fragile system.

According to some studies, sleep is the single most important factor in transferring knowledge into memory. If learning is directly connected to student achievement, and we can assume that sleep is directly connected to learning, one can only assume that adequate sleep is directly connected to student achievement. School start times have become a target for researchers who believe that sleep is directly connected to student achievement. Since sleep itself cannot be manipulated to ensure that students are well rested for the school day, school start times have begun to be examined as a way to make sure teenagers are getting adequate sleep. However, just as there are those who believe that school start times hold the key to a more alert and engaged teenager, there are those scientists who disagree. While other scientists do believe that sleep is a critical factor in brain functionality, they also believe that school start times have no real effect on student achievement. Either way, the topic needs to be examined by many more researchers and schools before any definitive evidence can be discussed.

## Review of the Literature

As humans, we spend approximately a third of our lives sleeping, making sleep one of the most critical actions in which we participate on a daily basis (Max, 2010). Whether our brains function at an optimal level is largely dependent on the amount of sleep we get on any given night (Jones, 2011). Adolescents have it especially hard because of the changes going on in the brain during the teenage years. During adolescence, the brain undergoes pruning, insulating frequently used synapses (or pathways) in the brain with myelin to speed up the rate at which signals can be sent and also getting rid of, or pruning, unused synapses (Spinks, 2000). During sleep, the teenage brain is also spending significant amounts of energy transferring knowledge into long-term memory (Zhang, 2004). An issue that has come to light recently is whether or not students are actually getting enough sleep, or whether they are coming to school too ‘sleepy’ to be actively engaged in learning. School start time is one variable that could potentially be manipulated in order to ensure that teenagers are getting enough sleep for the brain to function at maximum potential.

### Review of Previous Research

The general research surrounding the issue of school start times is centered on how sleep affects the teenage brain and how sleep deprivation affects student achievement. Several researchers, which will be discussed in depth, focus on the inherent changes that occur during adolescence. For example, Howard-Jones (2007) state that during adolescence the neurons in a teenage brain are still in a state of semi-plasticity, making the argument that the teenage brain is going through a monumental shift in thought capacity. Then, other scientists found that 45.7% of teenagers report feeling sleepy during the daytime at least one day a week (Moore & Meltzer, 2008). To make this all relevant to the current predicament of school start times, researchers at the Minneapolis School District tied this all together by studying how a shift in school start times had the capacity to affect student achievement. Every single study that discusses the neurological changes in the teenage brain, how sleep affects the brain, and how school start times have the capacity to impact student achievement play a role in our understanding of what the most logical route is for teenage education.

**The teenage brain.** To understand how sleep affects the teenage brain, we first try to understand the teenage brain. This is no small feat. Through technological and behavioral methods, many scientists are just beginning to discover several intricate complexities surrounding the human brain. Relatively new technology such as MRI scans and PET imaging allow scientists to chart the oxygen and blood flow to different parts of the brain when participants experience certain situations (Eaglemen, 2007). Scientists have also looked at certain behaviors associated with brain activity. While some skeptics say that the information is too new and not yet proven, others speculate that the new information surrounding the developing teenage brain may be invaluable for educators. This means taking scientific information and trying to translate that into valuable instructional practices that would enhance the learning capacity for teenagers based upon what scientists have recently discovered about distinctive features of the teenage brain. At this time, scientists and educators can only speculate about how to best adapt education to suit the plasticity of the teenage brain.

**The teenage brain and education.** The human brain is an intricate structure. Scientists are still trying to answer fundamental questions about the human brain like "What are emotions?" and "Why do brains sleep and dream?" (Eaglemen, 2007). Studying an adult brain is an immense task, trying to navigate the fully developed avenues of thought and matter. However, trying to study a developing teenage brain is like trying to understand the infiniteness of the galaxy. The teenage brain is an enigma, full of questions, hormones, and flighty responses and scientists are just beginning to scratch the surface. Understanding the teenage brain would give a vast amount of people, parents and educators alike, great insight into how teenagers function and how we can best support the process of learning and development.

Previous studies conducted by researchers in the United States provide valuable information about emotional, social and cognitive aspects of learning for teenagers. For education, the cognitive aspects of the teenage brain become increasingly important. At what age are our students experiencing maximum potential for learning? How can we remediate learning difficulties in students? Why does making academic work meaningful actually help students learn? How will our knowledge of the teenage brain help us understand how to best reach our students academically?

One implication that new information about the teenage brain has for education concerns teaching strategies. Current teaching strategies do not seem to take full advantage of the teenage brain. In the book *Leading and Learning in Schools: Brain Based Practices* by Cram and Germinario (2000), the following is stated:

> "What we now know about the human mind suggests that many of our instructional strategies are inconsistent with the brain's natural tendencies. The teacher-centered and teacher-directed classroom activities commonplace in most schools use strategies that ignore the students' needs for input, engagement, processing, feedback, and the construction of personal meaning that are critical to how they learn." (p. 194)

For the teenage brain to mature, part of the learning process has to allow the teenage brain to make personal connections on its own. Instructional strategies can support this growth by taking the emphasis away from the teacher and placing it back on the students. According to researcher Pat Wolfe, teachers should be making subject matter meaningful to teenage students through "problems, projects, and simulations" and be "using the visual and auditor senses to enhance learning" (Wolfe, 2001). Scientific studies have found that the teenage brain is still in the process of making strong connections between different parts of the brain; the neuron transfer is still is a state of semi-plasticity (Howard-Jones, 2007). This information tells us that teachers should be facilitating these avenues of understanding through interactive problem solving and critical thinking rather than simple rote memorization. This also tells us that it would be more beneficial for teachers to reach students on emotional, experiential, visual, or auditory levels, levels with which they have more experience and are able to make more meaningful connections.

It is important for educators to understand that 'pruning' of inactive synapses occurs in early childhood, when synapses that aren't being used die off. In recent studies, scientists have found that a second round of 'pruning' occurs in the teenage brain (Wolfe, 2001). After puberty, myelination begins to occur (dendrites begin to be coated with myelin to increase information transfer) (Cohen, 2001). It is important to recognize that teenagers are beginning to make lasting and meaningful connections among experiences and information. Educators can use this information to understand that the brain of a teenager is being reorganized shortly after puberty and this is a vital time to shape growth and learning in teenagers. Blakemore, a scientist at the Institute of Cognitive Neuroscience, states:

> "Just as linguistically sensitive periods have been linked to synaptic pruning in very young children, continuing synaptic pruning in adolescence suggests the possibility of sensitive periods here too. For example, research has shown that teenagers activate different areas of the brain from adults when learning algebraic equations, and this difference has been associated with a more robust process of long-term storage that that used by adults." (p. 5)

This kind of research points to how the teenage years of the brain may be significant years in which to learn certain concepts. For educators, that means maximizing the learning potential of students by teaching concepts that their brain is developmentally ready to establish. As Rohwer states, " . . . early childhood may simply be an inefficient period in which to try to teach skills that can be relatively quickly learned in adolescence" (Rohwer, 1971, p. 105). Several studies involving mathematics have attempted to show that certain parts of the human brain that are used for abstract thought are not developmentally ready (have not been coated with enough myelin) to ensure favorable success with mathematics. For example, Healy (1991) shares a personal struggle with mathematics and what she learned about how her brain was struggling to comprehend the material. She goes on to explain that we are not always developmentally ready to comprehend abstract thought at the age we are expected to learn certain types of mathematics.

> "In this personal example, it is very possible that the necessary neural equipment for algebra – taught in this particular manner – may not yet have been automatically available in my early-adolescent brain. The areas to receive the last dose of myelin are the association areas responsible for manipulating highly abstract concepts – such as symbols (X, Y, Z; graphs) that stand for other symbols (numerical relationships) that stand for real things (planes, trains, wells). Such learning is highly experience-dependent, and thus there are many potential neural routes by which it can be performed. Trying to drill higher-level learning into immature brains may force them to perform with lower-level systems and thus impair the skill in question . . . ." (p. 69)

This statement points to the fact that as educators we may be expecting our students to produce more complex thought, which their brain may not be capable of producing efficiently. Scientific factors such as myelination, pruning, and plasticity all serve as indicators to help scientists determine what it actually means to be 'developmentally ready' to learn.

**Neurological responses.** The human brain is comprised of several different structures that perform different functions. We aren't born innately knowing the difference between right and wrong, mistakes and correct answers, or easy and difficult matters. These are things we learn. We learn these things by having repeated exposure to them. In the brain, this looks like a repeated transfer of information (electrical signals) through a neuron. A neuron is what sends the information through our brain. These neurons fire off information through different parts of our brain; the information passes from the neuron to small extensions of the neuron called dendrites. These dendrites then link up to other neurons through empty space called synapses. After repeated signals have been sent through these synapses, our brain starts to create an avenue for that information, lining up neuron to neuron. This is how the different parts of our brain are connected. Over time, synapses (avenues) that we do not use will die off, and synapses that we do use will become main avenues for information. The dying off of synapses is called 'pruning'. Pruning generally occurs during early childhood. Eventually, after puberty, synapses that last will become coated with a layer of myelin (fatty tissue) to increase the speed of signal sending, making decision making and processing a far more efficient process. (Monastersky, 2007).

In the article, "Who's Minding the Teenage Brain?" by Monastersky, 2007, scientist Beatriz Luna, an associate professor of psychiatry and psychology at the University of Pittsburgh, states, that in theory, "you can imagine that very quick neural transmission would allow something like the prefrontal cortex, which is really the conductor of the brain, to go out to different places and say, 'Hey partial cortex, or cerebellum, or temporal cortex, Come and help out so I don't have to do all the work and we'll be a real efficient machine.'"(p. 3) Since some pruning occurs during adolescence, teenagers are still in the process of creating and adjusting these efficient avenues for information.

The prefrontal cortex is the part of the brain that we use when we need to make a decision based on rapidly changing information. As Cohen and Miller (2001) state in the article "An Integrative Theory of Prefrontal Cortex Function", the prefrontal cortex is critical in the sense that "… we need to use the 'rules of the game', internal representations of goals and the means to achieve them." (p.226). In adults, the prefrontal cortex has already created these avenues to other parts of the brain to make understanding information and making decisions an easier process. In teenagers, the prefrontal cortex is essentially ‘on its own’. The prefrontal cortex is working on making these pathways, but already having them and working on making them are two completely different responses.

However, not only does the prefrontal cortex takes time to mature in teenagers, other parts of the teenage brain are kicking into full gear. In a study by Casey, director of the Sackler Institute for Developmental Psychobiology at the Weill Medical College of Cornell University, (as cited in Monastersky, 2007) there has been evidence to show that the nucleus accumbens, a specific part of the brain that responds to rewards and is closely linked to the release of dopamine, is functioning at full capacity. According to Casey, the nucleus accumbens “lit up” when the teenager came in contact with an object it deemed as a reward and “seemed particularly primed for big payoffs” (as cited in Monastersky, 2007). This was in contrast to adults who participated in the same study (as cited in Monastersky, 2007). The nucleus accumbens responds more in the teenage brain than in the brain of adults. This has dangerous implications for teenagers who are seeking rewards, or situations that give them a rush of dopamine.

In alternate studies, scientists have found that peers not only influence each other, but can have an impact on the way that a teenager views the situation. Berns is conducting experiments to see how social interactions affect teenagers. Scans of the teenage brain suggest that participants were not just changing their answers to go along with the group, but that "The group's responses were changing activity in the subjects' visual and perception regions, which suggests that other people can change the perception of what you can see," (Monastersky, 2007, p.3). Teenagers aren’t acting stupid, they are being very gullible or naive.

All these aspects of the teenage brain that make it even more of an enigma than a fully developed brain, still don't provide answers about what to do to help teenagers function more appropriately, and efficiently. Scientists believe that teenagers are more likely to respond to rewards and engage in situations that release an exorbitant amount of dopamine into their nucleus accumbens. Scientists speculate that they are not always actually influenced by people, but that their perception of a situation can change based upon the company they keep. Scientists make conjectures that some behaviors are not intentional; we know these things are part of the teenage brain. Now what does this mean for education? One thing that can be inferred from this information is that there are many changes going on in a teenage brain, that sleep is one significant necessity for the maturation of the teenage brain, and that if educators want teenagers to function optimally then they need to make sure teenagers are getting enough sleep.

**Sleep, knowledge, and memory.** The brain needs REM sleep in order to transfer knowledge into long-term memory. In 2004, Zhang published an article that addressed how knowledge is transferred into memory during sleep and how humans at different stages in life need different amounts of sleep to accomplish this process (Zhang, 2004). Newborn babies need upwards of 16 hours because they are filing and transferring every single new encounter into memory (Zhang, 2004). Teenagers need a great deal of sleep, 9 1/4 hours, in order to transfer all the new skills and knowledge they are acquiring at school into memory. The less sleep a teenager gets, the less likely they are going to be able to remember something that was taught to them the previous day, week, or even month.

The average high school begins its day at 7:25 am. This means, the average teen needs to go to bed at 9 pm in order to be well rested and to get up and get ready for school in the morning. Adults and young children sleep in a regular circadian rhythm; the more tired we become, the more pressure is put on our body to sleep. This pressure that gets put on our bodies comes from the amount of light outside. The pressure on our bodies to get to sleep is a secretion of melatonin in the brain (Zhdanova, 1995).

**Sleep patterns.** As in other facets of life, teenagers are unique concerning sleep patterns. Although some teenagers do maintain a regular circadian sleep pattern, there are those teenagers that begin to notice a disruption to their sleep cycle known as Delayed Sleep Phase Syndrome (DSPS) (Mindell, Owens, & Carskadon, 1999). With all the complexities surrounding the developing teenage brain, sleep remains a critical component to intellectual success.

A recent study found that 45.7% of teenagers report feeling sleepy during the daytime at least one day a week (Moore & Meltzer, 2008). As the brain undergoes myelination and pruning, it also undergoes a complex sleep pattern change in how and when melatonin is produced. There are two distinct stages of sleep that all humans undergo. The first is REM sleep in which humans transfer knowledge into long-term memory. The other is non-REM sleep, also called Stages 1, 2, 3 and 4. Stages 3 and 4 are distinctly referred to as slow-wave sleep and these two stages represent the deepest level of sleep (Mindell, 1999). Slow-wave sleep onset usually occurs between the first and third hour after a person falls asleep. Incredibly, slow-wave sleep decreases approximately 40% through adolescent development (Mindell, 1999). This is one possible explanation for the sleepiness that teenagers reported in the Moore study.

Additional research suggests that approximately 5-10% of teenagers suffer a circadian rhythm disturbance known as delayed sleep phase syndrome (DSPS) (Mindell, 1999). DSPS forces sleep onset and wake times to occur later than normal, because of a later onset of melatonin secretion in the brain (Gibson, 2005). According to the American Academy of Sleep Medicine, DSPS occurs more frequently in adolescents and young adults than in adults or children. If most teenagers are truly suffering from DSPS then they are most likely not getting to bed until 11 p.m. or later, making it extremely difficult for them to get up at 5, 6, or even 7, depending on when they need to catch the bus or get to school. A student who doesn't get to bed until 11 p.m. needs until at least 8:15 to get the 9 ¼ hours needed to function optimally at school. DSPS poses a great problem for teenagers who are required to be at school at 7:25 AM and end up sleeping through their first two classes. Teenagers suffering from DSPS also require additional sleep during the day; however, napping during the afternoon is highly improbably for high school students (Mindell, 1999). Most high school students simply do not have time to take a nap due to the probably that they hold down a job, play a sport, participate in a club, or simply have too many other responsibilities/activities in which they are engaged.

**Current studies on teenage sleep.** A cross-sectional survey of 2201 high school students in Ontario, Canada was done in 2005 to measure sleepiness, and to see if there was a correlation between sleepiness and a decrease in academic achievement and extra curricular activity (Gibson, 2005). The persons conducting the research measured sleepiness on the Epworth Sleepiness Scale (EES). In this study, eight factors (age, gender, week night sleep hours, consistent bed time pattern, staying up late to study, drinking caffeinated beverages after 6PM, smoking before bed, and eating before bed) were tested to see if there was a relationship with the Epworth score of each student. Five of the factors did show a statistically meaningful correlation with the Epworth score (Gibson, 2005). Overall, the study found that sleepiness did seem to have a detrimental effect on academic and extra curricular activities.

In order to study the effect that sleep has on student achievement, the Minneapolis School District changed seven high school start times from 7:15 a.m. to 8:40 a.m. The results of this study, published in the Minneapolis Public Schools Start Time Study Executive Summary, showed that attendance for all grades improved significantly statistically, continuous enrollment has improved significantly statistically, and grades improved slightly, but the difference was not statistically significant (Wahlstrom, 2001). This study served to expand on beliefs in the medical community that students need more sleep to function optimally at school. This study encompassed far more than changing start times, as it focused on impacts to student achievement (attendance, continuous enrollment, grades) and impacts on students, teachers, parents, administrators, medical researchers and the community (Wahlstrom, 2001).

Owens from the Hasbro Children's Hospital in Providence, Rhode Island, studied 201 high school students (grades 9-12) to see if school start time had an effect on the students overall 'sleepiness' and performance. Much to the irritation of faculty and coaches, Owens changed the school start time from 8:00 am to 8:30 am for only two months (January 6-March 6). Students completed a Sleep Habits Survey before and after the time change. During the study, students gained an average of 45 minutes of sleep time during weeknights. Owens noted several findings; daytime sleepiness, fatigue, and depression decreased; satisfaction with sleep in increased, as did the number of hours of sleep each student was getting per night. Amazingly, the percentage of students getting less than seven hours of sleep decreased by 79.4% (JAMA, 2010). Although she did not research academic performance related to the time change, students, coaches, and faculty alike decided to stay with the later school start time because of the positive impact it seemed to have on the students.

In an effort to compare standardized test scores to school start times, Edwards, an economist, looked at two different middle schools in Wake County, North Carolina. The school that started an hour later showed increases in standardized test scores; data showed approximately a 2.2 percentile points jump in math and a 1.5 percentile points jump in reading (Edwards, 2012). This data reaffirms the notion that more sleep has the ability to significantly impact test scores.

The Ann Arbor Public Schools School Board of Ann Arbor, Michigan met on April 26, 2012 to discuss the possibility to starting high school classes later. The district still needs to consult with parents and local experts to gather input, as well as do some further research into the sleeping patterns of teenagers (Arndt, 2012). This is just another example of how schools all over the nation are becoming more aware about the need for sleep and addressing the one factor, school start times, that could have a positive impact on our students.

**Summary of Major Themes**

There are several major themes associated with academic achievement for high school students. The functionality of teenage brain has a direct impact on behavior and achievement. The way that sleep affects the teenage brain has a large impact on translating knowledge into long-term memory. The ways that sleep patterns, and the disruption to sleep patterns, have the capacity to inhibit certain aspects of the teenage life. How school start times can specifically inhibit a teenager from getting the proper amount of sleep and therefore have a negative impact on long term memory, myelin formation, and consequently, achievement.

Medical researchers have relatively recently begun to realize the full impact that sleep has on adolescents (mostly the adolescent brain) and, as a result of this, so have educators. However, sleep in itself is not a concrete independent variable because so many things impact sleep on a nightly basis. The normal circadian sleep rhythm that children and adults experience, when the body puts more pressure on the mind to sleep as it stays awake longer and longer, has become disrupted approximately 5-10% of adolescents (Mindell, 1999). Typically, as the body and mind get tired, melatonin is secreted to regulate the sleep cycle and the wake cycle. In adolescents, the secretion of melatonin is delayed until at least 2 hours later. This causes a disruption is the adolescent sleep cycle, making the ability to wake up early for school difficult for some adolescents. As a result of this, school start times have come under scrutiny. What is the *real* reason we start school so early? Several studies have shown the later school start times lead to a statistically significant increase in attendance and continuous enrollment and although not statistically significant, later school start times have led to an increase in grade point average as well.

**How Present Study will Extend Literature**

All studies that have been conducted were organized in large, urban school districts. In order to examine whether or not the current theories surrounding sleep, student achievement, and school start times can translate into any school district in the nation, this study examines how sleep and school start times affect student achievement in small, rural schools. The more data there is surrounding this topic, the more sure educators and medical professionals can be that sleep is actually the major cause of attendance, continuous enrollment, and academic achievement. With this information, students can boost attendance and continuous enrollment, which is a major factor that exists in most of the local, rural school systems. The fact that California Standardized Tests is the major way academic achievement is being measured at the moment means that we need to be doing everything in our power to make sure students are achieving at their highest potential. If sleep is truly such a critical factor in academic achievement, it seems only fair that we examine the full scope sleep plays in our own community.

# Method

This study aims to determine whether a 45-minute difference in school start times makes a statistically significant difference in academic achievement, as portrayed by grade point average. Additionally, this study aims to determine whether the difference in school start times has an effect on continuous enrollment, as portrayed by graduation rates. If school start time does in fact have some correlation to student achievement, then student achievement would then be directly related to how much sleep students are getting; student achievement is the dependent variable and sleep the independent variable. In order to see if there is a correlation, data was analyzed from both schools including: school start times, demographic data, grade point average, and graduation rates.

## Sample and Site

The participants in this study were from two rural high schools in Northern California. These two schools were chosen because of the similarity in population characteristics such as: ethnicity, socioeconomic status, and number of English Language

Learners. As Table 1 shows, demographics of the two schools are comparable, making a comparison of the academic achievement meaningful. Demographics from each school were taken from the 2010-2011 School Accountability Report Cards from each school because of the time lapse between gathering data and publishing. Additionally, they were chosen because the start times of these two high schools differ most drastically than other high schools in the area (School A: 7:30 AM and School B: 8:15 AM). Both high schools serve freshman, sophomore, juniors, and seniors.

**Access and Permissions**

Both school principals, whose schools are participating in this study, gave the permission to access district information via email or over the phone. Public information published on School Accountability Report Cards (SARC) was obtained via Internet to compare the general information, or demographics, of each school. The IRB approved pursuing permission from each school district for personal school data. Specific information, such as graduation rates and grade point average for each student, was accessed through ongoing communication with each principal. Each student remained anonymous, even to the researcher. Data was sent to the researcher in excel spreadsheets with only information that contained raw GPA. One school did break down GPA by grade level, but that specific breakdown of data was not incorporated into this paper.

**Data Gathering Strategies**

Data from School A and School B from the 2010-2011 school year was analyzed. Copies of the School Accountability Report Card (SARC) of each school were downloaded from the Internet; the SARC is public record and every school's SARC is available via internet. The SARC publishes information like demographics, STAR testing data, number and salary of teachers, and types of curriculum. The researcher created a table to compare relevant demographics from each school. To see whether or not the two schools were similar enough to compare, the researcher conducted a significance of the difference between two independent proportions test, also known as the z-test. The researcher had to use data from 2010-2011 because of the accessibility of when data is published. The researcher gathered graduation rates off of the SARC for both schools as well.

Contact to both principals via email was then established with the intent to obtain more specific information from each school (grade point averages for each enrolled student for whom data was available from the 2011-2012 school year).

**Data Analysis Approach**

In this study, data was analyzed to find if there was a statistically significant correlation between school start times and grade point average. Additionally, data was analyzed to see whether or not there is a correlation between school start times and graduation rates. Two types of test were conducted in order to obtain a $*p<0.05$. A z-test, used to generate a p value when comparing data of two independent proportions, was used for the demographic data and the graduation rates. A *t*-test, used to generate a p value when comparing two sets of raw data, was used for the raw GPA data from each school.

Grade point average was used as an indicator for student academic achievement because GPA is used as a general measure of academic success for students nationally. CST scores were not used because of the potential factors that could influence a student's test scores (test is given once a year, test anxiety, etc.) Overall, grade point average appeared to be a more accurate indicator for student academic achievement.

Grade point averages for each student in each grade level were organized into a data spreadsheet. Using Excel, averages for GPA for each school were then calculated. Also using Excel, standard deviation for the entire sample for each school was also calculated. Then, a *t*-test was used to analyze how statistically different the GPA was for each school. The *t*-test gave us a t value, p value, degrees of freedom, and other critical pieces of information that were used to conclude if the data showed a statistically significant difference.

Graduation rates for the 2010-2011 school year were obtained and put into a separate spreadsheet. The significance of the difference between two independent proportions test, or z-test, was then conducted in order to see if the difference between the two rates was statistically significant.

**Ethical Standards**

This study adheres to Ethical Standards in Human Subjects Research of the American Psychological Association (Publication Manual of the American Psychological Association, 2009). Additionally, the project was reviewed and approved by the Dominican University of California Institutional Review Board.

## Findings

The first calculations that were performed served to identify whether or not the schools were similar enough to compare. Traditionally, researchers compare the start time change of one school. Since this study compared the start times of two different

Table 1

*Comparison of demographics of School A and School B*

School A and School B (2010-2011)

| School Info | Population of Students | % Hispanic students | % White Students | % Native American Students | % Other Students | % English Language Learners | % Socioeconom-ically Disadvantaged Students | % Students with Disabilities |
|---|---|---|---|---|---|---|---|---|
| School A | 1,491 | 36.4% | 52.2% | 6.1% | 5.3% | 25.9% | 58.2% | 12.5 |
| School B | 478 | 35.5% | 53.1% | 2.8% | 5.5% | 16% | 64.7% | 10.3 |

schools, demographic data (in terms of English language learners, socioeconomically disadvantaged students, and students of various ethnicities) needed to be compared to see if the schools were similar enough. The significance of the difference between two independent proportions test, or z-test, was then conducted in order to see if the difference between each statistic was small enough to discard.

Table 1

Next, the raw GPA data from each school from the 2011-2012 school year was used to calculate an average GPA for each school, as well as a standard deviation of the data for each school. Table 3, below, shows the results of this initial calculation. Once the average GPA and the standard deviation was calculated from each set of data, a *t*-test was conducted. The *t*-test gives the critical information of two-tailed p value, which gives the probability that something other than random chance could explain the result. A 95% confidence interval was used for this *t*-test. The results of the *t*-test indicated that because the two-tailed p value was 0.1145 that the difference in the means is considered to be not statistically significant.

Graduation rates were compared in order to determine if, in addition to GPA, school start times might have an effect on continuous enrollment. Based on the results, the p value was $<0.0002$. Recall that the p value has to be less than 0.05 for the difference to be statistically significant. The results show that the difference between the graduation rates is statistically significantly different. School B has a statistically significantly higher graduation rate than School A.

**Description of the Data**

The results of this test appeared to be relevant. Each piece of demographic data was compared separately, for example, the population of English language learners from each school was compared in one test, and then the other student population data was compared in subsequent tests. Each piece of demographic data was put through its own z-test to make sure that each piece of demographic data was similar enough to compare. The z-test was used to compute the z score, which served to reject the null hypothesis. The p value conducted in the z-test had to be under 0.05 for a statistical difference to exist between the data. Since each piece of demographic data was computed separately, there was a separate z score and p value for each piece of data. Four out of the seven categories had the following p values: 0.7226, 0.7331, 0.8634, and 0.1953. This data is also organized in Table 4, below. These p values show a large correlation between the four individual pieces of demographic data. The other three p values (0.0021, 0.0002, and 0.0218) do indicate a difference between the values. The majority of the demographic data was statistically similar, but a portion of the data was not statistically similar, making this a possible source of error.

Each piece of demographic data from both schools, excluding English language learners, socioeconomically disadvantaged students, and the population of students classified as ‘other’ in the ethnicity category, were statistically similar. As a result, the breakdown of students by ethnicity (excluding ‘other’) and students with disabilities were statistically similar. The population of English language learners, however, was statistically significantly different between the two schools. School A had 25.9% ELL students, while School B had 16%. Another result showed that the population of

Table 2

*Significance of Difference between Demographic Data*

*School A and School B*

| | Hispanic Students | White Students | Native American Students | Other Students | English Language Learners | Socioeconomically Disadvantaged Students | Students with Disabilities |
|---|---|---|---|---|---|---|---|
| **School A (1,491)** | 543 | 778 | 91 | 79 | 386 | 868 | 186 |

socioeconomically disadvantaged students was statistically significantly different between the two schools. School A had 58.2% SED student, while School B had 64.7%.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **School B (478)** | 170 | 254 | 12 | 26 | 77 | 309 | 49 |
| | | | | | | | |
| **Z Score** | 0.355 | -0.341 | 3.07 | -0.172 | 4.441 | -2.294 | 1.295 |
| **P value (One-Tailed)** | 0.3613 | 0.3666 | 0.0011 | 0.4317 | <0.0001 | 0.0109 | 0.0977 |
| **P value (two tailed)** | 0.7226 | 0.7331 | 0.0021 | 0.8634 | <0.0002 | 0.0218 | 0.1953 |

Table 2

Overall, the results showed that the two schools might be similar enough to compare because although there are statistically significant differences between a couple pieces of demographic data, the majority of the data is statistically similar. Additionally, among all the schools in the area, these two high schools have the most similar statistics.

Next, the data showed that School A and School B did have different average GPA for the 2011-2012 school year. School A, with the earlier schools start time of 7:30am, had an average GPA of 2.71. School B, with the later school start time of 8:15am, had an average GPA of 2.78. When a *t*-test was conducted, the p value was 0.1145. This showed us that although there was a difference between the average GPA of each school, the difference was not statistically significant. Since 0.1145 is on the lower side of the scale between 0.0-1.0, we can assume that the data is *trending* toward being different, although we cannot make the conclusion that it is statistically different. The P value found in this data represents the probability that random chance could explain the result; for the GPA data there is an 11.45% chance that the data could be attributed to random chance. There would have to be a 5% chance or less for the results to be statistically significant. The data we gathered, t(1968)=1.5771 and p=.1145(two tailed), indicated that the p value was not 0.05 or smaller, therefore we could not reject the null hypothesis.

Table 3

The null hypothesis exists in any experiment to be disproven. If the null hypothesis can be disproven, then the researcher can say that there was a statistically significant result. Conversely, if it cannot be disproven, the researcher must say the data showed there was no statistically significant difference between the data. Although the p

Table 3

*T-test Results for GPA*

*School A and School B*

| **Group** | **Group One (School A)** | **Group Two (School B)** |
|---|---|---|
| **Mean GPA** | 2.71 | 2.78 |
| **SD** | 0.851755 | 0.817543 |
| **SEM** | 0.02205110 | 0.03739355 |
| ***n*** | 1,492 | 478 |
| | **Two-tailed P value** | 0.1145 |

value is small, indicating that there is some, fairly observable, difference between the means, it is not statistically significant. The data appears to be trending toward showing a difference between the GPA of both schools, but the data does not support a rejection of the null hypothesis. While the results are trending toward being statistically significant, they are not close enough to be considered statistically significant.

School A and School B also showed a significantly significant difference in graduation rates for the 2010-2011 school year. The data shows School A with a graduation rate of 84.95% and School B with a graduation rate of 91.92%. Both of these figures are from the 2010-2011 school year. A z-test was also conducted with this data to see if the data was statistically significantly different. The z-test gave me a z score and a p value, which I could use to see if the two proportions were statistically significantly different from one another. The *t*-test resulted in a p value of <0.0002. The p value is much less than the 0.05 needed to show statistically significant difference. This indicated that graduation rates are statistically significantly different between the two schools for the 2010-2011 school year.

Table 4

*Graduation Rate Comparison*

*School A and School B*

| | **Gradation Rate %** | **Z Score** | **P value (two tailed)** |
|---|---|---|---|
| **School A** | 84.95 | -0.3901 | <0.0002 |
| **School B** | 91.92 | | |

Table 4

**Analysis of Themes and/or Inferential Analysis**

Overall, some themes did seem to emerge out of the data. First, when comparing two schools, it is important to realize that they are never going to be 100% similar. In this case School A had more English language learners and School B had more socioeconomically disadvantaged students. The important thing is that overall the two schools are mostly similar to one another.

Looking at the data that emerged from this study, the question of whether school start time had an impact on student achievement was examined. There did appear to be a trend toward a higher GPA in the school with the later start time. There was definitely a statistically significant difference between graduation rates; the school that began later had a statistically significantly higher graduation rate. The fact that there was a statistically significant difference between the graduation rates is a major theme. Analogous to the Minneapolis District Longitudinal Study, there was not a statistically significant difference between grades, but there was a statistically significant difference between continuous enrollment, or graduation rates.

## Discussion

The results showed that the p value found in the *t*-test comparing the GPA from School A and School B was 0.1145. This p value shows the difference between the GPA is not statistically significant. Therefore, we cannot accurately say that because School B starts 45 minutes later than School A, students achieve better based upon GPA data. Average GPA from School A was 2.71 and average GPA for School B was 2.78, but those two GPA do not differ statistically significantly from one another. The data does appear to be trending in that direction because the GPA are difference and the p value is approaching 0.05, but the results were not statistically significantly different.

The results of this study did not definitively support the argument that a later school start time would have a statistically significant impact on student achievement. Although we know that adequate sleep is an important tool for teenagers to function optimally, in this study, it does not appear to have a statistically significant impact on student achievement.

The graduation rates for the two schools were statistically significantly different. The p value obtained from the z-test conducted using the graduation rates from the two schools showed a p value of $<0.0002$. This means that School A, with a graduation rate of 84.95%, was statistically significantly less than School B, which had a graduation rate of 91.92%. This graduation rate could be a direct result of school start times. According to the Minneapolis District Longitudinal Study, graduation rates were one of the major factors affected by the time change; graduation rates increased as a result of a later school start time.

The results of this study appear to definitively support the fact that school start times have an impact on graduation rates. School B, which started later, had a statistically significantly higher graduation rate than School A. This study supports previous studies that have been done, showing that graduation rates are indeed impacted by school start times.

**Summary of Major Results**

The difference between the GPA from School A and School B from the 2011-2012 school year is considered not to be statistically significant. It cannot be said with certainty that School B, which starts later, has a statistically significantly higher GPA than School A; although the p value is such that the data appears to be trending toward that conclusion.

The graduation rate for each school is where the data showed a significantly significant difference between the data. School B, with the later school start time, had a statistically significantly higher graduation rate than School A. We can make the conclusion, then, that school start times had an impact on graduation rates as a measure of student achievement. The conclusion can be made that student achievement, in the form of graduation rates, was impacted by school start times in rural communities.

**Comparison of Findings with Existing Studies**

The other comparable study was the "Minneapolis Public Schools Start Time Study". This study showed that attendance for all grades improved significantly statistically, continuous enrollment improved significantly statistically, and grades improved slightly, but the difference was not statistically significant. The correlation between the two studies is based solely on the continuous enrollment and grades aspect, since attendance was not used as an indicator in this paper. In both studies, continuous enrollment was significantly statistically higher when schools began classes later. Additionally, grades were slightly higher in the school that began later, but it was not enough to be statistically significant.

The difference between the Minneapolis Public Schools Start Time Study and the study conducted in this paper is that the Minneapolis Schools District changed the school start time of seven high schools in the district. They were able to compare data from the same exact school, with only one independent variable, which was the school start time change. This made the results of the study point directly to the start time change as the reason why differences were observed in the schools. The study in this paper, though finding similar results, conducted the experiment using two different high schools. Although the two high schools were similar enough demographically, there may be other factors that accounted for the results.

**Limitations of the Study**

There were two major limitations in this study. The first was that there is a myriad of factors that could have an impact on student achievement other than sleep and school start times. The scope of the issues that could impact student achievement was huge, and there was no way to account for these potential factors. The second was that two different schools were compared. Although the result of the *z*-test showed that the two schools were overall not too statistically significantly different in terms of demographics, it would have been more consistent to use one school that had changed its' start time in order to eliminate the potential discrepancies between schools. Since three of the seven categories did show a statistically significant difference, this could have an impact on the way the results are interpreted.

**Implications for Future Research**

This study addresses the national question of whether or not our teenagers are getting enough sleep to function at maximum potential. This study has shown that even though there are several factors that could be inhibited the precise conclusion of this study, there is an overall trend that later schools start times do have an impact on student achievement. Future research has the capacity to replicate the Minneapolis District Longitudinal Study, or to compare two schools.

An addition could be data analyzed from more rural schools. Urban and rural schools function differently as a result of culture, environment, and several other factors. An expansion focused on rural schools that has the potential to impact school start time policies could expand the results of this study.

**Overall Significance of Study**

Overall, the significance of this study shows that school start times appear to have an impact on student achievement through graduation rates. School start times may have the potential to keep students from pursing alternative schools as means for graduation. The study shows that school start times are trending toward having an impact on grades through grade point average. Although the difference between the two schools regarding grade point average was not statistically significantly different, it was different. School B did have a higher average grade point average than School A. In conclusion, science tells educators what is best for the teenage brain, but it is going to take a lot more research and evidence before the answer is clearly known.

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DOMINICAN UNIVERSITY of CALIFORNIA 1890

August 31, 2012

Cristin Allen
30684 Pudding Creek Road
Fort Bragg, CA 95437

Dear Cristin:

I have reviewed your proposal (entitled, In Desperate Need of Sleep: Teenagers and School Start Times) submitted to the Dominican University Institutional Review Board for the Protection of Human Subjects (IRBPHS Application, #10028). I am approving it as having met the requirements for expedited review.

In your final report or paper please indicate that your project was approved by the IRBPHS and indicate the identification number.

I wish you well in your very interesting research effort.

Sincerely,

Martha A. Nelson

Martha Nelson, Ph.D.
Chair, IRBPHS

cc: Lisa Kelly

**Institutional Review Board for the Protection of Human Subjects**
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