HEALTHIER SCHOOL START TIMES

Report of the School Start Time Committee

Recommendations for addressing adolescent health and social-emotional well-being by adjusting school start times in Norwalk.

September 3, 2019
# TABLE OF CONTENTS

I. EXECUTIVE SUMMARY  
   Page 2

II. BACKGROUND AND RATIONALE  
   History and Background  
   Review of Research  
   Page 4

III. COMMITTEE PROCESS AND ACTIVITIES  
   Committee Charge  
   Implementation Deferral  
   Overview of Meetings  
   Transportation Review  
   Athletics  
   Surveys and Focus Groups  
   Page 10

IV. COMMITTEE RECOMMENDATION  
   Discussions of Model Analysis  
   Committee Consensus  
   Proposal for Districtwide Bell Time Schedules  
   Athletics  
   Financial Considerations  
   Timing  
   Page 19

V. IMPLEMENTATION  
   Data Collection  
   Class and Program Schedules  
   Transportation  
   Communication to Stakeholders  
   Page 22

VI. CONCLUSION  
   Committee Submission  
   Letter from Norwalk Pediatricians  
   Endnotes  
   Page 24

VII. APPENDIX  
   A. School Start Time Change: An In-Depth Examination of School Districts in the United States  
   B. The Case for Improving and Expanding Time in School: A Review of Key Research and Practice  
   C. Later School Start Times in the U.S.: An Economic Analysis  
   D. NPS School Start Time Survey Summaries  
   E. Sleep for Success Westport FAQs  
   Page 29
I. EXECUTIVE SUMMARY

For nearly 20 years, Norwalk Public Schools had little significant change in its school start times. Over that time, scientific knowledge has grown about adolescent biorhythms and the effects of early start times on the health and well-being of high school students. Scientists have learned that around puberty, adolescents’ biological clocks shift later, so that it is difficult for them to fall asleep before 11 p.m. or wake up before 8 a.m., even when they practice excellent sleep hygiene. Our current schedule does not work for teens because they naturally sleep on a schedule that is different from children and adults.

For adolescents, the benefits of obtaining the proper amount of sleep include improved academic performance, cognitive function, creativity, athletic performance and mental health. Adequately rested teens are also less likely to be injured, involved in car accidents, engage in substance abuse, or commit suicide.

Thousands of adolescents across the country have shifted to later school start times and the results show very clearly that, in spite of concerns that teens will simply stay up later, bedtimes either stay about the same or even shift slightly earlier in some cases.

Based on this science and a growing understanding of the importance of sleep, the American Academy of Pediatrics, American Medical Association, the Centers for Disease Control and Prevention, and the American Academy of Sleep Medicine have all recommended that high school start no earlier than 8:30 a.m.

Amid the growing awareness of the negative impact of early bell times on student physical and social-emotional health, the Norwalk Board of Education approved a 2018-19 Priority Implementation Step on school start times under its Strategic Operating Plan, directing the superintendent to: “Conduct a study and develop plans to address findings of the American Academy of Pediatrics and the Center for Disease Control concerning later high school start times.”

Dr. Steven Adamowski, superintendent of schools, convened a committee comprised of community members, parents, teachers, administrators, and medical experts, supported by a consultant in school district transportation. The committee met as a whole 11 times from November 2018 to June 2019.

Committee work included a comprehensive review of the health research and data; extensive parent, student and community outreach; discussions of the potential impact on athletics and afterschool activities; consideration of potential impacts on other grade levels; and a

---

**Current NPS School Start Times (2019-20)**

- Elementary: 8:15, 8:50 or 9:05 a.m.
- Middle Schools: 8:15 a.m.
- High Schools: 7:30 a.m.
thorough analysis of complex timing and transportation scenarios. Two dozen alternative models of transportation options were considered based on varying start times by grade levels. Metrics included bell times, elementary school groupings, morning and afternoon bus deployment by “tier,” total window of transportation and potential cost. The committee also reviewed a letter from Norwalk pediatricians, who have endorsed the AAP, AMA, and CDC’s policy statements on changing middle and high school start times.

Based on its comprehensive study of the issues, impact and alternatives, the NPS School Start Time Committee recommends shifting to a high school start time of 8:30 a.m., beginning with the 2020-21 school year.

The 8:30 a.m. model:
- Aligns with sleep study research by offering a full hour of extra time in the morning.
- Does not have a major impact on start times for other grade levels.
- Does not compromise the quality of athletics, arts and other afternoon programs.
- Can be implemented at a cost that falls well within the Board’s placeholder for a 2020-2021 transportation cost increase.

With an 8:30 a.m. high school start time, the current middle school schedule can be maintained at 8:15 a.m. No elementary school would begin prior to 8 a.m. and most would follow the 2019-20 schedule.

Based on current contract pricing, the estimated annual increase in transportation costs would be $457,000. As a result, the recommended model can be implemented at a cost that falls well within the original budget placeholder of approximately $732,000.

The committee recommends full implementation for the 2020-21 school year. A decision by the Board in September 2019 provides ample time for students, families and community members to be informed and to adjust accordingly. This timing also aligns with the end of the current bus contract, and gives the district sufficient planning time to insure a smooth transition and implementation. Each of Norwalk’s four high schools may use this planning period as an opportunity to align their schedules in a manner that enhances their unique program offerings.
II. BACKGROUND AND RATIONALE

HISTORY AND BACKGROUND

In 2018, recognizing that Norwalk had one of the shortest school days in the state, the Board of Education approved the addition of 30 minutes of increased instructional time at all 12 elementary schools. The additional time was implemented in two phases, with six schools adopting it in 2018-19, and the remaining six adding the time in 2019-20. Middle and high school start times remained the same, with Norwalk high school students getting on buses as early as 6:45 a.m. and beginning classes by 7:30 a.m.

Other than adding instructional time to the elementary day, Norwalk Public Schools had little significant change in school start times for nearly two decades. NPS had last adjusted school start times during the 2000-2001 school year, when the Connecticut State Department of Education mandated that the Norwalk Board of Education add 15 minutes to meet requirements for a minimum school day. Prior to this change, school start times in Norwalk had remained the same since approximately 1991.

In the meantime, knowledge was growing about adolescent biorhythms and the effects of early start times on the health and well-being of high school students. Scientific research has provided school policy makers nationwide with valuable data and health information to inform better decision making on school start times.

Several area school districts, including Wilton and Greenwich, were early adopters in Fairfield County, making the switch to a later high school start time for the benefit of their high school students. Since then, several other area districts have also implemented or started to discuss the topic, including Newtown and neighboring Westport.

“CONDUCT A STUDY AND DEVELOP PLANS TO ADDRESS FINDINGS OF THE AMERICAN ACADEMY OF PEDIATRICS AND THE CENTER FOR DISEASE CONTROL CONCERNING LATER HIGH SCHOOL START TIMES.”

Norwalk Board of Education
2018-19 Priority Implementation Step

Amid this growing awareness of the negative impact of early bell times on student physical and social-emotional health, the Norwalk Board of Education approved a Priority Implementation Step on school starts for the 2018-19 school year under its Strategic Operating Plan.
REVIEW OF RESEARCH

Sleep deprivation in teens is a public health epidemic

Through extensive research spanning decades, scientists, health professionals and other concerned adults have begun to understand fully how crucial sleep is to adolescent physical, mental and social health. They have also concluded that most teens are woefully sleep-deprived.

*While it may be tempting to place blame solely on poor habits such as the use of electronics for teens’ lack of sleep, there is clear evidence that factors out of teens’ control, such as biology and school schedules, play a key role in the health crisis facing today’s teens.*

Our teens are suffering under current conditions

It is common knowledge that our teens are more anxious than ever. Suicide, depression, substance abuse and accidents factor into a teen’s world now in a way that they never did. With the stress of current competitive educational demands, our teens lives are riddled with anxieties and pressures.

Sleep deprivation increases the likelihood teens will suffer a wide range of negative consequences, including an inability to concentrate, poor grades, substance abuse, drowsy-driving incidents, anxiety, depression, thoughts of suicide and even suicide attempts.

Our current schedule does not work for teens because they naturally sleep on a schedule that is different from children and adults. It may not seem logical, but it is biological.

Scientists have learned that around puberty, adolescents’ biological clocks shift later so that it is difficult for them to fall asleep before 11 p.m. or wake up before 8 a.m., even when they practice excellent sleep hygiene.

Two main biological processes affect sleep: (1) the circadian rhythm, which is a hard-wired “clock” in the brain that controls the production of the sleep-inducing hormone melatonin, and (2) pressure to sleep, which builds over time while we are awake and dissipates as we sleep.  

When teens go through puberty, both of these biological processes change. First, their circadian rhythm shifts later. An adolescent’s body does not begin producing melatonin until around 11:00 p.m. and continues to produce melatonin until at least 8 a.m. Second, pressure to sleep builds more slowly during waking hours so that adolescents don’t feel sleepy until later at night.
Due to both of these purely biological changes, teens’ natural sleep time shifts later by at least two hours to 11:00 p.m. As teens progress into early adulthood (early to mid-20’s), their sleep cycle moves back to the earlier pattern it had followed before puberty.

This sleep-phase shift is a universal phenomenon of human development. It affects teenagers around the world, regardless of parenting methods, technology use, or sleep habits; even adolescents in pre-industrial cultures without cell phones or computers develop the same sleep-cycle delay.

As prehistoric humans evolved, they tended to live in extended family groups, and the adolescent sleep phase shift ensured that some family members would be naturally alert at different times in order to help protect the group. This change is not limited to humans, as scientists have observed the very same sleep shift at puberty in other species.

Along with naturally keeping later hours, teens also need more sleep than adults. Teens need 8 to 10 hours of sleep per night, and the average sleep need for teens is around 9 hours per night. This makes 7:30 a.m. the earliest time that teens should wake up in the morning.

Even if they are able to wake up earlier, because teens’ bodies keep producing the sleep hormone melatonin until at least 8:00 a.m., our adolescents are not primed for learning until after this time.

In fact, by waking up our adolescents prior to 7:30 a.m., we are taking away at least one full REM cycle each night, and this sleep stage is very important. Both physical repair and learning take place during sleep, and particularly during the REM phase of sleep, the brain consolidates and practices what the student learned during the day, forms long-term memories, and connects and prunes synapses in ways that improve daytime concentration, mathematical capacity, logical reasoning, complex thought, organization, and creativity.

Based on the science and a growing understanding of the importance of sleep, the American Academy of Pediatrics, American Medical Association, Centers for Disease Control and Prevention and American Academy of Sleep Medicine have all recommended that high school start optimally at 9:00 a.m., but no earlier than 8:30 a.m.

In one paper, the author explained that the sleep shift is biological and cannot be changed; we must push back the timing of our teens’ school schedule instead:

“In adolescence and early adulthood, optimal wake and sleep times are shifted 2-3 [hours] later in the day, and yet this group are still required to conform to education start times more appropriate to young children and older adults.
Traditionally, institutions have tried to tailor the humans to the organization, but research suggests that, at least as far as time is concerned, it is more **efficient, productive, and humane** to align the organization’s schedules to the natural time patterns of the humans who study and work in them.\textsuperscript{17}

In Norwalk, high school begins at 7:30 a.m. and busses pick up students as early as 6:30 a.m. This schedule is analogous to having adults leave home at 4:00 a.m. every weekday to start work at 5:30 a.m. \textsuperscript{1, 15, 16} Would the average adult perform well or be pleasant to live with under those circumstances? Would most adults be alert enough to drive safely or mentally healthy enough to make good decisions under such a schedule?

In short, our teens’ sleep needs and sleep cycles are fundamentally, biologically different from adults, and while starting work at 7:30 a.m. seems reasonable for adults, it is not healthy for high-school aged children. Later school start times would reduce the mismatch between adolescents’ developmental biological drive toward later bedtimes and wake times and Norwalk’s current school schedule. Additionally, later start help get their days off ready to learn and to benefit from the excellent education offered by our district’s schools.

**Shifting school start times later works because students do end up sleeping more**

Thousands of adolescents have shifted to later school start times and the results show very clearly that, in spite of concerns that teens will simply stay up later, bedtimes either stay about the same or even shift slightly earlier in some cases.\textsuperscript{5, 19, 20, 23, 24, 25, 25A, 25B.}

Out of the 11 studies published on this issue as of May 2016, weekday bedtimes stayed the same in 11 studies, and in two studies, students reported slightly earlier bedtimes.\textsuperscript{17} At the same time, students are using the extra time in the morning to sleep, which means that delayed school start times do accomplish the goal of increasing sleep duration for adolescents.\textsuperscript{17, 22, 23, 24, 25} In fact, researchers have determined that, as opposed to parenting methods, academic workload, and extracurricular activities, school start time has the single largest effect on how long adolescents sleep each night.\textsuperscript{18}

In Wilton, CT, for example, the high school start times moved later by 40 minutes from 7:35 a.m. to 8:15 a.m. In a follow-up study, students reported getting an average of 35 extra minutes of sleep per night.\textsuperscript{21} Likewise, in a four-year study of over 12,000 secondary school students in Minnesota, start times were pushed later by an hour. The students continued to go to bed at around the same time - even four years later - and got an extra hour of sleep each night. As the head researcher of this study explained, “this is contrary to the fears and expectations that a later start would result in students staying awake an hour later on school nights. Instead, students in Minneapolis high schools get 5 more hours of sleep per week than do their peers in the schools that start earlier in the day.”\textsuperscript{22}
Later start times have repeatedly been proven to benefit students in a wide variety of ways

For adolescents, the benefits of obtaining the proper amount of sleep include improved academic performance, cognitive function, creativity, athletic performance and mental health. Adequately rested teens are also less likely to be injured, involved in car accidents, engage in substance abuse, or commit suicide.

The University of Minnesota published a study that demonstrates that later high school start times improve student grades and overall health. “The three-year project, using data from more than 9,000 students attending eight high schools in three states, found that, when switching to a later start time:

- Attendance, standardized test scores and academic performance in math, English, science and social studies improved.
- Tardiness, substance abuse, symptoms of depression, and consumption of caffeinated drinks decreased.

A more recent study in Seattle found that later high school start times decreased sleepiness and increased grades. 26

Later start times can have an even greater positive impact on disadvantaged students

In a recent study of two high schools in Seattle that moved their start time later, the later school start led to decrease in sleepiness and better grades in both schools, and a marked increase in punctuality and attendance in the economically disadvantaged school. 26

Essentially, the incidence of both absences and tardiness in the economically disadvantaged school dropped to the same, lower, levels as those in the more advantaged school. As we know, attending school and arriving on time to school is fundamental and crucial for learning. This result suggests that delaying high school start times could help decrease the achievement gap between lower and higher socioeconomic groups.

Given Norwalk’s relatively high rates of chronic absence and tardiness compared to the state, such a measure could be particularly beneficial for our district, even more so than nearby, wealthier communities that are also considering making this change.

Moving start times later is a fiscally sound choice

- A 2017 RAND Corp. study examined the issue from a public policy perspective. The study’s findings demonstrate the significant economic gains resulting from the delay in school start times over a relatively short period of time following the adoption of the policy change.
- The study suggested that the benefits of later start times far outweigh the immediate costs. Even after just two years, the study projected an economic gain of $8.6 billion to the US economy, which would already outweigh the costs per student from delaying school start times to 8:30 a.m.
- After a decade, the study showed that delaying schools start times would contribute $83 billion to the US economy, with this increasing to $140 billion after 15 years.

Norwalk students need us to act now on their behalf

As a public health epidemic, widespread sleep deprivation needs to be taken as seriously as any other serious health issue. When mold, asbestos or other health risks threaten the health of our students, we do not argue about the cost. The health and safety of our students needs to continue to be our primary goal, always.

To make sure adolescents get the 8 to 10 hours of sleep that they need given this shift, the American Academy of Pediatrics (AAP), American Medical Association (AMA), American Academy of Sleep Medicine (AASP), and Centers for Disease Control and Prevention (CDC), have all stated that adolescent students should start no earlier than 8:30 a.m.

Moving start time later will not solve all of the challenges faced by Norwalk students, but it is an essential piece of the puzzle in Norwalk’s efforts to close the achievement gap, and removes a self-imposed barrier to learning.

Norwalk's pediatricians have signed a letter endorsing the AAP, AMA, and CDC’s policy statements, “grounded in broad medical and scientific consensus,” that state that changing middle and high school start times to 8:30 a.m. or later is a “necessary public health measure.” Although sleep has historically been viewed as a luxury that most people cannot afford, we now know better.
To fulfill the Board’s Priority Implementation step for 2018-19, Dr. Steven Adamowski, superintendent of schools, convened a committee comprised of community members, parents, teachers, administrators, and medical experts, supported by consultants in school district transportation.

### Norwalk School Start Time Committee

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jacqueline Aarons</td>
<td>Brien McMahon HS Assistant Principal</td>
</tr>
<tr>
<td>Dr. Sasha Carr</td>
<td>Silvermine Elementary Parent, Psychologist &amp; sleep coach, Off to DREAMLAND</td>
</tr>
<tr>
<td>Dr. Frank Costanzo</td>
<td>NPS Chief of School Operations</td>
</tr>
<tr>
<td>April Guilbault</td>
<td>Norwalk High Parent, School Governance Council</td>
</tr>
<tr>
<td>Maureen Ireland</td>
<td>Norwalk High Math Department Chair</td>
</tr>
<tr>
<td>Rob Karl</td>
<td>Norwalk High Teacher</td>
</tr>
<tr>
<td>Heidi Keyes</td>
<td>Norwalk Board of Education</td>
</tr>
<tr>
<td>James MacDonald</td>
<td>Brien McMahon HS Parent, School Governance Council</td>
</tr>
<tr>
<td>Joseph Madaffari</td>
<td>Brien McMahon HS Athletic Director</td>
</tr>
<tr>
<td>JoAnn Malinowski</td>
<td>NPS Nurse Coordinator</td>
</tr>
<tr>
<td>Dr. Jennifer Masone</td>
<td>Wolfpit Elementary Principal</td>
</tr>
<tr>
<td>Jimi Napoli</td>
<td>Norwalk High Parent, School Governance Council</td>
</tr>
<tr>
<td>Tanika Vellucci</td>
<td>Brien McMahon HS Teacher</td>
</tr>
<tr>
<td>Brenda Wilcox Williams</td>
<td>NPS Chief Communications Officer</td>
</tr>
<tr>
<td>Johanna Zanvettor</td>
<td>NPS Transportation Coordinator</td>
</tr>
<tr>
<td>Justin Zerega</td>
<td>Brien McMahon HS SPED Department Chair</td>
</tr>
<tr>
<td>Tom Platt, Griffin Scott</td>
<td>School Bus Consultants</td>
</tr>
<tr>
<td>Dr. Steven Adamowski</td>
<td>Convener</td>
</tr>
</tbody>
</table>

### School Start Time Committee Charge

At the initial meeting of the School Start Time Committee on November 29, 2018, Dr. Adamowski reviewed the following charge with committee members:
1. Review and distill medical/psychological research and evidence on student well-being in relation to high school start times for dissemination to parents and staff.
2. Determine impact and potential solutions concerning athletics, after-school activities and childcare.
3. Survey parents and high school students concerning aspects of changing school start times including timing of implementation; conduct at least one focus group of students and one of parents at each high school on the topic of later high school start time.
4. Review relevant District contracts to determine any potential financial impact of changing school start times.
5. Develop, with the assistance of School Bus Consultants, a cost neutral solution for school start time adjustments and a preferred solution (if they are not the same).
6. Keep stakeholders (parents, students and staff) appraised of the committee’s work and pending recommendations.
7. Make specific recommendations to the Board of Education regarding school start time adjustments including transportation and timing of implementation.

**Implementation Deferral**

As the Committee began work, the expectation was that a change to school start times could potentially take place beginning in 2019-20. A placeholder of $732,000 was included in the 2019-20 proposed budget with that timing in mind. In January 2019, the Board removed the $732K line item from the proposed budget, deferring implementation until 2020-21.

The School Start Time Committee viewed the delay as “silver lining,” as it gave the Committee additional time to complete a thorough review of the health research and data; conduct extensive parent, student and community outreach; analyze complex timing and transportation scenarios; and provide sufficient advance notice and planning time before implementation.

**Overview of Meetings**

The School Start Time Committee as a whole met 11 times since convening in November 2018:

- November 29, 2018
- December 13, 2018
- January 10, 2019
- January 24, 2019
- February 7, 2019
- February 21, 2019
- March 21, 2019
- May 2, 2019
- May 16, 2019
- May 30, 2019
- June 6, 2019
Early meetings were dedicated to reviewing reports and data on the importance of adequate sleep for school age children. The Committee carefully analyzed the negative ramifications that can occur when students do not get the proper amount of sleep. Studies reviewed and discussed included the following:

- “Sleep and Adolescents” by Dr. Jennifer Kannan, Assistant Professor of Medicine, Department of Pulmonary, Critical Care and Sleep Medicine, University of Connecticut School of Medicine. The discussion included additional comments from committee member Dr. Sasha Carr, licensed psychologist and certified family and child sleep coach.
- “School Start Time Change: An In-Depth Examination of School Districts in the United States,” published by the Children’s National Medical Center’s Blueprint for Change Team. (Appendix A)
- “The Case for Improving and Expanding Time in School,” published by the National Center on Time and Learning (Feb. 2015) (Appendix B)
- “Later School Start Times in the US: An Economic Analysis,” published by the RAND Corp. (Appendix C)
- Information and data from the Adolescent Sleep Health and School Start Time Conference, facilitated by Board of Education member Heidi Keyes, who attended the conference.
- Reports outlining experiences and information from other school districts, including what worked and what did not. (See Appendix E for a local example)

As the Committee identified areas it wanted to know more about, discussions evolved and covered a range of subjects. School leaders and subject matter experts were also invited in to speak with the Committee about their areas of expertise. Topics included:

- High school scheduling options, including benefits and drawbacks related to rotation of periods, flex periods and the extension of the school day (Denver Plan).
- Local health and wellbeing concerns with Dr. Norman Weinberger, pediatrician and medical advisor to Norwalk Public Schools.
- Athletic implications, presented by Committee member and Brien McMahon High School Athletic Director Joe Madaffari. Mr. Madaffari presented data about the number and percent of student athletes by school, participation by sport and participation by season. He also educated the Committee about FCIAC schedules and travel to away games and competitions.
- A panel discussion with high school leaders, including Brien McMahon Principal Scott Hurwitz, Norwalk High Principal Reginald Roberts, Center for Global Studies Director Julie Parham, and P-TECH Norwalk High Director Karen Amaker
- A review of current student bus ridership in Norwalk, facilitated by committee member and Transportation Coordinator Johanna Zanvettor.
- Norwalk traffic patterns and volume with Kathryn Hebert and Mike Yeosock of the Norwalk Department of Public Works. This topic was a suggestion out of the elementary parent focus group.
Transportation Review

Connecticut state law requires school districts to provide transportation for all school-age children whenever it is “reasonable and desirable” [CGS 10-220(a)]. In general, this requirement is limited to transportation to public and certain nonprofit, private schools located within the school district or city limits. The only out-of-district transportation that school districts must provide is for students attending state technical high schools and district-designated regional agricultural science and technology centers.

The law requires boards of education to furnish, by transportation or otherwise, school accommodations so that each child five years of age and over and under age 21 who has not graduated from high school or vocational school who may attend public school [CGS 10-186(a)].

The State of Connecticut provides policy guidelines to each board of education, but districts have discretion whether to use them. Guidelines recommend that districts consider the following in developing their policies: (1) a student’s age, (2) the walking distance to school, and (3) the existence of hazardous conditions. NPS has adopted the following State guidelines as policy for Norwalk transportation eligibility: for grades K - 3, 1 mile; grades 4 -8, 1.5 miles; grades 9 - 12, 2 miles. This distance is determined from the property line of a student’s home, shortest distance to the property line of the school.

NPS currently transports to 2 High Schools, 4 Middle Schools, 12 Elementary Schools, 1 Parochial and 1 Charter School, within city limits. In addition, we are required to provide transportation out-of-town to 1 Vocational Technical, 1 Vocational Agriculture and 1 Intra District Magnet program; all located in Stamford. NPS currently operates 49 Type I (large) school buses and 17 Type II (small) school buses with almost 200 scheduled routes. District transportation services approximately 7,700 students (plus 350 special needs students on door-to-door transportation).

The earliest scheduled bus pickup in Norwalk currently are as follows: for high school 6:27 a.m. public/6:16 a.m. nonpublic; middle school, 7:17 a.m. public/6:36 a.m. nonpublic; elementary school, 7:20 a.m. public/6:36 a.m. nonpublic. The latest afternoon drop offs are for elementary schools: 4:30 p.m. public/4:15 p.m. nonpublic. The average scheduled in town route time of 35 minutes.
The following chart represents the total number of typical students scheduled to ride for the 2018/19 school year:

**Table 1: 2018-19 Eligible Bus Ridership**

<table>
<thead>
<tr>
<th>School</th>
<th>Gr</th>
<th>Public Schools</th>
<th>Non Public Schools</th>
<th>Total Number By Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>High School</td>
<td>9</td>
<td>659</td>
<td>41</td>
<td>700</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>657</td>
<td>36</td>
<td>693</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>524</td>
<td>43</td>
<td>567</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>534</td>
<td>33</td>
<td>567</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2,374</td>
<td>153</td>
<td>2,527</td>
</tr>
<tr>
<td>Middle School</td>
<td>6</td>
<td>548</td>
<td>48</td>
<td>596</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>538</td>
<td>66</td>
<td>604</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>530</td>
<td>48</td>
<td>578</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,616</td>
<td>162</td>
<td>1,778</td>
</tr>
<tr>
<td>Elementary School</td>
<td>K</td>
<td>518</td>
<td>49</td>
<td>567</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>501</td>
<td>56</td>
<td>557</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>491</td>
<td>56</td>
<td>547</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>539</td>
<td>58</td>
<td>597</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>538</td>
<td>46</td>
<td>584</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>493</td>
<td>58</td>
<td>551</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,080</td>
<td>323</td>
<td>3,403</td>
</tr>
<tr>
<td><strong>Total Number of Students Scheduled</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>7,708</strong></td>
</tr>
</tbody>
</table>

Throughout the Committee’s work, Griffin Scott of School Bus Consultants provided more than two dozen alternative models of transportation options, based on varying start times by grade levels. Metrics included bell times, elementary school groupings, morning and afternoon bus deployment by “tier,” total window of transportation and potential cost. The Committee requested multiple revisions and different alternatives as input was gathered.

**Athletics**

Brien McMahon High School Athletic Director Joe Madaffari educated the Committee about aspects to consider regarding student athletes throughout the district. At the Committee’s December meeting, Mr. Madaffari reviewed the total number of eligible student athletes at each school. Brien McMahon HS had 619 unique student athletes in 2017-18, the last year that full student data was available at the time of discussion. Norwalk High had 618 athletes over the same period.
Table 2: 2017-18 Student Athlete Eligibility: Norwalk High School (25 sports, 3 seasons)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
<th>Athletes Per Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>9th</td>
<td>166</td>
<td>143</td>
<td>309</td>
<td>Fall: 357</td>
</tr>
<tr>
<td>10th</td>
<td>109</td>
<td>100</td>
<td>209</td>
<td>Winter: 206</td>
</tr>
<tr>
<td>11th</td>
<td>112</td>
<td>85</td>
<td>197</td>
<td></td>
</tr>
<tr>
<td>12th</td>
<td>110</td>
<td>60</td>
<td>170</td>
<td>Spring: 322</td>
</tr>
<tr>
<td></td>
<td>497</td>
<td>388</td>
<td>885</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: 2017-18 Student Athlete Eligibility: Brien McMahon HS (24 sports, 3 seasons)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
<th>Athletes Per Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>9th</td>
<td>146</td>
<td>156</td>
<td>302</td>
<td>Fall: 349</td>
</tr>
<tr>
<td>10th</td>
<td>126</td>
<td>103</td>
<td>229</td>
<td>Winter: 237</td>
</tr>
<tr>
<td>11th</td>
<td>131</td>
<td>67</td>
<td>198</td>
<td></td>
</tr>
<tr>
<td>12th</td>
<td>107</td>
<td>74</td>
<td>181</td>
<td>Spring: 358</td>
</tr>
<tr>
<td>Totals</td>
<td>510</td>
<td>400</td>
<td>910</td>
<td></td>
</tr>
</tbody>
</table>

A change in school start time would not impact team practices or home games. However, away games might lead to early dismissals from class, in cases where the opposing team is from a school with an earlier start time. Norwalk’s geographic location in the center of the FCIAC puts Norwalk in a better position compared to other districts at the far end of the athletic conference. Based on the number of scheduled away games anticipated for the full school year, Mr. Madaffari projected that a 45 minute early dismissal at 2:30 pm might be needed for 25-30% of games. It was estimated that for the one-third of students who participate in a sport, early release from class would be necessary once every three weeks during the season the sport was held. Mr. Madaffari relayed that athletic directors could work with others in the FCIAC to schedule Saturday games where feasible and to adjust scheduling where possible to reduce this further.

Surveys and Focus Groups

The School Start Time Committee conducted surveys and attended focus groups at the elementary, middle, and high school levels. The feedback from the focus groups generated a great deal of discussion and included transportation, budget, school bell schedules, and the impact on younger students. Parent, student and community input helped guide the Committee’s consideration of certain models, and is ultimately reflected in the final recommendation. See Appendix D for presentations on parent and student surveys.

Summary of Parent Survey

A parent survey helped inform the Committee about the issues that Norwalk parents considered most important to the school start time discussion. Survey questions were drafted
using a model that Newtown Public Schools had used successfully with their community. The Committee discussed the first draft in a meeting and recommended revisions and additional questions. The Committee also requested to include all parents for feedback from all grade levels, not just from high school parents.

The survey was subsequently distributed electronically in both English and Spanish to all parents at NPS, and reinforced through the district newsletter. The survey remained open for over three weeks, with a total of 1,070 responses received. All schools were represented, including All Saints and Side-by-Side. Responses were received across all grade levels, including high school (29%), middle school (21%), Elementary (43%) and PreK (7%).

Of the respondents:
- Parents overwhelmingly agreed that the impact of sleep deprivation on student physical safety and mental health was Important or Very Important.
- 75% felt that the schedules for school sponsored after-school activities was Important or Very Important to consider; 64% said the same for non-school sponsored after-school activities.
- 67% or parents overall expressed concern about daylight hours for transportation.
- Availability of before and after-school elementary child care was a recurring theme in the survey (as well as in focus groups.)
- 49% of parents supported changing the high school start time for the upcoming 2019-20 school year; 51% chose 2020-21. (Note: the question was asked prior to the Board’s decision to delay implementation to 2020-21 as part of the budget process.)
- 59% of high school parents believe their child does not get enough sleep.

**Summary of Student Survey**

Based on input from student focus groups, the Committee decided to conduct a survey of high school students for additional information. Committee members advised that an in-school survey would offer the best option for gathering feedback from students; a preferred time based on testing and advisory schedules was selected for each school. A committee sub-group drafted and revised survey questions.

A total of 492 Norwalk students (15%) answered the high school survey. Of the respondents:
- 40% report going to bed at 11:30 p.m. or later.
- 82% percent report getting 7.5 hours or less of sleep each night. 38% say they get six hours or less sleep each night.
- Almost half of the respondents report being late to school either occasionally or frequently.
- 40% of students say they do their homework late at night.
- 38% report that they are frequently responsible for taking care of a sibling either before or after school.
- 21% have a job after school or on weekends. Student jobs reported included babysitting, retail, restaurants, dance schools, lawn work, dog walking and more.
**Summary of Parent Focus Groups**

To make sure that the committee had input from parents and guardians, focus groups for Norwalk Public Schools high school families were originally scheduled for January 28, 2019 at Norwalk High School and January 30 at Brien McMahon. The McMahon session was cancelled three times due to bad weather, and finally took place on March 18.

Upon hearing input from committee members that elementary school parents wanted to opportunity to also make their voices heard, a focus group dedicated to elementary families was scheduled for held on February 4.

Each session started with an overview of the health implications of teens not getting enough sleep, a summary of the committee’s charge and work, and a review of the alternative start times that the committee was considering. Attendees then broke into smaller groups and were asked to discuss “warm” feedback and “cool” feedback to the start time alternatives. Each group then reported out their feedback to the wider audience.

Warm feedback from the **high school parent sessions** included:

- Support for the medical research and health feedback
- Agreement that high school students need additional sleep
- Alignment that changing start times likely results in a higher quality of learning
- Appreciation of efforts to engage parents through surveys and focus groups

Cool feedback included questions and concerns about:

- The impact on both varsity and sub-varsity sports schedules
- Loss of class time for athletes who travel to away competitions
- Cost and availability of after-school care for K-5 students
- The potential that simply switching start times would result in bell ties that are too early for elementary and middle schools; lack of research on the effects of earlier start times for K-5
- Flexible morning start schedules resulting in too many students choosing to start at 7:30 a.m., defeating the purpose of the later times.
- Challenges for working parents from a 9 a.m. or later high school start time
- Late end times (4p.m. or after) becoming too late for jobs, childcare, sports
- Impact on homework time, especially for AP and IB students

Warm feedback from the **elementary school parent sessions** included:

- An understanding and support for the academic and emotional benefits for high school kids
- Earlier start times are a positive for families that already use before care
- More time for elementary schoolers to play in the afternoon
Cool feedback and questions included:
- Cost and availability of before and after-school care
- Elementary students losing sleep
- Less time for working parents to spend time with children at night; less family time
- The impact of possibly combining buses for different grade levels
- Amount and timing of homework
- Traffic in Norwalk
- Options for minimizing changes to elementary schools to only those that are necessary

**Summary of Student Focus Groups**

Students at both schools acknowledged that they and many of their peers do not get typically get enough sleep. Several reported that they are regularly late for school because they do not wake up in time. While many welcomed the later start time concept, they are concerned about the impact on afterschool activities, including sports, band and jobs.

The amount of homework was a commented on, as well as the impact that a later day would have on a student’s ability to complete work at night, especially for the most rigorous programs and classes. Students discussed the potential benefits that may come for greater use of online courses as a more flexible way for students to learn, not just for credit recovery.

At Brien McMahon, students also shared concerns about walking home after dark following a later schedule, prompting the school and district to take a closer look at commonly used paths and “short cuts” behind the school.
Discussion of Model Analysis

More than two dozen school start time models were generated by School Bus Consultants over the course of the Committee’s work. With feedback from parents, students and the community in mind, the Committee analyzed in detail the options it identified as best suited to meeting student health needs, family preferences and financial considerations.

The “Denver model” was reviewed early in the process and was initially an interesting option. In this model, high school hours of operations would resemble a flexible schedule similar to a college or university. Students could opt to begin and end the day earlier or later, providing class hours of either 7:30 a.m. to 2:15 p.m. or 9:00 a.m. to 3:45 p.m. This option would require some variation in the start and end times for teachers; however, the length of the workday would remain the same across all certified staff members. In addition, transportation would be provided at one set schedule, the later time being the preferred.

The committee, some individuals within the student focus groups, as well as some of the high school principals that met with the committee expressed interest in this model. However, the model was considerably more expensive, and would create too many challenges to afternoon activities. The Denver model would also create an issue with shared services and staff for the P-TECH Norwalk and Center for Global Studies programs.

The committee simultaneously reviewed several more traditional options, in which high school students and staff would begin and end the day at the same times. School Bus Consultants, working with Johanna Zanvettor in the NPS Transportation Office, initially designed four options with high school start times ranging from 8:50 to 9:15 a.m., and ending at either 3:35 or 3:45 p.m. In each of these models, a middle school start time of 8:00 was established and elementary school start times ranged from 7:30 a.m. to as late as 8:45 a.m.

As the committee considered these options, increased costs became a major factor. Models ranged from peak deployment fleet totals of between 95-102 buses, translating into a 2.9 million to 3.5 million cost increase over current transportation spending. A cost neutral option would mean that some elementary schools would need to begin at 7:30 a.m. Although the cost neutral option was seriously considered, parent and community concerns about our youngest students waiting at bus stops in the dark early morning hours was a significant issue. As a result of this feedback, an elementary school start time no earlier than 8:00 a.m. became a parameter for the committee.
Committee Consensus

The committee next reviewed a separate set of options that included a model with a high school start time of 8:30 a.m. The Committee consensus is that an 8:30 a.m. schedule represents the best option for a later high school start times. The 8:30 a.m. model:

- Aligns with sleep study research by offering a full hour of extra time in the morning.
- Does not have a major impact on start times for other grade levels.
- Does not compromise the quality of athletics, arts and other afternoon programs.
- Can be implemented at a cost that falls well within the Board’s placeholder for a 2020-2021 transportation cost increase.

Proposal for Districtwide Bell Time Schedules

With an 8:30 a.m. high school start time, the current middle school schedule can be maintained at 8:15 a.m., while no elementary school would begin prior to 8 a.m. and most would remain at their 2019-20 schedule. The recommendation also incorporates the extended school day for enrichment at Kendall beginning in 2020-2021.

Table 3: Bell Time Schedules

<table>
<thead>
<tr>
<th>Bell Times</th>
<th>2019-20 Schedule</th>
<th>2020-21 Recommended Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>NECC:</td>
<td>9:00 - 3:30</td>
<td>NECC: 9:00 – 3:30</td>
</tr>
<tr>
<td>Elementary 1:</td>
<td>8:15 - 2:50</td>
<td>Elementary 1: 8:00 – 2:35</td>
</tr>
<tr>
<td>Elementary 2:</td>
<td>8:50 - 3:25</td>
<td>Kendall: 8:00 – 4:00</td>
</tr>
<tr>
<td>Elementary 3:</td>
<td>9:05 - 3:40</td>
<td>Elementary 2: 8:50 – 3:25</td>
</tr>
<tr>
<td>Middle Schools:</td>
<td>8:15 – 2:50</td>
<td>Elementary 3: 9:15 – 3:50</td>
</tr>
<tr>
<td>High Schools:</td>
<td>7:30 – 2:15</td>
<td>Middle Schools: 8:15 – 2:50</td>
</tr>
</tbody>
</table>

Elementary School Groups

<table>
<thead>
<tr>
<th>Group 1 at 8:15:</th>
<th>Fox Run, Jefferson, Marvin, Naramake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 2 at 8:50:</td>
<td>Brookside, Kendall, Tracey</td>
</tr>
<tr>
<td>Group 3 at 9:05:</td>
<td>Columbus, Cranbury, Rowayton, Silvermine, Wolfpit</td>
</tr>
</tbody>
</table>

Group 1 at 8:00: Fox Run, Jefferson, Marvin, Naramake, Kendall (8-4)

Group 2 at 8:50: Brookside, Tracey

Group 3 at 9:15: Columbus, Cranbury, Rowayton, Silvermine, Wolfpit

Note: The recommended 2020-21 schedule allows the district to continue to provide mandated services to our parochial, charter, vocational tech, vocational agriculture and magnet partners, without a change in scheduling or additional cost.
Athletics

With a year’s advance notice, athletic programs at both Norwalk High and Brien McMahon will have time to work with the other districts to adjust game start times. Just as there are currently, there will continue to be some occurrences where student athletes would need to leave earlier than the regularly scheduled dismissal time to arrive for away games. Athletic directors will also work to schedule games on Saturdays where possible. As more schools within the FCIAC adopt later times, the challenge on scheduling game times will be minimized.

With a later start time, practice times and all home games will begin and end later and will not impact educational time.

Financial Considerations

In 2017-18, NPS eliminated the practice of issuing courtesy bus passes, which had been allowing students not eligible for transportation to ride buses based on rider enrollment and available space. By doing so, the District consolidated three buses, saving approximately $240,000.

NPS is currently entering the last year of a five-year contract with First Student. The contract timing makes 2020-21 a logical point for a shift in high school start times.

Based on current contract pricing with First Student, the estimated annual increase in transportation costs would be $457,000. As a result, the recommended model can be implemented at a cost that falls well within the Board’s original placeholder of approximately $732,000 for annual transportation cost increases.

Timing

The Committee recommends a full implementation for the 2020-21 school year. A final decision in September 2019 provides ample time for students, families and community members to be informed and to adjust accordingly. This timing also aligns with the end of the current bus contract, and gives the district sufficient planning time to insure a smooth transition and implementation.
V. IMPLEMENTATION

Work to prepare for implementation in 2020-21 would begin in late September 2019 and continue throughout the school year. Action items include additional data collection, high school class scheduling adjustments, transportation route planning, and parent, student and community communications.

Data Collection

To measure the results and impact of the school start time change, existing data will need to be compiled and new data might be required. As a result, during the 2019-2020 school year, the district will gather high school baseline data for the following areas:

- Tardiness rates
- Absenteeism rates
- Longitudinal study of grade point averages
- In-school suspension (ISS) rates
- Bus ridership rates
- Impact of lost class hours for school sports
- Stress level indicators collected from annual climate survey
- Rates of loss of credit as a result of absences

Class and Program Schedules

Under the Board of Education’s Strategic Operating plan, high schools have autonomy to create schedules that function best for their individual programs. Each high school would be tasked with adjusting its class schedule to accommodate the 8:30 a.m. start time.

Modification of before school and after-school programs may need to be addressed with all providers. In some cases, expanded availability may need to be arranged if the later start time impacts the availability of an older sibling to babysit after school. Information from the data collection discussed above would be used to evaluate this potential need.

Transportation

With 2019-20 the final year of our five-year contract with First Student, the NPS school bus contract is scheduled to go out to bid in November - December 2019. Upon approval to adjust school start times, the RFP would incorporate the following requirements for the number of buses at each transportation tier:
Table 2: Bus Deployment by Tier

<table>
<thead>
<tr>
<th></th>
<th>2019-20 Buses</th>
<th>2020-21 Proposed Buses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peak Morning</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus Deployment</td>
<td>Tier 1: 59</td>
<td>Tier 1: 68</td>
</tr>
<tr>
<td></td>
<td>Tier 2: 66</td>
<td>Tier 2: 71</td>
</tr>
<tr>
<td></td>
<td>Tier 3: 66</td>
<td>Tier 3: 52</td>
</tr>
<tr>
<td><strong>Peak Afternoon</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus Deployment</td>
<td>Tier 1: 59</td>
<td>Tier 1: 42</td>
</tr>
<tr>
<td></td>
<td>Tier 2: 66</td>
<td>Tier 2: 59</td>
</tr>
<tr>
<td></td>
<td>Tier 3: 63</td>
<td>Tier 3: 53</td>
</tr>
</tbody>
</table>

The number of buses anticipates a shared bus for Roton and Brien McMahon, as well as Nathan Hale and Norwalk High, a practice common in many districts.

Bus routes across the district need to reviewed and revised with the new times in mind. Work would begin immediately following the successful completion of the start of the upcoming school year. The expected opening of the K-8 Ponus Ridge STEAM Academy campus would also be incorporated into this work.

Communication to Stakeholders

Education of all stakeholders is critical to the success of the school start time changes. Regular communication will take place throughout the 2019-2020 school year, including.

- Announcement to all audiences as soon as change is approved (e.g., press release, email blast, newsletter article, social media)
- Fact sheets and FAQs prepared and distributed to explain changes to families and the public, made available at all schools
- Materials in multiple languages available electronically via the district website
- Message and materials Incorporated into regularly scheduled meetings during the 2019-2020 school year, including open houses, PTO/A meetings, SGC meetings
- School communications to incoming and current high school parents
- School communications to parents regarding start time, schedule and after school programs at the elementary schools that are starting at 8:00 a.m.
- Newsletter articles and messages on social media throughout the school year
- Outreach to business community and employers via Chamber of Commerce and city, directly to those employers who regularly employ students afterschool (from survey)
- Outreach to preschool providers via Early Childhood
- Communications to before and after school providers
- Bus routes published (August 2020)
V. CONCLUSION

Based on the comprehensive study of the issues, impact and alternatives, as outlined in the pages above, the School Start Time Committee recommends that Norwalk Public Schools shift to a high school start time of 8:30 a.m. Implementation is recommended beginning with the 2020-21 school year. This recommendation to adjust school start times has also been endorsed by Norwalk area pediatricians.

Respectfully submitted,

Norwalk School Start Time Committee

Jacquelyn Aarons
Dr. Sasha Carr
Dr. Frank Costanzo
April Guilbault
Maureen Ireland
Rob Karl
Heidi Keyes
James MacDonald

Joseph Madaffari
JoAnn Malinowski
Jennifer Maione
Jimi Napoli
Tanika Vellucci
Brenda Wilcox Williams
Johanna Zanvettor
Justin Zerega, Ed.D.

Steven Adamowski, Ph.D.
June, 2019

To the Members of the Norwalk Board of Education:

The importance of adequate sleep to maintain optimal physical and mental health has long been established. Unfortunately, studies have shown that a majority of our adolescents do not get enough sleep, largely because a biological shift in their circadian rhythm results in a delayed sleep-wake cycle. Compared to adults, adolescents fall asleep later and wake up later. Such a pattern is in obvious conflict with the early school start times currently employed by Norwalk Public Schools.

This public health epidemic needs to be taken as seriously as any other health issue. For this reason, we the undersigned stand in accord with the positions of the American Academy of Pediatrics, the American Medical Association, the American Academy of Sleep Medicine and the Centers for Disease Control and Prevention, all of which support later school start times. We recognize that such a structural change may have its challenges but, as pediatricians, we indefatigably advocate for the health and welfare of children and stand in solidarity in support of this initiative for the betterment of our community. We robustly encourage the Norwalk Board of Education to reconfigure school start times expeditiously, adopting a plan which promotes student health, enhances student achievement, and positively impacts student safety. Please adjust school start times to give our Norwalk students their best chance at success.

Respectfully,

Norman Weinberger, MD
School Medical Advisor

AmeriCares Free Clinic

Day Street Community Health Center

Norwalk Community Health Center

Park Street Pediatrics

TLC Pediatrics

The Center for Advanced Pediatrics

East Avenue Pediatrics

Norwalk Health Department

Robert Appleby School Based Health
NOTES


School Start Time Change: An In-Depth Examination of School Districts in the United States

The Children's National Medical Center's Blueprint for Change Team

April 15, 2014
Index

I. Executive Summary ........................................................................................................... 2
II. Introduction ..................................................................................................................... 3
III. Process ........................................................................................................................... 5
IV. Select School Districts with Later Start Times Grid ..................................................... 6-10
V. National School Start Time Survey Results ................................................................. 11-15
VI. Selected Case Studies of Later Start Time Successes .................................................. 16-24
VII. Summary of Lessons Learned From Other School Districts ..................................... 25-28
VIII. References .................................................................................................................. 29-30
IX. Appendices:
    A. Historical Timeline of Adolescent Sleep Health and School Stars Times .................. 31-37
    B. School Survey Instrument ......................................................................................... 38-42
I. Executive Summary

In response to the scientific evidence documenting both profound changes in sleep and circadian rhythms during adolescence and the myriad of negative health, performance and safety outcomes associated with chronic sleep loss, some 70 school districts in the United States (U.S.), representing approximately 1,000 schools, have successfully implemented a delay in high school start times. However, despite the compelling evidence supporting school start time (SST) change as a key strategy in addressing the epidemic of adolescent sleep loss in the U.S., there are still many school districts across the country with early high school start times that have either not considered this option or have failed in their efforts to implement later bell schedules. In addition, while the scientific literature has clearly documented the positive outcomes associated with delayed high school start times, these studies contain limited information regarding the process by which school districts consider, approve and implement bell schedule changes. This can, in fact, be extremely challenging, as bell changes impacts not only the obvious stakeholders in the community (e.g., parents, students, teachers, school personnel) but also those citizens who may not have direct involvement in the school system (e.g., employers of adolescents, community members using school facilities).

Therefore, an in-depth examination of those school districts that have been successful in changing their bell schedules can be highly instructive to other districts at various stages of contemplating this measure. However, because there is no comprehensive national repository of information regarding start time change, a comprehensive summary necessitates the use of a multi-pronged approach to accessing relevant information in as comprehensive and up-to-date manner as is possible. Thus, in order to create this summary document, we identified and reviewed relevant scientific literature and existing information from a variety of sources, including online and print media articles, school reports, and case studies from other organizations, as well as personal notes of discussions with sleep experts, parents, and district officials conducted over the years. We also administered a brief web-based national survey to a select number of school districts that have successfully changed their school start times to obtain more specific information on methods and the process used to change schedules and gain community support. Finally, we conducted in-depth telephone interviews with personnel and stakeholders in several school districts to further identify and discuss challenges, opportunities and lessons learned in more detail.

The outcomes of this review process are presented as follows: 1) a summary grid of selected schools that have delayed start times with demographics, change strategies employed and additional comments, 2) results of the national school start times survey, and 3) in-depth case studies. An historical timeline of school start time change and advances in knowledge of sleep and circadian biology is included in the Appendix.

Finally, after reviewing all of the available information on the process of school start time change from a wide variety of sources as described above, we developed an integration and summary of the most common and salient points likely to best inform other school districts. While not necessarily exhaustive, as each school district has both unique challenges and solutions, the ten key messages, categorized according to major content themes, represent principles that have a basic foundation in successful implementation of start time change and are those that are most applicable to the majority of school districts, no matter their size or complexity of issues. It is our hope that this information will not only assist Fairfax County Public Schools in charting a course forward but will also be a useful tool for other school districts looking to protect the health, safety and academic opportunities of their students.
II. Introduction

Many studies have documented that the average adolescent in the United States is chronically sleep deprived and pathologically sleepy. As a result, many high school students are at risk for adverse consequences of insufficient sleep including impairments in mood, affect regulation, attention, memory, behavior control, executive function, and impulse control. In particular, many studies have shown an association between decreased sleep duration and lower academic achievement at the middle school, high school, and college levels, as well as higher rates of absenteeism and tardiness, and decreased motivation to learn (1,2). Other documented health-related effects of sleep loss in adolescents include increased use of stimulants (e.g., caffeine, prescription medications) to counter the effects of chronic sleepiness, which in turn may increase the risk of substance use later in adolescence and early adulthood (3). Adolescents are also at greater risk for drowsy driving-related crashes, as well as athletic and other injuries, due to insufficient sleep (4). Chronic sleep restriction increases subsequent risk of both cardiovascular disease and metabolic dysfunction such as type 2 diabetes (5). An association between short sleep duration and obesity in children and adolescents has been demonstrated in several cross-sectional and prospective studies, underscoring how chronic sleep restriction can undermine the health of our nation’s youth (6).

While a number of factors, including biological changes in sleep, lifestyle choices and academic demands impact upon sleep in students, the evidence strongly supports that early school start times (i.e., before 8:00 am) are a key contributor to sleep loss in high school students (7-9). Numerous studies have demonstrated that early start times significantly impede high school students’ abilities to obtain sufficient sleep (10, 11).

From a biological perspective, at about the time of the onset of puberty, adolescents begin to experience a sleep-wake “phase delay” (later sleep onset and wake times), as a result of well-documented changes in circadian rhythms. This is manifested as a shift in the fall-asleep time to about two-hours later relative to middle childhood. At the same time, adolescent sleep needs do not decline significantly from pre-adolescent levels, and optimal sleep amounts remain in the range of 8.5 to 9.5 hours per night for most teens (12). On a practical level, this means that the average adolescent cannot fall asleep before 11 pm and has significant difficulty in waking before 8 am (13).

A substantial body of research has now demonstrated that delaying school start times is an effective countermeasure to chronic sleep loss and has a wide range of potential benefits for students in regard to physical and mental health, safety, and academic achievement. Studies comparing high schools with start times even just 30 minutes earlier to those with later start times demonstrate adverse consequences such as shorter sleep duration, increased sleepiness, difficulty concentrating, behavior problems, and more school absences (14-16). Scientific literature has confirmed that delaying high school start times results in increased total sleep time, decreased tardiness rates and absenteeism, improved performance on standardized tests, reduced self-reported depression, and fewer automobile crashes (17, 18).

A precise tally of public high schools that have delayed school start times nationwide is not available, partly due to the fact that this tends to be a moving target, as more schools and districts make the decision to implement bell time changes. To the best of our knowledge, approximately 1,000 schools in some 70 school districts have taken this step. Importantly, only a handful of schools have subsequently returned to the original earlier bell time.

It is an important but under-appreciated fact that early high school start times are a relatively recent phenomenon that evolved as a result of factors, which had little to do with academics or what is best for the health and well-being of students. The overwhelming majority of modern day bell schedules in American public high schools are historically based on such “adult” considerations as school budgets, transportation logistics, parent work schedules, athletics, staff commute times, and
community use of fields and facilities. By and large, districts did not take into consideration the evolving scientific literature on biologically-based changes in sleep patterns and circadian rhythms associated with puberty and the evidence linking early school start times with detriments in the health, safety and well-being of students. While there are no systematic national databases of school start times, historical and media sources suggest that school districts in the U.S. began advancing school start times, especially at the high school level, first in the late 1950's and 1960's and then increasingly so during the 1970's. The move to earlier start times was likely in reaction to a number of increasing pressures (e.g., fiscal, political, sociological) faced by school districts to cut costs, to close neighborhood schools in favor of larger "feeder" schools, and basically to "do more with less" (a short summary timeline of public school bell schedule changes, contributing factors and the relationship to scientific advances in our understanding of sleep and circadian biology is included in Appendix A).

However, it should be noted that there are many school districts in the U.S. which have never succumbed to the same political, budgetary and social pressures described above and have maintained healthy start times for their high school students. For example, Loudon County, Virginia has had the same bell schedule since 1954, with high schools starting at 9:00 am, middle schools at 8:30 am and elementary schools at 7:50 am. Similarly, some large Texas districts, such as Dallas and Austin, have started their high schools at 9:00 am or later since the early 1990's. According to the U.S. Department of Education’s National Center for Education Statistics, a majority (60%) of the 19,000 public high school in the US currently start at 8 am or later, with 45% starting between 8 and 8:30 a.m., and 15% starting 8:30 a.m. or later (19).

Fairfax County in Virginia, the 11th largest school district in the country and one of the most socioeconomically and ethnically diverse, has been wrestling with the issue of delaying high school start time for more than a decade. The current high school start time of 7:20 am makes it virtually impossible for high school students in Fairfax County to obtain enough sleep to allow them function at minimally acceptable levels, given adolescents' biologically-based delayed sleep/wake preferences. In fact, in the Fairfax County Youth Survey of 8th, 10th, and 12th grade students found that two-thirds of respondents reported sleeping seven hours or less on an average school night, more than two hours short of their sleep needs. Recognizing the need to address this issue and in keeping with Fairfax County Public Schools (FCPS) long-standing interest in improving the health, safety and academic and athletic opportunities of its student body, the school board adopted a resolution on April 12, 2012 targeting a goal of starting high schools in the FCPS system after 8:00 am.

Shortly afterward, the district engaged Children's National Medical Center's (CNMC) Division of Sleep Medicine to develop a "Blueprint for Change" to accomplish this task. As part of the development of a "Blueprint for Change," the CNMC team evaluated other school districts across the U.S., with a specific focus on those schools that have successfully implemented start time change, in order to fully explore and utilize any "lessons learned" by our predecessors. While FCPS is unique in many ways (e.g., size, diversity, community use of school facilities), an examination of strategies employed by other school districts to identify and address potential roadblocks as well as to develop creative and innovative approaches can contribute valuable information regarding the process of start time change and inform the development of targeted approaches applicable to Fairfax County. A summary of the key findings and a set of resulting "take home points" are the subject of this report. It is our hope that this information will not only assist Fairfax County Public Schools in charting a course forward but will also be a useful tool for other school districts looking to protect the health, safety and academic opportunities of their students.
III. Process

In order to assist FCPS in finding the best approach to change bell schedules for its high school students, the CNMC team undertook a number of steps to identify, collate and summarize lessons learned from other school districts that have successfully changed their start times in the past. Because there is no comprehensive national repository of information regarding start time change, the CNMC team utilized a multi-pronged approach to access relevant information in as comprehensive and up-to-date manner as is possible. Furthermore, while there are now a number of studies that have examined *outcomes*, there are no studies that have documented the process of school start time change. Thus, this analysis necessarily entailed the use of a number of diverse but complementary sources.

The team identified and reviewed relevant scientific literature and existing information from a variety of sources including: online and print media articles, school reports, and case studies from other organizations, as well as interviews and other documentation from sleep experts, parents, and district officials. We also conducted a brief web-based national survey of a select number of school districts that have successfully changed their school start times to obtain basic information on their strategies for changing bell schedules and gaining community support. Finally, the team conducted in-depth telephone interviews with personnel and stakeholders in three school districts (Wilton, CT; Arlington, VA; Milwaukee, WI) to further identify and discuss challenges, opportunities, and lessons learned in more detail.

The outcomes of this review process are presented as follows: 1) summary grid of selected (chosen for their instructive value) school districts which provide lessons on how they delayed start times along with demographic information, change strategies and comments, 2) national school start times survey results, 3) in-depth case studies, and 4) integration and summary of lessons learned. An historical timeline of school start time change and advances in knowledge of sleep and circadian biology is included as Appendix B.
### IV. Select School Districts with Later Start Times Grid

The following districts were selected to provide a sample of different motivations (e.g., budgetary, sleep health) and strategies (transportation, curriculum, class scheduling, community engagement, etc.) that have been employed in school systems of various sizes, demographics, and economic backgrounds.

<table>
<thead>
<tr>
<th>School District</th>
<th>Year</th>
<th>Original Bell Times</th>
<th>Current Bell Times</th>
<th>#Students #Schools</th>
<th>Change Strategy</th>
<th>Additional Strategy</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bentonville, Arkansas</td>
<td>2007</td>
<td>HS: 7:45-2:45 MS: 8:00-3:00 ES: 8:00-3:00</td>
<td>HS: 8:45-3:45 MS: 7:40-2:40 ES: 7:30-2:30</td>
<td>11,100 14</td>
<td>Flip HS with MS and ES</td>
<td>HS uses A/B block schedule.</td>
<td>Change due to address sleep health &amp; growing traffic issues. Cost savings.</td>
</tr>
<tr>
<td>Albany Unified SD, California</td>
<td>2014</td>
<td>HS: 7:40-3:10 MS: 8:00-3:05 ES: 8:30-3:05</td>
<td>HS: 8:00-3:30 MS: 8:00-3:05 ES: 8:30-3:05</td>
<td>3,807 6</td>
<td>20 min shift as pilot HS/MS</td>
<td>Evaluate and consider future changes. Elimination of MS 7:00 zero hour proposed.</td>
<td>HS principal very influential in promoting sleep science.</td>
</tr>
<tr>
<td>Long Beach Unified SD, California</td>
<td>2014</td>
<td>HS: 7:50-2:40 MS: 8:00-2:40 ES: n/a</td>
<td>HS: 8:50-3:40 MS: 9:00-3:40 ES: 8:00-2:10 ES: 9:00-3:10</td>
<td>8,100 84</td>
<td>HS and changed ½ of all MS</td>
<td>Pilot in 1 HS and added ½ prep period on 1 day during the week.</td>
<td>3rd largest district in state. Primary impetus for change was cost savings. ½ of MS already start at 9:00. Superintendent used change to allow students to choose their schedule. Saved $750,000 &amp; 60 buses.</td>
</tr>
<tr>
<td>Denver PS, Colorado</td>
<td>2005</td>
<td>HS: 7:30-2:30 MS: 7:25-2:55 ES: 8:15-3:10 9:00-3:55</td>
<td>HS: 7:30-4:30 MS: 7:25-2:55 ES: 8:15-3:10 9:00-3:55</td>
<td>84,424 176</td>
<td>Added 2 hours to HS day for flexibility. Students pick their own start and end times.</td>
<td>District provides public transportation passes to eligible students &amp; allows for flexible schedules.</td>
<td>Superintendent formed task force to improve sleep, attendance &amp; academics. HSST still before 8:00.</td>
</tr>
<tr>
<td>Colorado Springs District 11, Colorado</td>
<td>2000</td>
<td>HS: n/a MS: n/a ES: n/a</td>
<td>HS: 7:40-3:00 MS: 8:45-3:45 ES: 8:00-2:30</td>
<td>30,296 60</td>
<td>HS shift.</td>
<td>Superintendent formed task force to improve sleep, attendance &amp; academics.</td>
<td></td>
</tr>
<tr>
<td>Wilton PS, Connecticut</td>
<td>2003</td>
<td>HS: 7:35-2:10 MS: 7:35-2:10 ES: 8:15-2:45</td>
<td>HS: 8:15-2:50 MS: 8:15-2:50 ES: 7:40-2:10</td>
<td>4,300 5</td>
<td>HS (6-12) and ES Flip</td>
<td>Inspired by a senator, a community group formed a task force to study the issue &amp; conduct outreach. Conducted survey of students after change.</td>
<td>Students reported to be more alert and better behaved. More participation in HS athletics &amp; ES after school activities. HS students reported high satisfaction &amp; 35 mins. more sleep.</td>
</tr>
<tr>
<td>School District</td>
<td>Year</td>
<td>Original Bell Times</td>
<td>Current Bell Times</td>
<td>#Students #Schools</td>
<td>Change Strategy</td>
<td>Additional Strategy</td>
<td>Comments</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------</td>
<td>---------------------</td>
<td>--------------------</td>
<td>--------------------</td>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>West Hartford SD, Connecticut</td>
<td>2007</td>
<td>HS: 7:30-2:15</td>
<td>HS: 7:30-2:15</td>
<td>10,222</td>
<td>Flex time for HS.</td>
<td>Made first hour study hall &amp; allowed students to use &quot;flex&quot; time to start 2nd period.</td>
<td>District reported positive impacts on emotional health, stress &amp; academic performance.</td>
</tr>
<tr>
<td>Milford County SD, Delaware</td>
<td>2012</td>
<td>HS: n/a</td>
<td>HS: 8:16-3:20</td>
<td>4,195</td>
<td>HS and ES flip.</td>
<td>Superintendent led. HS start at 8:30 on Wed. Block scheduling.</td>
<td>Decision based on sleep health, improvements in learning &amp; bus cost savings.</td>
</tr>
<tr>
<td>Brevard PS, Florida</td>
<td>2000</td>
<td>HS: 7:30-2:15</td>
<td>HS: 8:30-3:15</td>
<td>96,000</td>
<td>HS/MS shift. ES moves earlier.</td>
<td>MS activities changed to before school with own transportation.</td>
<td>District reported large reduction in tardiness &amp; absences.</td>
</tr>
<tr>
<td>Santa Rosa County SD, Florida</td>
<td>2006</td>
<td>HS: 8:00-2:45</td>
<td>HS: 9:15-3:15</td>
<td>26,144</td>
<td>HS shift.</td>
<td>Used 3-tier bus system, MS &amp; ED rolling windows.</td>
<td>Increased graduation rates, decreased delinquency &amp; lowered bus costs.</td>
</tr>
<tr>
<td>Marion County PR, Florida</td>
<td>2002</td>
<td>HS: n/a</td>
<td>HS: 8:35-3:05</td>
<td>43,123</td>
<td>HS shift.</td>
<td>Added a MS rolling window.</td>
<td></td>
</tr>
<tr>
<td>Bonneville Joint SD, Idaho</td>
<td>2000</td>
<td>HS: 8:45-2:39</td>
<td>HS: 8:05-2:31</td>
<td>11,200</td>
<td>HS shift.</td>
<td>Superintendent led based on sleep science.</td>
<td>Study showed absences dropped 15% &amp; tardiness 22%. Students get 44 min. more sleep on average.</td>
</tr>
<tr>
<td>Harlem School District 122, Illinois</td>
<td>2007</td>
<td>HS: n/a</td>
<td>HS: 8:25-3:15</td>
<td>6,721</td>
<td>HS/ES flip.</td>
<td>Superintendent &amp; school board led the effort due to concern about sleep health of students.</td>
<td>Teachers' union defeated 3rd effort, but a new contract allowed a start time change of up to 90 min. without union approval. District reported $750,000 in savings.</td>
</tr>
<tr>
<td>Fayette County PS, Kentucky</td>
<td>1996</td>
<td>HS: 7:30-2:20</td>
<td>HS: 8:00-2:50</td>
<td>40,000</td>
<td>HS/ES flip.</td>
<td>Parents went school board after earlier HS times were 2nd proposed. Superintendant was looking for way to boost attendance. Pre &amp; post studies conducted. Plan was announced 10 months ahead of change.</td>
<td>Pre &amp; post study 1 year after showed improved sleep &amp; reduced auto crashes, increased sleep across all grades. District reported better attendance &amp; a decrease in tardiness in 1999.</td>
</tr>
<tr>
<td>Jessamine County, Kentucky</td>
<td>Prior to 2005</td>
<td>HS: 7:30-2:15</td>
<td>HS: 8:40-3:25</td>
<td>7,000</td>
<td>MS/HS shift. ES 30 min. earlier.</td>
<td>Superintendent led. Community engagement was key.</td>
<td>Change based on sleep health. District reported lower tardiness &amp; increased attendance.</td>
</tr>
<tr>
<td>School District</td>
<td>Year</td>
<td>Original Bell Times</td>
<td>Current Bell Times</td>
<td>#Students #Schools</td>
<td>Change Strategy</td>
<td>Additional Strategy</td>
<td>Comments</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------</td>
<td>-----------------------------</td>
<td>----------------------------</td>
<td>-------------------</td>
<td>-----------------</td>
<td>---------------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>Brunswick County PS, Maine</td>
<td>2001</td>
<td>HS: 7:25-1:50 MS: 7:40-2:10 ES: 8:40-2:55</td>
<td>HS: 7:45-2:10 MS: 8:00-2:30 ES: 9:00-3:30</td>
<td>2,645 5</td>
<td>MS/HS 30 min. shift ES 15 min. shift</td>
<td>Superintendent &amp; school board influenced by neighboring Topsham district &amp; sleep science. Conducted district-wide student survey.</td>
<td>Decision based on sleep health &amp; community &amp; student body support.</td>
</tr>
<tr>
<td>Edina PS, Minnesota</td>
<td>1996</td>
<td>HS: 7:25-2:10 MS: n/a ES: n/a</td>
<td>HS: 8:25-3:10 MS: 7:40-2:38 ES: 8:30-3:05 9:15-3:50</td>
<td>8,300 9</td>
<td>HS shift.</td>
<td>Superintendent led based on sleep science &amp; MN Medical Association recommendations.</td>
<td>One of the first districts to change; outcomes extensively documented. One year after, 92% of parents preferred the change. Decline in tardiness &amp; absenteeism reported.</td>
</tr>
<tr>
<td>Mahtomedi PS, Minn.</td>
<td>2002</td>
<td>HS: 7:30-2:10 MS: n/a ES: n/a</td>
<td>HS: 8:00-2:30 MS: 8:00-2:30 ES: 9:10-3:30</td>
<td>3,305 4</td>
<td>HS/ES flip.</td>
<td>Encouraged use of personal transportation. 4-period day before &amp; after change. Students agreed to shorten “passing” time between classes.</td>
<td>District saw improved attendance, test scores &amp; grades. Decreased costs &amp; tardiness rates. 65% decrease in auto crashes.</td>
</tr>
<tr>
<td>Minneapolis PS, Minn.</td>
<td>1997</td>
<td>HS: 7:15-1:45 MS: 7:05-1:35 ES: 9:40-4:10</td>
<td>HS: 8:10-3:00 8:35-3:00 MS: 9:40-4:10 ES: 7:30-2:20 8:05-2:35</td>
<td>38,370 75</td>
<td>HS/MS flip.</td>
<td>School board led to reduce transportation costs. Sleep health of students was secondary motivation.</td>
<td>Most extensively documented outcomes of all school districts delaying start times. Students reported more sleep &amp; fewer depressive symptoms. Lower tardiness rates also reported.</td>
</tr>
<tr>
<td>School District</td>
<td>Year</td>
<td>Original Bell Times</td>
<td>Current Bell Times</td>
<td>#Students #Schools</td>
<td>Change Strategy</td>
<td>Additional Strategy</td>
<td>Comments</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------</td>
<td>---------------------</td>
<td>-------------------</td>
<td>-------------------</td>
<td>----------------</td>
<td>---------------------</td>
<td>----------</td>
</tr>
<tr>
<td>South Washington County, Minnesota</td>
<td>2009</td>
<td>HS: 7:35-2:05 MS: 7:30-2:00 ES: n/a</td>
<td>HS: 8:35-3:05 MS: 7:55-2:25 ES: 8:10-2:40 9:20-3:50</td>
<td>17,418 26</td>
<td>HS/MS shifted later.</td>
<td>Superintendent formed task force to study to optimize learning &amp; sleep. Initiated a 4x4 block schedule.</td>
<td>Part of 2014 study. Grades in 1st and 3rd period classes rose by as much as a full point. Scores on standardized tests improved. 58% of HS students slept 8 hrs. or more. Auto crashes fell by 6%.</td>
</tr>
<tr>
<td>Hattiesburg PSD, Mississippi</td>
<td>2013</td>
<td>HS: 7:20-2:45 MS: 8:30-3:50 ES: n/a</td>
<td>HS: 8:30-3:50 MS: 7:30-2:45 ES: 8:00-3:00</td>
<td>4,528 10</td>
<td>MS/HS flip.</td>
<td>Superintendent implemented in the last few days of the previous school year as an experiment.</td>
<td>Changed based on sleep science.</td>
</tr>
<tr>
<td>Ithaca City SD, New York</td>
<td>2006</td>
<td>HS: 8:00-2:37 MS: 8:00-2:21 ES: 7:55-1:55 9:00-3:00</td>
<td>HS: 8:55-3:32 MS: 9:10-3:25 ES: 8:00-2:00</td>
<td>5,273 11</td>
<td>HS/MS shift.</td>
<td>Superintendent led because buses were not arriving on time &amp; students were late. Sleep expert's advocacy over a few years helped bring the change. Discussions held with employers, athletic clubs &amp; public at board meetings.</td>
<td>Change primarily made to reduce bus costs. District realized about $400-600K.</td>
</tr>
<tr>
<td>Moore County, North Carolina</td>
<td>2012</td>
<td>HS: 8:00-3:00 MS: n/a ES: 8:00</td>
<td>HS: 8:00-4:00 MS: 8:00-3:00 ES: 7:45/7:30</td>
<td>12,491 23</td>
<td>HS shift.</td>
<td>Implemented 2-tiered bus system.</td>
<td>Saved $700,000 in transportation costs.</td>
</tr>
<tr>
<td>Hudson City, Ohio</td>
<td>2010</td>
<td>HS: 7:30-2:30 MS: 7:20-2:10 ES: 8:30-9:15</td>
<td>HS: 8:00-3:30 MS: 7:56-2:50 ES: 8:55-3:40</td>
<td>4,941 6</td>
<td>All shifted later.</td>
<td>Superintendent &amp; school board formed advisory committees to review health, transportation, outreach, &amp; other school districts. Subcommittees held separate public meetings &amp; conducted surveys. Phased-in over three years.</td>
<td>The whole process took about two years. Superintendent &amp; school board worked together to study the issues &amp; gain public support.</td>
</tr>
<tr>
<td>North Clackamas SD, Oregon</td>
<td>1889</td>
<td>HS: 7:30-2:20 MS: n/a ES: n/a</td>
<td>HS: 8:45-3:20 MS: 9:30-4:05 ES: 8:20-2:45</td>
<td>17,430 31</td>
<td>HS shift.</td>
<td>HS principals pushed change for a decade. Full year study proceeded change.</td>
<td>Improved attendance &amp; GPA in 1st year period. Large community acceptance.</td>
</tr>
<tr>
<td>Beaufort County SD, South Carolina</td>
<td>2014</td>
<td>HS: 7:45-2:30 MS: n/a ES: n/a</td>
<td>HS: 8:35-3:25 MS: 7:15-2:30 ES: 8:30-3:30</td>
<td>20,000 36</td>
<td>Pilot: 1 HS first.</td>
<td>HS principal led pilot based on sleep science provided by the superintendent. Students gave feedback.</td>
<td>Evaluation is expected following the 1-year pilot period.</td>
</tr>
<tr>
<td>School District</td>
<td>Year</td>
<td>Original Bell Times</td>
<td>Current Bell Times</td>
<td>#Students #Schools</td>
<td>Change Strategy</td>
<td>Additional Strategy</td>
<td>Comments</td>
</tr>
<tr>
<td>----------------</td>
<td>---------</td>
<td>---------------------</td>
<td>--------------------</td>
<td>-------------------</td>
<td>----------------</td>
<td>---------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Austin ISD, Texas</td>
<td>1990s</td>
<td>HS: n/a MS: n/a ES: n/a</td>
<td>HS: 9:00-4:10 MS: 8:20-3:30 ES: 7:45-2:25</td>
<td>87,000 158</td>
<td></td>
<td>HS shift.</td>
<td>No public records could be found regarding change.</td>
</tr>
<tr>
<td>Arlington, Virginia PS</td>
<td>2001</td>
<td>HS: 7:30-2:15 MS: 8:10-2:45 ES: 8:30-3:10</td>
<td>HS: 8:19-3:01 MS: 7:50-2:24 ES: 8:00-2:40 9:00-3:40</td>
<td>19,000 38</td>
<td>HS/MS flip.</td>
<td>School board &amp; superintendent formed a large task force with working groups. Formed district team for implementation. 4-tier bus system.</td>
<td>Teachers &amp; parents reported students were more alert &amp; focused. Teachers raised concerns, but none left the district.</td>
</tr>
<tr>
<td>Bedford County PS, Virginia</td>
<td>2013</td>
<td>HS: 8:30-3:00 MS: 8:30-3:00 ES: 8:30-3:00</td>
<td>HS: 8:55-3:35 MS: 8:55-3:35 ES: 7:55-2:35</td>
<td>10,000 21</td>
<td>HS/MS flip with ES.</td>
<td>Added tier to bus system &amp; students shared buses. Added online early classes &amp; early dismissal for athletes.</td>
<td>Changes led to cost savings.</td>
</tr>
</tbody>
</table>

**Notes:**
- **PS** = Public Schools
- **ISD** = Independent School District
- **SD** = School District
V. National School Start Time Survey

As part of the CNMC team’s compilation of successful practices and strategies related to delaying high school start times, we identified and surveyed public school districts across the country that had recently (within the past decade) changed their bell schedules. The team developed an online National School Start Time Survey and contacted a number of identified school districts that were successful in changing their start times. The survey consisted of three parts: Part One—background information on the districts; Part Two—in-depth information about their experience with school start time (SST) change strategies and implementation; and Part Three—perceived costs (financial and otherwise) and benefits associated with the changes (see Appendix B). This survey was intended to solicit input on a variety of experiences with later bell schedule changes and to supplement the grid (above) and the case studies (below) in this report; thus the results should neither be interpreted in isolation, nor viewed as a “scientific” survey.

Methods
The survey was designed to be completed by a single individual/superintendent with input as needed from ancillary school personnel. Over the summer of 2013, our team identified about 70 school districts that had previously delayed high school start times in the past ten years, using existing online compilations, scientific literature, documents previously collected by the team, media clips, and previous FCPS and other school reports. In the fall of 2013, the online survey was emailed to district superintendents in identified districts. There were 24 initial survey responses; however, many surveys were excluded from the final results due to incomplete crucial data that precluded further analysis (only surveys that reported at minimum the pre- and post-start times for high schools were included). A total of eight completed surveys were included in the final analyses. All participating districts for this report were de-identified.

Results
Part One: General Information (N=8) demonstrated a fair amount of variability in terms of the districts’ sizes (Table One) and in their final bell schedules (Table Two). The districts’ average delay in high schools’ bell schedules was 45 minutes with a range of 20 minutes to an hour and 15 minutes. About 75% (6/8) of the districts moved high school start times to after 8:30 am; only one district (FL) set the new start time to after 9:00 am.

Four districts (N=7) moved middle school start times earlier (range 10 minutes to 1 hour and 10 minutes), while the other districts moved middle school bell times later within a much narrower range (20-30 minutes). With two exceptions (VA and FL), all new middle school bell times were at 8:00 am or earlier. With regard to elementary schools (n=7), one district (CT) moved bell times earlier (by 5-30 minutes), two remained the same, and the rest delayed elementary start times (range 10-40 minutes). Two districts set new start times before 8:00 am; the latest ES start bell time was 8:50 am (MO).
Table One. Participating Districts and Population Indicators
(Listed in ascending order by total (ES/MS/HS) number of students in the district)

<table>
<thead>
<tr>
<th>District</th>
<th>Elementary School (ES)</th>
<th>Middle School (MS)</th>
<th>High School (HS)</th>
<th>Total Buses (Current)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA District</td>
<td>1,200 students (2 ES)</td>
<td>550 students (1 MS)</td>
<td>550 students (1 HS)</td>
<td>16</td>
</tr>
<tr>
<td>CA District</td>
<td>1,800 students (3 ES)</td>
<td>900 students (1 MS)</td>
<td>1,200 students (1 HS)</td>
<td>Unknown</td>
</tr>
<tr>
<td>CT District</td>
<td>1,900 students (2 ES)</td>
<td>1,050 students (1 MS)</td>
<td>300 students (1 HS)</td>
<td>33</td>
</tr>
<tr>
<td>MA District</td>
<td>2,300 students (5 ES)</td>
<td>1,200 students (1 MS)</td>
<td>1,200 students (1 HS)</td>
<td>20</td>
</tr>
<tr>
<td>MN District</td>
<td>4,600 students (6 ES)</td>
<td>2,300 schools (2 ES)</td>
<td>2,900 students (1 HS)</td>
<td>50</td>
</tr>
<tr>
<td>AK District</td>
<td>4,500 students (9 ES)</td>
<td>4,500 students (5 MS)</td>
<td>3,600 students (1 HS)</td>
<td>85</td>
</tr>
<tr>
<td>MO District</td>
<td>9,100 students (19 ES)</td>
<td>9,100 students (6 MS)</td>
<td>5,100 students (HS)</td>
<td>190</td>
</tr>
<tr>
<td>FL District</td>
<td>14,500 students (18 ES)</td>
<td>6,200 students (8 MS)</td>
<td>7,500 students (7 HS)</td>
<td>200</td>
</tr>
</tbody>
</table>

Table Two. Participating Districts and Bell Schedule Changes

<table>
<thead>
<tr>
<th>District</th>
<th>ES Start</th>
<th>MS Start</th>
<th>HS Start</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA District</td>
<td>7:55-8:30</td>
<td>8:30-8:55</td>
<td>8:30-8:55</td>
</tr>
<tr>
<td>CA District</td>
<td>8:30 (No Change)</td>
<td>8:00 (No Change)</td>
<td>7:40-8:00</td>
</tr>
<tr>
<td>CT District</td>
<td>(Pre-K-2) 9:00-8:55; (3-5) 8:10-7:40</td>
<td>8:15-7:35</td>
<td>7:35-8:15</td>
</tr>
<tr>
<td>MA District</td>
<td>8:15-8:25</td>
<td>7:50-7:20</td>
<td>7:15-7:45</td>
</tr>
<tr>
<td>MN District</td>
<td>8:00-8:40</td>
<td>9:15-7:50</td>
<td>8:00-8:40</td>
</tr>
<tr>
<td>AK District</td>
<td>7:30-8:00</td>
<td>7:40-8:00</td>
<td>8:00-8:55</td>
</tr>
<tr>
<td>MO District</td>
<td>8:20-8:50</td>
<td>7:30-8:00</td>
<td>7:45-8:55</td>
</tr>
<tr>
<td>FL District</td>
<td>7:30</td>
<td>8:30-8:20</td>
<td>8:00-9:15</td>
</tr>
</tbody>
</table>

Part Two: Change Strategy and Implementation (N=6) assessed districts’ overall bell change strategies (with particular focus on transportation components) and concerns associated with these changes. The districts surveyed reported employing an array of change strategies: three districts employed a “slide” (moving ES/MS/HS bell times later), and two used a “modified slide” (moving ES/HS later with MS earlier). None of the districts responding to the survey employed a straight “flip” (i.e., exchanging ES and HS bell times). Several ancillary strategies were also used; these included a zero period (i.e., a class offered before the start of the school day) in two districts, and student choice (i.e., flexible scheduling based upon student preference) in one district. While only two districts (MA and MO) had tiered busing prior to bell changes, all schools used tiered busing after SST change. All districts eventually had middle and high schools share buses, with three districts making the change as part of a comprehensive set of bell-related transportation changes (MA, VA, CA). Additional strategies employed in other districts included: the consolidation of bus depots (MO), the continuation of a flat fee for transportation (MA), and maintaining public transit use (CA). Notably, no districts cut transportation funding for magnet schools, and only one school used a phased-in
approach (CA), which involved changes only for part of the district in year one and the remainder of the district in year two.

Part Two also assessed the top identified challenges associated with changing school start times. When weighted to give more credence to higher-ranked options, the top five concerns were: (1) traffic flow at school, (2) changes in parents’ work schedules, (3) after-school extracurricular program attendance, (4) changes in teachers’ work schedules, and (5) before-school athletic practices schedules (Figure One). Of note: when all athletic-related items (i.e., before/after school athletics and games) were combined, athletics represented the most significant concern. Finally, Part Two included an open-ended question that solicited information about additional strategies employed: these included substituting early morning classes with online courses, giving athletes early dismissal, adding lighting to athletic fields, and allowing for more flexible academic scheduling.

**Figure One. Top-Ranked Concerns Associated with Later School Start Change**

![Bar chart showing top-ranked concerns](chart)

**Part Three: Benefits/Costs** (N=4) assessed benefits and costs associated with bell changes. With more weight given to higher ranked items, the top five identified benefits were: (1) increased daily attendance, (2) cost savings, (3) reduced tardiness rates, (4) improved standardized test scores, and (5) improved grades. Districts varied widely in terms of perceived benefits, with one district (AK) reporting no benefits other than cost savings. Attendance and academic measures were the most consistently reported benefits (Table Three), and all schools listed cost savings as a benefit, likely attributable to adaptation of an increased number of busing tiers. In regards to perceived costs, no districts identified loss of community support, changes in traffic patterns, or a reduction in student involvement in extracurricular activities as a consequence of SST change (Table Four). The negative impact was largely perceived to be on families (e.g., work schedules, financial issues).
Table Three. Perceived Benefits of School Start Time Change

<table>
<thead>
<tr>
<th>District</th>
<th>AK District</th>
<th>MA District</th>
<th>FL District</th>
<th>VA District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased daily attendance</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Reduced tardiness rates</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Improve standardized test scores</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Improved grades</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Higher graduation rates</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Fewer referrals for disciplinary action</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Improved sports team performance</td>
<td>No</td>
<td>N/A</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Fewer sports-related injuries</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Cost savings for public school system</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Fewer student visits to student health centers</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Lower rates of depression/suicidal thoughts</td>
<td>No</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Lower rates of car accidents</td>
<td>No</td>
<td>N/A</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Table Four. Perceived Costs of School Start Time Change

<table>
<thead>
<tr>
<th>District</th>
<th>AK District</th>
<th>MA District</th>
<th>FL District</th>
<th>VA District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial cost incurred by the school district</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Loss of community support</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Impact on parent work schedules</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Limitations on student after-school employment</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Financial cost incurred by families</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Changes in traffic patterns</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Reduction of student involvement in extracurricular activities/athletics</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Negative impact on teacher schedules</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Safety concerns for elementary students</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Survey Conclusion
Given the small sample size, the conclusions that can be drawn from this survey are limited but nonetheless valuable, as they add to our understanding of how and why school districts choose to delay high school start times, and what benefits/costs they perceive as a result. While it is not possible to generalize from this limited sample, a few key points can be made. First, the districts responding were quite varied in the strategies employed in changing bell times across all tiers. Moreover, none of the districts changed to a bell schedule that could be termed "biologically optimal" from a circadian/sleep perspective for all three groups (i.e., MS and HS later and ES earlier). Cost savings, presumably largely as a result of increasing the number of busing tiers, was the most prominent benefit (and may have been the real "driver" for the change in some cases). Although not a consistent finding in the scientific literature, the districts surveyed tended to perceive academic-related benefits resulting from adopting later start times for secondary schools. Finally,
many of the negative outcomes raised as concerns by other communities contemplating a change in high school bell times did not materialize in the responses given.

While the majority of districts are significantly smaller than Fairfax County Public Schools, delving into the experiences of a variety of school districts may be useful in generating new strategies not previously explored by a large district like Fairfax or, conversely, in determining why particular change strategies might not be generalizable to a larger district. The sheer variety of (as well as lack of majority-endorsed) successful implementation strategies employed strongly suggest that there is no “one size fits all” plan and indicates that FCPS should explore a wide range of bell scenarios and strategies that take into consideration those that have been most successfully employed around the country. Additionally, several secondary strategies merit further consideration; these include consolidating bus depots, charging a flat-rate transportation fee, and bundling MS/HS on buses. Finally, some of the other districts’ “new” cost-saving strategies highlight the strength and sophistication of FCPS’ existing transportation infrastructure, particularly its four-tiered busing system and its previous cost-saving efforts as a result of previous attempts to change the bells schedules.

The survey results also provided a broader framework for understanding FCPS’ school start time change-related concerns and background information that allows for some tentative predictions of cost/benefit outcomes following any change. While many of the top reported concerns regarding delays in high school start times mirror those expressed by some in the FCPS community, it is important to note that most of the concerns raised were not actualized. In addition, many of the districts did not systematically measure health, academic, or satisfaction outcomes, again underscoring both the need for additional research on bell change-related data and highlighting this project’s unique opportunity to contribute to public health and policy research and to provide districts considering similar changes a roadmap and a menu of approaches.
VI. Selected Case Studies of Later Start Time Successes

The number of published outcome studies on the impact of delaying high school start times is still somewhat limited, and the motivations and implementation strategies of schools and school districts deciding to adopt bell schedule changes are not easily captured in scientific studies. School start time survey results, such as those presented above, examine the challenges involved and the solutions generated but may fail to do so in adequate detail and may not fully explore important nuances of the process. Thus, it is useful to supplement the available empirical data with more anecdotal information from communities that have been involved in changing start times. A more in-depth understanding of the process of school start time change in other districts can yield important information that may guide other school districts, suggest strategies that might not have been considered and help to avoid both repeating mistakes and “re-inventing the wheel.” The following brief case studies are therefore presented to serve as examples of the scope, process, and outcomes of individual high schools and school districts across the country that have successfully implemented a delay in high school start times. The sheer variety in the size of the student populations, geographic considerations, initial and final bell schedules, and strategies employed are a bit daunting; nonetheless, valuable lessons can be gleaned, which can inform other school districts in various stages of change contemplation. The following case studies were chosen based on their instructive value and are listed in alphabetical order by state.

Bentonville School District, Arkansas
In 2007, the Bentonville School District, the 5th largest in the state (11,100 students), implemented a later start time for its one high school, moving a one later from 7:45 am to an 8:45 am start time. District officials changed the start times to better accommodate a new “A/B block” class schedule that allowed students to rotate courses every other day. The teachers reported liking the A/B block schedule and used the extended class time to incorporate cooperative learning groups and hands-on activities. In order to accomplish the bell schedule change, the district moved all of the five middle schools earlier (8:00 am to 7:40 am) and also moved the nine elementary schools earlier (8:00 am to 7:30 am).

Following the changes in bell schedules, many teachers and administrators anecdotally reported a high level of satisfaction, with some teachers indicating feeling more rested and productive throughout the day. Students who were active in extracurricular activities or worked after school preferred the later start time because it allowed the opportunity for more sleep. The community also found that the bell schedule change assisted in alleviating traffic congestion. The district found that block scheduling gave their students more class choices and the later start time change gave the district more flexibility in dealing with traffic and addressing the students’ sleep needs.

Lessons: Bentonville is an example of a successful collaboration between district officials and the school board to change class and transportation schedules. The changes resulted in the promotion of sleep health and more flexibility in students’ class schedules. Improvements in sleep and quality of life for both students and teachers were also reported.

(Source: [http://normessasweb.uark.edu/bestpractices/papers_Casestudies_401003.pdf](http://normessasweb.uark.edu/bestpractices/papers_Casestudies_401003.pdf))

Pulaski County Special School District, Arkansas
In 2012, the Pulaski County Special School district, with a student population of 17,500, “flipped” the start times for its six middle and six high schools with those of its 24 elementary schools. The
middle schools moved 50 minutes later from 7:30 am to 8:20 am, and high schools moved later by 65 minutes, from 7:30 am to 8:35 am, with all elementary schools remaining at their start time of 7:20 am. The changes were spurred by the district's interest in reducing transportation costs and improving the sleep health and safety of its students. To accomplish these changes, the district went from a single-tier to a two-tier busing schedule. The change was initiated by the district under the leadership of the new superintendent who was charged by the State Commissioner of the Department of Education with cutting costs following a period of financial mismanagement by the previous administration and the school board, which was dissolved. The district announced the change in January with implementation in September to allow enough time for parents to plan and change their childcare arrangements and utilized a toll-free line to field questions and comments from the community.

**Lessons:** The Pulaski County Special School district demonstrates that communities can successfully adapt to substantial changes if given appropriate time and if parents are provided with adequate information during implementation.


**Albany Unified School District, California**

Albany High School has 1,800 students in a small school district with one other high school for at-risk students, one middle school and three elementary schools. In 2013, the Albany High School principal proposed moving the current bell time of 7:40 am to 8:30 am, based on research from economists and sleep researchers as well as feedback from a series of community engagement sessions. A task force, named the Challenge Success Committee, was formed and included parents, students, teachers, counselors, and school administrators. The committee researched the issue and developed a set of recommendations. After receiving the report and recommendations, the high school’s Instructional Improvement Council (a small committee comprised of six staff members, two parents and two students) agreed to move the start time to 8:00 am as a one-year pilot and proposed to solicit feedback from the community through a series of surveys in order to gauge potential impact. The high school also sought input through several governance committees and a town hall forum. After reviewing the scientific rationale and as a result of these community discussions, the Albany Middle School principal also recommended eliminating the 7:00 am zero period and moving the start time to 8:00 am, which were both adopted.


**Lessons:** This district is a good example of a principal immersing himself in the sleep research and working hard to educate both his staff and community. His commitment to the issue and willingness to pilot the change had a positive impact on his colleagues in the rest of the district. The superintendent utilized local sleep experts and community members to educate the community about the health and safety benefits of changing start times.

**Long Beach Unified School District, California**

Long Beach Unified School District educates 81,000 students in six high schools, 15 middle schools and 51 elementary schools, with four charter and five alternative schools. In the 2013-2014 school year, the Long Beach Unified School District adopted a plan to move their high school from 7:50 am to 8:50 am with an end time of 3:40 pm, as part of a pilot program. The plan, debated about and approved by the school board early in 2013, also moved six middle schools to a 9:00 am to 3:40 pm bell schedule to be consistent with the district’s nine other middle schools. As part of the plan, all
affected schools were to develop action plans to provide supervision for students in the morning. Budget reductions were the driving factor for the realignment of bell schedules. District officials anticipated that the changes would save the district over $1 million, with much of the savings resulting from bus schedule adjustments for special education students requiring home pick-up and riding smaller buses.

Community outreach prior to schedule changes indicated mixed levels of support and initial reservations from key stakeholders. An online survey on school start time change, conducted by the district, showed that the respondents were about evenly split on the issue of changing start times. Additionally, the local teacher’s union expressed concern regarding contractual issues and the change’s impact on sports and other programs. The district worked closely with these groups to address their issues and ultimately to gain their support. Additionally, the district announced that it would convene a large ad hoc committee (40-60 members) to evaluate the impact of the pilot program.

**Lessons:** While the motivation for changing start times in Long Beach was to cut transportation costs, this district is taking a unique approach in forming a large committee of stakeholders to evaluate the impact of the change. Most school districts typically form such committees prior to considering taking action and then disband once a decision to delay start times is made. The ad hoc committee report is due in the fall of 2014.

(Source(s): [www.dailypreeze.com/general-news/20130326/long-beach-middle-schools-to-start-later-next-fall](www.dailypreeze.com/general-news/20130326/long-beach-middle-schools-to-start-later-next-fall) and [www.lbschools.net](www.lbschools.net).)

**West Hartford Public High School, Connecticut**

West Hartford Public Schools is a district with a student population of 10,222 in two high schools, three middle schools and 10 elementary schools. In the fall 2006, the West Hartford Board of Education voted 5-2 to adopt a flexible start time schedule for juniors and seniors at its two high schools beginning in the fall of 2007, with implementation for sophomores and freshmen beginning in 2008. The “flexible” start time option gave juniors and seniors the option of starting school at 8:15 am (second period), instead of at 7:30 am. The first period was converted to a study hall and the dismissal bell remained at 2:15 pm for all students, regardless of whether or not they elected the second period start. The “flexible” start time was a strategy developed in response to significant community resistance to a proposed “blanket” delay of high school start times. While acknowledging that this “flexible” option was a less-than-optimal compromise, the Board of Education concluded that at least it offered a delayed start time option to those students and parents who recognized the value of obtaining sufficient sleep. According to school administrators, the later start times had positive impacts on academic performance, student stress levels and emotional health.

**Lessons:** West Hartford Public Schools is a good example of a school board and administration continuing to seek solutions to provide choices to students and to encourage better sleep health, after deciding against full implementation of start time change due to community opposition.

(Source: Author’s notes, 2006)

**Wilton Public Schools, Connecticut**

Wilton engaged in a two-year long process, which culminated in delayed start times for both its middle and high school (7:35 am to 8:15 am) in 2003. Initially, legislation was proposed by State Senator Kevin Sullivan in 2001 to delay start times across Connecticut, but subsequently it was decided that this should occur on a local district-by-district level. Wilton’s local chapter of the League
of Women Voters became involved in the debate and distributed both a review of the literature on adolescent sleep and the results of a local survey of students and school staff, and recommended that Wilton Board of Education consider delaying start times. Existing community-planning teams consisting of teachers, administrators, parents, students and citizens were then engaged in studying the issue. Area superintendents met with physicians from the Connecticut Thoracic Society to ask for scientific input and to request their engagement in the process. It was decided by the superintendent with input from advisory groups that any potential solutions would need to meet three criteria: 1) be cost neutral, 2) require student bus rides no greater than 45 minutes and 3) avoid any student being picked up by a bus earlier than 7:00 am. Parents and teachers were offered the opportunity to participate in an "advisory vote" on the superintendent's recommendations regarding start times, which yielded diametrically opposed results (parents supported two to one, teachers supported two to one). While the Wilton Sports Council published full-page ads opposing the changes on a number of grounds, including compromising Wilton's reputation of athletic excellence, the head of the Connecticut Interscholastic Athletic Conference provided a written statement in support of delayed start times. After the start time change, teachers reported that students were better rested and more alert during the school day. There was no appreciable effect on athletics, and within a year, the change became the "norm" and "part of the fabric of the community" (Robert O'Donnell, current superintendent). While there has been considerable interest expressed by neighboring school districts, no other schools in the surrounding area have followed Wilton's lead.

**Lessons:** Wilton provides an illustration of several common themes related to changing school start times, including the vital role of the superintendent, community concerns regarding impact on athletics which were not subsequently substantiated, and the importance of ongoing stakeholder input. It also provides some unique perspectives (i.e., the potential for community groups to assume a leadership role, enlistment of local health professional societies, use of established models such as community planning teams to provide input), which may be applicable to other districts. In particular, the community's identity as a self-styled "sports town" provides a striking example of "cultural" considerations that have the potential to derail efforts to change start times if not adequately addressed.

(Source: Owens, J [2013, October 30]. Telephone interview.)

**Denver Public Schools, Colorado**

Denver Public Schools is a large district with over 84,000 students in 22 high schools, 21 middle schools and 74 elementary schools, and 59 alternative and charter schools. Due to concerns regarding the impact of early start times on adolescents and seeking a way to cut transportation costs, the district conducted a feasibility study in 2004. In 2005, the district took one of the more unique approaches to changing start times for all of its high school students. Under the leadership of the superintendent, the school district adopted a "flexible" schedule and radically changed how it provided transportation to its students. While conducting the feasibility study, the district found that 2,400 high school and 1,300 middle school students purchased bus passes from the local public transit agency, the Regional Transportation District (RTD). In the "flexible" plan, students were allowed to choose their arrival and dismissal times within a 7:30 am to 4:15 pm bell schedule, as long as they met the instructional time requirements. The new transportation plan involved switching more students to public transportation and providing free bus passes to all students who lived more than 3.5 miles from their base school and to students going to magnet schools elsewhere in the district. Other students were still provided with bus transportation by the district.

As part of the district's implementation plan, a series of public outreach sessions were held including two town hall meetings, a public hearing and a presentation by principals summarizing their discussions with parents and local communities. There were some initial concerns raised by parents
about students riding on public buses. The district also conducted surveys of students and found that many of the students were not initially open to taking advantage of the later start time options because of their involvement in after-school programs. However, in the 2006 school year, about 30% students chose a start time of 8:00 am or later. As a result, the district was able to eliminate 60 buses and save $750,000 in its transportation budget.

**Lessons:** The Denver public school district was open to unique solutions and working with the local public transportation system to allow options for its students. Those students who wished to take advantage of school schedule choices were presented with a number of options that were nonetheless within specific parameters. The process also involved significant community engagement through public meetings and online surveys. While the initiative lacked overwhelming community and stakeholder support, district officials decided to still pursue a course which they felt was in the best interests of the district, both financially and for the health and safety of its students.

(Source(s): National Sleep Foundation, [www.sleepinhfairfax.org/docs/CS_Denver.pdf](http://www.sleepinhfairfax.org/docs/CS_Denver.pdf), High School Transportation: Report to the Board, Department of Research, Planning and Special Programs, Department of Transportation, March 18, 2004.)

**Milford Public Schools, Delaware**

Milford Public Schools is a small district with about 4,100 students who attend one high school, one middle school and four elementary schools. After many years of studying ways to mitigate scheduling conflicts resulting from state requirements that mandated professional development time and standardized testing, the Superintendent of Milford Public Schools formed a task force to study potential solutions. The task force included teachers and administrators who volunteered to research the issue and develop recommendations. In 2012, the task force recommended the adoption of an “A/B block” scheduling system as well as a delay in school start times, with the high school start times moving 40 minutes later from 7:35 am to 8:15 am, the middle school start times moving from 7:35 am to 8:00 am, and the elementary school start times moving earlier to 7:40 am. A unique feature of the plan was to start school at 9:35 am for both middle and high school students on Wednesdays. The school accommodated parents who were concerned about leaving their older children at home unsupervised on late start time days by opening the libraries to students who needed to be at school earlier. The superintendent expressed the belief that these changes – both later start times for secondary students and earlier start times for elementary students – would be beneficial for all students and would increase daytime alertness.

**Lessons:** Milford Public Schools illustrates a situation in which a district initially changed its bell times to accommodate state requirements for standardized testing and professional development but subsequently realized that this schedule better accommodated the biological and learning needs of its students. Parental opinions were mixed, with some elementary school parents concerned about winter civil twilight violations, while found the earlier times to be more accommodating for their work schedules.

(Source(s): [https://milfordlive.com/2012/06/19/msd-to-see-changes-next-year-2](https://milfordlive.com/2012/06/19/msd-to-see-changes-next-year-2), [www.milfordbeacon.com/article/20120710/NEWS/307109954](http://www.milfordbeacon.com/article/20120710/NEWS/307109954))

**Brevard County School District, Florida**

Brevard County School District is a large system with 82 elementary schools, 16 middle schools, 21 high schools, 18 specialized centers, and a student population of 96,000 that is delivered on a three-tier bus system. Each bus has three routes that service all three school tiers. In 2000, the district delayed high school start times by a full hour, from 7:30 am to 8:30 am and middle school times by 25 minutes from 8:50 am to 9:15 am. The elementary schools, which incorporate grades K-
6, were moved earlier by a full hour and fifty minutes, from 9:50 am to 8:00 am. The change was implemented after extensive community outreach was conducted through public meetings to allow stakeholders the opportunity to express their concerns and share their views. The district also conducted research on other school districts that had successfully changed their start times and provided information to the public and school staff about improvements in academic performance and attendance rates. District staff also worked with a local hospital to provide scientific and health education presentations to the community and the school board, using information from the National Sleep Foundation. A proposal was developed by the superintendent and submitted to the school board, which subsequently approved the change. In order to offset some of its transportation related costs, the district charges students for special or out-of-boundary services.

Following the change, the school district found a significant reduction in the rate of first period tardiness and absences. Some of the negative outcomes reported by the district were limited availability of school buses for field trips and an increased need for after-school childcare.

**Lessons:** Brevard County demonstrates that students and the community in a large county can adapt to significant changes in school bell schedules. The district solicited a tremendous amount of public input but did not let negative opinions proffered by some constituencies and individuals deter them from finding solutions. Many of the non-academic concerns typically raised by parents regarding potential impact on after-school employment and on athletics were not realized. Finally, Brevard’s strategy of charging for non-academic and magnet transportation services may help reduce costs significantly in districts that provide substantial special transportation services.

(Source(s): Author's notes, 2006. [http://www.npeia.com/brevardcofl/search/policies_pe8600.htm](http://www.npeia.com/brevardcofl/search/policies_pe8600.htm)

**Bonneville School District, Idaho**

In the 1999-2000 school year, the Bonneville School District adopted a new school start time for its two high schools by shifting from a 7:45 am start time to 8:50 am. The district, which has 21 schools (including three middle and 14 elementary schools) and a student population of 11,200, was the first in the state to move start times later. In the year following the change, the district studied the impacts on attendance and found that absences dropped by 15 percent and tardiness decreased by 22 percent. The study also found that high school students were getting about 44 minutes more sleep on average after the change. Many students reported that they were more alert, and their teachers concurred. Some students also reported using part of the extended period morning before school to seek help from their teachers. For unclear reasons, the start times at the two high schools were subsequently shifted earlier to 8:25 am before 2014.

**Lessons:** The Bonneville School District is an example of a district evaluating the impact of the change in school start times and reporting the positive data back to its staff, students and the local community.

(Source(s): Author's notes, 2006)

**Needham Public School District, Massachusetts**

Needham Public School District is a small district consisting of six elementary schools, one middle school, and one high school with a student population of 5,476. Under the direction of the superintendent, an advisory body called the School Starting Time Advisory Committee was formed in the fall of 2002 to determine if start times for all schools should be changed to be more compatible with students' biological rhythms. The committee included one teacher, one administrator and a parent representative from each level, a school committee representative, a school nurse, a
representative from the transportation department, two high school students and the director of the arts department.

The committee reviewed the existing sleep and education research available at the time and conducted surveys of high school teachers regarding the level of alertness of students while in class. They also surveyed a small sample of students regarding their sleep habits and preferences regarding start times. The committee launched a website to provide information about their activities and encouraged members of the community to provide feedback. The committee also made a concerted effort to contact school districts that had successfully changed their start times and consulted sleep experts, health professionals and The National Institutes of Health.

As a result of their research and fact-finding, the committee concluded that, “the research about the educational and health benefits of a later high school starting time are clear and compelling.” Based on a review of the potential impact on athletics, after-school programs, religious activities, performing arts and transportation, the committee recommended changing the start times later for both primary and secondary schools. The committee developed five options, all of which had the high school start time moving from 7:40 am to 8:05 am, with middle schools either staying at their current time or also moving to 8:05 am, and all elementary schools staying at their current time or starting at 8:45 am. Due to redistricting in 2003, the school board delayed their decision a full year and conducted further community engagement. In 2004, the school board moved start times for all middle and high schools close to the time recommended by the committee with high schools starting at 8:00 am, middle schools starting at 7:50 am, and elementary school starting 15 minutes later, moving from 8:20 am to 8:35 am.

**Lessons:** Needham Public School District exemplifies many of the strategies used by other districts that have successfully changed their start times. It created a small working group composed of key department members and parent and teacher representatives to collect information on the scientific research (including interviews with sleep experts), to consider the potential impact and develop possible mitigating strategies, and to conduct meetings with stakeholders. The committee carefully studied the issues over a protracted period of time, developed and articulated a compelling rationale for changing the bell schedule and presented a range of options to the community based on an assessment of feasibility.

(Source(s): Needham Public Schools School Starting Time Report and Recommendation, January 2003.)

**Arlington Public Schools, Virginia**

Arlington Public Schools is a large urban district just outside of Washington, DC. Currently, the school district has more than 19,900 students in 22 elementary schools, five middle schools, and four high schools. In 1999, based on the growing interest of some parents and the school board in emerging sleep science and in order to reduce transportation costs and to improve academic performance, the district began a comprehensive and intricate two-year process to change its school start times.

The school board requested that the district’s Advisory Council for Instruction (ACI), a large body of 50 members, form a School Start Time Steering Committee to compile research on sleep and adolescence and to study the potential impact of changing bell schedules on transportation and extracurricular activities. In December of 1999, the committee recommended that the school board move high school start times 45 minutes later (from 7:30 am to 8:45 am) starting in the fall of 2000. Based on this recommendation, the school board voted unanimously to direct district staff to develop plans to change start times for high schools. As part of its direction, the school board provided four guiding principles: 1) the change should improve student achievement, 2) no school
should start before 7:50 for safety reasons, 3) change in high school start times should not negatively impact any group or school level, and 4) the ability of students being able to participate in extracurricular activities should not be affected. The board also expressed a desire that an evaluation study be conducted following implementation.

Following the board action, the superintendent formed a working group, comprised of both staff and community members, to review the ACI’s findings, study all relevant issues, and make recommendations for implementation in the fall of 2001. The working group consisted of a steering committee and several subcommittees to study and make recommendations regarding such issues as transportation, public engagement, after-school activities, and sleep research. The district also hired a transportation consultant to study bus schedule options and to look for additional efficiencies in the system. The consultant and the working group initially developed 12 options, eventually settling on a total of four, one of which included keeping the current bell schedules (status quo).

Once the options were refined, the steering committee and representatives from a couple of the subcommittees engaged in significant community engagement to educate the community about sleep science and to obtain feedback on the models. Materials were developed and distributed in back-to-school packets, at the superintendent’s public meetings, the local county fair as well as in press releases. Information was also posted on the district’s website and community feedback was requested via email through the website. Letters were sent to all of the local parent teacher associations (PTAs) and representatives from the steering committee attended meetings to provide information and answer questions. As part of its process, the working group worked with the University of Maryland to conduct surveys of parents, students and teachers and held two public forums to solicit input from the community.

Based on a few different periods of community engagement and staff input, the steering committee developed additional options and made further adjustments throughout. Finally, in October 2000, the steering committee made a recommendation to the school board, which voted unanimously to change start times for high schools from 7:30 am to 8:15 am, middle schools from 8:10 am to 7:50 am, and elementary schools from 8:10 am and 8:55 to three tiers of 8:00 am, 8:25 am and 9:00 am. Following the vote, the school board requested that district staff survey teachers about the proposed changes on whether or not they would leave the school district with the change taking place. The survey found that 14% reported that they would consider leaving their jobs.

During the implementation phase, the steering committee and school board continued to meet with the community and key stakeholder groups in order to discuss issues and foster support for the bell changes. A toll-free line was established to help parents and students ask questions about the implementation, but was rarely used. A series of surveys were conducted to gauge community, teacher and student satisfaction following the school start time changes.

In 2005, the school district’s Office of Planning and Evaluation did an analysis of surveys conducted after implementation and grades collected pre (2000-2001) and post (2001-2002) implementation. The results were largely inconclusive and the Office stated that its analysis “should be interpreted with caution” because it was “impossible to isolate the impact of the start time change on academic performance.” However, the Office found a “very slight” improvement in the first period grades for the graduating class of 2003. Other findings were insignificant improvements in academic performance but negligible or largely inconclusive results regarding tardiness and attendance. The Office did report that more high school students reported (41% vs. 47%) participating in “class discussions” and “being prepared for class” (41% vs. 47%) all of the time.
Lessons: Arlington is a good example of a district that conducted considerable research, did comprehensive planning, and included community members and key stakeholders throughout the process, including after implementation. This district staff, working group and school board conducted significant community engagement efforts and adjusted models and plans during the process, but did not let any opposition deter them from achieving what they believed was best for students. This case also demonstrates that while people express strong concerns about change, such fears rarely ever come to fruition in regard to making changes to bell schedules (no teachers left as a result of the change). As time goes by, people adapt, traffic patterns and personal schedules adjust.

http://www.fcps.edu/fts/taskforce07/documents/arlington0605.pdf.)
VII. A Summary of Lessons Learned From Other School Districts

After reviewing all of the available information on the process of school start time change from a wide variety of sources as described above, including the in-depth case examples, the CNMC team has compiled a summary of the most common and salient points to best inform school districts, such as Fairfax County, that are actively contemplating a change in bell schedules. While not necessarily exhaustive, as each school district will have both unique challenges and solutions, these ten key messages represent principles that have a basic foundation in successful implementation of start time change and are those that are most applicable to the majority of school districts, no matter their size or complexity of issues. The following are categorized according to major content themes.

1. The Importance of Leadership

Very often, the publically stated position of the district superintendent is the key determinate as to whether or not a school district is successful in changing school start times. This individual can set the tone for other staff, and can control communications, planning, logistics and community engagement, etc. The relationship and trust (i.e., political capital) that the superintendent has established in the community and with the school board is also extremely important. If the superintendent and district officials do not communicate their strong support for the bell time change and do not keep discussions focused on the health, safety and academic performance of students, then the process may get bogged down with special-interest concerns.

The school board’s public support for the superintendent and for school start time change is also critical. The school board’s support is especially vital in communicating to the broader public both the justification (e.g., health and safety benefits) for changing bell schedules and the message that any challenges can be addressed and most likely overcome. Those school districts that seemed to have been most successful in changing their start times are those in which the superintendent, district staff and the school board have become well-informed regarding the sleep science and have worked with key community organizations to address logistical challenges and study the truly relevant logistical or financial concerns or issues and to promote the benefits to student health, safety, and academic and athletic performance (e.g., Jessamine, KY; Bentonville, AR; Edina, MN; Minneapolis, MN; Needham, MA; Brunswick, ME; South Washington County, MN).

2. Education of the Entire Community

Change agents and stakeholders should have a working knowledge of the research on adolescent sleep and early start times in order to effectively communicate the rationale for changing bell schedules (Arlington, VA). It is important for school district leadership (i.e., superintendents, school board members, principals) to refute misconceptions (e.g., “if school starts later, teens will just stay up later and won’t get more sleep”) while also responding to the legitimate concerns of students, parents, and teachers. Community members and staff may either discount the scientific literature or choose to focus on perceived (whether or not valid) complications related to logistical or personal convenience concerns; thus, the more educated that district staff becomes about the sleep science, the more persuasive they will be in communicating these messages.

It is extremely important to emphasize the health and safety benefits associated with providing students the opportunity to get more sleep and that the potential benefits go far beyond academic improvements. When communicating the short and long-term consequences of chronic sleep loss (and, by implication, the potential dangers associated with failing to delay high school start times), it should be emphasized that these extend not only beyond the school grounds (e.g., drowsy driving, depression, obesity) but very well may set students up for debilitating (e.g., insomnia) or life-
threatening medical conditions (e.g., cardiovascular consequences such as hypertension or metabolic dysfunction such as type 2 diabetes) in the future.

Districts should seek to provide appropriate targeted education for the entire community (students, parents, teachers, school nurses) on sleep, sleep disorders, and the consequences of sleep deprivation. Efforts should be made to work with local sleep centers and hospitals to provide medically accurate information and to present that information in a variety of forums (e.g., fact sheets, slide presentations, webinars) for a range of audiences, and include ample time for discussion and addressing questions (Albany, CA; Fayette, KY). Teachers and other school personnel, especially health and counseling professionals, should be well educated about adolescent sleep needs and patterns, taught to recognize the signs of sleep-related difficulties among their students, and report such symptoms to parents and school health providers (20, 21). Superintendents, school boards and principals should consider integrating sleep-related education into curricula so students can learn about the physiology of sleep, the consequences of sleep deprivation, and the importance of sleep to their overall health. This education can be provided in science, health and athletic classes.

Finally, it is particularly important that information be provided to support families throughout the implementation phase in culturally sensitive ways. This includes translating basic print educational materials into multiple languages, providing translation services at community-wide online forums and reaching out to local press venues that serve minority communities.

3. Consensus Building Among Stakeholders
It is important to inform and engage all stakeholders early in the process to understand potential concerns and to seek potential solutions. This includes community members or organizations that use school district fields and facilities on a regular basis as well as other city or county agencies that provide programs and services to students (i.e., libraries, parks and recreation, police, employers). The district should notify these groups of any changes once the decision is made in order to allow them time to adjust their schedules and for planning, and should continue to engage them throughout implementation in a spirit of partnership.

Districts should consider the views of school staff and teachers in decision-making about implementation and develop policies that provide flexibility for teachers and other staff to adapt to the changes (e.g., easing periods to make transfer requests). It is also important to involve principals from all three levels (elementary, middle and high schools) in internal discussions because it is likely that all schools and students in the district will be impacted to some degree, whether or not their own bell times change. Engagement of the students themselves is also critical in garnering support for the change, and often they can be the most passionate and articulate voices in the community.

At all stakeholder levels, it should be noted that expressed concerns are sometimes based on contractual or personal issues rather than what is good for the health, safety and well-being of students. In these situations, the superintendent, school board and stakeholder group leaders' public support for start time change will be critical in overcoming any staff or community opposition.

When considering bell changes, the district should first bring together key staff representing several areas (e.g., transportation, curriculum, special or health services, athletics) to do their own fact-finding before engaging additional outside consulting groups. This allows internal staff to identify logistical issues early and begin to develop potential solutions before opening up the debate to the wider community.
In regard to process, it may be prudent to engage the leadership of key community groups in face-to-face meetings in order to build trust, air mutual concerns, and establish an open dialogue prior to establishing working groups or task forces. In general, smaller working groups focused on specific tasks tend to be more productive and successful than large cumbersome ones that include many stakeholders.

4. Transportation as a Major Logistical and Cost Factor
Transportation of students determines most start time schedules and is typically the largest cost and logistical factor that districts consider. However, in many districts, transportation is actually the main driver for seeking changes in an attempt to lower costs by adopting a multi-tiered bus delivery schedule (Academy District 20, CO; Santa Rosa, CO). Districts that already employ a multi-tiered delivery schedule may have to use more creative strategies to find transportation savings. One strategy that is commonly used to overcome potential transportation costs is what is commonly referred to as “flipping” secondary/high school and elementary bell schedules. This may have the added benefit of being more “in sync” with circadian rhythms in both groups (e.g., younger children typically fall asleep earlier and wake earlier). For some districts, new approaches should be considered; these include encouraging car pools, providing incentives for using public transportation (e.g., Denver, CO), creating bus depots for special program and centers, charging a flat-rate transportation fee to students for special activities (e.g., Brevard, FL), and allowing middle school and high school students to ride on the same buses.

5. Athletics and Community Use of Recreational Facilities
Community members in districts contemplating school start time changes frequently are concerned about impact on after-school sports practices and competition; however, most of these concerns do not actually materialize or can easily be mitigated by scheduling or policy changes (e.g., game day early dismissal, more flexible instruction time and scheduling). There appear to be no districts in which athletic programs were cancelled or significantly adversely affected following start time changes. To the contrary, a number of districts found that more students participated in athletics and that sports programs grew after high school bell times were delayed (e.g., Edina, MN) and reported that their teams performed better following the change (e.g., Wilton, CT; Edina, MN; Seattle, WA). Thus, it is important for administration officials, coaches and student athletes to not only appreciate the likely lack of negative impact on athletics of delayed start times, but to also understand the potential repercussions on relevant health (e.g., metabolic dysfunction, weight gain), performance and safety (e.g., increased sport-related injuries) outcomes related to chronic sleep loss (22, 23).

6. One Size Does Not Fit All
While there are clearly general overarching principles that can (and should) be applied across diverse communities, it should also be emphasized that the extent to which changing school start times impacts a given community and the relative importance of the different challenges and benefits (anticipated and experienced) varies widely across school districts. Thus, it follows that there is also no “one-size-fits-all” or singular optimal approach to tackling this issue. Among the myriad of variables that need to be considered on a case-by-case basis include average (and range of) student commute times, number and length of school bus routes, availability of public transportation, traffic patterns, community use of school recreational facilities, the number of students enrolled in free breakfast programs, and the impact of later dismissal times on after-school programming both for disadvantaged students and for high-achieving students seeking additional academic enrichment opportunities. For example, concerns about access to personal transportation tend to be more prevalent in less affluent school districts than in more affluent ones. Similarly, modes of transportation are typically much more of an issue for larger districts, especially those in urban or metropolitan centers with high traffic congestion (Denver, CO).
7. Prioritizing Sleep Health is an Important Corollary to School Start Time Change
Despite the best of efforts, there is likely to be some variability in how much individual students within a district benefit from start time change. While studies definitively show that students overall obtain more sleep when start times are delayed, there will be families and students who choose not to take advantage of the additional sleep opportunity (24, 25). This underlines the importance of providing education about sleep health and time management to both parents and students in conjunction with schedule changes. In addition, schools may undermine the benefits of delayed start times by rescheduling after-school programs and activities to before school (e.g., early morning sports practices). Excessive homework, an issue frequently raised by students and parents, may also diminish students’ abilities to obtain optimal sleep. Districts should consider using the change in start times as an opportunity to make other adjustments that are in the best health interests of students and which complement the benefits associated with increased sleep.

8. Adjustments Take Time
It is critical to allow adequate time prior to implementing changes for families and other community members to become informed and make sufficient plans (e.g., childcare, transportation, family time). Once finalized, district leadership should communicate the details of the new schedules soon as possible, along with information on the rationale for making changes (e.g., Pulaski, AR). District-level organized and comprehensive communication and outreach efforts are absolutely key in conveying information in a timely manner to the community and in addressing the misinformation and misconceptions that often circulate in the advent of such an important (and often controversial) societal change.

9. Anticipation is Often Worse than the Reality
Similar to concerns regarding the impact of delayed start and dismissal times on athletic practices and games, many of the other potential problems typically raised in the community prior to the change are often not substantiated (Arlington, VA; Wilton, CT). For example, several studies have shown that participation by students in extracurricular activities does not decline when start times are delayed (16). Teacher retention is another commonly expressed concern that may not be realized; in Arlington VA, for example, the predicted mass exodus of teachers in the district never occurred and in fact, only one teacher left. Communities often make adjustments to accommodate changes in schedule; for instance, employers shift work hours for student workers and parents utilize after-school childcare for elementary students instead of before school options if start times are “flipped.” Finally, some problems dissipate over time; for example, traffic may temporarily worsen when bus routes are changed, until drivers in the community adjust their commuting patterns.

10. Monitoring Outcomes
Districts should monitor the results and outcomes following the change to later start times, communicate positive results to the community and seek ways to mitigate or address negative or unforeseen impacts (Arlington, VA). Ideally, districts should work with county health professionals or local university or medical centers to design pre- and post-surveys and other methods to measure the impact of changing school start times on student health, safety and academics. Districts that have conducted outcomes research have been able to communicate the findings to the community to foster further acceptance of changing school start times. Additionally, they have been able to provide important data for the growing scientific literature in this area as well as invaluable resources for other districts contemplating school start time change.

V. Conclusions
Establishing healthy school start times has a clear scientific rationale but can introduce considerable challenges for communities, including school administrators, families, students and other stakeholders. While the potential benefits to the health, safety and performance of students are irrefutable, many school districts remain reluctant to "take the plunge" and commit time, effort, resources and political capital to this effort. It is our hope that providing this "blueprint for change" with general recommendations regarding the process involved in changing school start times will be an impetus for school districts across the country take this important step.
VIII. References


IX. Appendices

A. History of School Start Times and Sleep Research on Adolescents in the United States

Historically, public school bell times across the nation evolved as a result of economic, social, legal and political pressures on school districts and municipalities – not from sleep science pertaining to adolescents (which essentially did not exist until the 1970’s) or concerns about the health, safety and academic performance of students. Below is an overview of the interplay between influential factors in the development of public education and its transportation systems as well as major milestones in science of sleep and circadian biology.

1800s
Until the 1840s, the educational system is highly localized and largely accessible only to certain privileged groups (i.e., the wealthy, whites, males).

Mid 1800s
Educational reform movement led by Horace Mann and Henry Barnard leads to free public education at the elementary level for all American children.

Late 1800s
17 states had operable public school transportation programs, starting with Massachusetts in 1869 (e.g., horseback, wagon).

At the end of the nineteenth century, 93% of the highways in the country are dirt roads. Horse-drawn carriages and the railroad are the leading means of transportation. Automobiles first came into use in the 1890s, and the first auto arrived in Seattle in 1900. By the 1950s, the “Age of the Automobile” had come into its own and there is great pressure to create an improved transportation infrastructure; i.e., to build more and better roads that link new houses being built outside cities and jobs that still exist mostly in urban centers.

1900s

1915—Navistar manufactures the first “school bus” for Ravinia School District in South Dakota.

By 1918, all states have passed laws requiring children to attend at least elementary school.

1919—All 48 states have laws allowing the use of public funds for transporting children to and from school.

1920s
Dr. Nathaniel Kleitman, one of the earliest and most influential sleep researchers, begins to study the regulation of sleep and wakefulness at the University of Chicago.
1925—Supreme Court rules in Pierce v. Society of Sisters that states cannot compel children to attend public schools and that children can instead attend private schools.

As the 20th century progresses, most states enact legislation extending compulsory education to age 16.

The availability of and access to affordable motor vehicle transportation helps transport children from more rural and remote areas and helps lead to the consolidation and modernization of schools.

1939—Dr. Nathaniel Kleitman publishes his seminal book Sleep and Wakefulness.

1940s
In the 1940s, responsibility for financing public education becomes more regionalized at the state, district and municipality levels. In 1940, local property taxes finance 68% of public school expenses, while state governments contribute 30%. By 1990, local districts and states each contribute 47% to public school revenues. The federal government provides most of the remaining funds.

1941-1945—U.S. in World War II: Industrialization and a post-war economic boom dramatically change the prosperity of Americans and they buy more houses, automobiles and start families, which will become the “baby boomers.”

By the middle of the 20th century, most states take a more active regulatory role in public education than in the past. Many states consolidate school districts into larger units. In 1940, there are over 117,000 school districts in the United States, but by 1990 the number decreases to just over 15,000. This regionalization often results in transporting a greater number of students over longer distances.

1950s
All in all, new highways, faster & cheaper vehicles, and economic prosperity stimulate a tremendous urban sprawl and the “suburbanization of America” from the 50s to present day.

1950s-1960s—“Baby boomers” begin to reach school age. More than 50% of today’s schools are built during this period.

1953—Dr. Nathaniel Kleitman and his graduate student, Eugene Aserinsky, make the landmark discovery of rapid eye movement (REM) during sleep. Shortly afterwards, their student, Dr. William Dement describes the “cyclical” nature of sleep and the relationship between REM and dreaming.

1954—Brown v. Board of Education outlaws “separate but equal” facilities. “White flight” from urban centers begins, leading to the rapid development of suburban school districts. In many regions of the country, children are bused longer distances to assist in integrating schools.
1956—President Dwight D. Eisenhower signs the Interstate and Defense Highways Act and helps accelerate the suburbanization of America. 47,000 miles of federal highway are built.

1960s
By the early 1960s, there is a rapid increase in the school population due to the consolidation of remaining schools—larger and more complicated school districts are created. Educators begin looking for new ways to deal with the problem of overcrowding, which leads to staggered start times being considered and implemented in some school districts. With little or no sleep science available to guide decision-making, high school start times are typically placed earlier than elementary schools.

1961—Fairfax joins Montgomery and Prince Georges Counties in MD in staggering start times for elementary and secondary schools to reduce operating costs. All high schools except Herndon and Luther Jackson start at 8:15 am.

1970s
During the 1970s, recession, inflation, increasing fuel costs and budget cuts further contribute to a “do more with less” mentality in school systems and in state and local governments. As a result of waning enrollment and decreasing property tax revenues, many school districts look for ways to cut transportation costs and adopt tiered bell schedules so that they could move the same number of students with fewer buses.

1970—Court-ordered busing begins to help integrate schools, but in some regions of the country, this leads to an even greater exodus from urban centers. The further consolidation of schools and the creation of still larger school districts result in longer commutes for some students.

Dr. William Dement, “the father of sleep medicine,” founds the first sleep research center at Stanford University.

1972—Animal studies lead to the discovery of the suprachiasmatic nuclei in the hypothalamus is the center of the “biologic (or circadian) clock” in the human brain.

The Fairfax County School Board adopts ½ Mondays in elementary schools to allow for planning time for teachers.

1973-1974—Stock market crash causes inflation and devaluation of the dollar.

U.S. experiences an energy crisis due to an oil boycott by the Organization of Arab Petroleum Exporting Countries (OAPEC). President Nixon asks the nation to adopt measures to conserve energy. School districts lower thermostats, consider shorter days and many adopt tiered-busing to save fuel, which will more than double in price by the end of the decade.

1974—Daylight Saving Time is expanded to more states and for a more extended time period, which leads to concerns regarding younger students waiting for the bus in the dark.

1976—Using a standardized protocol (the Multiple Sleep Latency Test), Dr. Mary Carskadon establishes sleep latency (time to fall asleep) as a physiologic measurement of sleep propensity (likelihood of falling asleep). This allows researchers to objectively measure the extent of daytime sleepiness resulting from acute and chronic sleep loss and begin to quantify the impact of sleep loss on daytime performance.
1975-1976—The Fairfax County School Board cancels plans to buy 80 new replacement busses and instead adjusts bell schedules earlier by 10-15 minutes and adds a fourth tier to its busing schedule.

Late 1970s—Dr. Mary Carskadon at Brown University and others conduct initial research on normal biological and circadian changes in adolescent sleep.

1979—Second energy crisis hits the nation following the Iranian revolution; increasing pressure on school districts and municipalities to lower transportation costs.

1979—1986—During the next decade, Fairfax County Public Schools moves its high school start times from 8:00-8:15 am to 7:40 am.


1980s
During the 1980s, an increase in the birth rate and new immigration contributes to the growth of the nation’s student population, adding pressure on many school systems.

Starting in the 1980s, important research on adolescent sleep needs and sleep schedules is conducted by Dr. Carskadon and others.

1982—Researchers develop a hypothesis about how sleep may play a key role in learning and memory consolidation.

1986—Dr. Charles Czeisler and colleagues describe for the first time how bright light influences the human biological clock.

1987—Fairfax County Public Schools’ high schools move start times earlier by 10 minutes to 7:30 am.

1988—U.S. Congress appoints Dr. William Dement as Chair of the National Commission on Sleep Disorders Research to study the prevalence of sleep deprivation and sleep disorders and their impact on the health of all Americans.

1990s
Sleep researchers begin to describe delayed phase preference in teenagers and the impact of school schedules and employment on their sleep. Researchers also begin to study sleep disorders and the relationship between sleep loss and depression in adolescents.

1990—Fairfax County Public Schools increases its secondary school day by 30 minutes by adopting a 7-period day, with high schools going from 7:30 am to 2:20 pm.

1992—The National Commission on Sleep Disorders Research issues its report and declares, “America is seriously sleep-deprived with disastrous consequences.”

1993—The Minnesota Medical Association adopts a resolution calling on local school districts to eliminate early start times for adolescents.
The National Center for Sleep Disorders Research (NCSDR) is established at the National Institutes of Health; its mission is to coordinate research and national educational efforts about sleep and sleep disorders.

1994—The CLOCK gene is discovered, which both demonstrates the genetic influence on normal human circadian functioning and emphasizes the importance of circadian regulation on health and disease.

1996—Edina, Minnesota becomes the nation’s first school district to delay start times for high school students based on sleep research showing the impact of sleep loss on young people.

High school start time in Fairfax County is adjusted 10 minutes earlier to 7:20 am, where it currently remains.

1997—The National Institutes of Health (NIH) declares that adolescents and young adults (ages 12 to 25 years) are a population at high risk for problem sleepiness based on “evidence that the prevalence of problem sleepiness is high and increasing with particularly serious consequences.”

1997—As a means of mitigating after-school criminal activity by unsupervised teenagers, Congresswoman Zoe Lofgren introduces Concurrent Resolution 227 (ZZZ’s to As Act) expressing the “sense of Congress that secondary schools should begin the school day no earlier than 9:00.”

1998—Dr. Kyla Wahistrom and colleagues publish the preliminary findings of their research on the impact of changing start times in 3 Minneapolis high schools.

1999—Congresswoman Zoe Lofgren introduces H.R. 1267, “Zs to As Act.” The bill provides grants up to $25,000 to local educational institutions that agree to begin school for secondary students after 9:00 am. This time, the bill focuses on the sleep needs of adolescents. It does not pass, but gains significant media attention and helps spur a “national conversation” about the issue.

1999—The National Research Council holds Sleep Needs, Patterns and Difficulties of Adolescents Workshop, which raises awareness amongst federal agencies and other health professionals about more than two decades of sleep research on teens. Dr. William Dement declares, “Adolescence is the time of greatest vulnerability from the standpoint of sleep.”

Dr. Eve Van Cauter and her colleagues describe the effects of sleep debt in young adults, establishing an association between sleep loss and metabolic and hormonal function. The research later leads to findings linking sleep loss with an increased risk of obesity.

2000s
Sleep researchers increasingly focus on cultural and international differences in sleep habits, including public policies related to work and school hours and their impact on sleep, etc. There is also emerging evidence that puberty-related changes in sleep patterns may affect middle school students as well, thus highlighting the importance of considering later start times in this population as well.

2000—The National Sleep Foundation releases an Adolescent Sleep Research Report and Resource Guide at a press conference on Capitol Hill with Congresswomen Zoe Lofgren in order to draw national media attention to the consequences of early start times on the health and safety of adolescents.
2001—A state senator in Connecticut introduces the first statewide legislation to change school start times in the nation, but it does not pass.

2002—Dr. Kyla Wahlstrom publishes Changing times: Findings from the first longitudinal study of high school start times, the nation’s first major study that details the positive impacts of later school start times.

2002—A bill is introduced in the Connecticut Senate that bans administering state tests before 9:00, but does not pass.

2003—Stickgold and colleagues at Harvard Medical School publish evidence of the relationship between sleep and memory and learning.

2004—The State of Connecticut passes legislation that allows districts to administer the tenth grade mastery test as early as 8:30.

2006—The National Sleep Foundation issues its annual “Sleep in America” poll. The national poll is the first of its kind, detailing the findings of telephone interviews from a random sample of 1,602 caregivers and their adolescent children about the student’s sleep and sleep habits. It finds that only 9% of high school-aged respondents get the amount of sleep recommended by physicians on school nights.

2009—The Centers for Disease Control and Prevention (CDC) releases data from a national survey used to assess the prevalence of unhealthy sleep behaviors in 12 states and declares “insufficient sleep is a public health epidemic.”

1900-2010—The percentage of teenagers who graduate from high school increases from about 6% in 1900 to about 85% in 1996, and then declines over the next decade and a half to 75% in 2010.

2010s

2010—The Department of Health and Human Services releases Healthy People 2020, which for the first time gives sleep its own focus area and sets the objective of increasing “the proportion of students in grades 9 through 12 who get sufficient sleep.”

2010—The American Medical Association (AMA) adopts Resolution 503, “Insufficient Sleep in Adolescents,” – sponsored by the American Sleep Apnea Association – which confirms “adolescent insufficient sleep and sleepiness as a public health issue” and supports “education about sleep health as a standard component of care for adolescent patients.”

2011—Vorona et al publish findings on adolescent automobile crash rates in Virginia Beach and Chesapeake, Virginia showing a significant increase in crashes in the district with earlier high school start times.

The Brookings Institute issues its report, Organizing Schools to Improve Student Achievement: Start Times, Grade Configurations, and Teacher Assignments, identifying high school start time delay as one of the 3 most important strategies to improve America’s schools and projecting a potential benefit-to-cost ratio of 9:1.
The CDC publishes an epidemiological study showing that almost 70% of high school students are not getting sufficient sleep and sleep loss is associated with 10 at-risk behaviors including smoking, alcohol and marijuana use, sexual activity, feelings of sadness, and thoughts of suicide.

2012—The Florida Chapter of the American Academy of Pediatrics issues a position statement supporting, "considerations to policy changes where students' physical and mental health is promoted. The FCAAP/FPS supports efforts to change high school start times after 8:00 a.m."

2013—U.S. Department of Education Secretary Arne Duncan tweets, "Common sense to improve student achievement that too few have implemented: let teens sleep more, start school later.

Virginia Chapter of the American Academy of Pediatrics issues a statement supporting later school start times for all Virginia high schools.

2014—Dr. Kyla Wahlstrom, with funding from the CDC, publishes the findings from a 3-year research study looking at the impacts of later start times in 8 public high schools in 3 states. The study finds that later start times improve sleep, academic performance and reduce motor vehicle crashes.
B. National School Start Time Survey

You are being asked to fill out this survey because your school district has prior experience with delaying high school start times and you participated in and/or have knowledge about the process. Thank you for your time.

General Information
1. Name and title of individual filling out survey:
2. Name and location of school district:

3a. What year did your school district begin to implement school start time change?

3b. If your district employed a phased-in approach, over how many years was start time change implemented?

4. Please indicate the number of schools in your district in the following categories:
   - Elementary School
   - Middle School
   - High School

5. Please indicate the approximate number of students enrolled in each category:
   - Elementary School
   - Middle School
   - High School

6. Please indicate the total number of school buses transporting students in your district:

7. Please indicate the school start/end times PRIOR to the change for:
   - Elementary School
   - Middle School
   - High School

8. Please indicate the school start/end times AFTER the change for:
   - Elementary School
   - Middle School
   - High School

9. Please indicate the current school start and end times (2013-14 academic year)
   - Elementary School
   - Middle School
   - High School

II. Change strategy and Implementation

10. Which best describes your district’s school start time change strategy (select all that apply)?
    - “Flip” (e.g., switch high school and elementary school start times)
    - All school start times (ES, MS, HS) delayed (“slide” later)
    - Addition of a “zero period” in the morning
    - Students chose late or early start times
    - Other (please describe)

11. Please indicate which transportation approaches were in place before and/or after the start time change (may select more than one):
12. Please mark “Yes” or “No” for the following challenges that your school district faced in changing school start times.

1) Traffic flow at the school during drop off and pick up  
2) Commuting distances  
3) Before-school extracurricular program attendance  
4) After-school extracurricular program attendance  
5) Before-school academic enrichment program attendance  
6) After-school academic enrichment program attendance  
7) Use of school facilities by non-school community groups (e.g., Boy Scouts)  
8) Athletic game schedules  
9) Before-school athletics practice schedules  
10) After-school athletics practice schedules  
11) Use of practice fields by non-school groups (e.g., Parks and Recreation)  
12) Before-school child care  
13) After-school child care  
14) Changes in parents’ work schedules  
15) Changes in teachers’ work schedules  
16) Changes in staff commute times  
17) Student after-school employment  
18) Participation in school breakfast programs  
19) “Civil twilight” violations (i.e., leaving home before dawn or after dusk) for elementary students  
20) Other (please specify):

13. Please rank order the top five issues that were the most challenging (from 1=most challenging to 5=least challenging)

1) Traffic flow at the school during drop off and pick up  
2) Commuting distances  
3) Before-school extracurricular program attendance  
4) After-school extracurricular program attendance  
5) Before-school academic enrichment program attendance  
6) After-school academic enrichment program attendance  
7) Use of school facilities by non-school community groups (e.g., Boy Scouts)  
8) Athletic game schedules  
9) Before-school athletics practice schedules  
10) After-school athletics practice schedules  
11) Use of practice fields by non-school groups (e.g., Parks and Recreation)  
12) Before-school child care  
13) After-school child care  
14) Changes in parents’ work schedules  
15) Changes in teachers’ work schedules  
16) Changes in staff commute times  
17) Student after-school employment
18) Participation in school breakfast programs
19) "Civil twilight" violations (i.e., leaving home before dawn or after dusk) for elementary students

14. Please mark “Yes” or “No” for the following strategies that your school district employed in changing school start times.
   Yes  No  N/A
   1) Substitute online education for early morning classes
   2) Substitute summer school for early morning classes
   3) Substitute Saturday classes for early morning classes
   4) Increasing the length of winter break to reduce early morning travel for elementary students ("civil twilight violations") and decreasing the summer break by a corresponding number of days
   5) Flexible start and end-time scheduling (not requiring school bus transportation)
   6) Adding lighting for selected athletic playing fields
   7) Increased use of public transportation (e.g., providing incentives for use)
   8) Increased use of personal transportation (e.g., "kiss and ride")
   9) Decreased use of personal transportation
   10) Student athletes’ early dismissal
   11) Extracurricular programs on Saturdays
   12) Mid-morning “breakfast break” for students
   13) Other (please specify):

15. Please rank order the top five issues that were the most challenging (from 1=most challenging to 5=least challenging)

   1) Substitute online education for early morning classes
   2) Substitute summer school for early morning classes
   3) Substitute Saturday classes for early morning classes
   4) Increasing the length of winter break to reduce early morning travel for elementary students ("civil twilight violations") and decreasing the summer break by a corresponding number of days
   5) Flexible start and end-time scheduling (not requiring school bus transportation)
   6) Adding lighting for selected athletic playing fields
   7) Increased use of public transportation (e.g., providing incentives for use)
   8) Increased use of personal transportation (e.g., "kiss and ride")
   9) Decreased use of personal transportation
   10) Student athletes’ early dismissal
   11) Extracurricular programs on Saturdays
   12) Mid-morning “breakfast break” for students
   13) Other (please specify):

III. Benefits/Costs

16. Please mark “Yes” or “No” for the following beneficial outcomes that your school district observed at the high school level as a result of school start time changes; if you did not measure an outcome, please check “Not Applicable” N/A
   Yes  No  N/A
   1) Increase in daily attendance
   2) Reduced tardiness rates
   3) Improved standardized test scores
   4) Improved grades
   5) Higher graduation rates
   6) Fewer referrals for disciplinary action
   7) Improved sports team performance
   8) Fewer sports-related injuries
   9) Cost saving for public school system
   10) Fewer student visits to school health centers
   11) Lower rates of depression/suicidal thoughts
   12) Lower rates of car accidents
   Other (please describe):
17. Please rank order the top five beneficial outcomes that you believe were the most important (from 1=most important to 5=least important).

1) Increase in daily attendance
2) Reduced tardiness rates
3) Improved standardized test scores
4) Improved grades
5) Higher graduation rates
6) Fewer referrals for disciplinary action
7) Improved sports team performance
8) Fewer sports-related injuries
9) Cost saving for public school system
10) Fewer student visits to school health centers
11) Lower rates of depression/suicidal thoughts
12) Lower rates of car accidents

18. Please mark “Yes” or “No” for the following negative outcomes that your school district observed as a result of school start time changes; if you did not measure an outcome, please check “Not Applicable” N/A

Yes  No  N/A

1) Financial cost incurred by the school district
2) Loss of community support
3) Impact on parent work schedules
4) Limitations on student after-school employment
5) Financial cost incurred by families (loss income, additional child care expenses)
6) Changes in traffic patterns
7) Reduction of student involvement in extracurricular activities/athletics
8) Negative impact on teacher schedules
9) Safety concerns for ES students

19. Please rank order the top five negative outcomes that you believe were the most important (from 1=most important to 5=least important).

1) Financial cost incurred by the school district
2) Loss of community support
3) Impact on parent work schedules
4) Limitations on student after-school employment
5) Financial cost incurred by families (loss income, additional child care expenses)
6) Changes in traffic patterns
7) Reduction of student involvement in extracurricular activities/athletics
8) Negative impact on teacher schedules
9) Safety concerns for ES students

Thank you very much for completing this survey!
The Children’s National Medical Center’s Blueprint for Change Team

**Judy Owens, MD, MPH**—Director of Sleep Medicine at Children’s National Medical Center and Professor of Pediatrics at George Washington University School of Medicine and Health Sciences.

**Danny Lewin, Ph.D., D.ABSM**—Associate Director of the Pediatric Sleep Medicine and Director of the Pulmonary Behavioral Medicine Program at Children’s National Medical Center, Assistant Professor of Pediatrics at George Washington University School of Medicine.

**Darrel Drobnich**—Partner, Midamr Group

**Allison Baylor**—Research Assistant, Sleep Medicine Division, Children’s National Medical Center.
The Case for Improving and Expanding Time in School:

A Review of Key Research and Practice

Updated and Revised
February 2015

By David A. Farbman, Ph.D.

**COMMON SENSE TELLS US THAT WHEN IT COMES TO LEARNING, TIME MATTERS.** An individual simply cannot advance in any given area of study without committing a certain amount of time to grasping new content, practicing and honing skills, and then harnessing knowledge and skills to realize specific aims. Think of the chess master who plays match after match to improve his game or the scientist who toils long hours in her laboratory to unlock the mysteries of an intricate phenomenon. For them, becoming more adept in their chosen field results, in no small part, from the time they invest.

The great irony is that our nation's public school system has, by its rigid adherence to the conventional calendar of 180 six-and-a-half-hour days for roughly 100 years, essentially disregarded the fundamental connection between time and learning. Consider that while the expectations for how schools prepare the next generation of American workers and citizens have risen dramatically, education and policy leaders have usually not updated policies and practices around learning time to meet these mounting demands. The school calendar looks much the same as it did a century ago.

According to the 1994 *National Education Commission on Time and Learning*, to expect a much higher degree of learning from today's young people, without providing them additional time to assimilate content and develop skills constitutes no less than "self-deception... [that] asks the impossible of our students." The Commission report then concluded with a stark observation: "If the United States is to grasp the larger education ambitions for which it is reaching, we must strike the shackles of time from our schools." And that was 20 years ago; since then, the complexity of the world and the base level of knowledge and skills needed to thrive in the 21st century have only grown. Having more time in school to meet these ever-intensifying demands would seem all the more pressing.

How can more time in school lead to more learning and, by extension, greater success in life? As this review will highlight, both research and practice indicate that adding time to the school day and/or year can have a meaningfully positive impact on student proficiency and, indeed, upon a child's entire educational experience. Such enhancement can be especially consequential for economically disadvantaged students, who tend to enter school trailing behind their more affluent peers academically, continue to lag as they proceed through each grade, and have fewer opportunities outside of school for learning. For these millions of students, more time in school can be a path to equity.

The evidence makes clear that expanding school time holds this potential because, when planned and implemented well, it confers three distinct, though interdependent, benefits to both students and teachers:

- **More engaged time in academic classes**, allowing broader and deeper coverage of curricula, as well as more individualized learning support;
- **More dedicated time for teacher collaboration and embedded professional development** that enable educators to strengthen instruction and develop a shared commitment to upholding high expectations; and
- **More time devoted to enrichment classes and activities** that expand students' educational experiences and boost engagement in school.
In the following pages, we explore these three benefits, which emerge as a redesigned education, built upon a longer school day and year, opens up new learning and growth opportunities. Using a mix of formal research inquiries and effective practices studies from the field, we consider evidence that demonstrates how time relates to each of the three benefits. Along with explicating the value that more time in schools can bring, the research also makes clear that time is a resource which must be used well and in concert with a continuous focus on quality implementation to realize its full potential.

School Time in America

Before diving into the three facets of having more time in school, it is helpful first to lay out some basic facts about the American school schedule and calendar. Analysis of the federal Schools and Staffing Survey, the only nationally representative data source available for identifying variations in time across schools, shows that the average school year of 179 days has remained unchanged over at least the decade, while the average school day has also changed little, standing at 6.8 hours for non-charter schools. Perhaps even more important to understand is that schools in the lowest quartile do not average much less time than the highest. (That is, the gap between the 25th and 75th percentiles is just 4 days and 0.6 hours, respectively). This narrow range of the length of the school year and day suggests that time expectations are remarkably uniform. (Figure 1.1 and 1.2)

A second fact indicated by the SASS data is that the proportion of schools that are breaking from the standard is growing. The trend in a longer school day is particularly apparent among charter schools, which have taken advantage of their autonomy from contract constraints and state and district policy related to school time to operate with longer days. As such, the average charter school day has grown markedly over the last decade, with particular growth in the upper quartile. (Figure 2)

Charter schools may be at the leading edge of this move to increase school time, but they are not alone. In its latest count of schools with at least a seven-hour day and at least 30 more minutes than surrounding schools, NCTL found a total of over 1,200 non-charter schools that met the criteria, representing about 80 percent of the extended-time schools population.
The following sections will make clear why an increasing number of educators have found it worth the challenge of overcoming logistical and resource barriers to expand school time. Still, it is essential to keep in mind that even with the spread of expanded-time schools, they still represent a small minority within the greater American school landscape.

**Time and Student Achievement**

The place to begin in exploring how expanded time plays a role in advancing student learning is to look first at the broader questions of what factors contribute to making schools effective or, put another way, what makes high-performing schools work? The question resonates in an era when turning around chronically low-performing schools, especially those that serve large portions of high-poverty children, tops the national agenda. In recent years, a number of scholars have begun to apply complex analytical tools to identify particular practices and policies that do, in fact, generate real and lasting improvements in student outcomes. Among these, the condition of having significantly greater time than the norm consistently emerges as one of the key elements. A few of the more compelling research studies include:

- A study from Harvard economist Roland Fryer examined charter schools of New York City to identify those elements within schools that have the greatest impact on academic outcomes. Fryer determined that instructional time of at least 300 more hours than the conventional district calendar is one of the strongest predictors of higher achievement (along with high-dosage tutoring, consistent feedback to teachers, use of data, and high expectations). Meanwhile, traditional factors presumed to have a positive impact on student achievement like smaller class size and advanced teacher qualifications were found to have minimal effect.²

- Using essentially the same data set, Stanford University economist Caroline Hoxby employed a multivariate analysis to identify how strongly specific school policies—from board composition to curricular choices to school structures—correlate with student outcomes. Hoxby and her colleagues found that total learning time was one of the strongest predictors of student outcomes among the long list of policies they had identified and analyzed. (Because most charter schools have a day longer than the district schools, Hoxby and colleagues used the indicator of a longer school year as a proxy for significantly more learning time in order to differentiate among charters.)³

- In a mixed-methods study designed to understand why middle school students in four Boston charter schools significantly outperformed students in district middle schools, the American Institute of Research reported that one of the major structural differences between the two types of schools was their hours of operation. Students at these four Boston charters attend school for substantially more hours per day and more days per year than their peers in district schools. (In fact, these charter students attend for the equivalent of an extra 62 traditional-schedule days per year.) The authors indicate that this resource of additional time enables the schools to build in many more opportunities for core instruction, academic support, and teacher development and collaboration.⁴

- Likewise, an evaluation of the Promise Academy, the charter school run by the Harlem Children’s Zone, suggested that the expanded day and year are key to its strong outcomes.⁵

With expanded time identified as a key ingredient in successful schools, one group of scholars took a look at 15 empirical studies of schools that had extended days and/ or years to determine if students performed better in schools once they had more time. This meta-analysis found that adding time was, more often than not, associated with improved schoolwide outcomes, noting stronger effects among schools serving primarily at-risk students.⁶

The pivotal role of time in these schools that produce high (or higher) student performance, most of which serve large proportions of disadvantaged students, aligns with two other major areas of education research.

First, many researchers have suggested that more time in school (i.e., formal educational settings) can help to overcome the negative effects of poverty on learning, like poorer health, less stable home lives, and fewer out-of-school learning opportunities. The clearest way to demonstrate the positive effects of school on at-risk students is to examine what performance is like during the period when students are consistently engaged in school (i.e., September through May) versus performance during those extended times when they are not (i.e., summer). A meta-analysis of studies that looked at the impact of the prolonged absence from school determined that the lowest-SES group declined in both reading and math. (Higher SES groups also lost the equivalent of one month of learning in math, but gained proficiency in reading over the summer.)⁷

More dramatically, a well-known study suggests that the widening achievement gap between low- and high-SES students might be traced back entirely to the long summer vacation. Examining a large cohort of students over the course of five years, the authors identified the gap in academic achievement between high- and low-SES
students widening over the summer months, and narrowing during the school year.\textsuperscript{10} Considering similar findings from a much broader data set, one set of scholars declared that schools, given their record of promoting learning growth among low-income students when they are actually there, can be "equalizers," if only poor students would spend more time in school.\textsuperscript{11}

The second reason why it stands to reason that highly effective schools are those with considerably more time than the conventional is that, almost by definition, they provide more time in classrooms. And more time in class should then, assuming reasonably efficient instruction, translate into more raw learning time or, as it is known in the literature, "time on task." A substantial body of research has long identified quantity of time on task by itself as a key determinant of student performance on an individual level.

The conceptual framework connecting time to learning first took root in 1963 when educational psychologist John Carroll articulated a "Model of School Learning." His framework unpacked the commonsensical connection between time and learning, demonstrating in sound educational terms how quantity of time serves as the pivot point in what he called the "degree of learning" that any individual achieves.\textsuperscript{19} Since then, many studies have confirmed Carroll's theory and, specifically, have delved into the phenomenon that spending more time in productive learning environments does, indeed, typically lead to increases in proficiency. For example:

- An analysis of three years of test data from Illinois schools validated that the more time individual students spent in reading and math class, the higher their scores in those subjects.\textsuperscript{11}
- A team of researchers found that the number of minutes students spent reading each day during reading period held a causal relationship to reading achievement.\textsuperscript{11}
- In a series of experiments, one scholar determined a direct correlation between time students spent studying a passage and proficiency on a fact-based assessment, finding that the more time students dedicated to studying the passage, the greater their performance in both the near- and longer-term.\textsuperscript{12}
- Research based on a large dataset of classroom observations in California found that differences in the amount of engaged learning time among students accounted for 9 percent of differences in student outcomes in elementary grades—a strong association in the field of education.\textsuperscript{14}
- A later study, using similar methodology, discovered that after disaggregating student outcomes by performance cohorts (i.e., examining four different student groups arranged according to their scores), the amount of time students spent engaged in learning was able to predict 36 percent of test score variance among the lowest performers.\textsuperscript{17}

Thus, schools with substantially more allotted time than average that, in turn, provide students with more time in academic classes than they would otherwise have are more likely to generate better student performance, especially among those who lag most.

A concrete illustration of this dynamic comes through an interesting study conducted by the education research organization McREL. In it, researchers surveyed teachers with many years experience to determine how many hours they would need to enable students to reach proficiency in learning standards for language arts, civics, mathematics, and science across four different grade spans. On average, the teachers estimated that teaching what students were expected to learn in these subjects would take, at grades 5, 8 and 12, considerably more time than the roughly 900 instructional hours that are available during a standard school year.\textsuperscript{18} (Table 1, p. 5)

With the majority of states across the country now implementing the Common Core State Standards (CCSS), the difference between the time needed to teach to standards and the time available will only grow, because learning expectations are more rigorous and students will need to demonstrate higher degrees of achievement in order to be deemed proficient.\textsuperscript{18}

Consider that in Massachusetts, a state whose prior standards were generally considered to be of nearly equivalent rigor to those of CCSS, only 38 percent of teachers believe they had sufficient time to teach the curriculum.\textsuperscript{20} By contrast, 85 percent of teachers in Massachusetts Expanded Learning Time (ELT) schools believe they have sufficient time with their students to reach learning goals. (ELT schools are part of a statewide program to expand the school year by 300 hours, meaning each ELT school operates with an instructional day that is roughly 100 minutes longer than that of other district schools.) Massachusetts ELT teachers report the following advantages of having more time to teach:

- Coverage of more material and examining topics in greater depth;
- Completing, reinforcing, and extending lessons;
- Connecting concepts occurring in different classes;
- Setting context and repeating content, if necessary;
- Answering students' questions; and
- Discussing and reflecting on lessons.\textsuperscript{21}

Activating this broader array of teaching strategies has a direct, positive impact on students. As one ELT teacher describes, "More learning time has significantly increased student engagement and allows students and
### Table 1
Estimates of Total Instructional Time Needed (in hours)
To Teach Standards-Based Curricula in Four Academic Domains

<table>
<thead>
<tr>
<th>Academic Domain</th>
<th>Grade Level</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2nd Grade</td>
<td>5th Grade</td>
<td>8th Grade</td>
<td>12th Grade</td>
<td></td>
</tr>
<tr>
<td>Language Arts</td>
<td>447</td>
<td>555</td>
<td>608</td>
<td>258</td>
<td></td>
</tr>
<tr>
<td>Civics</td>
<td>237</td>
<td>201</td>
<td>278</td>
<td>446</td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>243</td>
<td>289</td>
<td>261</td>
<td>309</td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td>90</td>
<td>129</td>
<td>260</td>
<td>215</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>819</strong></td>
<td><strong>1,058</strong></td>
<td><strong>1,428</strong></td>
<td><strong>1,148</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Source: Florian, Teacher Survey of Standards-based Instruction Addressing Time, 1999.*

Staff to establish more meaningful relationships that create credibility in the classroom.

**Digging Deeper on Time Use in Schools**

The evidence is clear that, given the strong connection between time and learning, expanding learning time in schools can contribute significantly to better performance for individual students and for the student body as a whole, with particular impact among populations of at-risk students.

Of course, the research cited above also makes plain that more learning time is not the standalone factor of effective schools, but a core component that lives within a multifaceted system to promote student learning and growth. As educators seek to harness the power of more time, research indicates that they must focus on two interrelated dimensions of the organization and execution of the educational program to generate the intended effects of more time on student learning.

The first aspect relates to how schools structure the use of time within the day and across the year. That is, the specific ways that teachers and students spend their time (e.g., duration of particular classes, the balance between academics and enrichment, the amount of time for teacher collaboration, etc.) matters as much as the total amount of time available for learning. High-performing schools do not just have more time, then, but also employ an integrated series of practices to maximize use of that time. Practices include: continuously analyzing data measuring student learning and targeting instruction to individual student needs, managing classrooms tightly to "make every minute count," and consistently holding students to high expectations for learning and behavior.

In its publication, *Time Well Spent*, NCTL describes how school time in more effective schools operates as a single gear embedded within the complex machinery of educational resources that must turn together to achieve the promise of enhancing learning. (Figure 3, p. 6) Recall that in his research Roland Fryer described a similar dynamic of interconnected practices that blend to produce conditions that lead to higher student performance. Likewise, Katherine Merseth describes the process well in her book about five high-performing charter schools:

> High-performing schools do not just have more time, but also employ an integrated series of practices to maximize use of that time.

The purposefulness with which these schools structure time illustrates their priority for academics and facilitates the pursuit of their missions. ... These practices, combined with deliberate structuring of people and nurturing culture, enable these charters to maximize time on task....

The opposite is also true, of course. In less effective schools, time allotted for instruction is often wasted. Research from California indicates that schools that use time inefficiently—that is, those where a combination of factors act to erode allotted time for learning—tend to cluster in schools with large numbers of high-poverty students. At these schools, interruptions to instruction, ranging from discipline problems to the lack of capable substitute teachers, end up reducing real learning time.

The second (and related) issue concerns the hard-to-meas-
The relationship between the quantity of time and learning cannot, in other words, be considered in isolation; instead, time’s impact is governed by the user. Teachers who are effective within a conventional schedule will likely advance student learning further with any time added precisely because they would be inclined to use that “extra time” well.28

A piece of research that draws upon data from the Programme for International Student Assessment (PISA)—a triennial test in reading, math, and science for 15-year-olds administered in dozens of countries—confirms this interplay between time and instructional quality, as indicated by metrics related to classroom environment. Because PISA asks students (as well as principals and teachers) to complete a survey that includes a range of questions related to school and learning context, the researchers were able to identify and analyze associations among learning time, other components of the learning environment like teacher professional development and instructional practices, and student performance together. They found that even as more instructional time generally translated to better outcomes, “the benefit of additional instructional time appears to vary with the quality of the classroom environment.” The authors derived the quality of environment through a formula that accounted for survey responses on the level of class disruptions and student and teacher behavior. So, the higher the quality indicators (e.g., fewer disruptions, more student and teacher interactions, etc.), the greater the effect of increased time on student outcomes.29

**Teacher Learning and Collaboration**

Because the impact of time spent learning for students is mediated by the quality of the instruction they receive during that time, more successful schools do not simply provide more classroom time, but also strive to make that classroom time as efficacious as possible. And the prime way to increase efficacy is by strengthening pedagogy. As the National Staff Development Council (NSDC) states plainly, “Efforts to improve student achievement can succeed only by building the capacity of teachers to improve their instructional practice....” The question that then
naturally emerges is how to build this capacity. Research demonstrates that, as with students, providing expanded opportunities for teacher learning plays a pivotal role.

The learning process for teachers entails two key components. First, evidence indicates that advancing teacher aptitude is best achieved not by keeping teachers isolated from one another, but rather by structuring opportunities for teachers to convene, working on instructional improvements collaboratively.

Why is teacher collaboration so essential? Optimally, these opportunities to work together will lead to the formation of what are known as "professional learning communities," or PLCs. An approach that has become more widely pursued over the last decade, PLCs encourage teachers to develop a culture of collaboration with a shared objective of improving their instruction together. Several research studies confirm the value of PLCs. For example:

- **One study** showed that compared to traditional professional development meetings, collaborative planning time (also known as "embedded learning opportunities") led to much higher incidence of reflective practice among teachers and, as the author explains, reflecting on practice is a first step towards strengthening instruction.

- **Researchers** from the Center on Organizing and Restructuring Schools have found definitively that in schools with well-developed PLCs—as measured by teachers reporting high levels of collective responsibility for student learning—students performed better in reading, math, science, and history. The authors of the report stress that students tend to do better in class because they receive the consistent message from teachers that everyone should strive to do their best. This messaging to students comes about as the adults develop their own shared commitment to hold one another accountable for improved outcomes. The mutual professional obligation, in turn, emerges from, and is reinforced by, frequent interactions among and between teachers.

The second feature of effective systems for teacher learning and, in turn, instructional improvement dovetails the first: committing time to collaborate. Richard DuFour, a leading expert on collaboration, summarizes the connection: "For teachers to participate in such a powerful process, the school must ensure that everyone belongs to a team that focuses on student learning. Each team must have time to meet during the workday and throughout the school year."

Indeed, there is considerable evidence to suggest that absent these opportunities to sit down together and discuss student learning needs and their own abilities to address those needs, teachers are much less likely to form PLCs and, in turn, to have an impact on learning outcomes. One set of researchers from Minnesota and Ohio, for example, conducted a study of the teaching staffs in 24 schools to try to determine those elements that might affect the formation of strong PLCs. These researchers found that, among the various school conditions they identified, having a regular time for teachers to meet together was the most powerful factor—one that explained up to 70 percent of the variation in the relative strength of PLCs among schools.

Incidentally, having sufficient time is not important just for the effective operation of PLCs, but also for professional learning that revolves around the acquisition of particular skills and implementation of specific curricula, a set of work that typically takes place in a more formal or workshop model. The Institute of Education Sciences conducted a meta-analysis of over 1,300 studies which linked teacher professional learning practices to student achievement and found that programs delivering "a positive and significant effect" were those that averaged 40 annual hours in the professional development being evaluated. On average, these programs enabled teachers to help their students perform at a much higher level (compared to students in classrooms whose teachers did not participate in the professional development). Meanwhile, those programs with fewer than 30 hours of training for teachers had negligible effect on student performance.

Giving teachers time to collaborate and learn together to strengthen instruction seems obvious and, yet, often meets obstacles in American schools. The NSDC reports that teachers in the United States typically have three to five hours per week reserved for lesson planning; but that this time is seldom held in conjunction with colleagues. Further, available data from the Organisation for Economic Cooperation and Development indicates that the proportion of time American teachers have outside of classrooms to prepare for instruction is much lower than the international average.

The lack of teacher collaboration time is evident from a number of sources:

- **A survey** from the National Center for Literacy Education found that teachers believe the most effective form of professional learning is collaboration with colleagues—dedicated time when they can prepare for and reflect on lessons together. Yet, respondents reported that they have little opportunity to do this kind of collaborative work. Only 82 percent of respon-
students have a chance to frequently co-create or reflect with colleagues about particular lessons; 21 percent are given time to examine student work jointly and consistently; and only 14 percent dependably receive feedback from colleagues.\textsuperscript{59}

- According to data collected through a Scholastic teacher survey, educators have an average of just 15 minutes per day—about 75 minutes per week—for collaboration.\textsuperscript{59}

- An analysis of teacher contracts in a database of many of the largest school districts in the country reveals that only about 40 percent mention teacher collaboration at all, and of that number, a mere handful specify set times for this collaboration to take place.\textsuperscript{60}

In schools with more time in the day, however, available evidence suggests that teachers meet more frequently. Among Massachusetts ELT schools, for example, principals reported that teachers spend an extra hour (or more) per week collaborating than they did when they operated with a day closer to the standard 6.5 hours.\textsuperscript{61} In the high-performing schools studied in NCTM’s Time for Teachers, the schools averaged almost two hours per week for scheduled collaboration, on top of an hour for individual coaching, an hour for schoolwide trainings, and over nine hours for individual planning and informal collaboration.\textsuperscript{62}

While the amount of collaboration time needed each week to generate meaningful impact on student achievement is uncertain, one piece of evidence suggests that the difference between what qualifies as sufficient time in collaboration and what might be inadequate is relatively modest in real terms—roughly one hour per week. In the 2010 MetLife survey of the American teacher, high-collaboration schools were defined as those where teachers meet an average of 3.4 hours per week, compared to low-collaboration schools, where teachers meet an average of 2.3 hours weekly. Still, survey responses indicate that this extra hour can have a marked effect on the proclivity of teachers to work together, with teachers much more likely to respond positively that they collaborate and to do so in productive ways.\textsuperscript{63} (Table 2)

As much of the nation’s teaching force transitions to integrate the Common Core into classrooms, the need for collaboration has become even more pronounced. A survey of teachers by Education Week found that 71 percent of respondents sought more collaborative planning time to work with their peers so that they could more effectively re-align instruction to the new standards.\textsuperscript{64}

It is worth noting, too, that even as collaborative planning and review sessions stand as the hallmark of effective professional learning, high-performing schools also put other related practices in place, as well. These include: teams of teachers analyzing student performance data, coaching and support of individual teachers, and peer observations. One principal describes the rationale for dedicating so much time to this multi-faceted program for building teacher capacity: “Our goal is to be a place where every teacher gets better at their craft every day.”\textsuperscript{65}

### A Well-Rounded Education

Without a doubt, the primary purpose of school is to prepare every student to read, write, calculate, and analyze. But most Americans also hold schools to a more far-reaching mandate. Public surveys frequently show widespread support for the notion that schools should, in addition to developing academic skills, furnish students with experiences that nurture aptitude in critical thinking, problem solving, teamwork, and the like. They also value the inclusion of arts, music, and other enrichments within school.\textsuperscript{66} Within the confines of the standard American school schedule, however, the task of satisfying several agendas

### Table 2

**Higher Level vs. Lower Level of Teacher Collaboration at School: Attitudes and Experience Profile**

<table>
<thead>
<tr>
<th>Frequency of Collaborative Activities (% responding always/often)</th>
<th>All Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Higher (3.4 hrs./week)</td>
</tr>
<tr>
<td>Teachers meet in teams to learn what is necessary to help their students achieve at higher levels</td>
<td>98%</td>
</tr>
<tr>
<td>Teachers examine and discuss student work with each other regularly</td>
<td>93%</td>
</tr>
<tr>
<td>My school structures time for teachers to work together</td>
<td>94%</td>
</tr>
<tr>
<td>My principal’s decisions on school improvement are influenced by faculty input</td>
<td>92%</td>
</tr>
<tr>
<td>Beginning teachers have opportunities to work with more experienced teachers</td>
<td>95%</td>
</tr>
</tbody>
</table>


8
at once is tremendously challenging.

As a result, the second facet of schools’ mission—affording students a well-rounded education—tends to take a back seat, even though research indicates that these “secondary” educational opportunities can have enormous impact on student learning and growth.

This trend of favoring academics over well-roundedness is patently obvious just by looking how students are spending their time in school. In a 2008 study, the Center on Education Policy found that elementary students spent, on average, 142 more minutes per week in English classes and 88 more minutes per week in math than in the days before the 2002 No Child Left Behind Act.

In the zero-sum game of school time, increases in some classes necessarily mean decreased time in others. For the schools surveyed, the classes that most often lost time include science and social studies (now meeting about 7.5 fewer minutes per week), followed by art (a 57-minute loss), and physical education (40 minutes).7 (Figure 4)

Perhaps not surprisingly, the effect of this narrowing usually hits low-income students harder than their more affluent peers and does so in two ways. First, there are some indications that students in low-achieving schools—which are much more likely to be serving high-poverty populations—are shedding enrichments at a faster clip. A report from the Government Accountability Office found that teachers in schools designated as “needs improvement,” or that had higher percentages of minority students, were more likely to report decreased time spent in the arts than teachers from schools that were not deemed in need of improvement. Simultaneously, these same teachers from “needs improvement” schools reported increased time spent in math and English classes or remediation sessions.8 This decreasing time spent on arts in struggling schools might help explain why the New York City comptroller reported that arts teacher positions were much more likely to be cut from schools serving primarily poor students. While 20 percent of schools citywide lacked an art teacher, nearly half of these schools are located in the poorest neighborhoods.9

Second, poorer students are less likely to have access to enrichment learning during hours outside of school, including the summer months. Data cited by Robert Putnam shows that the gap in spending on out-of-school enrichment has, over the last 30 years, remained essentially flat for lower-income families, while spending has risen dramatically for upper-income families over the same period. It seems, then, that as schools have scaled back their capacity to furnish an array of enrichments, more affluent parents have sometimes overcome the loss by accessing private programs or better supporting their schools to supply these types of activities.10 Fayette County, Kentucky, for example, registers a stark divide in the amount of activity fees that schools serving more affluent communities have raised compared to schools with mostly poor students. These additional funds support everything

---

**Figure 4**

Number of Weekly Minutes of Allotted Instructional Time


*By Subject*

![Diagram showing comparison of weekly minutes of allotted instructional time pre-NCLB (2002) vs. with NCLB (2007).](image)

- **Total lost time:** 243 minutes
- **Total gained time:** 250 minutes

*Source:* Center on Education Policy, 2008.
from field trips to after-school athletic events, so less funds means fewer programs for students to develop non-academic skills and interests.41 Similarly, in San Francisco, overall cutbacks to schools have pushed more affluent parents to fundraise to offset the decline of public dollars. Notes one observer, “The growing reliance on private dollars has widened inequities between the impoverished majority and the small number of schools where affluent parents cluster.”

And this clustering points to perhaps the most far-reaching effect of the gap in personal financial capital on schooling and, by extension, the enrichment opportunities that are connected with those schools. Summing up the research, scholar Daniel Willingham explains that, “wealthier families often seek housing in what they believe to be superior school districts.”42 Thus, more affluent students not only live near (or have ready access to) schools and other places that offer enrichment programming, they also have the financial wherewithal to participate in those activities. Poorer students tend to have much less access to these types of opportunities, so the resulting phenomenon has become known as the “opportunity gap.” That an opportunity gap in overall enrichment available exists between students of different socioeconomic background also puts more pressure on schools serving lower-income neighborhoods to narrow that disparity through in-school programming.

The case of arts education offers some of the strongest evidence of both its potential impact and, at the same time, its declining place in the lives of young people, especially poorer children. To begin, surveys conducted by the National Endowment for the Arts reveal that young people’s participation in some form of arts education has declined markedly over the last three decades. The drop is steepest among people considered most at-risk (as measured by parental education).43

This trend continues despite the fact that, separate and apart from research drawing correlations between arts participation and performance in school, many researchers suggest that the value of the arts is broad and consequential.44 A focus on arts education helps to promote underlying attributes associated with being well-prepared for life, such as creativity, persistence, and the ability to communicate and collaborate.45 Some examples:

- A study of more than 2,000 middle-school students by researchers at Columbia University, for example, found that students who had participated in at least three years of in-school arts instruction scored significantly higher on an instrument measuring creative thinking and that these students self-reported much higher rates of positive attitudes towards school and learning than did their peers who had experienced less arts education.46

- A smaller-scale evaluation of a six-month program that involved youth in drama reported that these participants demonstrated less aggressive and violent tendencies, while also exhibiting more pro-social behaviors like cooperation and self-control.47

Scholars from Project Zero, an arts education research group at the Harvard Graduate School of Education, have written about the development of "studio habits" within high-quality classes. These habits have the potential to bring together concepts in students’ minds that effort, revision and hard work can produce excellence.48

Arts educators (and artists, for that matter) also insist that participation in the arts is as much about their intrinsic value—stimulating a depth of emotion that few other activities can—as it is about the transferrable skills that artistic endeavors promote.49 RAND researchers, for instance, describe the arts as a “communicative experience” with the ability to “stimulate curiosity, questioning, and the search for explanation,” even as they acknowledge that such effects are nearly impossible to measure.50

A similar concept of needing to look beyond narrow academic benefits relates also physical education classes, which have also lost weekly minutes in school, despite the fact that there are some concrete metrics through which to demonstrate their value. For starters, a growing field of research suggests that greater participation in physical education classes in school yield a number of physiological benefits, including increased coordination, skeletal strength, and accelerated metabolism, which, in turn, might help ameliorate the skyrocketing incidence of childhood obesity.51 And the potential advantages of more physical education opportunities do not stop with improvements to the body. Research on brain structure and function suggests that regular physical activity might also stimulate physiological change to the brain that will, in turn, promote cognitive growth. Eric Jensen explains in Teaching with the Brain in Mind that the cerebellum, which controls physical movement, also regulates neuron activity to and from the cerebral cortex.52 Many studies have revealed that invigorating the cerebellum through physical exercise can then influence brain capacity to pay attention in class, engage in higher-order thinking, and hone memory, spatial perception, and decision making.53

There are other facets of the school experience that, though less structured, also can be vital to children’s
growth and development. The classic field trip, which has declined in frequency over the last few years, is a prime example. An evaluation of half-day school visits to a new art museum in Arkansas, for example, found that students demonstrated significantly greater critical thinking skills—like observation and empathy—than a control group that had not attended. Poorer and more rural students demonstrated particularly strong gains.  

The most common unstructured time during the school day is recess, a period that has been vulnerable to reductions as educators consider how to wedge more time for academic pursuits into the day. This tendency to cut recess comes despite research that shows that recess can contribute to the healthy development of children across a number of domains, including increasing physical activity, spurring brain development, lowering obesity, and encouraging social development through game playing and negotiating relationships through unstructured activities. One experiment suggests that recess can even affect the amount of time that students focus on learning when they return to class. Comparing two fourth-grade classes, researchers observed student behavior in these classes on randomly chosen days when a recess period was given for 20 minutes. On those days when students had recess, they were observed to fidget less and pay greater attention in class.  

When it comes to these broader learning and growth opportunities, the fundamental question is whether schools have the flexibility and resources to provide them. As noted, in an era of increasing demands in academic standards, but no corresponding increase in the resource of time, the activities and classes associated with a well-rounded education get squeezed out. Evidence suggests that schools with more time are less likely to face this harsh choice, however. NCTM’s Time Well Spent documents that in the 90 highly-effective schools profiled—schools which averaged 1,467 hours per year—students have about an hour per day for enrichments. And these schools are no exception. According to data from the U.S. Department of Education’s (USED’s) Schools and Staffing Survey (SASS), schools with more time overall also provide their students with significantly more time in art, foreign language and physical education.  

Further, schools that have added substantially more time to the school day, like the ELT schools in Massachusetts or schools profiled in Time Well Spent, report integrating a much broader range of learning opportunities than the more traditional enrichments of physical education and art. In part through partnerships with community-based organizations and in part by drawing upon in-school resources, these schools offer their students the opportunity to participate in apprenticeships; specialized science classes like robotics, astronomy, and meteorology; cooking; performing arts like drama and dance; and alternative exercise like karate and yoga.  

School Time and the National Future  

Americans have ambitious goals for the nation’s educational system. We want nothing less than to enable the next generation to compete successfully in the global economy and to live rich, fulfilling lives. Yet, many signs indicate that this aspiration is under serious threat. A startling study from the consulting firm McKinsey & Company revealed that failing to provide a first-rate education to all students and, by implication, allowing socioeconomic achievement gaps to persist, “imposes on the United States the economic equivalent of a permanent national recession.”  

But the report’s authors also found reason for hope. As they wrote, “the wide variation in performance among schools and school systems serving similar students suggests that the opportunity and output gaps related to today’s achievement gap can be substantially closed.” In other words, if some schools can successfully educate at-risk students, there’s no reason many more schools cannot do the same.  

Certainly, myriad factors account for the ability of schools to be effective in promoting learning and at closing achievement gaps, but, as this review has described, a preponderance of evidence points to the powerful association between more time in school (both generally and spent in specific activities) and better outcomes for students, especially for those who otherwise lack productive learning outside school. From increased breadth and depth of academic content, through greater exposure to the arts and other enrichments that deepen engagement and broaden skills, to dedicated sessions for teachers to collaborate on improved instruction, a longer school day and year translate to expanded opportunities for learning and growth.  

If some schools can successfully educate at-risk students, there’s no reason many more schools cannot do the same.  

While having more opportunities does not automatically guarantee higher proficiency and better-developed skills among students from all backgrounds, without expanding learning time, there seems to be a much smaller chance of achieving such results. As Richard Barth, CEO and President of the KIPP Foundation, has asserted: “When you look at the public schools that are fundamentally changing the trajectory of students’ lives in high-poverty communities, the overwhelming majority offer expanded learning time in school.”

---

65.  
66.  
67.  
68.  
69.  
70.
Notes:


2 Source paper to be published. School Time...

3 Source paper to be published. Mapping School Time

4 Will Dobbie and Roland G. Fryer, Jr. "Getting Beneath the Veil of Effective Schools: Evidence from New York City." NBER Working Paper, No. 17692, December 2011. On the number of hours, Dobbie and Fryer found that high-achieving elementary schools provide about 56.6 percent more instructional hours per year than typical NYC schools, while high-achieving middle schools provide about 28.1 percent more. Non-high-achieving charter schools, on the other hand, provide just 11.4 and 21.4 percent more instructional time at the elementary and middle school levels, respectively. (The typical high-achieving elementary school has 190.67 instructional days and an instructional day of 8.1 hours, compared to 183.8 instructional days and 7.4 instructional hours at other charter schools. The typical high achieving middle school meets for 191.0 instructional days, with a typical instructional day lasting 8.2 hours. Other charter middle schools in the sample meet for only 187.1 instructional days with an average day of 7.9 hours.)

5 Caroline Hoxby and Sonali Murarka, "New York City Charter Schools: How Well Are They Teaching Their Students?", Education Next, Summer 2008: pp. 54-61.


8 Erika A. Patall, Harris Cooper and Ashley Batts Allen, "Extending the School Day or School Year: A Systematic Review of Research (1985-2008)," Review of Educational Research, 80:3 (September 2010), pp. 401-436. In addition to this investigation of schools in the United States, another scholar examined schools in Israel, after a revised funding formula prompted a large number of them to expand school time significantly. He found that the more a school had increased instructional time in a particular subject, the better students' performance in that subject. (Victor Lavy, "Expanding School Resources and Increasing Time on Task: Effects of a Policy Experiment in Israel on Student Academic Achievement and Behavior," NBER Working Paper No. 18369, September 2012.)


18 Judith Florian, Teacher Survey of Standards-based Instruction: Addressing Time (Aurora, CO: Mid-Continent Research for Education and Learning, 1999). The average school year can be derived from the 2011 SASS data as 1,217 hours—that is, 179 6.8-hour days—but this total also includes time for lunch, transitions, and other activities that cannot be counted toward actual learning time. Moreover, the rough calculation does not account for half-days and other regular interruptions to the learning day like testing. When these deductions are taken into account the result is closer to 5 hours per day
of actual learning or 900 total annual hours.

For a comparison of Common Core to current state standards, see Sheila Byrd Carmichael, et al. The State of State Standards—and the Common Core—in 2010 (Washington: Fordham Institute, 2010). For details on the learning time implications of the Common Core requirements both in the classroom and for teacher preparation during the transition to the new standards, see David A. Fastman, David J. Goldberg and Tiffany Miller, Redesigning and Expanding School Time to Support Common Core Implementation (Washington, DC: Center for American Progress, 2014). For example, the education standards group, Achieve, has already expressed its view that “Teachers will likely need more instructional time in order to teach more rigorous, higher-level content in more depth and to integrate literacy skills into their lessons.” (Implementing the Common Core State Standards: The Role of the Elementary School Leader (Washington, DC: Achieve, Inc., February 2013), p. 20.) For more information on the details of how the new standards will impact time usage in the classroom see Seeing the Future: How the Common Core Will Affect Mathematics and English Language Arts in Grades 3-12 Across America (Princeton, NJ: The Center for K-12 Assessment & Performance Management at Educational Testing Service, May 2013).

For comparison of Massachusetts learning standards to CCSS, see WestEd, Analysis of the Commonwealth of Massachusetts State Standards and the Common Core State Standards for English Language Arts and Mathematics, Study Prepared for the Massachusetts Business Alliance for Education, July 2010. For survey results, see Massachusetts Teaching, Learning, and Leading Survey (MassTELLS), 2012.


Massachusetts 2020, Kiss Middle School: Expanding Time to Accelerate School Improvement (Boston: Author, 2009), p. 4.


See, for example, James H. Stronge, Effective Teachers=Student Achievement: What the Research Says (Larchmont, NY: Eye on Education, 2010).

Patall, et al., p. 480.

Two sets of research suggest how time metrics may be a helpful prism through which to view teacher quality. The first relates to how managing time in very subtle ways—and, more specifically, the way in which teachers structure classroom discussion—can have an impact. Studies of classroom interactions between teachers and students that examine deliberate or expected pauses in conversation—either to allow for questions from students or responses to questions from teachers, known in the research as “wait time”—have shown an effect on learning. Especially in math and science classes, teachers’ wait time of three to five seconds (as opposed to shorter wait times) has been associated with an increased cognitive depth. On the one hand, if teachers paused a few seconds before posing questions, the questions themselves were more likely to be better focused on querying students’ understanding rather than their mere recall. On the other, students’ responses tended to be longer and more complex, if the teacher waited a few moments before calling on a particular student to answer. [Kenneth Tobin, “The Role of Wait Time in Higher Cognitive Level Learning,” Review of Educational Research, 57:1 (Spring, 1987), pp. 69-95.]

Teacher quality also relates to how teachers motivate students to learn. Keep in mind that when it comes to maximizing productive learning time, the ultimate arbiter of how much time any given student commits to learning is the student him or herself. Each student must decide to what degree she will persevere and dedicate her or his own mind to grasping new concepts and practicing skills. There is no single piece of evidence indicating with any precision to what degree teachers can influence student motivation, but several researchers have found that various techniques, including using extrinsic rewards sparingly, supporting students consistently, and promoting mastery learning, can enhance student attention and engagement. [For various research on teachers’ role in enhancing student motivation, see Sandra Brooks, Susan Freiburger and Debra Grothner, Improving Elementary Student Engagement in the Learning Process through Integrated Thematic Instruction. (Unpublished master’s thesis, Chicago, IL: Saint Xavier University); L. Anderson and Carol Middley, “Motivation and Middle School Students” (ERIC digest, 1998). Champaign, IL: ERIC Clearinghouse on Elementary and Early Childhood Education; Linda Lumsden, Student Motivation to Learn (ERIC Digest No. 92), 1994, (Eugene, OR: ERIC Clearinghouse on Educational Management); and Ellen Skinner and Michael Belmont, A Longitudinal Study of Motivation in School: Reciprocal Effects of Teacher Behavior and Student Engagement Unpublished manuscript, (Rochester, NY: University of Rochester, 1991).]

Steven G. Rivkin and Jeffrey C. Schiman, “Instruction Time, Classroom Quality, and Academic Achievement,” NBER Working Paper No. 19464, September 2013. This phenomenon might help explain, too, why an analysis of schools in Mexico generally found little effect of adding days to the school year, especially in poorer schools. As the authors note, “in order to increase student performance in math and reading broader policies that raise several inputs of the school production are needed, as opposed to single isolated policies.” [See Jorge M. Aguero and Trinidad Beleche, “Test-Mex: Estimating the Effects of School Year Length on Student Performance in Mexico,” Journal of Development Economics, 103:C (2013), pp. 359-361.]

An evaluation of KIPP middle schools demonstrates that such variation is evident within a smaller set of schools, as well, even when all among them have significantly more time than is typical in the United States. Although most KIPP schools included in this evaluation saw significantly higher math scores among their students (as compared to peers in the respective local districts), the outcomes were not equally strong across the schools. In fact, 7 KIPP schools were able to advance scores in math only modestly—though still outperforming their district peers—while 11 schools posted more impressive
gains. The point is not to dismiss the positive effects that more time can bring, but merely to indicate that even among a highly–coordinated network of schools, variation in results is to be expected. Over the long term, some schools generate stronger gains than others because variation in instructional quality and in the use of time at its most granular level is unavoidable. [Christina Clark Tuttle, et al., Student Characteristics and Achievement in 22 KIPP Middle Schools (Washington, DC: Mathematica Policy, June 2010).]


35 Kwang Suk Yoon, et al, Reviewing the Evidence on How Teacher Professional Development Affects Student Achievement (Washington: Institute for Educational Sciences, U.S. Department of Education, 2007). Study authors calculated the effect of professional development on student learning using formulas of the What Works Clearinghouse. Specifically, authors calculated improvement by comparing the effect sizes (i.e., change in achievement) of the group of students who had teachers with the intervention to a group with teachers who lacked the intervention. The difference between these two effect sizes is called the “improvement index.” Authors then averaged the improvement index across the nine studies to determine a 21 percentile gain in achievement.


39 Primary Sources, America’s Teachers on the Teaching Profession (New York: Scholastic, 2012), p. 132.


50 Over 33 years (1984 to 2006), spending on extracurriculars among families in the bottom income quintile rose from $1,264 to $1,915 (in 2008 dollars), while spending among the top–quintile families rose from $5,650 to $8,872. See Robert Putnam, “Requiem for the American Dream?: Unequal Opportunity in America” Lecture at Aspen Ideas Festival, Aspen, CO, 29 June 2012.


54 Data reported in Nick Rabin and E. C. Hedberg, Arts Education in America: What the Declines Mean for Arts Participation (National Endowment for the Arts, February 2011), p. 47.

55 The most notable work in unearthing these correlations has been carried out by James Catterall and his colleagues who, using large national data sets, found “significant and substantial” associations between grades and scores on standardized assessments and the level of participation in arts programming, both in school and out. (James Catterall, Richard Chapleau and John Iwanaga, “Involvement in the Arts and Human Development: General Involvement and Intensive Involvement in Music and Theater Arts,” in Edward Fiske,
ed. Champions of Change: The Impact of the Arts on Learning (Washington, DC: President’s Committee on the Arts and Humanities, 1999).” See also: James Catterall, The Arts and Achievement in At-Risk Youth: Findings from Four Longitudinal Studies, Research Report #55 (Washington, DC: National Endowment for the Arts, March 2012). Take note that there is no causation indicated. It is possible that unrelated factors, such as personality type or other school structures, might account for this association of high-arts participation with better academic performance.

For a thorough analysis of the findings and limitations of arts education research, see Kevin F. McCarthy, Elizabeth H. Donoauto, Laura Zarkas, and Arthur Brooks, Gifts of the Muse: Restating the Debate About the Benefits of the Arts (Santa Monica, CA: the RAND Corporation, 2004). Other sources adopting this perspective include: Elliot W. Eisner, Arts and the Creation of Mind (New Haven, CT: Yale University Press, 2002) and Richard J. Deasy, ed. Critical Links: Learning in the Arts and Student Academic and Social Development (Washington, DC: Arts Education Partnership, 2002), a compendium of studies that examine the wide range of effects that art programming (music, dance, drama and visual arts) can have on students’ cognitive development and their creative thinking skills.


See, for example, Elliot Eisner, The Arts and the Creation of Mind, (New Haven, CT: Yale University Press, 2002).

Gifts of the Muse, pp 40-42.


Later school start times in the U.S.

An economic analysis

Marco Hafner, Martin Stepanek, Wendy M. Troxel
Preface

This report presents the findings of a study on the economic implications of later school start times in the United States. The report follows a previous piece of research from RAND Europe on the economic costs of insufficient sleep (RR-1791-VH).

The report will be of interest to policy-makers, and the wider society and people interested in the field of sleep, health and wellbeing and economics in general.

RAND Europe is an independent not-for-profit policy research organisation that aims to improve policy and decision-making in the public interest through research and analysis. This report is joint work by researchers from RAND Europe and RAND Health and has been peer reviewed in accordance with RAND’s quality assurance standards. For more information about RAND Europe or this document, please contact Marco Hafner (mhfner@rand.org):

RAND Europe
Westbrook Centre, Milton Road
Cambridge CB4 1YG
United Kingdom
Tel. +44 1223 353 329
Numerous studies have shown that later school start times (SST) are associated with positive student outcomes, including improvements in academic performance, mental and physical health, and public safety. While the benefits of later SST are very well documented in the literature, in practice there is opposition against delaying SST. A major argument against later SST is the claim that delaying SST will result in significant additional costs for schools due to changes in school bus transportation strategies. However, to date, there has only been one published study that has quantified some of the potential economic benefits of later SST in relation to potential costs. The present study investigates the economic implications of later SST by examining a policy experiment of a statewide shift in school start times to 8:30 a.m. and its subsequent economic effects. Using a novel macroeconomic modeling approach, the study estimates changes in the economic performance of 47 U.S. states following a delayed SST, which includes the economic benefits of higher academic performance of students and reduced car crash rates. The benefit–cost projections of this study suggest that delaying school start times is a cost-effective, population-level strategy that could have a significant impact on public health and the U.S. economy. From a policy perspective, these findings are crucial as they demonstrate that significant economic gains resulting from the delay in SST accrue over a relatively short period of time following the adoption of the policy shift.
Table of contents

Preface ........................................................................................................ ii
Abstract ......................................................................................................... iii
Table of contents .............................................................................................. iv
Figures ........................................................................................................... vi
Tables ............................................................................................................. vii
Executive summary ......................................................................................... viii
Acknowledgements ....................................................................................... xiv
Abbreviations .................................................................................................. xv

1. Introduction ................................................................................................. 1
   1.1. Inadequate sleep among adolescents: a public health problem ............ 1
   1.1.1. Empirical evidence on the benefits of later school start times ........ 2
   1.1.2. The potential cost of delaying school start times ....................... 2
   1.2. Objectives of the study ........................................................................ 3
   1.3. Research approach ............................................................................. 4
   1.4. Structure of this report ....................................................................... 5

2. Methodological approach ......................................................................... 6
   2.1. General modeling approach .............................................................. 6
   2.2. How a delay in SST is captured in the economic model .................. 7
       2.2.1. Model dynamics ...................................................................... 9

3. The economic implications of later school start times ......................... 13
   3.1. Cumulative economic gains from later school start times ............... 13
   3.2. Economic benefits per student and benefit-cost ratios .................... 16
       3.2.1. The predicted economic benefits per student ......................... 16
       3.3. The predicted benefit-cost ratios per student ............................ 18

4. Summary and discussion ......................................................................... 24
   4.1. Summary .......................................................................................... 24
   4.2. Discussion ......................................................................................... 25
<table>
<thead>
<tr>
<th>References</th>
<th>27</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix A: The overlapping generations model</td>
<td>31</td>
</tr>
<tr>
<td>Model description</td>
<td>31</td>
</tr>
<tr>
<td>Calibration parameters</td>
<td>35</td>
</tr>
<tr>
<td>Appendix B: Derivation of educational attainment data</td>
<td>36</td>
</tr>
<tr>
<td>Appendix C: Net increase in sleep length</td>
<td>38</td>
</tr>
<tr>
<td>Appendix D: Benefit-cost ratios per student (&quot;Very High&quot; cost scenario)</td>
<td>40</td>
</tr>
</tbody>
</table>
Figures

Figure ES1: Predicted cumulative economic gains from delayed SST to 8:30 a.m. ........................................... x
Figure 1: Predicted cumulative economic gains from delayed SST to 8:30 a.m. ............................................. 13
Figure 2: Predicted benefit–cost ratio of delayed SST. (aggregated across 47 U.S. states) .............................. 19
Tables

Table ES1: Predicted benefit–cost ratios by state over time .......................................................... xi
Table 1: Predicted cumulative economic gain by state ($ million GSP) ........................................ 14
Table 2: Predicted cumulative economic gain by state ($ per student) ........................................ 16
Table 3: Cost scenarios applied in the analysis .................................................................................. 18
Table 4: Predicted benefit–cost ratios by state ("Normal" cost scenario) ........................................ 20
Table 5: Predicted benefit–cost ratios by state ("High" cost scenario) .............................................. 22
Table 6: Model calibration parameters ............................................................................................ 35
Table 7: Graduation rates .................................................................................................................. 36
Table 8: School information by state and increase in sleep length in the counterfactual scenario .... 38
Table 9: Benefit-cost ratios by state ("Very High" cost scenario) .................................................... 40
Executive summary

Background to the study
Up to 60 per cent of U.S. middle and high school students report weeknight sleep duration of less than the recommended (for this age group) 8 to 10 hours of sleep per night. While many factors have been found to be associated with adolescent sleep loss, including busy social lives, homework, participation in after school activities and use of technology in the bedroom, one other factor is a direct matter of public policy: school start times.

Known biological changes in adolescents contribute to delayed sleep–wake cycles. Sleep–wake cycles are in large part governed by the circadian rhythm, which controls the production of the sleep-inducing hormone melatonin. Adolescents experience major changes in their circadian rhythm, resulting in a roughly three-hour shift towards later bed and wake-up times compared to adults. At the same time of this well-documented biological shift in bedtimes and wake-up times however, school start times, particularly in the U.S., tend to shift earlier. Ideally, in order to accommodate early school start times, adolescents would go to bed early, but due to the biological change in sleep–wake cycles, they generally struggle to fall asleep early enough and do not get the adequate amount of sleep. As rise times for adolescents are primarily determined by school start times (SST), this results in an inherent conflict between adolescent biology and SST policy. Even though major medical and pediatric organizations recommend that middle and high schools should start no earlier than 8:30 a.m., data by the Centers for Disease Control and Prevention (CDC) suggests that about 80 per cent of U.S. middle and high schools start before 8:30 a.m., with a country-wide average of 8:03 a.m.

Indeed, empirical evidence suggests that later SST can improve adolescent sleep patterns, as it has been shown that following delayed SST, students get more sleep. With later starts, adolescent’s bedtimes remain fairly constant but their wake-up times are extended, resulting in more weekday sleep. In addition, numerous studies have shown that later SST are associated with positive student outcomes, including improvements in academic performance, mental and physical health, and public safety. While the benefits of later SST are very well documented in the literature, in practice there is opposition against delaying SST. A major argument against later SST is the claim that delaying SST will result in significant additional costs for schools, for instance due to changes in school bus schedules. Given that many school districts are already facing significant shortages and economic challenges, concerns about added costs are understandably a significant deterrent to such a policy change.

However, despite the active public debate for and against the potential benefits of later SST, to date, there has been only one published study that has aimed to quantify some of the potential economic benefits of later SST in relation to potential costs. Specifically, a study by the Brookings Institution found that a one
hour delay in SST would lead to a $17,500 lifetime earnings gain for students, compared to a cost of $1,950 over a student’s school career.

This study provides a comprehensive economic analysis of later SST in the U.S.

The present study investigates in more detail the economic implications of later SST by examining a hypothetical policy experiment involving a universal state-wide shift in SST to at least 8:30 a.m. and its subsequent state-by-state economic effects. Using a novel macroeconomic modeling approach, the study compares changes in the economic performance of 47 U.S. states under a scenario with delayed SST, compared to the status quo of current SST.

As a first step, the model simulates the economic forecast of each of the states under consideration in the baseline scenario, using the current distribution of SST across middle and high schools data provided by the CDC. In a second step, under a different ‘what if’ scenario (compared to the current start times at baseline), the model predicts how the economic output (e.g. gross domestic product) of each state would change over time if the state implemented a universal shift to 8:30 am SST. The population directly affected by the policy change is students from grade 6 to grade 12.

The analysis presented in this report departs from the previous Brookings Institution benefit–cost analysis in several ways:

First, instead of assuming a one hour delay in school start time, the current distribution of school start times across different states provided by the CDC is taken into account and the impact of an 8:30 a.m. SST is modeled. Therefore, the model considers the impact of what could potentially be a relatively small change (approximately 30 minutes) for some states, given that the average start time is 8:03 a.m.

Second, instead of looking at the overall economic impact over the working life of an individual (i.e., up to 45 years), this analysis examines the year-by-year effects on the economy of delayed SST. From a policy and decision-maker’s perspective it is important to understand when the effects of a policy shift occur, now, in 5 years, 10 years or in 50 years?

Third, when calculating the benefits of delayed SST, this study takes into account the effects on student lifetime earnings as well as the potential effects of reduced car crashes among adolescents, which can create a negative impact of the future labor supply of an economy if young adults die prematurely.

Fourth, the Brookings Institution analysis focused only on a general potential gain per student, partially based on data from a single school district in North Carolina, whereas this study takes a more national approach by predicting the economic implications for different regions, taking into account the variation of school start times and economic factors across different U.S. states.

Finally, this study also takes into account potential multiplier effects of increased lifetime earnings of individuals. For instance, at any given point in time, the additional income individuals save or consume will create further opportunities through further income for others agents in the economy.

Overall, this study takes a conservative approach and the reported benefits in this study are likely an underestimation of the full benefits related to delaying SST to at least 8:30 a.m. That is, in the modelling process only parameters in the calibration process of the model have been applied for which robust empirical evidence is available in the literature concerning the impact of sleep loss on adolescents' health.
and academic performance. Specifically, only the effects of car crash mortality and impaired academic performance are modeled and other potential impacts of insufficient sleep, such as the effects on mental health, including depression and suicide, or other potential negative effects related to obesity or other morbidities that are also associated with insufficient sleep have not been taken into account.

In the calculation of the benefit-cost ratios associated with a delay in SST two types of potential cost are taken into account. First, it is documented that the largest cost of delaying SST in the U.S. would incur from changes in school bus schedules, which have been estimated to be around $150 per student per year. Second, some argue that a delay in SST may impose a need for rescheduling after-school activities such as sports team practices, due to later school dismissals and diminishing outdoor light for evening practices or games. The costs of making additions to school infrastructure (e.g. additional lighting equipment) to accommodate delayed SST have been estimated to be $110,000 per school. In order to test the robustness of the benefit-cost ratios against higher cost assumptions and to take into account additional cost that potentially could arise from delaying SST (e.g. additional childcare expenses), further cost scenarios have been applied in the analysis.

Study predicts economic gains from a delay in school start times across the U.S.

This study illuminates the link between a delay in SST and profound economic gains across 47 U.S. states, showing that a state-wide universal move to at least 8:30 a.m. could contribute $83 billion to the U.S. economy within a decade (see Figure ES1).

**Figure ES1: Predicted cumulative economic gains from delayed SST to 8:30 a.m.**

![Graph showing predicted cumulative economic gains from delayed SST to 8:30 a.m.](image)

**Source:** Authors' calculations.

**Notes:** The figure plots the predicted discounted cumulative gains (2016 $) of delayed SST to 8:30 a.m. in gross state product (GSP) terms, aggregated across 47 U.S. states. GSP is a measurement of a state's economic output and is the state counterpart to gross domestic product (GDP) at country level.

As it would take at least a year until the first student cohort that benefited from the policy shift enters the labor market, the gains are zero in the first year. However, already after just two years, the study projects a
cumulative economic gain of about $9 billion, which gradually increases over time as more student
cohorts will benefit from the policy shift in terms of higher academic performance (e.g. higher likelihood
to graduate from high school or college) and reduced car crash mortality. After 15 years, the cumulative
economic gain is predicted to be around $140 billion. On average, this corresponds to an annual gain of
about $9.3 billion each year, which is roughly the annual revenue of Major League Baseball (MLB).

Delaying school start times is cost-effective population-level strategy that benefits public health
and the economy

In line with previous studies, the economic analysis presented in this report suggests that later SST could
be a cost-effective population strategy with a substantial impact on public health and the U.S. economy.
The predicted benefit cost-ratios per student suggest that under reasonable cost assumptions, even after a
relative short period of time, the benefits will outweigh the costs (see Table ES1).

For instance, after 5 years of the shift to at least 8:30 a.m. SST, the average predicted benefit-cost ratio is
between 1.7 and 2.1, meaning that for every $1 spent, the return is between $1.7 and $2.1. Even after
only 2 years following the adoption of later SST, it is predicted that some states (e.g. Connecticut,
Massachusetts, Rhode Island) would break even and achieve a benefit-cost ratio of at least 1 (meaning that
$1 spent is at least paid back). The benefit-cost ratios increase over time and range between 3.46 and 3.73
after 20 years.

Table ES1: Predicted benefit–cost ratios by state over time

<table>
<thead>
<tr>
<th>State</th>
<th>2 years</th>
<th>5 years</th>
<th>10 years</th>
<th>15 years</th>
<th>20 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
</tr>
<tr>
<td>Alabama</td>
<td>0.11</td>
<td>0.07</td>
<td>0.35</td>
<td>0.29</td>
<td>0.75</td>
</tr>
<tr>
<td>Arizona</td>
<td>1.27</td>
<td>0.81</td>
<td>2.16</td>
<td>1.74</td>
<td>2.63</td>
</tr>
<tr>
<td>Arkansas</td>
<td>0.65</td>
<td>0.41</td>
<td>1.30</td>
<td>1.05</td>
<td>1.51</td>
</tr>
<tr>
<td>California</td>
<td>1.14</td>
<td>0.73</td>
<td>1.95</td>
<td>1.58</td>
<td>2.45</td>
</tr>
<tr>
<td>Colorado</td>
<td>1.00</td>
<td>0.64</td>
<td>1.73</td>
<td>1.39</td>
<td>2.27</td>
</tr>
<tr>
<td>Connecticut</td>
<td>1.76</td>
<td>1.12</td>
<td>3.18</td>
<td>2.57</td>
<td>4.10</td>
</tr>
<tr>
<td>Delaware</td>
<td>2.49</td>
<td>1.59</td>
<td>4.41</td>
<td>3.56</td>
<td>5.72</td>
</tr>
<tr>
<td>Florida</td>
<td>1.55</td>
<td>0.99</td>
<td>2.57</td>
<td>2.07</td>
<td>3.12</td>
</tr>
<tr>
<td>Georgia</td>
<td>0.91</td>
<td>0.58</td>
<td>1.58</td>
<td>1.28</td>
<td>1.96</td>
</tr>
<tr>
<td>Hawaii</td>
<td>1.62</td>
<td>1.03</td>
<td>3.30</td>
<td>2.67</td>
<td>3.71</td>
</tr>
<tr>
<td>Idaho</td>
<td>0.61</td>
<td>0.39</td>
<td>1.06</td>
<td>0.85</td>
<td>1.32</td>
</tr>
<tr>
<td>Illinois</td>
<td>0.88</td>
<td>0.56</td>
<td>1.56</td>
<td>1.26</td>
<td>2.01</td>
</tr>
<tr>
<td>Indiana</td>
<td>0.93</td>
<td>0.59</td>
<td>1.83</td>
<td>1.48</td>
<td>2.23</td>
</tr>
<tr>
<td>Iowa</td>
<td>1.34</td>
<td>0.86</td>
<td>2.34</td>
<td>1.89</td>
<td>2.91</td>
</tr>
<tr>
<td>Kansas</td>
<td>0.98</td>
<td>0.63</td>
<td>2.13</td>
<td>1.72</td>
<td>2.46</td>
</tr>
<tr>
<td>Kentucky</td>
<td>0.89</td>
<td>0.57</td>
<td>2.08</td>
<td>1.68</td>
<td>2.40</td>
</tr>
<tr>
<td>Louisiana</td>
<td>1.29</td>
<td>0.83</td>
<td>2.29</td>
<td>1.84</td>
<td>2.94</td>
</tr>
<tr>
<td>Maine</td>
<td>0.93</td>
<td>0.60</td>
<td>1.65</td>
<td>1.33</td>
<td>2.17</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>2.39</td>
<td>1.53</td>
<td>3.88</td>
<td>3.13</td>
<td>4.48</td>
</tr>
<tr>
<td>State</td>
<td>2 years (1)</td>
<td>2 years (2)</td>
<td>5 years (1)</td>
<td>5 years (2)</td>
<td>10 years (1)</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Michigan</td>
<td>1.12</td>
<td>0.72</td>
<td>1.97</td>
<td>1.59</td>
<td>2.57</td>
</tr>
<tr>
<td>Minnesota</td>
<td>1.22</td>
<td>0.78</td>
<td>2.08</td>
<td>1.68</td>
<td>2.68</td>
</tr>
<tr>
<td>Mississippi</td>
<td>0.60</td>
<td>0.38</td>
<td>1.23</td>
<td>1.00</td>
<td>1.46</td>
</tr>
<tr>
<td>Missouri</td>
<td>1.16</td>
<td>0.74</td>
<td>2.01</td>
<td>1.62</td>
<td>2.61</td>
</tr>
<tr>
<td>Montana</td>
<td>1.15</td>
<td>0.73</td>
<td>1.97</td>
<td>1.59</td>
<td>2.33</td>
</tr>
<tr>
<td>Nebraska</td>
<td>0.88</td>
<td>0.56</td>
<td>1.58</td>
<td>1.27</td>
<td>2.00</td>
</tr>
<tr>
<td>Nevada</td>
<td>0.65</td>
<td>0.41</td>
<td>1.14</td>
<td>0.92</td>
<td>1.50</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>0.97</td>
<td>0.62</td>
<td>1.93</td>
<td>1.56</td>
<td>2.46</td>
</tr>
<tr>
<td>New Jersey</td>
<td>1.87</td>
<td>1.20</td>
<td>3.18</td>
<td>2.56</td>
<td>4.04</td>
</tr>
<tr>
<td>New Mexico</td>
<td>1.27</td>
<td>0.81</td>
<td>2.12</td>
<td>1.71</td>
<td>2.58</td>
</tr>
<tr>
<td>New York</td>
<td>1.00</td>
<td>0.64</td>
<td>1.79</td>
<td>1.45</td>
<td>2.35</td>
</tr>
<tr>
<td>North Carolina</td>
<td>1.16</td>
<td>0.74</td>
<td>2.03</td>
<td>1.64</td>
<td>2.54</td>
</tr>
<tr>
<td>Ohio</td>
<td>1.39</td>
<td>0.89</td>
<td>2.37</td>
<td>1.91</td>
<td>2.77</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>0.99</td>
<td>0.63</td>
<td>1.66</td>
<td>1.34</td>
<td>2.03</td>
</tr>
<tr>
<td>Oregon</td>
<td>1.00</td>
<td>0.64</td>
<td>1.73</td>
<td>1.39</td>
<td>2.18</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>0.94</td>
<td>0.60</td>
<td>1.75</td>
<td>1.41</td>
<td>2.36</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>1.83</td>
<td>1.17</td>
<td>3.46</td>
<td>2.80</td>
<td>4.23</td>
</tr>
<tr>
<td>South Carolina</td>
<td>1.08</td>
<td>0.69</td>
<td>1.99</td>
<td>1.60</td>
<td>2.41</td>
</tr>
<tr>
<td>South Dakota</td>
<td>1.01</td>
<td>0.64</td>
<td>1.87</td>
<td>1.51</td>
<td>2.17</td>
</tr>
<tr>
<td>Tennessee</td>
<td>0.76</td>
<td>0.49</td>
<td>1.39</td>
<td>1.12</td>
<td>1.81</td>
</tr>
<tr>
<td>Texas</td>
<td>1.13</td>
<td>0.72</td>
<td>1.92</td>
<td>1.55</td>
<td>2.38</td>
</tr>
<tr>
<td>Utah</td>
<td>0.77</td>
<td>0.50</td>
<td>1.34</td>
<td>1.08</td>
<td>1.84</td>
</tr>
<tr>
<td>Vermont</td>
<td>1.24</td>
<td>0.79</td>
<td>2.19</td>
<td>1.77</td>
<td>2.74</td>
</tr>
<tr>
<td>Virginia</td>
<td>2.02</td>
<td>1.29</td>
<td>3.07</td>
<td>2.47</td>
<td>3.77</td>
</tr>
<tr>
<td>Washington</td>
<td>1.71</td>
<td>1.09</td>
<td>3.32</td>
<td>2.68</td>
<td>3.78</td>
</tr>
<tr>
<td>West Virginia</td>
<td>0.80</td>
<td>0.51</td>
<td>1.40</td>
<td>1.13</td>
<td>1.79</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>1.22</td>
<td>0.78</td>
<td>2.16</td>
<td>1.74</td>
<td>2.82</td>
</tr>
<tr>
<td>Wyoming</td>
<td>1.57</td>
<td>1.00</td>
<td>2.85</td>
<td>2.30</td>
<td>3.55</td>
</tr>
</tbody>
</table>

Average: 1.18 0.75 2.10 1.70 2.62 2.31 3.20 2.92 3.73 3.46

Source: Authors' calculations.
Notes: Column (1) assumes cost of $150 per student per year and column (2) assumes that in addition to the $150 per student per year, each school has to invest $110,000 upfront for updates in school infrastructure related to after-school activities (e.g. update of lighting equipment).

Discussion

The findings of this study are based on a simulated or hypothetical "natural experiment" which presupposes a statewide universal shift in school start times to 8:30 a.m. or later. This presupposition may seem unjustified given that start times are generally determined at the local district level. However, there are several examples of proposed policy initiatives in states across the country, including a bill that is under consideration in the California state legislature, which mandates that California middle and high schools start no earlier than 8:30 a.m. Thus, the hypothetical policy shift modeled in the current analysis
is potentially a conceivable strategy. In the economic analysis, only the benefits of better academic performance and lower mortality from car crashes are modeled; however, as mentioned, there are numerous other potential costs associated with mental and physical morbidity that were not included in the model predictions, and yet are known to be associated with insufficient sleep among adolescents. For instance, it has been documented that the combined public health costs of the obesity epidemic in children and adolescents and its associated cardiovascular morbidities are significant, and sleep loss is longitudinally associated with increased risk of obesity in children and adolescents. Further, insufficient sleep among adolescents is associated with an increased risk of engaging in property and violent crime. The direct and indirect costs of crime, including direct economic losses, increased insurance rates, loss of productivity, and various aspects of the criminal justice system, from police, to courts, to juvenile facilities and prisons, are potentially substantial. In addition, the robust association between insufficient sleep and poor sleep quality and adolescent risk for mental health problems and other risk-taking behaviors, including substance use, could also contribute to substantial societal costs.

In summary, it is important to put these economic findings in context. The predictions of this study, as well as the Brookings Institution findings, suggest that the benefits of later start times likely outweigh the immediate costs. Moreover, when paired with the substantial literature demonstrating the dire public health consequences of insufficient sleep among adolescents, the multitude of health and academic benefits associated with later start times, and the lack of any scientific evidence to suggest that there are benefits to having adolescents start school earlier, these findings are relevant to policymakers, educators, and community members and suggest that in addition to the well-documented public health benefits, later start times may also yield significant economic benefits.
Acknowledgements

The authors would like to thank the quality-assurance reviewers Julie Belanger (RAND Europe) and Alex Armand (University of Navarra).

This report involves independent research and analysis from RAND and the research ideas to this report have been developed by RAND researchers. The views presented in this report are the authors' and remaining errors are also our own.
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
</tr>
<tr>
<td>CGE</td>
<td>Computable General Equilibrium model</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GSP</td>
<td>Gross State Product</td>
</tr>
<tr>
<td>OLG</td>
<td>Overlapping generations model</td>
</tr>
<tr>
<td>SST</td>
<td>School Start Time</td>
</tr>
</tbody>
</table>
1. Introduction

1.1. Inadequate sleep among adolescents: a public health problem

Even though it is recommended that adolescents should get an average of 8 to 10 hours of sleep each night (NHLBI, 2012), up to 60 per cent of U.S. middle and high school students report weeknight sleep duration of less than 8 hours per night (Basch et al., 2014). The existing literature has shown that a lack of sleep among adolescents is associated with a diverse set of adverse outcomes, including poor physical and mental health, behavioral problems, suicidal ideation and attempts, attention and concentration problems, and suboptimal academic performance (Short et al. 2013; Pallesen et al. 2011; Pasch et al. 2010). Insufficient sleep in adolescents has further been linked with lower levels of physical activity, increased food intake and obesity, as well as unhealthy risk behaviors such as alcohol use, smoking, and marijuana and other illicit drug use, all of which can set the stage for chronic health conditions in adulthood (Lowry et al. 2012; Lytle et al. 2011; Hart et al. 2013; McKnight-Eily et al. 2011; Winsler et al. 2015; O’Brien and Mindell 2005; Kubiszewski et al. 2014). Furthermore, inadequate sleep among adolescents has been associated with motor vehicle crashes, the leading cause of death of adolescents in the United States (GHSAA, 2015).

Many factors have been found to be associated with adolescent sleep loss, including busy social lives, homework, participation in after school activities and use of technology in the bedroom (Carskadon, 2002). Furthermore, known biological changes in adolescents contribute to delayed sleep-wake cycles. Sleep-wake cycles are, in large part, governed by the circadian rhythm, which controls the production of the sleep-inducing hormone melatonin. Adolescents experience major changes in their circadian rhythm, resulting in a roughly three-hour shift towards later bed and wake-up times compared to adults or younger children (Crowley et al., 2007). Concurrent with the adolescent shift in sleep-wake schedules, towards later bedtimes and later rise times, most middle and high schools, particularly in the U.S. shift towards earlier school start times. Ideally, in order to accommodate early school start times, adolescents would go to bed early, but due to the biological change in sleep-wake cycles, it has been documented that they generally struggle to fall asleep early enough and to get the adequate amount of sleep. Rise times for adolescents, during the weekdays, are primarily determined by school start times (SST), which is a factor of public policy, resulting in an inherent conflict between adolescent biology and SST policy (Shapiro, 2015).

1 For instance, due to the delayed sleep-wake cycles, a 7:30 a.m. start for an adolescent is the equivalent to 4:30 a.m. for an adult.
In order to accommodate the known biological shift in adolescent sleep–wake cycles, major medical and pediatric organizations, including the American Medical Association, the American Academy of Pediatrics, the American Academy of Sleep Medicine, and others, recommend that middle and high schools should start no earlier than 8:30 a.m. (Owens et al. 2010). Despite these recommendations, a Centers for Disease Control and Prevention (CDC) study estimated that 82 per cent of middle and high schools start before 8:30 a.m., with an average start time across the United States of 8:03 a.m., highlighting significant variation in SST across different U.S. states (Wheaton et al., 2015).

1.1.1. Empirical evidence on the benefits of later school start times

The empirical evidence suggests that later SST generally represent a measure to improve adolescent sleep patterns. For instance, the existing literature suggests that following delayed SST adolescents’ bedtimes remain fairly constant (i.e., bedtimes are not delayed), but rise times are extended, leading to longer weekday sleep duration among U.S. adolescents (Minges and Redeker 2016; Paksarian et al. 2015; Boergers et al. 2014). Furthermore, several studies have highlighted that early SST are indeed associated with physical and mental health risks for adolescents, with earlier start times associated with increased tardiness and poorer attendance, and higher rates of motor vehicle accidents, suicidal ideation and depression (Adam et al. 2007; Vorona et al. 2014; Danner and Phillips 2008). Conversely, literature has shown that delaying SST can be linked to an improvement of attention and better academic performance (Lüft et al. 2011; Wahlstrom et al. 2014), as well as improvements in measures of health, well-being, and safety.

With regard to the academic effects of SST, the empirical literature using natural experiments and exogenous variation in start times finds relatively large benefits for students, especially compared to other educational measures such as improving teacher quality or reducing class sizes (Shapiro, 2015). For instance, investigating variation in SST between and within middle schools in Wake County (North Carolina) a study found that an increase in SST by one hour would lead to a three percentile point increase in standardized math and reading test scores for the average student (Edwards, 2012). To put into context, these effects on standardized test scores following a delay in SST are of similar magnitude as compared to reducing class sizes by one-third fewer students. Similar results have been found for standardized test scores among first-year U.S. Air Force Academy students, where a 50-minute delay in start times led to a 0.15 standard deviation increase in standardized course grades from improved performance in earlier classes but also classes during the day (Carrell et al., 2011). Putting the improvements in test scores into economic perspective, the existing literature suggests that a one standard deviation increase in test scores is associated with an increase in a student’s future earnings by about 8 per cent (Shapiro, 2015).

1.1.2. The potential cost of delaying school start times

While the health and educational benefits of later SST are very well documented in the literature, in practice, there is often opposition against delaying SST. A major argument against later SST is the concern that delaying SST will result in significant additional costs to school districts and communities endeavoring to make a change in SST. Specifically, altering current school bus schedules and moving
after-school activities to later in the day are often highlighted as major cost factors related to delaying SST (Owens et al., 2010).

It is estimated that the largest cost of later SST in the U.S. would incur from changes in school bus schedules from the current three-tier to a one-or two-tier school bus systems. Specifically, in order to reduce the total number of school buses, many school districts stack start times according to the three school levels, elementary, middle and high school, generally with middle and high schools starting first. Often high-school starts first because of safety concerns arising from having younger children walking to school or waiting for buses early in the morning when it is potentially still dark outside. That is, schools that currently provide transportation for students would likely have to reduce the bus tiers and invest and operate more buses amid a delay in SST. Previously, these costs have been estimated to be approximately $150 per student per year, or about $1,950 over a student’s school career (Edwards, 2012).

Furthermore, a delay in SST may impose a need for rescheduling of after-school activities such as sports team practices, due to later school dismissals, and diminishing outdoor light for evening practices or games. In order to offset this, some schools may opt for installing new lighting systems on sport fields which would allow for outdoor practice and games later in the day. The costs of adding light equipment have previously been estimated to a total one-time expense of around $110,000 and yearly operating costs of around $2,500 (Jacob and Rockoff, 2011). However, other approaches to offset the negative impact on sports and outdoor field time have been offered, such as altering student class schedules in order to make the last hours of the schedule available for sports activities, or to move activities indoors, which would mitigate the issue and hence reduce cost (Jacob and Rockoff, 2011).

1.2. Objectives of the study

Despite the public debate on the implementation challenges of later SST, including concerns about potential increased costs, so far only one study has aimed to quantify some of the potential economic benefits of later SST and compared them against the potential costs. Specifically, the analysis by the Brookings Institution (Jacob and Rockoff, 2011) examined the cost and benefits of delaying SST and found a benefit–cost ratio of 9:1 for a one hour later start time among middle and upper grades. In other words, for every $1 spent, the return is $9. Cumulatively, the study estimated an average $17,500 gain per student in terms of lifetime earnings compared to $1,950 cost per student over the school career. While the Brookings analysis shows a high benefit-to-cost ratio, it is important to highlight that the total time horizon of the potential benefits to occur is around 45 years, the average working life of an individual. However, from a political decision-makers’ perspective, it is important to have a more granular understanding of the timeframe when these benefits are likely to accrue.

Against this background and to facilitate decision-making among policy makers, the present study examines the potential economic consequences from delaying SST to at least 8:30 a.m. across the United States and predicts future potential benefits on an annual basis. This directly follows the recommendation by major medical organizations, like the American Academy of Pediatrics (AAP), which recommends that
middle and high schools start at 8:30 a.m. or later, to give students the opportunity to get the amount of sleep they require. Specifically, the main research questions addressed in this study are:

1) What are the economic implications of a state-wide universal shift in start times for middle and high schools to at least 8:30 a.m.?
2) What is the expected time horizon for potential benefits to occur?
3) How are the economic effects distributed across different states?

In order to answer these research questions, this study runs a hypothetical policy experiment which presupposes a statewide universal shift of SST to at least 8:30 a.m. Although the presupposition for this policy experiment may seem unjustified given that start times are generally determined at the local district level, there are, in fact, recent examples of proposed policy initiatives across the United States, including a bill that is currently under consideration in the California State Senate, which mandates that California middle and high schools start no earlier than 8:30 a.m. Hence, the hypothetical policy shift examined in this analysis represents a generally conceivable strategy.

The analysis presented in this report departs from the Brookings Institution benefit–cost analysis in several ways. First, instead of assuming a one hour delay in school start times, the current distribution of start times across different states is taken into account and the impact of an 8:30 a.m. SST is modeled. Second, this analysis examines the year-by-year effects on the economy of delayed SST, as opposed to examining the overall impact over the whole working life of an individual, which is about 45 years. From a policy and decision-maker’s perspective it is important to understand when the effects of a policy shift occur; now, in 5 years, 10 years or in 50 years? From a policy-maker’s perspective, that time horizon may have significant implications for garnering public support and decision-making. Third, when calculating the benefits of delayed SST, this study takes into account the effects on student lifetime earnings as well as the potential effects of reduced car crashes among adolescents, which can create a negative impact of the future labor supply of an economy if young adults die prematurely. Fourth, the Brookings Institution analysis focused only on a general potential gain per student, whereas this study looks at potential economic implications for different regions, taking into account the variation of start times and economic factors across different U.S. states. Finally, this study also takes into potential multiplier effects of increased lifetime earnings of individuals. For instance, at any given point in time the additional money these individuals save or consume will create further opportunities through further income for others agents (e.g. firms) in the economy.

1.3. Research approach

In order to address the research objectives and questions formulated above, the research incorporates two main methodological strands:

---

2 Note that no study has yet established the optimal school start time. However, among existing studies it has been shown that even relative small delays in the hours between 7:00 a.m. and 8:00 a.m. are associated with better student performance.

1) Literature review: we review the available literature in order to collect available evidence about the relation between sleep and wider health outcomes, mortality, and academic performance of adolescents. The literature review also serves to identify and extract parameters relevant for the economic model developed in the analysis.

2) Macroeconomic model development and calibration: we apply a macroeconomic model that enables the assessment of the economic implications of later SST across different U.S. states. In essence, the economic model used in this analysis is an overlapping generations (OLG) model, which by definition assumes that the modelled economy is represented by people of different age cohorts. In a nutshell, the economy in our model has three main actors – households, firms, and government – which continuously interact with the markets, just as in reality. Specifically, firms, representing the production sector, hire labor supplied by households to create output, paying wages in exchange for labor and interest rate as a cost of capital. In addition, the government collects income taxes from individuals and subsequently provides them with retirement and other social benefits. The strength of the model is that it enables the modelling of factors that affect different economic agents at different stages of their lifetime. For instance, for the purpose of this analysis, the policy change modelled affects individuals while they are in the education system and hence, before they enter the labor market. Subsequently, the modelling framework enables the quantification of a policy impact through comparison of the current status quo (no policy change) to a 'what if' scenario in which a change of policy affects agents in the economy in different ways. We outline the specifics of the model in more detail in Chapter 2 and Appendix A.

Note that in predicting the economic impacts of delaying SST, the study follows a generally conservative modelling approach. For instance, only those effects for which robust evidence is available in the relevant adolescent sleep literature (i.e. academic performance, car crashes) are modelled and whenever possible only parameter values are applied that lead to a potential underestimation of the benefits. Furthermore, it is important to highlight that the model applied in this analysis depends on parameters for calibration that stem from external sources and in the data collection process assumptions had to be made to make them tractable as modelling inputs. At every stage of the modelling description the assumptions and their implications are highlighted.

1.4. Structure of this report

This report is organized as follows: Chapter 2 outlines the methodological approach taken and describes in more detail the data used in the analysis. Chapter 3 reports the findings from the economic analysis of delayed SST for the whole United States and separately by each state. Chapter 4 summarizes the findings of the study and concludes.
This chapter outlines the research approach taken for this study. Specifically, the model to analyze the economic implications of delayed SST is described in more detail, together with a description of the data used in the analysis.

2.1. General modeling approach

The economic analysis is based on a theoretical dynamic general equilibrium model related to a system of mathematical equations to characterize the different economic interaction of different agents in an economy such households, firms, or the government. The economic model builds on the long tradition of computable general equilibrium (CGE) models, which have been extensively applied for economic policy analysis (see for example Allan et al., 2014; Lofgren et al., 2013; Zodrow & Diamond, 2013). CGE models are based on a detailed theoretical framework simulating the behavior of various agents and depicting relationships between subjects in an economy described by a set of parameters, equations and conditions that are to be satisfied simultaneously. The equations are then evaluated using mathematical software, giving a set of numerical results representing, for example, the labor or capital stock in a simulated economy. CGE models explicitly allow for the analysis of multiple comparable scenarios which differ only in the selected set of parameters, for example, by creating either a baseline (or status quo) and a 'what if' situation showing how the economy would evolve under alternative policy scenarios.

The specific model applied in this study is based on a family of general equilibrium models, a so-called overlapping generations (OLG) model. OLG models have been developed to account for complex economic interactions involving more than one generation of people. The basic mechanism behind the OLG modeling approach is driven by the life choices of representative economic agents (e.g. individuals in households) regarding education, labor supply, savings, investments and retirement based on a utility function that determines their preferences at any given point in time throughout their lifetimes. Specifically, the simplified model economy in each state of the analysis consists of three agents – individuals/households, firms, and government – which continuously interact on different markets, just as in reality. For instance, firms, representing the production sector, hire labor supplied by households to create output, paying wages in exchange for labor and interest as a cost of capital. Households buy goods and services with the income they receive from their labor supply. Within the model economy all assets are ultimately in possession of people, who also constitute the final consumer of all produced goods in the

---

4 For the purpose of this analysis we use MatLab. See https://uk.mathworks.com/products/matlab
economy. In addition, the government collects taxes from individuals and subsequently produces a public good and provides households with retirement and other transfers. In other words, in each state, profit-maximizing firms demand inputs from the factor markets (e.g. labor and capital) and compare these costs with the revenue they expect from selling the final goods in the product market. This forms the production side of the economy. Simultaneously, consumers/households are endowed with capital and labor, which they offer on the factor markets. Consumers then demand a bundle of goods produced by firms to maximize their utility, subject to their budget constraints, which forms the demand side of the model. In equilibrium, prices adjust so that demand and supply is equal. In principle, the model assumes the economy to be populated by individuals of different age cohorts who make decisions about schooling in earlier years, then enter the labor market and produce goods, receive wages for their labor, pay taxes and receive unconditional pensions from the government in retirement. Appendix A provides a more detailed model description, together with a table that describes the relevant model calibration parameters.

2.2. How a delay in SST is captured in the economic model

As a first step, the model simulates the economic forecast of each state in the baseline scenario, using the current distribution of SST across middle and high schools in different U.S. states provided by the CDC (Wheaton et al., 2015). Note that the CDC data does not provide average school start time for the District of Columbia and Maryland and the average start times in Alaska and North Dakota are later than 8:30 a.m. Hence, included in the analysis are the 47 U.S. states for which the SST distribution is available and is currently earlier than 8:30 a.m. In a second step, under a different ‘what if’ scenario (compared to current start times at baseline), the model predicts how the economic output of each state would be affected if the state would implement a universal shift to at least 8:30 a.m. SST. Or, in other words, how much would the economic welfare change in each state year-by-year after introducing the policy of delaying SST?

In the applied economic model, the population directly affected by the policy change is adolescents from school grade 6 to grade 12 and it is assumed that delaying SST leads to extended sleep duration for adolescents, which subsequently affects the economy in a given state through different channels. Specifically, only effects are included for which there were sufficiently robust and suitable parameters from the existing literature available. In particular, this study focuses on two specific beneficial channels that could be derived from later SST:

The first channel is mortality from motor vehicle crashes. The data for car crash mortality includes the underlying cause of death data provided by the CDC on weekday motor vehicle fatalities among teenagers.

---

5 Note that the empirical literature suggests that delaying SST is not associated with later bed time, but is associated with later rise times, which results in a net increase in sleep duration among students (see for example the systematic review by Minges & Redeker, 2016).

6 For instance, while it has been documented that longer sleep duration can be associated with improvements in mental and physical health outcomes for students, including lower levels of depression, suicide ideation or calorie intake, it has been proven difficult to translate the existing empirical estimates on these effects into suitable model parameters. Similar applies to the potential morbidity and disability implications of car crashes involving adolescents, which could lead to large medical expenses, disability payments and a potential loss of future earnings. As this study does not take these effects into account, the predicted economic effects serve as a lower bound estimate.
age 16 to 18, combined with parameters from a study by the AAA Foundation for Traffic Safety, which revealed that about one fifth of fatal motor vehicle crashes involved a driver impaired by sleepiness, drowsiness or fatigue (Tefft, 2014). Together with the estimate by Danner & Phillips (2008), which suggests that the car crash rate decreases by 16.5 per cent due to an hour delay in SST, the potential reduction of car crash mortality rates for each state is calculated. Note that in the applied economic model, reduced mortality levels among adolescents increase the potential future labor population and therefore has a positive effect on the economy. Thus, the labor supply effect on the economy derived from motor vehicle mortality data consists of two factors: 1) the direct impact of the individual being alive and productive; and 2) the impact on the individual's potential future offspring, which will subsequently be missing and hence will not contribute to the economy in the future.

The second channel potentially contributing to the benefits of later SST is the impact on academic performance. Using parameters on the effect of adolescent sleep on academic performance and graduation rates from Wang et al. (2016), the model takes into account that longer sleep can lead to increased high school and college graduation rates. Specifically, Wang et al. (2016) estimate that one additional hour of sleep is estimated to increase the probability of high school graduation on an average by up to 8.6 per cent (with decreasing marginal returns as the second-order effect is estimated at -0.5 per cent) and the college attendance rate by 13.4 per cent (with second-order effect of -0.9 per cent). Due to the non-linear effect of sleep duration, Wang et al.'s findings suggest that later start times may create long-run human capital benefits especially for those adolescents that sleep on average less than 7 hours a night, which applies roughly to between 40 per cent and 60 per cent of the adolescent population between ages 12 to 19 (e.g. Keyes et al., 2015). The positive effect on adolescents' academic performance and likelihood of high school and college graduation, in turn, impacts the jobs they are able to obtain in the future. This has a direct effect on how much a particular person contributes towards the economy in future financial earnings. Due to the dynamic nature of the model, at any given point in time, the increased income these individuals save or consume will create further opportunities through additional income for other agents in the economy.

Note that a shift to 8:30 a.m. SST is likely associated with some costs, and hence it is relevant to compare the economic benefits of the delayed SST to its potential costs. As mentioned, one of the most important factors driving costs is a change in the bussing system from a three-tier to a one- or two-tier system. The Brookings Institution analysis (Jacob and Rockoff, 2011) uses a cost estimate of $150 per student per year for the benefit–cost analysis, based on estimates from a school district in Wake County, North Carolina. Importantly, the cost will depend on the local circumstances of each state, and even at the more granular school district level it is impossible to representatively estimate them across the USA. Hence, for the

---

1 WONDER online database, available at https://wonder.cdc.gov/

2 Note that some studies found up to 70 per cent decreases in car crashes in some districts following a delay in SST by one hour (Wahlgren et al., 2014).

3 The study by Keyes et al. (2015) suggests that less than 60 per cent of students aged 12 to 19 get 7 or more hours of sleep per night. Hence, in order to be conservative in the predictions of economic benefits of delayed SST, in the analysis only students that sleep on average less than 7 hours will profit from the policy shift of later SST to 8:30 a.m. or later.

4 In economics this is referred to as the well-known "multiplier effect", which is when extra income leads to more spending in the economy which subsequently can create more income.
purpose of illustration of the potential benefit–cost ratios, different cost scenarios are applied in the present analysis to provide a more comprehensive range of potential costs. The scenarios include different values of annual costs per student, including $150, $350, and $500.\textsuperscript{11} It is assumed that these cost per student will occur in perpetuity after the policy shift to 8:30 a.m. SST, which is likely overestimating the actual costs as the majority of the costs in relation to make changes to bussing systems would probably accrue at the beginning of the policy shift in the form of upfront investments for new buses. In addition, the cost scenarios also include some cost factors that may occur as upfront investments which are assumed to be related to updates of school infrastructure (e.g., athletic field lighting) in order to accommodate after school-activities.

\subsection*{2.2.1. Model dynamics}

In the model, the economic output of state $s$ consists of goods and services $Y_s$ that are produced using input factors capital $K_s$ and effective labor $L_s$ (e.g., labor input adjusted for efficiency units), and hence production is modeled as a function of $Y_s = F(K_s, L_s)$. In each time period $t$, the model assumes that physical labor is adjusted for efficiency units by $L_s = \bar{L} \cdot \theta$ with the physical supply of labor input $\bar{L}$ and efficiency labor $\theta$, which represents population levels in productivity.\textsuperscript{12} As the delay in SST directly impacts the labor component of the model, the law of motion of the components of $L_s$, in both the baseline and the “what if” policy scenario, needs to be derived.

\textbf{Physical labor}

To address the first component, physical labor $\bar{L}$, a cohort-component model is applied to predict the size of the future populations in each state using current base population estimates from the United States Census Bureau,\textsuperscript{13} as well as mortality and fertility rates data provided by the CDC.\textsuperscript{14}

Specifically, the cohort-component model starts with the base population in each state and is categorized by age and gender. The base population subsequently evolves by applying assumptions on mortality and fertility so that the population changes according to a ‘natural’ increase (births minus deaths), which depends on the particular scenario.\textsuperscript{15} The outcome of the model is a projection of the population by 1-year age and gender groups into the future, applied to each of the states.

\textsuperscript{11} While it is difficult to precisely model the cost implications of other factors such as increased stress on family and home life, we assume that the additional higher cost estimates applied in the model would cover some of these potential costs. In addition, it is assumed in the model that a delay in SST would not affect parent’s labor supply, meaning that there is no strong evidence in the literature suggesting that a delay of roughly 30 mins to 60 mins would induce parents of 6 to 12 grades to alter their hours of work or stop working altogether.

\textsuperscript{12} Note that we refer to the labour efficiency effect as “productivity”. However, alternatively one could also use the term “human capital” as the underlying assumption is that higher levels of human capital lead to higher levels of productivity.

\textsuperscript{13} Available at \url{https://www2.census.gov/programs-surveys/popest/datasets/2010-2015/state/asrh/}


\textsuperscript{15} E.g. current status quo versus scenario with delayed SST.
The total births in a given period depend on the size of the population, its age structure and age- and state-specific fertility rates. Similarly, the number of deaths in any given period depends on the population size, the age distribution and age- and gender-specific mortality rates. In addition, net migration can lead to an increase in the population. More formally, the population of age \( a \), gender \( g \) at time \( t \) is calculated as:

\[
P_{s,a,g,t+1} = P_{s,a,g,t} + B_{s,a,g} - D_{s,a,g} + IM_{s,a,g} - OM_{s,a,g}
\]

where \( B_{s,a,g,t} \) represents the total births, \( D_{s,a,g,t} \) total deaths. For example, a reduction in fatal motor vehicle crashes among adolescents would reduce the level of \( D_{s,a,g,t} \) in the specific age group. \( IM_{s,a,g} \) and \( OM_{s,a,g} \) represent inward and outward migration respectively.\(^{16}\)

**Efficiency labor**

In order to address the second component, the level of productivity \( \theta \) is determined, which is essentially a combination of the level of educational attainment \( \theta \) and the corresponding wage level in the working-age population \( \Delta \). In order to determine both the current level of productivity at baseline \( \theta \) and the level of productivity associated with a change in SST to 8:30 a.m., \( \theta^* \), we perform a set of different analytical steps and draw on a variety of different data sources.

In a first step, we derive the current educational attainment distribution using the proportion of high school dropouts \( n \), high school graduates \( h \) and college graduates \( u \) in each state by gender \( g \), age \( a \) and ethnicity \( r \), with data from the United States Census Bureau data.\(^{17}\) The educational attainment data are not directly available for all gender-ethnicity-state combinations, unlike the overall population data, but for gender-ethnicity pairs and states separately. The two datasets are combined assuming that the differences across gender and ethnicity groups are independent by state but are jointly determined by the overall educational attainment in the given state.\(^{18}\) The process is formally described in Appendix B.

In a second step, the level of productivity after the policy change, which is denoted as \( \theta^* \), is determined. To that end we draw on data derived in the first step on the distribution of educational attainment, as well as information on the distribution on average school start times in different states and information on the average income per age-state-gender-ethnicity combination. First, to determine the average change in sleep duration due to changes in SST, \( \Delta \), we use data on the distribution of SST for different U.S. states from the CDC (Wheaton et al., 2015). The school start times are provided in 30-minute intervals: before 7:30 a.m., 7:30–8:00 a.m., and 8:00–8:30 a.m. For simplicity, it is assumed that those intervals correspond to a starting time of 7:30 a.m., 7:45 a.m., and 8:15 a.m. and therefore a net average increase

---

\(^{16}\) Approximate net migration rates per state have been derived using data from the U.S. Census Bureau: https://www.census.gov/data/tables/time-series/demo/geographic-mobility/state-to-state-migration.html

\(^{17}\) United States Census Bureau (https://www.census.gov/data.html), 2015 population data. Hispanic refers to individual of any race of Hispanic origin. The "Other" category includes Asians, Native Americans and all other ethnicities.

\(^{18}\) In other words, educational attainment of, for example, white males compared to white females is assumed to be the same in North and South Dakota — but educational attainment of white males in North Dakota compared to white males in South Dakota will follow the overall educational attainment across the whole population in those two states.
in sleep duration of 60, 45, and 15 minutes, respectively.\textsuperscript{19} The calculated average net increase in sleep duration by state is reported in Appendix C.\textsuperscript{20}

In line with Wang et al.'s (2016) findings on the non-linear effect of adolescent sleep on educational attainment, we assume that only students who get on average less than 7 hours of sleep per night, as compared to the recommended 8–10 hours, would benefit from the delay in SST. In order to derive the exposure–response relationship of the delay in the SST for students sleeping less than 7 hours, we need to determine the size of their population and their average amount of sleep at baseline. The proportions of students aged 12 to 19 sleeping less than 7 hours a night is from Keyes et al. (2015) and Eaton et al. (2010), which show that only about 32 per cent to 60 per cent of students get at least 7 hours of sleep per night, depending on the age group. In order to determine the average sleep duration at baseline for students sleeping less than 7 hours a night, we draw on further granular information on the refined proportions of students sleeping less than 7 hours by McKnight-Eily et al. (2011). They report that about 6 per cent, 10 per cent, 23 per cent, and 30 per cent get on average ≤4, 5, 6, and 7 hours of sleep per night, respectively. To remain conservative in our estimates, we assume that in each of these groups, students slept exactly 4, 5, 6, and 7 hours, resulting in a weighted average of 6.12 hours of sleep per night for students who receive less than 7 hours of sleep per night on average.

Second, using the second order parameter estimates from Wang et al. (2016)\textsuperscript{21} we derive the changes in the level of educational attainment $e^*$ regarding high school dropouts ($n$), high school graduates ($h$) and college graduates ($u$) by a delay in SST in each state $s$ by gender, and ethnicity group as follows:

$$e_{s,g,r}^n = e_{s,g,r}^n - (e_{s,g,r}^h - e_{s,g,r}^h)$$
$$e_{s,g,r}^h = [0.086\Delta - 0.005 \cdot (2\Delta + \Delta^2) + s_{s,g,r}^h] \cdot g_{s,g,r}^h - (e_{s,g,r}^u - e_{s,g,r}^u)$$
$$e_{s,g,r}^u = [0.134\Delta - 0.009 \cdot (2\Delta + \Delta^2) + s_{s,g,r}^u] \cdot g_{s,g,r}^u$$

where $\Delta$ represents the average increase in sleep duration per night as a result of later start times (see Appendix C), and where $e_{s,g,r}^n$ and $e_{s,g,r}^u$ represent the number of individuals that attended high school and university, respectively, whereas $g_{s,g,r}^h$ and $g_{s,g,r}^u$ represent the respective graduation rates (see Appendix B).

Finally, by bringing all previous steps together, the predicted change in educational attainment $e^*$ induced by the policy change needs to be translated into future economic gains. To that end, we use information on the average earnings per highest educational attainment level collected by the Bureau of Labor Statistics.\textsuperscript{22} In principle, we assume that higher educated individuals have, on average, higher levels of productivity $\theta$, approximated using average earnings, and that productivity evolves over one’s lifetime.

\textsuperscript{19} Note that the hypothetical policy scenario analyzed in this study assumes a universal state-wide shift of SST to 8:30 a.m. or later and hence we assume that schools which already start later than 8:30 a.m. would not move forward their start times.

\textsuperscript{20} Note that overall 47 U.S. states are included in the analysis. The publicly available CDC data does not provide school start time distributions for District of Columbia and Maryland. In addition, average school start times in Alaska and North Dakota are later than 8:30 a.m.

\textsuperscript{21} Table 3, column 3.

\textsuperscript{22} https://www.bls.gov/emp/ep_chart_001.htm
using an age-productivity profile. However, we also need to reflect that the shift in SST would take several years to have a full impact as some students may only be exposed for a short period of time, and also due to a delay between when potential college attendees graduate and when they enter the labor market. To do this, we assume in the model – and consistent with the other data presented above – that the high school and college education takes four years to complete and that the effects estimated by Wang et al. (2016) decrease linearly for students exposed less than the full four years of the delay in SST. For instance, assuming that the policy would be implemented in the first year \((t = 0)\), students graduating at the end of the first year \((t = 1)\) would only see 25 per cent of the estimated effects of higher academic performance, students graduating at the end of the third year \((t = 2)\) would be affected by 50 per cent and so on.\(^{23}\) In addition, only students that do not pursue tertiary education would have an immediate impact on the labor market, whereas those students that go to college will only enter the labor market with a four years delay, albeit more likely with a higher entry salary. Hence, in the predictions of this model, the full effect of higher educational attainment associated with the delay in SST would emerge 8 years after the policy shift.

Putting all the pieces together, the total predicted relative change in productivity level \(\theta\) for age \(a\) in state \(s\) is as follows:

\[
\frac{\theta_{as}^*}{\theta_{as}} = \sum_{r \in E} \sum_{g \in G} e_{s,gr,a} n \mu_{s,gr,a} m_{gr,a} n + \sum_{r \in E} \sum_{g \in G} e_{s,gr,a} h \mu_{s,gr,a} m_{gr,a} h + \sum_{r \in E} \sum_{g \in G} e_{s,gr,a} u \mu_{s,gr,a} m_{gr,a} u
\]

The average aggregate increase in productivity at any given point in time due to the delay in SST is a weighted sum of the relative changes in educational attainment of all individuals of the specific age \(a\), gender \(g\), ethnicity \(r\), living in the given state \(s\), weighted by the share of such individuals within the total population of the given age and education in that state \(\mu_{s,gr,a}\), multiplied by the relative average earnings of each group \(m_{gr,a}\) compared to the average earnings of all individuals with the same level of education of that age \(m_a\). This aims to replicate heterogeneity of effects of educational attainment across different socio-economic population subgroups.

\(^{23}\) Note this adjustment is essentially to make the estimates more conservative. The existing literature suggests that improvements in sleep duration improves the adverse outcomes of insufficient sleep already in a very short period of time (e.g. within a year).
This chapter presents the findings of the economic analysis from a statewide universal delay in SST to at least 8:30 a.m. First, the predicted cumulative gains in present values and their distribution across 47 U.S. states are reported. This is followed by a breakdown of the benefits by student and state. Finally, the overall benefits are compared to a set of different cost scenarios.

### 3.1. Cumulative economic gains from later school start times

This section illuminates the link between delayed SST and profound economic gains for 47 U.S. states. The economic gains are displayed as higher levels of economic output that would occur if SST would be delayed to 8:30 a.m. compared to the current distribution of SST (status quo). Economic output by state is measured in gross state product (GSP) terms.24

**Figure 1: Predicted cumulative economic gains from delayed SST to 8:30 a.m.**

![Graph showing predicted cumulative economic gains from delayed SST to 8:30 a.m.](image)

**Source:** Authors' calculations.

**Notes:** The figure plots the predicted discounted cumulative gains (2016 $) of delayed SST to 8:30 a.m. in gross state product (GSP) terms, aggregated across 47 U.S. states.

24 The gross state product is essentially the equivalent of gross domestic product (GDP) at the country level. [https://www.bea.gov/regional/](https://www.bea.gov/regional/).
Figure 1 depicts the predicted cumulative economic gains from delayed SST in present-day value aggregated across the 47 U.S. states included in the analysis. In the first year of the shift in SST to 8:30 a.m., the model projects no immediate economic gains, given that the first cohort of students graduating from high school is only experiencing one-year of change in the SST policy before graduation. However, as more students will benefit in the future from the delayed start times as they enter the labor market, the findings suggest a gradual increase of economic gains over time. For instance, two years after the policy shift, the model projects a total economic gain of about $8.6 billion. This gain occurs in the form of increased aggregated gross state product, which represents about 0.04 percent of current total U.S. gross domestic product. After five years, the predicted cumulative economic gain increases to about $37 billion, to $83 billion after ten years and to about $140 billion after fifteen years. On average, this corresponds to an annual economic gain of about $9.3 billion, aggregated across the 47 U.S. states, which is roughly the annual revenue of Major League Baseball (Brown, 2016).

The distribution of the cumulative economic gains across the different states over time is reported in Table 1, suggesting profound regional variation of the effects. Note that the variation of predicted gains across states is mainly driven by differences in the statewide initial average SST and underlying economic factors that also vary significantly by state (e.g. the industrial composition or average productivity levels). In absolute terms, larger states such as California would gain the most from a delay in SST to at least 8:30 a.m. For instance, after 2 years, it is predicted that California’s GSP would be about $1.1 billion larger compared to the status quo. This is predicted to increase to about $17 billion after 15 years. In comparison, Florida would gain about $0.6 billion and Texas about $0.8 billion after 2 years and about $9 billion and $13 billion after 15 years, respectively.

Regarding the relative changes in per cent of current GSP, compared to the status quo, after 2 years the relative average gains from the policy change to later SST range from 0.01 per cent (Alabama) to 0.08 per cent (Massachusetts) of GSP. In year 10, the relative gains range from 0.16 per cent (Alabama) to 0.66 per cent (Delaware) of GSP. After 20 years, the gains range from 0.64 per cent (Alabama) to 1.58 per cent (Delaware).

<table>
<thead>
<tr>
<th>Table 1: Predicted cumulative economic gain by state ($ million GSP)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>State</strong></td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Alabama</td>
</tr>
<tr>
<td>Arizona</td>
</tr>
<tr>
<td>Arkansas</td>
</tr>
<tr>
<td>California</td>
</tr>
<tr>
<td>Colorado</td>
</tr>
<tr>
<td>Connecticut</td>
</tr>
<tr>
<td>Delaware</td>
</tr>
<tr>
<td>Florida</td>
</tr>
<tr>
<td>Georgia</td>
</tr>
<tr>
<td>Hawaii</td>
</tr>
<tr>
<td>Idaho</td>
</tr>
</tbody>
</table>
### Later school start times in the U.S.

<table>
<thead>
<tr>
<th>State</th>
<th>2 years</th>
<th></th>
<th>5 years</th>
<th></th>
<th>10 years</th>
<th></th>
<th>15 years</th>
<th></th>
<th>20 years</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>$261</td>
<td>0.03%</td>
<td>$1,091</td>
<td>0.14%</td>
<td>$2,559</td>
<td>0.33%</td>
<td>$4,535</td>
<td>0.58%</td>
<td>$6,753</td>
<td>0.87%</td>
</tr>
<tr>
<td>Indiana</td>
<td>$153</td>
<td>0.05%</td>
<td>$712</td>
<td>0.21%</td>
<td>$1,579</td>
<td>0.47%</td>
<td>$2,849</td>
<td>0.85%</td>
<td>$4,170</td>
<td>1.24%</td>
</tr>
<tr>
<td>Iowa</td>
<td>$98</td>
<td>0.06%</td>
<td>$405</td>
<td>0.23%</td>
<td>$917</td>
<td>0.53%</td>
<td>$1,433</td>
<td>0.82%</td>
<td>$1,988</td>
<td>1.14%</td>
</tr>
<tr>
<td>Kansas</td>
<td>$59</td>
<td>0.04%</td>
<td>$302</td>
<td>0.20%</td>
<td>$636</td>
<td>0.42%</td>
<td>$1,064</td>
<td>0.71%</td>
<td>$1,530</td>
<td>1.02%</td>
</tr>
<tr>
<td>Kentucky</td>
<td>$54</td>
<td>0.02%</td>
<td>$261</td>
<td>0.14%</td>
<td>$1,089</td>
<td>0.56%</td>
<td>$1,760</td>
<td>0.91%</td>
<td>$2,452</td>
<td>1.27%</td>
</tr>
<tr>
<td>Louisiana</td>
<td>$120</td>
<td>0.05%</td>
<td>$501</td>
<td>0.21%</td>
<td>$1,176</td>
<td>0.49%</td>
<td>$2,029</td>
<td>0.85%</td>
<td>$2,917</td>
<td>1.22%</td>
</tr>
<tr>
<td>Maine</td>
<td>$29</td>
<td>0.05%</td>
<td>$121</td>
<td>0.21%</td>
<td>$288</td>
<td>0.50%</td>
<td>$494</td>
<td>0.86%</td>
<td>$708</td>
<td>1.24%</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>$371</td>
<td>0.08%</td>
<td>$1,419</td>
<td>0.29%</td>
<td>$2,990</td>
<td>0.62%</td>
<td>$4,769</td>
<td>0.98%</td>
<td>$6,606</td>
<td>1.36%</td>
</tr>
<tr>
<td>Michigan</td>
<td>$295</td>
<td>0.07%</td>
<td>$1,218</td>
<td>0.26%</td>
<td>$2,894</td>
<td>0.62%</td>
<td>$4,794</td>
<td>1.02%</td>
<td>$6,728</td>
<td>1.44%</td>
</tr>
<tr>
<td>Minnesota</td>
<td>$188</td>
<td>0.06%</td>
<td>$753</td>
<td>0.23%</td>
<td>$1,772</td>
<td>0.54%</td>
<td>$2,960</td>
<td>0.90%</td>
<td>$4,200</td>
<td>1.23%</td>
</tr>
<tr>
<td>Mississippi</td>
<td>$48</td>
<td>0.05%</td>
<td>$233</td>
<td>0.22%</td>
<td>$502</td>
<td>0.47%</td>
<td>$846</td>
<td>0.80%</td>
<td>$1,211</td>
<td>1.14%</td>
</tr>
<tr>
<td>Missouri</td>
<td>$181</td>
<td>0.06%</td>
<td>$740</td>
<td>0.25%</td>
<td>$1,750</td>
<td>0.59%</td>
<td>$3,115</td>
<td>1.06%</td>
<td>$4,488</td>
<td>1.52%</td>
</tr>
<tr>
<td>Montana</td>
<td>$26</td>
<td>0.06%</td>
<td>$107</td>
<td>0.24%</td>
<td>$229</td>
<td>0.51%</td>
<td>$363</td>
<td>0.80%</td>
<td>$505</td>
<td>1.12%</td>
</tr>
<tr>
<td>Nebraska</td>
<td>$39</td>
<td>0.03%</td>
<td>$164</td>
<td>0.15%</td>
<td>$379</td>
<td>0.33%</td>
<td>$654</td>
<td>0.58%</td>
<td>$965</td>
<td>0.85%</td>
</tr>
<tr>
<td>Nevada</td>
<td>$53</td>
<td>0.04%</td>
<td>$219</td>
<td>0.16%</td>
<td>$524</td>
<td>0.37%</td>
<td>$919</td>
<td>0.66%</td>
<td>$1,351</td>
<td>0.97%</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>$33</td>
<td>0.04%</td>
<td>$156</td>
<td>0.21%</td>
<td>$362</td>
<td>0.49%</td>
<td>$628</td>
<td>0.85%</td>
<td>$905</td>
<td>1.23%</td>
</tr>
<tr>
<td>New Jersey</td>
<td>$385</td>
<td>0.07%</td>
<td>$1,541</td>
<td>0.27%</td>
<td>$3,568</td>
<td>0.63%</td>
<td>$5,920</td>
<td>1.04%</td>
<td>$8,297</td>
<td>1.46%</td>
</tr>
<tr>
<td>New Mexico</td>
<td>$56</td>
<td>0.06%</td>
<td>$222</td>
<td>0.24%</td>
<td>$493</td>
<td>0.53%</td>
<td>$786</td>
<td>0.84%</td>
<td>$1,091</td>
<td>1.17%</td>
</tr>
<tr>
<td>New York</td>
<td>$493</td>
<td>0.04%</td>
<td>$2,077</td>
<td>0.15%</td>
<td>$4,960</td>
<td>0.35%</td>
<td>$8,847</td>
<td>0.63%</td>
<td>$13,130</td>
<td>0.94%</td>
</tr>
<tr>
<td>North Carolina</td>
<td>$263</td>
<td>0.05%</td>
<td>$1,084</td>
<td>0.22%</td>
<td>$2,469</td>
<td>0.50%</td>
<td>$4,157</td>
<td>0.84%</td>
<td>$5,926</td>
<td>1.20%</td>
</tr>
<tr>
<td>Ohio</td>
<td>$435</td>
<td>0.07%</td>
<td>$1,746</td>
<td>0.29%</td>
<td>$3,724</td>
<td>0.61%</td>
<td>$6,010</td>
<td>0.98%</td>
<td>$8,360</td>
<td>1.37%</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>$104</td>
<td>0.06%</td>
<td>$410</td>
<td>0.22%</td>
<td>$914</td>
<td>0.49%</td>
<td>$1,504</td>
<td>0.81%</td>
<td>$2,132</td>
<td>1.15%</td>
</tr>
<tr>
<td>Oregon</td>
<td>$83</td>
<td>0.04%</td>
<td>$338</td>
<td>0.16%</td>
<td>$778</td>
<td>0.36%</td>
<td>$1,356</td>
<td>0.62%</td>
<td>$1,999</td>
<td>0.92%</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>$276</td>
<td>0.04%</td>
<td>$1,213</td>
<td>0.17%</td>
<td>$2,990</td>
<td>0.42%</td>
<td>$5,387</td>
<td>0.76%</td>
<td>$7,908</td>
<td>1.11%</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>$36</td>
<td>0.07%</td>
<td>$164</td>
<td>0.29%</td>
<td>$364</td>
<td>0.65%</td>
<td>$592</td>
<td>1.06%</td>
<td>$821</td>
<td>1.47%</td>
</tr>
<tr>
<td>South Carolina</td>
<td>$130</td>
<td>0.06%</td>
<td>$567</td>
<td>0.28%</td>
<td>$1,254</td>
<td>0.62%</td>
<td>$1,951</td>
<td>0.97%</td>
<td>$2,677</td>
<td>1.33%</td>
</tr>
<tr>
<td>South Dakota</td>
<td>$23</td>
<td>0.05%</td>
<td>$101</td>
<td>0.21%</td>
<td>$214</td>
<td>0.45%</td>
<td>$346</td>
<td>0.73%</td>
<td>$490</td>
<td>1.04%</td>
</tr>
<tr>
<td>Tennessee</td>
<td>$120</td>
<td>0.04%</td>
<td>$515</td>
<td>0.16%</td>
<td>$1,219</td>
<td>0.39%</td>
<td>$2,131</td>
<td>0.67%</td>
<td>$3,122</td>
<td>0.99%</td>
</tr>
<tr>
<td>Texas</td>
<td>$851</td>
<td>0.05%</td>
<td>$3,412</td>
<td>0.21%</td>
<td>$7,686</td>
<td>0.48%</td>
<td>$12,835</td>
<td>0.80%</td>
<td>$18,307</td>
<td>1.14%</td>
</tr>
<tr>
<td>Utah</td>
<td>$68</td>
<td>0.05%</td>
<td>$277</td>
<td>0.19%</td>
<td>$691</td>
<td>0.47%</td>
<td>$1,175</td>
<td>0.80%</td>
<td>$1,679</td>
<td>1.14%</td>
</tr>
<tr>
<td>Vermont</td>
<td>$17</td>
<td>0.06%</td>
<td>$70</td>
<td>0.23%</td>
<td>$159</td>
<td>0.53%</td>
<td>$270</td>
<td>0.90%</td>
<td>$385</td>
<td>1.28%</td>
</tr>
<tr>
<td>Virginia</td>
<td>$330</td>
<td>0.07%</td>
<td>$1,182</td>
<td>0.25%</td>
<td>$2,650</td>
<td>0.55%</td>
<td>$4,277</td>
<td>0.89%</td>
<td>$5,975</td>
<td>1.24%</td>
</tr>
<tr>
<td>Washington</td>
<td>$264</td>
<td>0.06%</td>
<td>$1,214</td>
<td>0.27%</td>
<td>$2,518</td>
<td>0.57%</td>
<td>$4,031</td>
<td>0.91%</td>
<td>$5,608</td>
<td>1.26%</td>
</tr>
<tr>
<td>West Virginia</td>
<td>$38</td>
<td>0.05%</td>
<td>$155</td>
<td>0.21%</td>
<td>$362</td>
<td>0.49%</td>
<td>$610</td>
<td>0.82%</td>
<td>$871</td>
<td>1.17%</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>$152</td>
<td>0.05%</td>
<td>$634</td>
<td>0.21%</td>
<td>$1,511</td>
<td>0.50%</td>
<td>$2,552</td>
<td>0.84%</td>
<td>$3,642</td>
<td>1.21%</td>
</tr>
<tr>
<td>Wyoming</td>
<td>$23</td>
<td>0.06%</td>
<td>$99</td>
<td>0.25%</td>
<td>$225</td>
<td>0.56%</td>
<td>$378</td>
<td>0.95%</td>
<td>$535</td>
<td>1.34%</td>
</tr>
</tbody>
</table>

Source: Authors' calculations.
Notes: The table reports the predicted discounted cumulative economic gains ($ million GSP) of delayed SST to 8:30 a.m. across all 47 U.S. states that would occur in years after the policy change, compared to status quo.
3.2. Economic benefits per student and benefit-cost ratios

The effects from delaying SST state-wide to at least 8:30 a.m. reported in Figure 1 and Table 1 suggest that even if a very conservative methodological approach is taken, the predicted economic benefits are substantial. However, in order to assess the effectiveness of the policy to delay SST, it is important to compare the economic benefits to their corresponding costs. To that end, this section provides an overview of the predicted economic gains per student across the 47 U.S. states and compares them against different cost scenarios in more detail.

3.2.1. The predicted economic benefits per student

Using the total number of students across U.S. middle and high-schools,\textsuperscript{35} Table 2 reports the cumulative economic benefits per student after 2, 5, 10, 15 and 20 years, respectively.

\textbf{Table 2: Predicted cumulative economic gain by state ($ per student)}

<table>
<thead>
<tr>
<th>State</th>
<th>Years after policy change (gain $ per student)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Alabama</td>
<td>31</td>
</tr>
<tr>
<td>Arizona</td>
<td>374</td>
</tr>
<tr>
<td>Arkansas</td>
<td>190</td>
</tr>
<tr>
<td>California</td>
<td>335</td>
</tr>
<tr>
<td>Colorado</td>
<td>294</td>
</tr>
<tr>
<td>Connecticut</td>
<td>517</td>
</tr>
<tr>
<td>Delaware</td>
<td>733</td>
</tr>
<tr>
<td>Florida</td>
<td>456</td>
</tr>
<tr>
<td>Georgia</td>
<td>269</td>
</tr>
<tr>
<td>Hawaii</td>
<td>476</td>
</tr>
<tr>
<td>Idaho</td>
<td>180</td>
</tr>
<tr>
<td>Illinois</td>
<td>259</td>
</tr>
<tr>
<td>Indiana</td>
<td>273</td>
</tr>
<tr>
<td>Iowa</td>
<td>395</td>
</tr>
<tr>
<td>Kansas</td>
<td>289</td>
</tr>
<tr>
<td>Kentucky</td>
<td>263</td>
</tr>
<tr>
<td>Louisiana</td>
<td>381</td>
</tr>
<tr>
<td>Maine</td>
<td>275</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>704</td>
</tr>
<tr>
<td>Michigan</td>
<td>331</td>
</tr>
<tr>
<td>Minnesota</td>
<td>360</td>
</tr>
<tr>
<td>Mississippi</td>
<td>177</td>
</tr>
<tr>
<td>Missouri</td>
<td>341</td>
</tr>
<tr>
<td>Montana</td>
<td>338</td>
</tr>
<tr>
<td>Nebraska</td>
<td>258</td>
</tr>
</tbody>
</table>

\textsuperscript{35} See Table 8 in Appendix C for the numbers of students and schools.
<table>
<thead>
<tr>
<th>State</th>
<th>2</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nevada</td>
<td>191</td>
<td>795</td>
<td>1,897</td>
<td>3,330</td>
<td>4,896</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>286</td>
<td>1,343</td>
<td>3,117</td>
<td>5,416</td>
<td>7,801</td>
</tr>
<tr>
<td>New Jersey</td>
<td>551</td>
<td>2,207</td>
<td>5,112</td>
<td>8,482</td>
<td>11,886</td>
</tr>
<tr>
<td>New Mexico</td>
<td>373</td>
<td>1,469</td>
<td>3,268</td>
<td>5,204</td>
<td>7,226</td>
</tr>
<tr>
<td>New York</td>
<td>295</td>
<td>1,244</td>
<td>2,970</td>
<td>5,298</td>
<td>7,862</td>
</tr>
<tr>
<td>North Carolina</td>
<td>342</td>
<td>1,411</td>
<td>3,215</td>
<td>5,413</td>
<td>7,717</td>
</tr>
<tr>
<td>Ohio</td>
<td>410</td>
<td>1,646</td>
<td>3,510</td>
<td>5,665</td>
<td>7,879</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>291</td>
<td>1,153</td>
<td>2,568</td>
<td>4,226</td>
<td>5,989</td>
</tr>
<tr>
<td>Oregon</td>
<td>294</td>
<td>1,198</td>
<td>2,758</td>
<td>4,810</td>
<td>7,088</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>276</td>
<td>1,212</td>
<td>2,987</td>
<td>5,381</td>
<td>7,900</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>537</td>
<td>2,406</td>
<td>5,358</td>
<td>8,703</td>
<td>12,081</td>
</tr>
<tr>
<td>South Carolina</td>
<td>317</td>
<td>1,380</td>
<td>3,050</td>
<td>4,747</td>
<td>6,513</td>
</tr>
<tr>
<td>South Dakota</td>
<td>296</td>
<td>1,300</td>
<td>2,744</td>
<td>4,438</td>
<td>6,287</td>
</tr>
<tr>
<td>Tennessee</td>
<td>225</td>
<td>967</td>
<td>2,286</td>
<td>3,998</td>
<td>5,858</td>
</tr>
<tr>
<td>Texas</td>
<td>333</td>
<td>1,335</td>
<td>3,007</td>
<td>5,022</td>
<td>7,162</td>
</tr>
<tr>
<td>Utah</td>
<td>228</td>
<td>931</td>
<td>2,327</td>
<td>3,956</td>
<td>5,654</td>
</tr>
<tr>
<td>Vermont</td>
<td>365</td>
<td>1,523</td>
<td>3,464</td>
<td>5,876</td>
<td>8,365</td>
</tr>
<tr>
<td>Virginia</td>
<td>595</td>
<td>2,129</td>
<td>4,774</td>
<td>7,706</td>
<td>10,765</td>
</tr>
<tr>
<td>Washington</td>
<td>503</td>
<td>2,308</td>
<td>4,786</td>
<td>7,664</td>
<td>10,662</td>
</tr>
<tr>
<td>West Virginia</td>
<td>235</td>
<td>972</td>
<td>2,263</td>
<td>3,813</td>
<td>5,443</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>360</td>
<td>1,498</td>
<td>3,572</td>
<td>6,034</td>
<td>8,610</td>
</tr>
<tr>
<td>Wyoming</td>
<td>461</td>
<td>1,982</td>
<td>4,497</td>
<td>7,553</td>
<td>10,702</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>346</td>
<td>1,461</td>
<td>3,309</td>
<td>5,552</td>
<td>7,906</td>
</tr>
</tbody>
</table>

Source: Authors' calculations.

Notes: The table reports the predicted discounted cumulative economic gains per student of delayed SST to 8:30 a.m. across all 47 U.S. states, compared to the status quo with current distribution of SST.

On average, the predicted benefit per student across states after 2 years is $346, which is rising to $3,309 and $5,552 after 10 and 15 years, respectively. Similar to the predictions reported in Table 1, there is substantial variation across states. For instance, in Alabama the economic gain per student after 2 years is predicted to be about $31. This is significantly lower than the average of $346 per student across the 47 states. Other states with relatively low gains per student are Arkansas, Idaho and Mississippi (between $177 and $190 after 2 years). On the other hand, states such as Delaware and Massachusetts are predicted to proportionally gain more than $700 per student already after 2 years. Other states with relatively large gains per student are Connecticut, New Jersey, Ohio, Rhode Island and Wyoming.

The predictions presented in Table 2 depict the potential economic gains per student, but in order to make an assessment about the cost-effectiveness of the policy of later SST, the gains need to be compared against their corresponding costs.
3.3. The predicted benefit-cost ratios per student

Generally, the costs associated with delaying SST will vary by region and even by school district. The previous benefit–cost analysis by the Brookings Institution used a cost estimate of $150 per student per year, and we apply this figure as well. However, in order to illustrate a range of relevant cost scenarios which may apply for different regions and under different settings, we apply a set of scenarios denoted as “Normal”, “High” and “Very High”, and vary them by different type of costs, including annually reoccurring or upfront investment costs. The six different scenarios are outlined in Table 3.

Table 3: Cost scenarios applied in the analysis

<table>
<thead>
<tr>
<th>Cost scenario:</th>
<th>Normal</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1): annual cost</td>
<td>$150 per student</td>
<td>$350 per student</td>
<td>$500 per student</td>
</tr>
<tr>
<td>(2): upfront + (1)</td>
<td>$110,000 per school</td>
<td>$220,000 per school</td>
<td>$330,000 per school</td>
</tr>
</tbody>
</table>

Notes: It is assumed that the occurring annual costs would capture costs in relation to changes in bussing strategies, whereas the upfront costs would capture the update of school infrastructure in relation to after-school activities. The cost per school is transformed into costs per student using data on the total number of students and schools provided in Table 8, Appendix C. The two variants of the “Normal” cost scenario mimic the general cost assumptions taken regarding costs of delaying SST from existing studies.

Each of the cost scenarios “Normal”, “High” and “Very High” has two variants: (1) only annual costs per student apply; and (2) annual costs plus an upfront investment per school which aims to estimate costs for potential updates of school infrastructure related to after-school activities apply. For instance, in the “Normal” scenario, it is assumed that the annual costs per student are $150 and the upfront cost is an additional $110,000 per school. For the “High” and “Very High” scenarios, it is assumed that the upfront investment costs per school would double and triple in size, respectively. Note that the cost scenario “Normal” is using the cost estimates from previous studies (e.g. Jacob and Rockoff, 2011), whereas scenario “High” and “Very High” are projections intended to illustrate the potential impact of higher cost assumptions on the effectiveness of the policy to delay SST.

Accordingly, Figure 2 reports the benefit-cost ratio per student across the 47 U.S. states for the different cost scenarios. Under the “Normal” scenario and the assumption that the costs per student are $150 per year in perpetuity and no upfront costs, the benefits are predicted to outweigh the costs per student (e.g. benefit–cost ratio is larger than 1) after 2 years of making the switch and delay SST to at least 8:30 a.m. After 13 years, the benefit–cost ratio would reach 3:1, meaning that every $1 invested would yield a return of $3. The ratio increases over time, reaching 5.5:1 just after 20 years. With upfront costs, the benefit will exceed the cost per student after 3 years and will reach a benefit-cost ratio of 3:1 after 16 years.

Under the “High” cost scenario, with a higher cost of $350 per student per year, the economic benefits from a universal statewide delay in SST to 8:30 a.m. is estimated to outweigh the cost between 6 and 7 years after the policy change, or 9 to 10 years if we assume upfront costs.

---

26 Both benefits and costs per student are discounted and presented in present-day values. The future benefits and costs have been discounted by a rate of 4 per cent, which is common among the macroeconomic literature.
Under the "Very High" cost scenario, the costs per student per year are assumed to be $500 and upfront cost of $330,000. Remarkably, even under the assumption of extensive costs associated with delaying SST to at least 8:30 a.m., the predicted benefits are projected to outweigh the estimated costs between 16 and 18 years after the policy change, depending on whether upfront costs are taken into account or not.

**Figure 2: Predicted benefit-cost ratio of delayed SST. (aggregated across 47 U.S. states)**

![Graph showing predicted benefit-cost ratio over years after policy shift]

**Source:** Authors' calculations.
**Notes:** The different cost scenarios "Normal", "High" and "Very High" are described in Table 3.

The projections presented in Figure 2 represent predicted figures aggregated across the 47 U.S. states, but Table 4 reveals significant state-by-state variation in the benefit-cost ratios. Specifically, Table 4 reports the predicted benefit-cost ratios for a delay in SST to at least 8:30 a.m. under the "Normal" cost scenario from 2 to 20 years after the policy change for the two variants (1) and (2). The findings suggest that in the vast majority of states, with the exception of Alabama, Idaho and Nevada, the predicted economic benefits for delaying SST would outweigh the costs within 5 years after the change (meaning that for every $1 spent the return is at least $1), independent of whether only annual costs or also upfront costs have been taken into account. The predicted benefit-cost ratio after two years varies from 0.11 (Alabama) to 2.39 (Massachusetts), which increases over time as more student cohorts will benefit from the change.
to later SST. After 10 years, on average, the benefit-cost ratio is between 2.31 and 2.62, meaning that for every $1 the return is more than double the initial investment.

### Table 4: Predicted benefit-cost ratios by state ("Normal" cost scenario)

<table>
<thead>
<tr>
<th>State</th>
<th>2 years</th>
<th>5 years</th>
<th>10 years</th>
<th>15 years</th>
<th>20 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
</tr>
<tr>
<td>Alabama</td>
<td>0.11</td>
<td>0.07</td>
<td>0.35</td>
<td>0.29</td>
<td>0.75</td>
</tr>
<tr>
<td>Arizona</td>
<td>1.27</td>
<td>0.81</td>
<td>2.16</td>
<td>1.74</td>
<td>2.63</td>
</tr>
<tr>
<td>Arkansas</td>
<td>0.65</td>
<td>0.41</td>
<td>1.30</td>
<td>1.05</td>
<td>1.51</td>
</tr>
<tr>
<td>California</td>
<td>1.14</td>
<td>0.73</td>
<td>1.95</td>
<td>1.58</td>
<td>2.45</td>
</tr>
<tr>
<td>Colorado</td>
<td>1.00</td>
<td>0.64</td>
<td>1.73</td>
<td>1.39</td>
<td>2.27</td>
</tr>
<tr>
<td>Connecticut</td>
<td>1.76</td>
<td>1.12</td>
<td>3.18</td>
<td>2.57</td>
<td>4.10</td>
</tr>
<tr>
<td>Delaware</td>
<td>2.49</td>
<td>1.59</td>
<td>4.41</td>
<td>3.56</td>
<td>5.72</td>
</tr>
<tr>
<td>Florida</td>
<td>1.55</td>
<td>0.99</td>
<td>2.57</td>
<td>2.07</td>
<td>3.12</td>
</tr>
<tr>
<td>Georgia</td>
<td>0.91</td>
<td>0.58</td>
<td>1.58</td>
<td>1.28</td>
<td>1.96</td>
</tr>
<tr>
<td>Hawaii</td>
<td>1.62</td>
<td>1.03</td>
<td>3.30</td>
<td>2.67</td>
<td>3.71</td>
</tr>
<tr>
<td>Idaho</td>
<td>0.61</td>
<td>0.39</td>
<td>1.06</td>
<td>0.85</td>
<td>1.32</td>
</tr>
<tr>
<td>Illinois</td>
<td>0.88</td>
<td>0.56</td>
<td>1.56</td>
<td>1.26</td>
<td>2.01</td>
</tr>
<tr>
<td>Indiana</td>
<td>0.93</td>
<td>0.59</td>
<td>1.83</td>
<td>1.48</td>
<td>2.23</td>
</tr>
<tr>
<td>Iowa</td>
<td>1.34</td>
<td>0.86</td>
<td>2.34</td>
<td>1.89</td>
<td>2.91</td>
</tr>
<tr>
<td>Kansas</td>
<td>0.98</td>
<td>0.63</td>
<td>2.13</td>
<td>1.72</td>
<td>2.46</td>
</tr>
<tr>
<td>Kentucky</td>
<td>0.89</td>
<td>0.57</td>
<td>2.08</td>
<td>1.68</td>
<td>2.40</td>
</tr>
<tr>
<td>Louisiana</td>
<td>1.29</td>
<td>0.83</td>
<td>2.29</td>
<td>1.84</td>
<td>2.94</td>
</tr>
<tr>
<td>Maine</td>
<td>0.93</td>
<td>0.60</td>
<td>1.65</td>
<td>1.33</td>
<td>2.17</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>2.39</td>
<td>1.53</td>
<td>3.88</td>
<td>3.13</td>
<td>4.48</td>
</tr>
<tr>
<td>Michigan</td>
<td>1.12</td>
<td>0.72</td>
<td>1.97</td>
<td>1.59</td>
<td>2.57</td>
</tr>
<tr>
<td>Minnesota</td>
<td>1.22</td>
<td>0.78</td>
<td>2.08</td>
<td>1.68</td>
<td>2.68</td>
</tr>
<tr>
<td>Mississippi</td>
<td>0.60</td>
<td>0.38</td>
<td>1.23</td>
<td>1.00</td>
<td>1.46</td>
</tr>
<tr>
<td>Missouri</td>
<td>1.16</td>
<td>0.74</td>
<td>2.01</td>
<td>1.62</td>
<td>2.61</td>
</tr>
<tr>
<td>Montana</td>
<td>1.15</td>
<td>0.73</td>
<td>1.97</td>
<td>1.59</td>
<td>2.33</td>
</tr>
<tr>
<td>Nebraska</td>
<td>0.88</td>
<td>0.56</td>
<td>1.58</td>
<td>1.27</td>
<td>2.00</td>
</tr>
<tr>
<td>Nevada</td>
<td>0.65</td>
<td>0.41</td>
<td>1.14</td>
<td>0.92</td>
<td>1.50</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>0.97</td>
<td>0.62</td>
<td>1.93</td>
<td>1.56</td>
<td>2.46</td>
</tr>
<tr>
<td>New Jersey</td>
<td>1.87</td>
<td>1.20</td>
<td>3.18</td>
<td>2.56</td>
<td>4.04</td>
</tr>
<tr>
<td>New Mexico</td>
<td>1.27</td>
<td>0.81</td>
<td>2.12</td>
<td>1.71</td>
<td>2.58</td>
</tr>
<tr>
<td>New York</td>
<td>1.00</td>
<td>0.64</td>
<td>1.79</td>
<td>1.45</td>
<td>2.35</td>
</tr>
<tr>
<td>North Carolina</td>
<td>1.16</td>
<td>0.74</td>
<td>2.03</td>
<td>1.64</td>
<td>2.54</td>
</tr>
<tr>
<td>Ohio</td>
<td>1.39</td>
<td>0.89</td>
<td>2.37</td>
<td>1.91</td>
<td>2.77</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>0.99</td>
<td>0.63</td>
<td>1.66</td>
<td>1.34</td>
<td>2.03</td>
</tr>
<tr>
<td>Oregon</td>
<td>1.00</td>
<td>0.64</td>
<td>1.73</td>
<td>1.39</td>
<td>2.18</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>0.94</td>
<td>0.60</td>
<td>1.75</td>
<td>1.41</td>
<td>2.36</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>1.83</td>
<td>1.17</td>
<td>3.46</td>
<td>2.80</td>
<td>4.23</td>
</tr>
<tr>
<td>South Carolina</td>
<td>1.08</td>
<td>0.69</td>
<td>1.99</td>
<td>1.60</td>
<td>2.41</td>
</tr>
</tbody>
</table>
From a policy perspective, these findings are important as they demonstrate that significant economic gains resulting from the delay in SST could accrue over a relatively short period of time following the adoption of the policy shift. In comparison, the Brookings Institution estimated a benefit–cost ratio of 9:1 per student, but calculated the benefits and costs over the working life of an individual, which is about 45 years on average, and hence the benefit–cost ratio cannot directly be compared to the ratios predicted in this study, which are year-on-year. However, if we apply the annual cost in perpetuity assumption of $150 per student per year to the Brookings Institution analysis (Jacob and Rockoff, 2011), which found that the overall lifetime gain of a student is $17,500 for a one-hour shift in SST, and further assume a 45 year time horizon, then the predicted adjusted benefit–cost ratio of the Brookings Institution analysis is approximately 6:1, instead of 9:1. By taking a more comprehensive and more detailed national approach, the figures presented in Table 4 suggest that after only 15 years (about a third of the working life of an individual), the benefit–cost ratio across the 47 states is about half of the benefit–cost ratio of the Brookings analysis. If the estimates reported in Table 4 would be extended to 45 years, the ratio would increase to about 7.5:1, which is about 1.2 times larger than the estimated adjusted benefit–cost ratio by Brookings Institution (of 6:1), even though the current analysis implies generally a net increase in SST of less than an hour (approximately 30 minutes).

In order to show the variation of the benefit–cost ratios under different cost assumptions, Table 5 reports the predicted benefit–cost ratios for the "High" cost scenario. In comparison to Table 4, the benefit–cost ratios in Table 5 are lower, as the assumed cost per student are higher. For instance, taking a cost of $350 per student per year and no upfront costs (variant 1), after two years two states would already reach a benefit–cost ratio of at least 1:1 (Delaware and Massachusetts). After 5 years more states would reach that threshold, and after 10 years, the majority of states would get every $ spent at least back in return. However, for Alabama, Idaho and Mississippi the predicted benefit-cost ratio under the “High” cost scenario would need longer to reach the “break even” threshold, as they are not larger than 1 even after 20
years. Nevertheless, Table 5 reveals that even under a relatively high cost scenario, in the majority of states the policy change would pay off latest after 10 years, meaning that $1 spent would return at least $1.

**Table 5: Predicted benefit-cost ratios by state ("High" cost scenario)**

<table>
<thead>
<tr>
<th>State</th>
<th>2 years (1)</th>
<th>5 years (2)</th>
<th>10 years (1)</th>
<th>10 years (2)</th>
<th>15 years (1)</th>
<th>15 years (2)</th>
<th>20 years (1)</th>
<th>20 years (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>0.05</td>
<td>0.03</td>
<td>0.15</td>
<td>0.13</td>
<td>0.32</td>
<td>0.29</td>
<td>0.55</td>
<td>0.51</td>
</tr>
<tr>
<td>Arizona</td>
<td>0.54</td>
<td>0.37</td>
<td>0.92</td>
<td>0.77</td>
<td>1.13</td>
<td>1.01</td>
<td>1.34</td>
<td>1.24</td>
</tr>
<tr>
<td>Arkansas</td>
<td>0.28</td>
<td>0.19</td>
<td>0.56</td>
<td>0.46</td>
<td>0.65</td>
<td>0.58</td>
<td>0.83</td>
<td>0.76</td>
</tr>
<tr>
<td>California</td>
<td>0.49</td>
<td>0.33</td>
<td>0.84</td>
<td>0.70</td>
<td>1.05</td>
<td>0.94</td>
<td>1.29</td>
<td>1.19</td>
</tr>
<tr>
<td>Colorado</td>
<td>0.43</td>
<td>0.29</td>
<td>0.74</td>
<td>0.61</td>
<td>0.97</td>
<td>0.88</td>
<td>1.27</td>
<td>1.18</td>
</tr>
<tr>
<td>Connecticut</td>
<td>0.75</td>
<td>0.51</td>
<td>1.36</td>
<td>1.13</td>
<td>1.76</td>
<td>1.58</td>
<td>2.19</td>
<td>2.02</td>
</tr>
<tr>
<td>Delaware</td>
<td>1.07</td>
<td>0.72</td>
<td>1.89</td>
<td>1.57</td>
<td>2.45</td>
<td>2.20</td>
<td>3.03</td>
<td>2.80</td>
</tr>
<tr>
<td>Florida</td>
<td>0.66</td>
<td>0.45</td>
<td>1.10</td>
<td>0.91</td>
<td>1.34</td>
<td>1.20</td>
<td>1.61</td>
<td>1.49</td>
</tr>
<tr>
<td>Georgia</td>
<td>0.39</td>
<td>0.26</td>
<td>0.68</td>
<td>0.56</td>
<td>0.84</td>
<td>0.76</td>
<td>1.02</td>
<td>0.94</td>
</tr>
<tr>
<td>Hawaii</td>
<td>0.69</td>
<td>0.47</td>
<td>1.42</td>
<td>1.18</td>
<td>1.59</td>
<td>1.43</td>
<td>1.87</td>
<td>1.72</td>
</tr>
<tr>
<td>Idaho</td>
<td>0.26</td>
<td>0.18</td>
<td>0.45</td>
<td>0.38</td>
<td>0.57</td>
<td>0.51</td>
<td>0.69</td>
<td>0.64</td>
</tr>
<tr>
<td>Illinois</td>
<td>0.38</td>
<td>0.25</td>
<td>0.67</td>
<td>0.55</td>
<td>0.86</td>
<td>0.77</td>
<td>1.11</td>
<td>1.03</td>
</tr>
<tr>
<td>Indiana</td>
<td>0.40</td>
<td>0.27</td>
<td>0.79</td>
<td>0.65</td>
<td>0.96</td>
<td>0.86</td>
<td>1.26</td>
<td>1.16</td>
</tr>
<tr>
<td>Iowa</td>
<td>0.58</td>
<td>0.39</td>
<td>1.00</td>
<td>0.83</td>
<td>1.25</td>
<td>1.12</td>
<td>1.42</td>
<td>1.31</td>
</tr>
<tr>
<td>Kansas</td>
<td>0.42</td>
<td>0.28</td>
<td>0.91</td>
<td>0.76</td>
<td>1.06</td>
<td>0.95</td>
<td>1.29</td>
<td>1.19</td>
</tr>
<tr>
<td>Kentucky</td>
<td>0.38</td>
<td>0.26</td>
<td>0.89</td>
<td>0.74</td>
<td>1.03</td>
<td>0.93</td>
<td>1.21</td>
<td>1.12</td>
</tr>
<tr>
<td>Louisiana</td>
<td>0.55</td>
<td>0.37</td>
<td>0.98</td>
<td>0.81</td>
<td>1.26</td>
<td>1.13</td>
<td>1.59</td>
<td>1.47</td>
</tr>
<tr>
<td>Maine</td>
<td>0.40</td>
<td>0.27</td>
<td>0.71</td>
<td>0.59</td>
<td>0.93</td>
<td>0.84</td>
<td>1.16</td>
<td>1.07</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>1.03</td>
<td>0.69</td>
<td>1.66</td>
<td>1.38</td>
<td>1.92</td>
<td>1.73</td>
<td>2.24</td>
<td>2.07</td>
</tr>
<tr>
<td>Michigan</td>
<td>0.48</td>
<td>0.32</td>
<td>0.84</td>
<td>0.70</td>
<td>1.10</td>
<td>0.99</td>
<td>1.33</td>
<td>1.23</td>
</tr>
<tr>
<td>Minnesota</td>
<td>0.52</td>
<td>0.35</td>
<td>0.89</td>
<td>0.74</td>
<td>1.15</td>
<td>1.03</td>
<td>1.40</td>
<td>1.30</td>
</tr>
<tr>
<td>Mississippi</td>
<td>0.26</td>
<td>0.17</td>
<td>0.53</td>
<td>0.44</td>
<td>0.62</td>
<td>0.56</td>
<td>0.77</td>
<td>0.71</td>
</tr>
<tr>
<td>Missouri</td>
<td>0.50</td>
<td>0.33</td>
<td>0.86</td>
<td>0.71</td>
<td>1.12</td>
<td>1.01</td>
<td>1.45</td>
<td>1.34</td>
</tr>
<tr>
<td>Montana</td>
<td>0.49</td>
<td>0.33</td>
<td>0.84</td>
<td>0.70</td>
<td>1.00</td>
<td>0.90</td>
<td>1.15</td>
<td>1.06</td>
</tr>
<tr>
<td>Nebraska</td>
<td>0.38</td>
<td>0.25</td>
<td>0.68</td>
<td>0.56</td>
<td>0.86</td>
<td>0.77</td>
<td>1.08</td>
<td>1.00</td>
</tr>
<tr>
<td>Nevada</td>
<td>0.28</td>
<td>0.19</td>
<td>0.49</td>
<td>0.41</td>
<td>0.64</td>
<td>0.58</td>
<td>0.82</td>
<td>0.76</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>0.42</td>
<td>0.28</td>
<td>0.83</td>
<td>0.69</td>
<td>1.06</td>
<td>0.95</td>
<td>1.34</td>
<td>1.24</td>
</tr>
<tr>
<td>New Jersey</td>
<td>0.80</td>
<td>0.54</td>
<td>1.36</td>
<td>1.13</td>
<td>1.73</td>
<td>1.56</td>
<td>2.10</td>
<td>1.94</td>
</tr>
<tr>
<td>New Mexico</td>
<td>0.54</td>
<td>0.37</td>
<td>0.91</td>
<td>0.75</td>
<td>1.11</td>
<td>1.00</td>
<td>1.29</td>
<td>1.19</td>
</tr>
<tr>
<td>New York</td>
<td>0.43</td>
<td>0.29</td>
<td>0.77</td>
<td>0.64</td>
<td>1.01</td>
<td>0.90</td>
<td>1.31</td>
<td>1.21</td>
</tr>
<tr>
<td>North Carolina</td>
<td>0.50</td>
<td>0.34</td>
<td>0.87</td>
<td>0.72</td>
<td>1.09</td>
<td>0.98</td>
<td>1.34</td>
<td>1.24</td>
</tr>
<tr>
<td>Ohio</td>
<td>0.60</td>
<td>0.40</td>
<td>1.02</td>
<td>0.84</td>
<td>1.19</td>
<td>1.07</td>
<td>1.40</td>
<td>1.29</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>0.42</td>
<td>0.29</td>
<td>0.71</td>
<td>0.59</td>
<td>0.87</td>
<td>0.78</td>
<td>1.04</td>
<td>0.97</td>
</tr>
<tr>
<td>Oregon</td>
<td>0.43</td>
<td>0.29</td>
<td>0.74</td>
<td>0.61</td>
<td>0.93</td>
<td>0.84</td>
<td>1.19</td>
<td>1.10</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>0.40</td>
<td>0.27</td>
<td>0.75</td>
<td>0.62</td>
<td>1.01</td>
<td>0.91</td>
<td>1.33</td>
<td>1.23</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>0.78</td>
<td>0.53</td>
<td>1.48</td>
<td>1.23</td>
<td>1.81</td>
<td>1.63</td>
<td>2.15</td>
<td>1.99</td>
</tr>
<tr>
<td>South Carolina</td>
<td>0.46</td>
<td>0.31</td>
<td>0.85</td>
<td>0.71</td>
<td>1.03</td>
<td>0.93</td>
<td>1.17</td>
<td>1.08</td>
</tr>
<tr>
<td>State</td>
<td>Years after policy shift</td>
<td>2 years</td>
<td>5 years</td>
<td>10 years</td>
<td>15 years</td>
<td>20 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------</td>
<td>---------</td>
<td>---------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>South Dakota</td>
<td>0.43</td>
<td>0.29</td>
<td>0.80</td>
<td>0.67</td>
<td>0.93</td>
<td>0.84</td>
<td>1.10</td>
<td>1.01</td>
</tr>
<tr>
<td>Tennessee</td>
<td>0.33</td>
<td>0.22</td>
<td>0.60</td>
<td>0.50</td>
<td>0.77</td>
<td>0.70</td>
<td>0.99</td>
<td>0.91</td>
</tr>
<tr>
<td>Texas</td>
<td>0.49</td>
<td>0.33</td>
<td>0.82</td>
<td>0.68</td>
<td>1.02</td>
<td>0.92</td>
<td>1.24</td>
<td>1.15</td>
</tr>
<tr>
<td>Utah</td>
<td>0.33</td>
<td>0.22</td>
<td>0.57</td>
<td>0.48</td>
<td>0.79</td>
<td>0.71</td>
<td>0.98</td>
<td>0.90</td>
</tr>
<tr>
<td>Vermont</td>
<td>0.53</td>
<td>0.36</td>
<td>0.94</td>
<td>0.78</td>
<td>1.17</td>
<td>1.05</td>
<td>1.45</td>
<td>1.34</td>
</tr>
<tr>
<td>Virginia</td>
<td>0.87</td>
<td>0.58</td>
<td>1.31</td>
<td>1.09</td>
<td>1.62</td>
<td>1.45</td>
<td>1.90</td>
<td>1.76</td>
</tr>
<tr>
<td>Washington</td>
<td>0.73</td>
<td>0.49</td>
<td>1.42</td>
<td>1.18</td>
<td>1.62</td>
<td>1.46</td>
<td>1.89</td>
<td>1.75</td>
</tr>
<tr>
<td>West Virginia</td>
<td>0.34</td>
<td>0.23</td>
<td>0.60</td>
<td>0.50</td>
<td>0.77</td>
<td>0.69</td>
<td>0.94</td>
<td>0.87</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>0.52</td>
<td>0.35</td>
<td>0.92</td>
<td>0.77</td>
<td>1.21</td>
<td>1.09</td>
<td>1.49</td>
<td>1.38</td>
</tr>
<tr>
<td>Wyoming</td>
<td>0.67</td>
<td>0.45</td>
<td>1.22</td>
<td>1.02</td>
<td>1.52</td>
<td>1.37</td>
<td>1.87</td>
<td>1.72</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>0.50</strong></td>
<td><strong>0.34</strong></td>
<td><strong>0.90</strong></td>
<td><strong>0.75</strong></td>
<td><strong>1.12</strong></td>
<td><strong>1.01</strong></td>
<td><strong>1.37</strong></td>
<td><strong>1.27</strong></td>
</tr>
</tbody>
</table>

Source: Authors' calculations.

Notes: Column (1) assumes cost of $350 per student per year and column (2) assumes that in addition to the $350 per student per year, each school has to invest $220,000 upfront for updates in school infrastructure related to after-school activities (e.g. update of lighting equipment).

Appendix D reports the breakdown by state of the predicted benefit-cost ratios for the “Very High” cost scenario. The findings suggest that even under the assumption of artificially set very high costs related to a delay in SST to 8:30 a.m., a handful of states would still break even after 10 years of the shift to later SST. After 20 years, it is predicted that the majority of states would have either reached the benefit-cost ratio threshold of 1 or would be very close to 1.
4. Summary and discussion

The current study illuminates the economic implications from a delay in later school start times across different states in the United States. This chapter summarizes and discusses the main findings.

4.1. Summary

The current study is the first to measure the economic gains associated with delaying school start times for different states across the U.S. Using a macroeconomic modeling approach, the findings suggest that delaying SST to at least 8:30 a.m. could lead to profound economic gains in the form of increased overall economic performance. Departing from the previous benefit–cost analysis provided by the Brookings Institution, this study takes into account the effect of later SST on academic performance and mortality from car crashes, and reports the estimated year-by-year and state-by-state changes the benefit-cost ratios from delaying SST. The study findings suggest that the economic benefits of delaying SST even by a relative short amount (approximately 30 minutes on average) would be large. For instance, by 2030, the predicted cumulative economic gain from delaying SST across the U.S. are about $116 billion, corresponding to a predicted annual average increase of $9.3 billion, which is roughly the annual revenue of the Major League Baseball. Examining the cost-effectiveness of the delay in SST, the benefit-cost ratios per student reveal that on average, and under a normal cost assumption, already between 2 to 3 years after the policy change, every $1 spent is paid back in estimated benefits. Specifically, after 5 years, for every $1 spent, the predicted national average return is between $1.7 and $2.1.

From a policy perspective, these findings are crucial as they demonstrate that profound economic gains could result from the delay in SST, which potentially already accrue over a relatively short period of time following the adoption of the policy shift. In comparison, the Brookings Institution estimated a benefit–cost ratio is 9:1, but calculated over the working life of an individual, which is about 45 years on average. By taking a more comprehensive and national approach, and assuming a relative shorter delay in SST (30 mins compared to 1 hour), the figures presented in this study suggest that after 45 years, the anticipated time an individual spends in the labor market until retirement, the predicted benefit-cost ratio would be even about 1.2 times larger.

Overall, it is important to stress that this study takes a conservative approach in only applying parameters in the calibration process of the model for which robust empirical evidence is available in the literature concerning the impact of sleep loss on affects adolescents’ health and academic performance. Specifically, we utilized available data on car crash mortality and impaired academic performance. However, other potential impacts of insufficient sleep, such as the effects on mental health, including depression and
suicide, or other potential negative effects related to obesity or other morbidities, that are also associated with negative impacts on the economy have not been taken into account. Hence, the reported benefits in this study are likely an underestimation of the full benefits related to delaying SST to at least 8:30 a.m.

On the cost side, this study uses a previous estimate of $150 per student per year and adds potential upfront investment costs of $110,000 per school to update infrastructure to accommodate after-school activities. In addition, in order to evaluate the robustness of the cost-effectiveness of the policy to delay SS, higher cost scenarios have been taken into account. Since costs will vary by school district, the costs applied in the current model serve for illustration purposes, but represent ostensible ranges. Furthermore, beyond increased transportation costs and other infrastructure investment cost, it is possible that there could be other costs that are not included in our model calculations, such as the costs that could incur for parents with having to go to work later or before or after school childcare and there could be a potential loss of income associated with a reduction in after school employment for adolescents. However, in our analysis, on average, the delay SST to 8:30 a.m. only reflected an average delay of 30 minutes. In reality, given that many schools start before 8 a.m., it is also possible that a greater "dose" of the intervention (i.e. more than a 30 minute change) could result in even greater benefits to outweigh the costs. Nevertheless, even if much higher cost estimates (e.g. $500 per student per year) are applied, which likely would cover some of these difficult to quantify additional potential costs to parents and the wider society, the benefits from delaying SST would still outweigh the costs after about twenty years. Moreover, in conjunction with the highly consistent and robust data showing the widespread consequences of adolescent sleep loss on health, safety, and academic performance (see e.g. Lowry et al. 2012 or Lytle et al. 2011), these benefit–cost projections suggest that delaying school start times is a cost-effective, population-level strategy that could have a significant impact on public health and the U.S. economy.

4.2. Discussion

These findings must be interpreted within the constraints of the study and the specific modeling approach. First, our model is a simulated or hypothetical "natural experiment" which presupposes a statewide universal shift in school start times to 8:30 a.m. or later. This presupposition may seem unjustified given that start times are generally determined at the local district level. However, there are several examples of proposed policy initiatives in states across the country, including a bill that recently has been discussed in the California state senate, which mandates that California middle and high schools start no earlier than 8:30 a.m. Thus, the hypothetical policy shift modeled in the current analysis is potentially a conceivable strategy. Second, we focused on the benefit–cost ratios of later SST for the 47 states for which there was available data from the CDC on SST, and therefore do not have estimates for Maryland, District of Columbia, North Dakota, and Alaska. Third, the specific modeling approach taken in this study is in part based on assumptions that may influence the modeling outcome. It is important to emphasize that whenever an assumption had to be made, we aimed to make sure that the specific assumption would be conservative, hence leading to a potential underestimation of the potential true

---

effect. Finally, as mentioned, our model focuses on two specific factors that drive costs: the impact of sleep insufficiency on motor vehicle crashes mortality and academic achievement (i.e. high school and college graduation rates). These factors were chosen because we were able to derive robust estimates from the literature. However, as mentioned, there are numerous other costs associated with mental and physical morbidity that were not included in our model. For instance, the combined public health costs of the obesity epidemic in children and adolescents and its associated cardiovascular morbidities are estimated at $45 billion a year, and sleep loss is longitudinally associated with increased risk of obesity in children and adolescents (Magee et al., 2012). Further, insufficient sleep among teens is associated with an increased risk of engaging in property and violent crime (Umlauf et al., 2011). The direct and indirect costs of crime, including direct economic losses, increased insurance rates, loss of productivity, and various aspects of the criminal justice system, from police, to courts, to juvenile facilities and prisons, are estimated in the billions of dollars (NCJRS, 2000). In addition, the robust association between insufficient sleep and poor sleep quality and adolescent risk for mental health problems and other risk-taking behaviors, including substance use, could also contribute to substantial societal costs. Taken together, our estimates suggest substantial benefits relative to costs on a statewide basis related to a universal change in SST, and if anything, these estimates are likely conservative estimates of the true benefits.

In summary, it is important to put this economic data in context. The findings of this study, as well as the Brookings Institution findings, suggest that the benefits of later start times may outweigh the immediate costs. Moreover, when paired with the substantial literature demonstrating the dire public health consequences of insufficient sleep among adolescents, the multitude of health and academic benefits associated with later start times, and the lack of any scientific evidence to suggest that there are benefits to having teens start school earlier, these findings provide a strong case to counter the argument that changing school start times is too costly to endeavor. As policymakers, educators, and community members consider the challenges associated with implementing later start times, including the potential for upfront costs, it is important to balance these challenges, many of which may be short-term, with the potential for long-term return on investment in terms of public health and economic benefits.
References


Magee, L., Hale, L. (2012) "Longitudinal associations between sleep duration and subsequent weight


Appendix A: The overlapping generations model

Model description

The simulation model used in our study is an overlapping generations (OLG) model first introduced by Samuelson (1958) and Diamond (1965), and later developed by Auerbach and Kotlikoff (1987) who used simulated a pioneering large-scale numerical OLG model to evaluate fiscal policies. Unlike other models assuming all workers to be essentially equal, OLG model by definition assumes that the modeled economy is represented by people of different ages, which is necessary to capture effects of sleep deficiency through various means. Moreover, to allow for effects to differ across income groups, we further differentiate among workers in terms of their skill in a similar fashion to Heer and Maussner (2009) and Krueger and Ludwig (2013).

The economy has three sectors – households, firms, and government – which continuously interact on the markets just as in reality. Specifically, firms, representing the production sector, hire labor supplied by households to create output, paying wages in exchange for labor and interest rate as a cost of capital. In absence of international trade and public enterprises, all assets within the economy are ultimately in possession of people and they also constitute the final consumer of all production. The government collects income taxes from individuals and subsequently provides them with retirement benefits. We assume that the foreign trade effect is negligible as sleep deficiency has no direct influence on it and do not explicitly model foreign economies.

Households

Households and individuals are used interchangeably in the model and we only assume individuals aged 18+ in the economy (i.e. those that are economically active) in line with the related literature in order to decrease computation requirements. This will slightly underestimate the positive effect of later school starting times as individuals who would otherwise not graduate and start working will not be captured. However, given the overall high graduation rates, low human capital of high school dropouts and short time period, the number is negligible.

All people are assumed to live 60 years from the inception of their professional careers, out of which they spend 7 = 44 years working and 7R = 16 in retirement, reflecting that the retirement age is set at 66 years in the U.S. and the average life expectancy is slightly over 80 years, according to the World Bank data. Since life expectancy in the model remains constant over the assumed period, retirement age also remains unchanged.
All individuals that end their education with at most a high school diploma are assumed to start working at the age of 18 in the model, while those with bachelor's degree are assumed to start working at the age of 22. The labor supply is exogenously set at 8 hours per workday for everyone. Besides the explicit modeling of differences in educational attainment, we model the differences in people's skill sets and other personal characteristics through determination of a labor-endowment distribution and its changes over time so that the ultimate distribution of labor output resembles what we can observe in reality. This can be understood also as a tool to model intra-generation wage distribution, including probability of being unemployed, ill, unable to work or, on the other hand, promoted or finding a better job. Specifically, we assume each individual is subject to an idiosyncratic productivity shock log-normally distributed with mean $\gamma_1$ and variance $\sigma_{\gamma_1}$. Over an individual's life, the idiosyncratic productivity shock $z_t$ follows a Markov (AR(1)) process given by:

$$z_t = \rho z_{t-1} + \epsilon_t,$$

where $\epsilon_t \sim N(0, \sigma_\epsilon)$, and thus depends on its past realisations.

In order to approximate the autoregressive process, the continuum of all possible shocks must be limited; to do so, we follow Huggett (1996) and discretize the state space $Z$ containing all shocks into nine realizations ranging from $-2\sigma_{\gamma_1}$ to $2\sigma_{\gamma_1}$. These realizations, in fact, constitute nine different income classes. The probability of having a given productivity shock can then be computed using integration over corresponding area under the normal distribution, and the efficiency index $e(z, t) = e^{z_t + \bar{y}_t}$, where $t$ represents an agent’s age and $\bar{y}_t$ is the mean log-normal income of $t$-aged workers, follows a finite Markov chain. Given wage $w$ defined below, tax rate $\tau$ and labour supply $n$, the total annual salary $l$ can then be calculated as:

$$l = (1 - \tau) e(z, t) w n.$$

Individuals within one cohort differ in their earnings in a way such that the resulting after tax Gini coefficient (a measure of statistical distribution of income) closely follows empirical data. We assume that the individual’s productivity and earnings change over time, following the age–productivity profile reported by Hansen (1993). We assume that individuals may belong to any income class despite their education and that the change in school starting time – and the number of graduates – increases the aggregate productivity and wage levels rather than alters the wage distribution profile, adding more individuals in the higher income classes. This is principally due to the lack of detailed data on wage distribution of individuals per educational attainment level. Note that the shift in productivity differs by gender, ethnicity, state, and age, shifting the whole age–productivity profile.

During retirement, agents receive pension transfers from the government in a simplified social security framework where social security benefit repayment rates are based on a 35-year salary average (30-year in the model) and complemented by individual savings into pension funds.

Given a maximum life expectancy and certain death at that time, each year the remainder of the oldest cohort dies and a new generation is born. Population size in each age category is based on the population predictions described further. The model assumes no bequests implying that each worker starts with no wealth and, due to rational expectations, consumes all their remaining savings at the age of 60. However, all individuals also face a positive probability of death throughout their live, implicitly increasing their interest in immediate consumption rather than saving.
The lifetime utility function maximized by households operates with the standard constant relative-risk aversion (CRRA) function:

\[ E_1 \left[ \sum_{t=1}^{T+T_R} \beta^{t-1} \left( \prod_{j=1}^{t} s_j \right) u(c_t) \right] \]

\[ u(c) = \frac{c^{1-1/\sigma_u}}{1-1/\sigma_u}, \]

where \( \sigma_u \) is the intertemporal elasticity of substitution, \( u(c) \) is the instantaneous utility function with consumption as its only parameter, \( s_j \) is the survival probabilities implicitly determined by population projections, and \( \beta \) is the discount factor determining time preference.

Finally, we assume that agents cannot borrow money and their consumption thus cannot exceed revenue, i.e. the sum of annual salary, pension payments (if retired), and one-year bond holdings earning risk-free interest rate \( r \). The budget constraint is thus in general given by:

\[ c_t = (1 + r)k_{t-1} + (1 - r)e(z,t)wn + \text{pension} - k_t. \]

Firms and government

Firms produce output using effective labor \( N \) and capital \( K \), which are hired at wage \( w \) and interest rate \( r \), equal to the marginal product of labour and capital, respectively, as determined within the competitive equilibrium framework (see below). Capital also depreciates at rate \( \delta \). Production is characterized by constant returns to scale and we assume the standard neoclassical Cobb–Douglas production function in form of:

\[ Y = AK^\alpha L^{1-\alpha}, \]

\[ r = \alpha AK^{\alpha-1} L^{1-\alpha} - \delta, \]

\[ w = (1 - \alpha)AK^\alpha L^{-\alpha}, \]

where \( A \) is the total factor productivity growth parameter denoting efficiency with which can the factors of production be used and \( \alpha \) is capital output elasticity (capital share on production). Given the lack of multifactor productivity level data at the state level, we use the real GDP growth per state, multiplied by the ratio of multifactor productivity growth and real GDP growth at the aggregate US level, as a proxy. Note that the production function works with units of effective labor; wage and interest rate are then equal for all agents despite differences in their age and productivity group. The model assumes no inflation and all predicted changes to GDP are therefore in real terms.

The total factor productivity growth is assumed to be constant in all years; while not particularly realistic due to existence of business cycles and other external and internal disturbances, the constant value fits purposes of this study as we are mainly interested in output differences between the status quo and an optimal scenario. Arguably, lower labor productivity and output would also slightly diminish the total factor productivity growth in the long term; hence, our estimates are conservative as the potential difference would have been bigger in case of lower productivity growth in the status quo scenario.

The government has no active role in the economy and only collects taxes from individuals in exchange for future unilateral pension transfers. For simplicity, we assume that the taxes and pension system
repayment rates (i.e. the ratio of retirement benefit to the average wage) remain constant over time as these have essentially no effect on our analysis.

General equilibrium

We assume the economy to be in equilibrium at all times, with all prices being simultaneously determined such that the market clearing conditions are met. Formally, for given initial distribution of capital \(\{k_0^s\}_{s=1}^{T+TR}\), the set of value functions \(V^s(k^s_t, K_t, N_t)\), individual policy rules \(c^s(k^s_t, K_t, N_t)\), \(n^s(k^s_t, K_t, N_t)\) and \(k^s(k^s_t, K_t, N_t)\), and relative prices of labor and capital \(w_t\) and \(r_t\), the equilibrium is such that:

1. Individual and aggregate behaviour are consistent:
   \[
   N_t = \sum_{s=1}^{T} \frac{n_t^s}{T + TR}
   \]
   \[
   K_t = \sum_{s=1}^{T+TR} \frac{k_t^s}{T + TR}
   \]

2. Households’ dynamic programs and firms’ optimisation problems are solved by satisfying the budget constraints using the relative prices \(w_t\), \(r_t\), pensions, and the individual policy rules:
   \[
   c^s(\cdot), n^s(\cdot) \text{ and } k^s_{t+1}(\cdot).
   \]

3. The goods market clears:
   \[
   AK^{\alpha}L^{1-\alpha} = \sum_{s=1}^{T+TR} \frac{c_t^s}{T + TR} + K_{t+1} - (1 - \delta)K_t.
   \]

We follow the approach from Nishiyma and Smetters (2007) and use value function iteration to compute agents’ policy functions. Specifically, let \(v(K)\) be the value function and let it be the discounted sum of all instantaneous utility functions \(u(c_1), u(c_2), \ldots, u(c_{T+TR})\), where \(c_t\) denotes household’s consumption at age \(t\) and \(K\) denotes the optimal capital decisions that maximise household’s lifetime utility. Further, assume an optimal sequence of capital stocks from \(t = 0\) to time \(t = q\), i.e. \(K = k_0, k_1, \ldots, k_q\). Then the best level of capital \(K^*\) in time \(t = q + 1\) is given by:
   \[
   v(K^*) = \max_{0<s<k^s} u(f(K) - K') + \beta v(K'),
   \]
   where \(f(K)\) denotes the production function and \(f(K) - K'\) thus denotes consumption in a given period. In case the value function is known, we may then compute the solution \(K^*\) using a policy function \(g\), i.e.: 
   \[
   K^* = g(K)
   \]

Policy function thus represents the optimal decision regarding the next period level of capital as a function of the current capital stock.

Due to the presence of idiosyncratic shocks, policy functions cannot be computed from time \(t = 0\) onwards because individuals do not know their future income and cannot plan consumption and savings accordingly. The algorithm therefore computes the policy functions retrospectively instead using backward induction, working iteratively from the set of initial assumptions.
### Table 6: Model calibration parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of students who get less than 7 hours of sleep per night</td>
<td>0.6</td>
<td>Keyes et al. (2015)</td>
</tr>
<tr>
<td>Average baseline amount of sleep</td>
<td>6.12</td>
<td>McKnight-Eily et al. (2011)</td>
</tr>
<tr>
<td>Average annual hours worked</td>
<td>1,765</td>
<td>Penn World Tables (v9)</td>
</tr>
<tr>
<td>Capital-labour ratio</td>
<td>0.6036</td>
<td>Yamarik (2011)</td>
</tr>
<tr>
<td>Capital stock depreciation rate</td>
<td>0.0471</td>
<td></td>
</tr>
<tr>
<td>Elasticity of intertemporal substitution</td>
<td>0.594</td>
<td>Havranek et al. (2015)</td>
</tr>
<tr>
<td>Gross Domestic Product (GDP); Gross State Product (GSP)</td>
<td>Various</td>
<td>Bureau of Economic Analysis</td>
</tr>
<tr>
<td>Average real GDP growth rate (based on the 1997–2013 period)</td>
<td>Various</td>
<td>Bureau of Economic Analysis</td>
</tr>
<tr>
<td>Ratio of multifactor productivity and real GDP growth rates over the 1995–2014 period.</td>
<td>0.4361</td>
<td>OECD</td>
</tr>
<tr>
<td>Wealth Gini coefficient</td>
<td>32.6</td>
<td>World Bank</td>
</tr>
</tbody>
</table>

28 http://www.rug.nl/research/ggdc/data/pwt
29 https://www.bea.gov/regional/
30 http://stats.oecd.org
31 http://data.worldbank.org/indicator/SI.POV.GINI
Appendix B: Derivation of educational attainment data

As the data on educational attainment is not directly available for each state, gender and ethnicity combination, the data needs to be combined. More formally, the multivariate joint probability distribution of any individual having a certain level of education and being from state $s$, gender $g$, and ethnicity $r$ is determined as:

$$e_{s,g,r} = e_{g,r} \cdot e_s,$$

where $e_{g,r}$ is the share of individuals of gender $g$ and ethnicity $r$ at the given educational attainment and $e_s$ is the share of individuals at the given educational achievement in state $s$. Both data is available from the United States Census Bureau.\[^{32}\] For the combination, we assume that the two marginal distributions are independent, i.e. that the educational attainment of white males relative to white females in North Dakota is the same as in South Dakota.

Further, note that educational attainment in a state is essentially a combination of the number of individuals that attended a given institution and the graduation rates. We may therefore calculate the proportions of high school dropouts ($n$), high school graduates ($h$) and college graduates ($u$) any missing, or $e_{s,g,e}^n$, high school $e_{s,g,e}^h$, and university education $e_{s,g,e}^u$, as:

$$e_{s,g,r}^n = 1 - e_{s,g,r}^h$$
$$e_{s,g,r}^h = s_{s,g,r}^h \cdot g_{s,g,r}^h - e_{s,g,r}^u$$
$$e_{s,g,r}^u = s_{s,g,r}^u \cdot g_{s,g,r}^u$$

where $s_{s,g,e}^h$ and $s_{s,g,e}^u$ represent the number of individuals that attended high school and university, respectively, whereas $g_{s,g,r}^h$ and $g_{s,g,r}^u$ represent the respective graduation rates. The data for graduation rates stem from different sources outlined below.

**Table 7: Graduation rates**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Granularity</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>High school graduation rate</td>
<td>State, ethnicity</td>
<td>The share of students who graduate in 4 years with a regular high school diploma (as a percentage of all students in the class).</td>
<td>National Center for Education Statistics[^{33}]</td>
</tr>
<tr>
<td>High school graduates</td>
<td>State/gender and ethnicity</td>
<td>Share of persons 25 to 29 years old with a regular high school diploma (as a percentage)</td>
<td>United States Census Bureau, &quot;2011-2015&quot;</td>
</tr>
</tbody>
</table>

\[^{32}\]https://www.census.gov/data.html

<table>
<thead>
<tr>
<th>Variable</th>
<th>Granularity</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2015)</td>
<td></td>
<td>of the total population of that age.</td>
<td>American Community Survey 5-Year Estimates®, National Center for Education Statistics³⁴</td>
</tr>
<tr>
<td>University graduation rate (2013)</td>
<td>State, gender, ethnicity</td>
<td>Percentage of students who graduated within 1.50 per cent of normal/expected time (as a share of all students in the program). Data for 4-year bachelor courses at state universities used as a proxy for the average graduation rates across all programs.</td>
<td>The Chronicle of Higher Education, College Completion information.³⁵</td>
</tr>
</tbody>
</table>

Appendix C: Net increase in sleep length

<table>
<thead>
<tr>
<th>State</th>
<th>Nr of schools</th>
<th>Nr of students</th>
<th>Net increase in sleep length (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>680</td>
<td>344,000</td>
<td>36</td>
</tr>
<tr>
<td>Arizona</td>
<td>860</td>
<td>506,000</td>
<td>24</td>
</tr>
<tr>
<td>Arkansas</td>
<td>450</td>
<td>292,000</td>
<td>23</td>
</tr>
<tr>
<td>California</td>
<td>3880</td>
<td>3,303,000</td>
<td>22</td>
</tr>
<tr>
<td>Colorado</td>
<td>730</td>
<td>527,000</td>
<td>33</td>
</tr>
<tr>
<td>Connecticut</td>
<td>360</td>
<td>260,000</td>
<td>40</td>
</tr>
<tr>
<td>Delaware</td>
<td>90</td>
<td>63,000</td>
<td>44</td>
</tr>
<tr>
<td>Florida</td>
<td>1570</td>
<td>1,406,000</td>
<td>26</td>
</tr>
<tr>
<td>Georgia</td>
<td>1030</td>
<td>955,000</td>
<td>22</td>
</tr>
<tr>
<td>Hawaii</td>
<td>280</td>
<td>81,154</td>
<td>28</td>
</tr>
<tr>
<td>Idaho</td>
<td>370</td>
<td>157,000</td>
<td>18</td>
</tr>
<tr>
<td>Illinois</td>
<td>1590</td>
<td>1,008,000</td>
<td>19</td>
</tr>
<tr>
<td>Indiana</td>
<td>740</td>
<td>559,000</td>
<td>28</td>
</tr>
<tr>
<td>Iowa</td>
<td>550</td>
<td>249,000</td>
<td>13</td>
</tr>
<tr>
<td>Kansas</td>
<td>540</td>
<td>204,000</td>
<td>24</td>
</tr>
<tr>
<td>Kentucky</td>
<td>710</td>
<td>358,000</td>
<td>25</td>
</tr>
<tr>
<td>Louisiana</td>
<td>630</td>
<td>316,000</td>
<td>48</td>
</tr>
<tr>
<td>Maine</td>
<td>240</td>
<td>105,000</td>
<td>34</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>700</td>
<td>527,000</td>
<td>34</td>
</tr>
<tr>
<td>Michigan</td>
<td>1540</td>
<td>891,000</td>
<td>33</td>
</tr>
<tr>
<td>Minnesota</td>
<td>1190</td>
<td>522,000</td>
<td>16</td>
</tr>
<tr>
<td>Mississippi</td>
<td>570</td>
<td>272,000</td>
<td>40</td>
</tr>
<tr>
<td>Missouri</td>
<td>900</td>
<td>530,000</td>
<td>30</td>
</tr>
<tr>
<td>Montana</td>
<td>220</td>
<td>78,000</td>
<td>15</td>
</tr>
<tr>
<td>Nebraska</td>
<td>370</td>
<td>150,000</td>
<td>17</td>
</tr>
<tr>
<td>Nevada</td>
<td>260</td>
<td>276,000</td>
<td>33</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>180</td>
<td>116,000</td>
<td>41</td>
</tr>
<tr>
<td>New Jersey</td>
<td>870</td>
<td>698,000</td>
<td>28</td>
</tr>
<tr>
<td>New Mexico</td>
<td>310</td>
<td>151,000</td>
<td>20</td>
</tr>
<tr>
<td>New York</td>
<td>2070</td>
<td>1,670,000</td>
<td>27</td>
</tr>
<tr>
<td>North Carolina</td>
<td>1120</td>
<td>768,000</td>
<td>25</td>
</tr>
<tr>
<td>Ohio</td>
<td>1640</td>
<td>1,061,000</td>
<td>35</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>700</td>
<td>356,000</td>
<td>17</td>
</tr>
<tr>
<td>State</td>
<td>Students</td>
<td>Teachers</td>
<td>Percent</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------</td>
<td>----------</td>
<td>---------</td>
</tr>
<tr>
<td>Oregon</td>
<td>480</td>
<td>282,000</td>
<td>19</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>1280</td>
<td>1,001,000</td>
<td>38</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>100</td>
<td>68,000</td>
<td>37</td>
</tr>
<tr>
<td>South Carolina</td>
<td>500</td>
<td>411,000</td>
<td>25</td>
</tr>
<tr>
<td>South Dakota</td>
<td>230</td>
<td>78,000</td>
<td>15</td>
</tr>
<tr>
<td>Tennessee</td>
<td>760</td>
<td>533,000</td>
<td>29</td>
</tr>
<tr>
<td>Texas</td>
<td>3940</td>
<td>2,556,000</td>
<td>22</td>
</tr>
<tr>
<td>Utah</td>
<td>410</td>
<td>297,000</td>
<td>22</td>
</tr>
<tr>
<td>Vermont</td>
<td>100</td>
<td>46,000</td>
<td>25</td>
</tr>
<tr>
<td>Virginia</td>
<td>850</td>
<td>555,000</td>
<td>26</td>
</tr>
<tr>
<td>Washington</td>
<td>930</td>
<td>526,000</td>
<td>23</td>
</tr>
<tr>
<td>West Virginia</td>
<td>300</td>
<td>160,000</td>
<td>31</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>860</td>
<td>423,000</td>
<td>29</td>
</tr>
<tr>
<td>Wyoming</td>
<td>130</td>
<td>50,000</td>
<td>27</td>
</tr>
</tbody>
</table>

Source: (Wheaton et al., 2015) and authors' calculations.

Notes: Net increase in average sleep time calculated using proportions schools in 3 start time intervals (before 7:30 a.m.; 7:30-8:00 a.m. and 8:00-8:30 a.m.). Information on number of schools and students for Hawaii obtained directly from Hawaii State Department of Education.
Appendix D: Benefit-cost ratios per student ("Very High" cost scenario)

Table 9: Benefit-cost ratios by state ("Very High" cost scenario)

<table>
<thead>
<tr>
<th>State</th>
<th>Years after policy shift</th>
<th>2 years</th>
<th>5 years</th>
<th>10 years</th>
<th>15 years</th>
<th>20 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) (2)</td>
<td>(1) (2)</td>
<td>(1) (2)</td>
<td>(1) (2)</td>
<td>(1) (2)</td>
<td>(1) (2)</td>
</tr>
<tr>
<td>Alabama</td>
<td>0.03 0.02</td>
<td>0.11 0.09</td>
<td>0.23 0.20</td>
<td>0.38 0.35</td>
<td>0.53 0.49</td>
<td></td>
</tr>
<tr>
<td>Arizona</td>
<td>0.38 0.25</td>
<td>0.65 0.53</td>
<td>0.79 0.71</td>
<td>0.94 0.87</td>
<td>1.08 1.01</td>
<td></td>
</tr>
<tr>
<td>Arkansas</td>
<td>0.19 0.13</td>
<td>0.39 0.32</td>
<td>0.45 0.40</td>
<td>0.58 0.53</td>
<td>0.69 0.64</td>
<td></td>
</tr>
<tr>
<td>California</td>
<td>0.34 0.23</td>
<td>0.59 0.48</td>
<td>0.73 0.66</td>
<td>0.90 0.83</td>
<td>1.06 0.99</td>
<td></td>
</tr>
<tr>
<td>Colorado</td>
<td>0.30 0.20</td>
<td>0.52 0.43</td>
<td>0.68 0.61</td>
<td>0.89 0.82</td>
<td>1.06 0.99</td>
<td></td>
</tr>
<tr>
<td>Connecticut</td>
<td>0.53 0.35</td>
<td>0.95 0.79</td>
<td>1.23 1.10</td>
<td>1.53 1.41</td>
<td>1.79 1.67</td>
<td></td>
</tr>
<tr>
<td>Delaware</td>
<td>0.75 0.50</td>
<td>1.32 1.09</td>
<td>1.72 1.54</td>
<td>2.12 1.96</td>
<td>2.44 2.28</td>
<td></td>
</tr>
<tr>
<td>Florida</td>
<td>0.46 0.31</td>
<td>0.77 0.63</td>
<td>0.93 0.84</td>
<td>1.13 1.04</td>
<td>1.29 1.21</td>
<td></td>
</tr>
<tr>
<td>Georgia</td>
<td>0.27 0.18</td>
<td>0.47 0.39</td>
<td>0.59 0.53</td>
<td>0.71 0.65</td>
<td>0.83 0.77</td>
<td></td>
</tr>
<tr>
<td>Hawaii</td>
<td>0.49 0.32</td>
<td>0.99 0.82</td>
<td>1.11 0.99</td>
<td>1.31 1.20</td>
<td>1.51 1.41</td>
<td></td>
</tr>
<tr>
<td>Idaho</td>
<td>0.18 0.12</td>
<td>0.32 0.26</td>
<td>0.40 0.36</td>
<td>0.48 0.45</td>
<td>0.57 0.53</td>
<td></td>
</tr>
<tr>
<td>Illinois</td>
<td>0.26 0.18</td>
<td>0.47 0.38</td>
<td>0.60 0.54</td>
<td>0.78 0.72</td>
<td>0.95 0.89</td>
<td></td>
</tr>
<tr>
<td>Indiana</td>
<td>0.28 0.18</td>
<td>0.55 0.45</td>
<td>0.67 0.60</td>
<td>0.88 0.81</td>
<td>1.06 0.99</td>
<td></td>
</tr>
<tr>
<td>Iowa</td>
<td>0.40 0.27</td>
<td>0.70 0.58</td>
<td>0.87 0.78</td>
<td>1.00 0.92</td>
<td>1.13 1.06</td>
<td></td>
</tr>
<tr>
<td>Kansas</td>
<td>0.29 0.20</td>
<td>0.64 0.53</td>
<td>0.74 0.66</td>
<td>0.90 0.83</td>
<td>1.06 0.99</td>
<td></td>
</tr>
<tr>
<td>Kentucky</td>
<td>0.27 0.18</td>
<td>0.62 0.51</td>
<td>0.72 0.65</td>
<td>0.85 0.78</td>
<td>0.97 0.91</td>
<td></td>
</tr>
<tr>
<td>Louisiana</td>
<td>0.39 0.26</td>
<td>0.69 0.56</td>
<td>0.88 0.79</td>
<td>1.11 1.02</td>
<td>1.31 1.22</td>
<td></td>
</tr>
<tr>
<td>Maine</td>
<td>0.28 0.19</td>
<td>0.50 0.41</td>
<td>0.65 0.58</td>
<td>0.81 0.75</td>
<td>0.95 0.89</td>
<td></td>
</tr>
<tr>
<td>Massachusetts</td>
<td>0.72 0.48</td>
<td>1.16 0.96</td>
<td>1.35 1.20</td>
<td>1.57 1.44</td>
<td>1.77 1.66</td>
<td></td>
</tr>
<tr>
<td>Michigan</td>
<td>0.34 0.22</td>
<td>0.59 0.49</td>
<td>0.77 0.69</td>
<td>0.93 0.86</td>
<td>1.07 1.00</td>
<td></td>
</tr>
<tr>
<td>Minnesota</td>
<td>0.37 0.24</td>
<td>0.62 0.51</td>
<td>0.80 0.72</td>
<td>0.98 0.90</td>
<td>1.14 1.06</td>
<td></td>
</tr>
<tr>
<td>Mississippi</td>
<td>0.18 0.12</td>
<td>0.37 0.30</td>
<td>0.44 0.39</td>
<td>0.54 0.50</td>
<td>0.63 0.59</td>
<td></td>
</tr>
<tr>
<td>Missouri</td>
<td>0.35 0.23</td>
<td>0.60 0.50</td>
<td>0.78 0.70</td>
<td>1.02 0.94</td>
<td>1.20 1.12</td>
<td></td>
</tr>
<tr>
<td>Montana</td>
<td>0.34 0.23</td>
<td>0.59 0.49</td>
<td>0.70 0.62</td>
<td>0.81 0.74</td>
<td>0.92 0.86</td>
<td></td>
</tr>
<tr>
<td>Nebraska</td>
<td>0.26 0.17</td>
<td>0.47 0.39</td>
<td>0.60 0.54</td>
<td>0.75 0.69</td>
<td>0.91 0.85</td>
<td></td>
</tr>
<tr>
<td>Nevada</td>
<td>0.19 0.13</td>
<td>0.34 0.28</td>
<td>0.45 0.40</td>
<td>0.58 0.53</td>
<td>0.69 0.65</td>
<td></td>
</tr>
<tr>
<td>New Hampshire</td>
<td>0.29 0.19</td>
<td>0.58 0.48</td>
<td>0.74 0.66</td>
<td>0.94 0.86</td>
<td>1.10 1.03</td>
<td></td>
</tr>
<tr>
<td>New Jersey</td>
<td>0.56 0.37</td>
<td>0.95 0.78</td>
<td>1.21 1.08</td>
<td>1.47 1.35</td>
<td>1.68 1.57</td>
<td></td>
</tr>
<tr>
<td>New Mexico</td>
<td>0.38 0.25</td>
<td>0.63 0.52</td>
<td>0.77 0.69</td>
<td>0.90 0.83</td>
<td>1.02 0.96</td>
<td></td>
</tr>
<tr>
<td>New York</td>
<td>0.30 0.20</td>
<td>0.54 0.44</td>
<td>0.70 0.63</td>
<td>0.92 0.84</td>
<td>1.11 1.04</td>
<td></td>
</tr>
<tr>
<td>North Carolina</td>
<td>0.35 0.23</td>
<td>0.61 0.50</td>
<td>0.76 0.68</td>
<td>0.94 0.86</td>
<td>1.09 1.02</td>
<td></td>
</tr>
<tr>
<td>Ohio</td>
<td>0.42 0.28</td>
<td>0.71 0.59</td>
<td>0.83 0.74</td>
<td>0.98 0.90</td>
<td>1.11 1.04</td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>2 years</td>
<td></td>
<td>5 years</td>
<td></td>
<td>10 years</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
<td>-----</td>
<td>---------</td>
<td>-----</td>
<td>----------</td>
<td>-----</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>0.30</td>
<td>0.20</td>
<td>0.50</td>
<td>0.41</td>
<td>0.61</td>
<td>0.54</td>
</tr>
<tr>
<td>Oregon</td>
<td>0.30</td>
<td>0.20</td>
<td>0.52</td>
<td>0.43</td>
<td>0.65</td>
<td>0.58</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>0.28</td>
<td>0.19</td>
<td>0.52</td>
<td>0.43</td>
<td>0.71</td>
<td>0.63</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>0.55</td>
<td>0.36</td>
<td>1.04</td>
<td>0.86</td>
<td>1.27</td>
<td>1.14</td>
</tr>
<tr>
<td>South Carolina</td>
<td>0.32</td>
<td>0.21</td>
<td>0.60</td>
<td>0.49</td>
<td>0.72</td>
<td>0.65</td>
</tr>
<tr>
<td>South Dakota</td>
<td>0.30</td>
<td>0.20</td>
<td>0.56</td>
<td>0.46</td>
<td>0.65</td>
<td>0.58</td>
</tr>
<tr>
<td>Tennessee</td>
<td>0.23</td>
<td>0.15</td>
<td>0.42</td>
<td>0.34</td>
<td>0.54</td>
<td>0.48</td>
</tr>
<tr>
<td>Texas</td>
<td>0.34</td>
<td>0.23</td>
<td>0.58</td>
<td>0.47</td>
<td>0.71</td>
<td>0.64</td>
</tr>
<tr>
<td>Utah</td>
<td>0.23</td>
<td>0.15</td>
<td>0.40</td>
<td>0.33</td>
<td>0.55</td>
<td>0.49</td>
</tr>
<tr>
<td>Vermont</td>
<td>0.37</td>
<td>0.25</td>
<td>0.66</td>
<td>0.54</td>
<td>0.82</td>
<td>0.73</td>
</tr>
<tr>
<td>Virginia</td>
<td>0.61</td>
<td>0.40</td>
<td>0.92</td>
<td>0.76</td>
<td>1.13</td>
<td>1.01</td>
</tr>
<tr>
<td>Washington</td>
<td>0.51</td>
<td>0.34</td>
<td>1.00</td>
<td>0.82</td>
<td>1.13</td>
<td>1.01</td>
</tr>
<tr>
<td>West Virginia</td>
<td>0.24</td>
<td>0.16</td>
<td>0.42</td>
<td>0.35</td>
<td>0.54</td>
<td>0.48</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>0.37</td>
<td>0.24</td>
<td>0.65</td>
<td>0.53</td>
<td>0.85</td>
<td>0.76</td>
</tr>
<tr>
<td>Wyoming</td>
<td>0.47</td>
<td>0.31</td>
<td>0.86</td>
<td>0.70</td>
<td>1.07</td>
<td>0.95</td>
</tr>
<tr>
<td>Average</td>
<td>0.35</td>
<td>0.23</td>
<td>0.63</td>
<td>0.52</td>
<td>0.78</td>
<td>0.70</td>
</tr>
</tbody>
</table>

**Source:** Authors’ calculations.

**Notes:** Column (1) assumes cost of $500 per student per year and column (2) assumes that in addition to the $500 per student per year, each school has to invest $330,000 upfront for updates in school infrastructure related to after-school activities (e.g. update of lighting equipment).
School Start Time Survey

February 21, 2019
Background

- NPS survey questions based on a survey used in Newtown
- Intended as general direction for Committee
- Revisions and additional questions added by Start Time Committee
- Committee requested to include all parents for feedback from all grade levels
- Distributed in both English and Spanish
- Responses open for 3+ weeks, promoted in district newsletters with reminders
- 1,070 responses received
  - Some families responded for multiple children, so numbers may vary in categories reported
- All schools represented, including All Saints and Side-by-Side
Grade Levels of Students from Responses

- PreK: 7%
- Elementary: 43%
- Middle School: 29%
- High School: 21%
The impact of chronic sleep deprivation on teen physical health and safety (e.g., obesity risk, drowsy driving accidents)

1 = Not important, 4 = Very important
The impact of chronic sleep deprivation on teen mental health (e.g., depression, mood, risk-taking behaviors)

1 = Not important, 4 = Very important
The impact of early start times on high school tardiness and attendance

1 = Not important, 4 = Very important
Ability of students to work part-time

1 = Not important, 4 = Very important
Schedules for school sponsored after-school activities (drama, music, clubs, etc.)

1 = Not important, 4 = Very important
Access to non-school sponsored after-school activities (private dance lessons, sports, etc.)

1 = Not important, 4 = Very important
Daylight hours for transportation (bus pick up or drop off in the dark)

1 = Not important, 4 = Very important
Daylight Hours for Transportation -- Elementary Grades

Daylight Hours for Transportation -- Elementary Grades

- Grade 1: 111
- Grade 2: 189
- Grade 3: 302
- Grade 4: 461
Length of bus rides

1 = Not important, 4 = Very important
Availability of before-school elementary childcare

1 = Not important, 4 = Very important
Availability of after-school elementary childcare

1 = Not important, 4 = Very important
Availability of older sibling to provide childcare

1 = Not important, 4 = Very important
Coordination with parent/guardian work schedules

1 = Not important, 4 = Very important
Preference for Timing of Start Time Change

- 51% for 2019-20
- 49% for 2020-21

[Image: Pie chart showing the proportion of preference for timing of start time change between 2019-20 and 2020-21.]
Bedtimes in Norwalk

- 8:00 PM: 300
- 8:30 PM: 361
- 9:00 PM: 455
- 9:30 PM: 373
- 10:00 PM: 405
- 10:30 PM: 197
- 11:00 PM: 135
- 12:00 AM: 53
- 12:30 AM: 12
- 1:00 AM or later: 14

Bedtimes in Norwalk

Before 7:30 pm: 148
Wake Up Times in Norwalk
Hours of Sleep in Norwalk

- Less than 5: 15
- 5 to 6: 109
- 6 to 7: 205
- 7 to 8: 366
- 8 to 9: 445
- 9 to 10: 515
- More than 10: 249

Hours of Sleep in Norwalk
Do you feel your child gets enough sleep?

- Yes: 63%
- No: 37%
Does Your HS Child Get Enough Sleep?

- Yes: 283
- No: 197
School Start Time Survey
High School Student Responses

May 2, 2019
On a school night (Sunday - Thursday), what time do you typically go to sleep?

492 responses

- **Before 10:00 PM**: 28.3%
- **10:30 PM**: 12.6%
- **11:00 PM**: 13.6%
- **11:30 PM**: 11.2%
- **12:00 AM (midnight)**: 20.3%
- **12:30 AM**: 11.2%
- **1:00 AM**: 11.2%
- **After 1:00 AM**: 11.2%
On a school day, what time in the morning do you usually get up?

492 responses

- 38.8% before 5:00 AM
- 35.2% at 5:30 AM
- 13.8% at 6:00 AM
- 6% at 6:30 AM
- 3% at 7:00 AM
- 1% at 7:30 AM or after

Norwalk Public Schools
Approximately how many hours of sleep would you say you normally get on a regular school night?

492 responses

- Less than 5 hours: 17.1%
- 5.5 hours: 13.4%
- 6 hours: 11.6%
- 6.5 hours: 7.3%
- 7 hours: 13.2%
- 7.5 hours: 17.9%
- 8 hours: 13.2%
- 8.5 hours: 7.3%
- 9 or more hours: 11.6%
How often are you tardy (late) to school each week?

492 responses

- Never: 48.8%
- A few times each marking period: 25.2%
- 1-2 times each week: 14%
- Most days: 12%
How often do you stay at school for extra-curricular activities, such as sports, music, clubs, etc?

492 responses

- Never: 17.5%
- Sometimes: 26%
- Often: 28.5%
- Always: 28%
Are you eligible to take a school bus to and from school? (Eligible means that you have a bus pass, or live far enough from school that you could get one to take a school bus every day.)

492 responses

- Yes: 317 (64.4%)
- No: 179 (36.4%)
How do you usually get to school in the morning?

492 responses

- 50.40%: A parent or family member drops me off
- 30.30%: School bus
- 8.90%: Walk
- 4.70%: I drive myself
- 4.70%: I ride with a friend
- Other

(Chart showing percentages of different modes of transportation to school.)
When you are not participating in an extra-curricular club, sports, band or other after-school program, how do you usually get home after school?

492 responses

- School bus: 33.9%
- Walk: 17.7%
- A parent or family member picks me up: 9.1%
- I drive myself: 31.9%
- Public transportation: 0%
- I ride with a friend: 0%
When do you usually do your homework?

492 responses

- Immediately after school: 40.2%
- Early to mid evening: 38%
- Late at night: 19.5%
- In the morning: 0%

Norwalk Public Schools
Are you frequently responsible for taking care of a younger brother or sister in the morning or after school?

492 responses
Do you have a job after school or on weekends?

492 responses

78.9% Yes
21.1% No
How many days each week do you usually work after school?

172 responses

- 32%: 1 day
- 16.9%: 2 days
- 18.6%: 3 days
- 12.8%: 4 days
- 11%: 5 days
- 8.7%: Weekends only
FAQ’s and Concerns

- How much would changing school start times cost?

- The bus study is too expensive. Besides, we already have a transportation administrator on staff, so we don’t need a third party consultant to do the study.

- Changing school start times would be too expensive.

- You are nuts - we shouldn’t be having this conversation now. Our local tax burden is a bigger concern than ever before due to the new federal tax bill, and changing the school start times might be an extra expense in a school budget that is already large.

- My child gets enough sleep under the current schedule.

- Can’t we just have our teens go to bed earlier instead?

- Adolescents aren’t going to get more sleep. They’ll just stay up an hour later if school start times are later.

- I went to school at 7:30 a.m. and I turned out fine. Besides, don’t teens need to get used to waking up early to prepare for the real world?

- Have Westport’s community leaders and Board of Education discussed changing school start times before?

- I’m worried about how changing school start times might affect sports and other extracurricular activities.

- Does starting middle and high school later mean that elementary schools in Westport will start earlier?

- Can’t my kids just catch up on sleep on the weekend?

- What about after school jobs?

- Why do most of the references on this website link to abstracts instead of full articles?
Q: How much would changing school start times cost?

A: To determine how much changing school times would cost, the first step is to have our Board of Education hire a third-party bus consultant. This consultant would analyze our district’s bus routes and come up with different start time and bus route options along with the costs of implementing each option. Even if Westport did not end up changing its school start times, this analysis could pay for itself by identifying ways to make our current bus routes more efficient.

Greenwich commissioned two bus studies, additional analyses, and staffing for ten to twelve on-site meetings, which cost around $80,000 total. Our study would probably cost less given all of the extra work that the consultants did for Greenwich and because Greenwich is a much larger school district, with over twice as many elementary schools and approximately 8,827 students compared to the 5,750 students in Westport.

Click here to see the bus study commissioned by the Greenwich Board of Education.
Q: The bus study is too expensive. Besides, we already have a transportation administrator on staff, so we don't need a third party consultant to do the study.

A: The bus study is not too expensive. Please remember that our current school start times harm our students' health immensely. This issue is not equivalent to determining whether to add STEM classes or improve our schools in other ways as part of the town's strategic long term planning. Like mold or lead in our classrooms - which our town has historically remediated immediately - our school schedule is a serious public health issue. This is why our country's leading medical organizations have issued policy statements that middle and high school should start no earlier than 8:30 a.m. These organizations do not opine on the content of curricula or how to make our infrastructure more efficient. They warn us about serious risks to our health like smoking, ebola, and lead poisoning. We should take their policy statements seriously and act on them.

Commissioning the study also makes sense in the context of Westport's prior expenditures to improve the safety of our students. For the 2017-2018 school year, Westport spent $65,000 to install seat belts on 13 school buses. It will then cost $500,000 to install seat belts on the rest of our school bus fleet. We have spent these funds even though, for the time period between 2003 and 2012, only 55 school bus passengers died in crashes. As you can see in the table on the right, for the year 2012 alone, over 3,000 adolescents died in motor vehicle accidents and over 2,000 adolescents committed suicide. The $65,000 we have already allocated to reduce a risk responsible for taking 55 lives over an entire decade is probably more expensive than the cost of our bus study.

In 2013, in the wake of Sandy Hook, our town paid $98,000 for a security audit of our schools. Yet out of all adolescent deaths, only 0.34% consist of homicides on school grounds. By comparison, car accidents are the number one killer of our teens, making up 35.0% of teen deaths, while suicide causes 11% of teen deaths. Moving school times later has been shown to dramatically decrease motor vehicle accidents and improve mental health. Why would Westport spend $98,000 to identify ways to reduce only 0.34% of teenage deaths and possibly $565,000 to reduce less than .01% of adolescent deaths from school bus accidents, but not spend around $40,000 to figure out the best way for our town to reduce 46% of teenage deaths?
Moreover, the bus study should be conducted by an independent third party with expertise in this exact area of school start time changes rather than Westport’s transportation coordinator. This is a different kind of analysis than those involved with the more minor schedule changes that we have implemented in past years. Creating an accurate and comprehensive bus study for our purposes here is, in and of itself, a full time job for professionals that have dedicated themselves to this type of analysis and possess specific tools and years of expertise in this area. Put differently, as opposed to handing day-to-day operations with occasional alterations in scheduling, as our transportation administrator does every day, the bus study would be a complex, multivariate analysis where the output would be a detailed report that, depending on what constraints we give to the bus consultants, could have 20 or more start time options - with all the related costs accurately accounted for and other non-monetary pros and cons described in detail. To perform this unique logistics task the third party bus consultants have proprietary algorithms, systems, processes, software and techniques that local transportation administrators don’t have access to. Moreover, in other school systems that have first tried to have their transportation administrator do this type of analysis, their administrators have been accused of bias when sophisticated parent advocates found inaccurate figures, assumptions, and gaps in the analyses. An independent, third-party consultant eliminates any patina of bias from the process.

For all of these reasons, Greenwich hired a third-party bus consultant to do multiple analyses, even though its transportation administrator and CFO are sophisticated professionals as well. Ridgefield has also hired a third-party bus consultant as the first step in figuring out how to implement later start times for the 2018-2019 school year. Hiring a third-party bus consultant should be Westport’s first step as well.

Q: Changing school start times would be too expensive.

A: Before anyone starts arguing about this point, we need to commission a bus study to find out what all the different options would be for implementing later high school and middle school start times and what each option would cost. Perhaps there is a way to make this change that would not affect our school budget.

Also, as mentioned in response to the prior question, please remember that our current school start times harm our students' health immensely. This issue is not equivalent to determining whether to add STEM classes or improve our schools in other ways as part of the town’s strategic long term planning. Like mold or lead in our classrooms - which our town has historically remediated immediately - our school schedule is a serious public health issue. This is why our town’s pediatricians and the country’s leading medical organizations have issued policy statements that
middle and high school should start no earlier than 8:30 a.m. These organizations do not opine on the content of curricula or how to make our infrastructure more efficient. They warn us about serious risks to our health like smoking, ebola, and lead poisoning. We should take their policy statements seriously and act on them. Despite any budget difficulties, this is a problem we need to fix now for the sake of our children.

Even if starting school later would involve additional cost, this would be money well spent by our town. Economists investigating this issue have concluded that even using the most conservative numbers, delaying school start times has a substantial benefit-to-cost ratio of 9:1:5

Delivering start times by one hour for students in secondary school would increase overall student achievement by roughly .1 standard deviation, on average... A one standard deviation rise in test scores is estimated to increase future earnings by 8%. Assuming a 1% growth rate for real wages and productivity and a 4% discount rate, this translates to an approximately $10,000 increase in future earnings per student, on average, in present value terms.... Having districts alter their bussing system so that all students start school at the same time would cost approximately $150 per student per year – or $1,950 over a student’s school career.6

Aligning school start times with adolescent biology is so cost effective because it has the same effect on educational outcomes as putting all students in classes that are 1/3 smaller or putting students in classes with teachers whose performance is one standard deviation higher.6, 7, 8, 9, 10 Economists estimate that obtaining the same educational outcomes by actually reducing class size or hiring different teachers would cost seven times as much as starting school later.10

The economists’ analyses above don’t even take into account the savings of parent taxpayers from fewer automobile accidents and sports injuries. Drowsy driving has an estimated annual societal cost of $109 billion.9 And one study found that for one North Carolina town, starting school later would save $1 million in medical costs for minor sports-related injuries alone.9

In addition, given that the most preeminent medical organizations in our country have all said that middle and high school should start no earlier than 8:30 a.m. and other Fairfield County towns have moved start times later, by not following suit Westport is exposing itself to potentially large legal costs. If a teen sustains injuries that arguably could have been prevented with later start times, the individual harmed could sue the town for negligence. The Education Commission of the States has warned school districts about this potentially massive liability:
There appears to be no argument for keeping early start times that is supported by scientific or medical studies, and this may make it difficult to defend current practice. The mere existence of more than 3 million adolescents and young adults younger than 24 with delayed sleep phase disorders indicates the scale of potential problems arising from negligence suits (given that states already spend millions of dollars on settlements and judgments from injuries to students). Education start times are the responsibility of education bodies and institutions, and thus it could be argued they have full responsibility for any foreseeable negative impact of early start times. 6a

Such lawsuits might not succeed if they go to trial because the plaintiff would have to prove that the earlier start times caused his or her injuries, but the legal costs of defending against these lawsuits would be significant. By moving start times later we could avoid exposing our town to this potential liability.

Q: You are nuts - we shouldn't be having this conversation now. Our local tax burden is a bigger concern than ever due to the new federal tax bill, and changing the school start times might be an extra expense in a school budget that is already large.

A: If you understand the science behind the adolescent sleep cycle and have read the policy statements of the AMA, AAP, and CDC on school start times, it is crazier that we haven't fixed this problem in our schools already. Students learn the information they were exposed to during the day when they are sleeping. For every day that we keep our current high school start times spending, all the money that we spend on our schools is not as effective as it otherwise could be.

Moreover, and as explained in more detail above, our current middle and high school start times are a serious public health threat. When our town recently found out that there was mold at Coleytown Middle School, our public officials had the mold remediated as soon as possible. This issue is no different.

The Westport Board of Finance has encouraged strategic investments in our education system that
will yield long-term benefits and productivity. As noted in detail above and on the Benefits page of this website changing middle and high school start times to 8:30 a.m. or later is one of the best investments that our town can make in the productivity of our school system and the health of our adolescents.

Back To The Top

Q: My child gets enough sleep under the current schedule.

MYTHBUSTERS - My teen gets enough sleep, My teen can catch up on sleep on the weekend

Presented by Rafael Pelayo, MD, Clinical Professor, Psychiatry and Behavioral Sciences, Stanford Center for Sleep Sciences and Medicine.

A: Are you sure? As the American Academy of Pediatrics has pointed out, there is a “significant lack of awareness among adults regarding the extent of adolescent sleep loss.” A nationwide poll showed that only 9% of high school students are getting the sleep that they need each night, while 71% of the parents surveyed believed that their adolescent did in fact get enough sleep. As Dr. Pelayo explains in more detail in the video below a teen that, when left to his or her own devices, sleeps two or more hours on the weekends past the time that he or she wakes up on school days, this teen is sleep deprived.

Back To The Top
Q: Can’t we just have our teens go to bed earlier instead?

A: No, this is biologically unfeasible for most adolescents, as explained in detail on the Science page of this website. As scientists have explained, “students cannot force themselves to fall asleep at a time early enough to get an adequate night’s rest... sleep researchers have found that adolescents stay awake later largely for biological reasons.” And because an adolescent’s body continues to secrete melatonin until at least 8:00 a.m., “simply going to bed earlier does not necessarily make someone less tired in the early morning hours.”

MYTHBUSTERS - Our students will just stay up later if school starts later

presented by Rafael Pelayo, MD, Clinical Professor, Psychiatry and Behavioral Sciences, Stanford Center for Sleep Sciences and Medicine

A: No, this isn’t true, as scientist Wendy Troxel has explained:
The findings are unequivocal, and as a sleep scientist, I rarely get to speak with that kind of certainty. Teens from districts with later start times get more sleep. To the naysayers who may think that if schools start later, teens will just stay up later, the truth is, their bedtimes stay the same, but their wake-up times get extended, resulting in more sleep.\textsuperscript{92}

Thousands of adolescents have shifted to later school start times and the research all shows that bedtimes either stay about the same or in some cases actually shift slightly earlier.\textsuperscript{5, 19, 20, 23, 24, 25, 25a, 25b} Out of the 11 studies published on this issue as of May 2016, weekday bedtimes stayed the same in 11 studies and in 2 studies students reported slightly earlier bedtimes.\textsuperscript{17} At the same time, students are using the extra time in the morning to sleep, which means that delayed school start times do accomplish the goal of increasing sleep duration for adolescents.\textsuperscript{17, 22, 23, 24, 25} In fact, researchers have determined that, as opposed to parenting methods, academic workload, and extracurricular activities, school start time has the single largest effect on how long adolescents sleep each night.\textsuperscript{18}

In Wilton, for example, the high school start times moved by 40 minutes from 7:35 a.m. to 8:15 a.m. In a follow-up study, students reported getting an average of 35 extra minutes of sleep per night.\textsuperscript{21} Likewise, in a four year study of over 12,000 secondary school students in Minnesota, start times were pushed later by an hour. The students continued to go to bed at around the same time – even four years later – and got an extra hour of sleep each night. As the head researcher of this study explained, “this is contrary to the fears and expectations that a later start would result in students staying awake an hour later on school nights. Instead, students in Minneapolis high schools get 5 more hours of sleep per week than do their peers in the schools that start earlier in the day.”\textsuperscript{22}

As an added bonus, students who begin school later also spend less time watching television and more time on homework each week.\textsuperscript{10, 26}

Q: I went to high school at 7:30 a.m. or even earlier, and I turned out fine. Besides, don’t teens need to get used to waking up early to prepare for the real world?

A: It might seem like high school has started at 7:30 a.m. or earlier forever, but that isn’t the case. A hundred years ago, most schools started around 9:00 a.m.\textsuperscript{27} During the recession in the 1970s, many schools shifted high school and middle school start times earlier so they could have tiered bus schedules.\textsuperscript{27, 28} Back then, the importance of sleep and the adolescent sleep cycle shift weren’t
because there seemed to be no downside to earlier start times, saving money by using the fewest possible busses in three cycles was appealing.27

Now that we know better and leading health organizations have recommended that school start no earlier than 8:30 a.m., it makes no sense to leave start times as they are. When the American Academy of Pediatrics recommends that we have babies sleep on their backs without crib bumpers, should we ignore them because our parents did otherwise and we turned out fine? When the American Medical Association recommends that we not expose our children to cigarette smoke, should we ignore them because we were exposed as kids and we turned out fine? When the CDC tells us we shouldn't have more than a specific amount of lead in our schools, should we leave a school covered in chipping lead paint the way it is because some of our schools were the same way when we were students? As one school superintendent explained, "the science and the evidence is so clear, that if I did nothing at all and just continued on with the same start times, I was hurting kids."66 Now that we know better, we need to do better in Westport too.

Put differently, imagine that you spent a long time in Iceland during your youth, but since then researchers have discovered that there is something in the environment that, for teens, causes lower academic and sports performance, reduced creativity, poor mental health, an increased likelihood of car accidents, and a greater likelihood of sports injuries. So the CDC recommends that teens not travel there. Would you send your adolescent children there anyways because you grew up in that environment and turned out fine?

And not changing school start times because teens will have to wake up early in the "real world" is equally ridiculous. Biology causes adolescents' sleep cycle to shift later, just like biology causes toddlers to need 1 or 2 naps each day. Making teenagers attend school so early to "prepare" for the real world is like asking toddlers to skip their naps to prepare for second grade. By the time teens are in their early twenties and in the "real world," their sleep cycle will have shifted back.6 The "real world" is also a diverse place, with schedules varying greatly from person to person. We shouldn't compromise adolescents' health and potential by making them wake up so early now just because they might have to, or choose to, wake up early years later.

Moreover, the "real world" that our students will join prioritizes sleep and corporations even see it now as a "status symbol" and "human potential enhancer."72 Accenture, JP Morgan Chase, and Uber, among other companies, provide "antiburnout programing" which "educates their employees on the importance of sleep."72 Aetna, the health care company, is paying its workers up to $500 a year if they can prove they have slept for seven hours or more for 20 days in a row.72 And even the Army "has proclaimed sleep a pillar of peak soldier performance."72
Q: Have Westport’s community leaders and Board of Education discussed changing school start times before?

A: Yes. In 2003, the Westport Board of Education formed a special school start time committee that included principals of 4 schools, 3 teachers, the athletic director, a nursing supervisor, and a PPS coordinator. The committee commissioned Clive R. Belfield of Columbia University to examine the research on school start times and write a report.

In his report, professor Belfield wrote that “the link between lack of sleep and impaired general cognitive capacities is strong and compelling” and that “it is possible to infer” that Westport’s current school start times impair educational performance. He ultimately concluded, however, that there needed to be more research on the effect of start times on academic performance. He also noted that scientists hadn’t yet determined what school start time would be most beneficial for adolescents.

After meeting 13 times and reviewing Professor Belfield’s report, the special committee wrote a final report in March 2004. In the report, the committee concluded that “the scientific literature does not provide enough evidence to support altering school start time for high school students at the present time” because: (1) the committee wanted more evidence that students would get more sleep with later start times, (2) the committee was waiting for more guidance from experts on what start time would be best.

The medical community has answered both of these questions in the intervening years. First, students have gotten more sleep with later school start times in every one of the many studies that have been done on this issue. Second, as of 2016 the evidence regarding the public harm caused by current school start times was so compelling that the American Academy of Pediatrics, American Medical Association, and the Center for Disease Control, and many other organizations have all recommended that middle and high schools start no earlier than 8:30 a.m. Any starting time before this hour, such as Staples High School’s start time of 7:30 a.m., is NOT optimal. Rather, it is a serious public health hazard for our teens.

In fact, some scientists suggest that, while changing start times to 8:30 a.m. is a move in the right direction, start times of 10:00 a.m. or 11:00 a.m. would be ideal for high school students and freshmen in college. Changing our middle and high school start times to 8:30 a.m. is the very least that we should do for Westport's adolescents.

Since 2004, scientists have also learned more about the importance of sleep and how later school start times improve academic performance, sports performance, mental health, and numerous other benefits.
other important facets of teenage life.

School start times have been brought up on other occasions during the past 13 years, but the Board of Education has not looked at the issue in depth again.

Q: I’m worried about how changing school start times might affect sports and other extracurricular activities.

A: Changing school start times might involve altering extracurricular activity schedules as well, but this inconvenience is nothing in comparison with what we have to gain. As explained in further detail on the benefits page, our teens will be much better athletes and get significantly fewer sports injuries with later school start times. Our artists will be more creative. And our musicians will have more effective practice sessions as their bodies are better able to learn the fine muscle movements needed to play their instruments.

What’s more, student participation in all of these activities either stayed the same or increased in ALL follow up studies of middle and high schools that moved their start times later. As one group of researchers that reviewed all of these studies reported, “we identified no districts in which athletic programs were canceled or significantly adversely affected by school start time change. To the contrary, a number of districts found that more students participated in athletics and that sports programs grew after high school bell times were delayed, and reported that their teams performed better following the change.”

Nor should we worry that moving start times later would make it difficult to schedule games with other schools. Students at Wilton High School have benefited from later start times for over a decade, and according to Wilton’s athletic director there have been “no problems with the athletic schedule because neighboring schools simply pushed back the starting times for some of our away games at their sites by 15-30 minutes.” The Wilton superintendent also reported that they had one of their best athletic years ever after moving start times and that participation in all sports increased.

The Connecticut Interscholastic Athletic Conference (“CIAC”) has even issued a position statement in support of later start times: “research shows that switching to later school start times does create a more optimal learning environment and improves student achievement for high school athletes... [with later start times] “interscholastic athletic activities can continue to be offered, with appropriate accommodations, within any reasonable school day structure...To do less would be to
elevate high school athletics to an importance greater than that which is its true purpose.  

Other schools in the CIAC are also working towards implementing later start times. Ridgefield has committed to institute later start times for the 2018 - 2019 school year, and Greenwich High School will start classes at 8:30 a.m. starting in September 2017. Reportedly, Greenwich athletic director Gus Lindine was originally apprehensive about the change, but he is now excited that the district’s new sports schedule will take advantage of the many scientifically demonstrated benefits of more sleep for student-athletes, including enhanced performance and significantly reduced injuries. If Westport does not follow suit and move school start times later as well, our adolescents will be at a significant disadvantage to their better-rested peers in Wilton, Greenwich, and Ridgefield, not only in the classroom but also on the playing field, in the orchestra, and in the artists’ studio.

Q: Does starting middle and high school later mean that elementary schools in Westport will start earlier? I don’t want my young children waiting for the bus in the dark.

A: There will be many different scheduling options for implementing healthier school start times, and the first step to figuring out what these options are is to commission a third-party bus study. This study will come up with a long list of all the different start time options, the estimated costs of implementing each new schedule, if any, and any other pros and cons of each option.

Ideally, none of our children should be waiting for a bus in the dark, regardless of their age. Age does not make pedestrians more visible to drivers. Nor does age make adolescents invisible to predators lurking in shadows of the dawn. Our school start times should keep ALL children safe, not just the youngest ones.

Q: Can’t my kids just catch up on sleep on the weekend?
MYTHBUSTERS - My teen gets enough sleep, My teen can catch up on sleep on the weekend

presented by Rafael Pelayo, MD, Clinical Professor, Psychiatry and Behavioral Sciences, Stanford Center for Sleep Sciences and Medicine

A: Sleeping in on the weekend wrecks further havoc on teens' sleep cycles. After waking up so much later in the morning, adolescents have an even harder time falling asleep on Sunday nights. Moreover, the average teen would have to sleep most of the weekend to make up for the sleep debt accumulated during the week with our current school start times.

Q: What about after school jobs?

A: Our current school start times are a serious public health hazard for our adolescents, as the AAP, AMA, and CDC have explained in their position statements. After school employment should not take priority over fixing something that is so detrimental to our teens' health and futures. We also need to remember that changing school start times has such a large impact on academics alone that our students can expect their future earnings to increase by 8%. And most high school students work lower wage jobs. If students did have to work less hours now due to later start times, the end result would be a cost-effective investment in their future.

Ultimately, however, we don't need to worry that teens won't be able to work as much if their school start times move later. In all of the school districts that have moved school start times later, no follow up study has found that altering the hours of after school jobs caused any sort of problem.
for the communities at issue. For example, in one study of seven high schools that shifted their start times from 7:15 a.m. to 8:40 a.m., researchers found that there was no negative impact on after-school employment of high school students because employers had no trouble adjusting hours and many employers didn’t need additional staff until at least 4:00 p.m. anyways.22

Q: Why do most of the references on this website link to abstracts instead of full articles?

A: While most of the articles and news sources referenced on this website are publicly available through other websites, if we link to those websites directly and the website at issue has posted that particular article in violation of copyright law, we could be sued.

Q: Where does the theme song to Sleep for Success' videos come from?

A: The song is called "City of Love" and it was written and performed by Jake Bernard, an amazing young musician and graduate of Staples High School. You can read more about Jake on Dan Woog's Westport blog, 06880, and hear more of his music on YouTube, Facebook, and Spotify.

Q: Can I start a Sleep for Success chapter in my town?

A: Great idea! Contact us for more information.
Q: Our high school is already ranked the 5th best in Connecticut according to US News & World Reports and our students are already the best, so your data about academic performance isn’t compelling to me.

MYTHBUSTERS - Our students and schools are far above average so later start times cannot help us

presented by Rafael Pelayo, MD, Clinical Professor, Psychiatry and Behavioral Sciences, Stanford Center for Sleep Sciences and Medicine

A: Without a doubt, our schools are amazing. But there is ample room for improvement.

The US News & World Report rankings are arguably problematic, but if we are going to use them as a benchmark, Westport also placed 391th in the national high school rankings. We called the high schools ranked in the top ten. The morning start times for first period at these schools, put in order of the best high school to the tenth best high school, are 8:25, 8:25, 8:40, 9:15, 8:15, 8:40, 8:25, 8:25, 9:15, and 8:15, respectively. Staples High School starts at 7:30 a.m.

The top three private schools in the country, Phillips Academy, Phillips Exeter Academy, and the Lawrenceville School, start first period at 8:00 a.m. This is especially significant given that over 70% of these schools’ students live at the school and have incredibly short morning “commutes.”

Even if Westport was ranked #1, however, we are still failing our students when it comes to
academics. The mission of Westport Public Schools is “to prepare all students to reach their full potential as life-long learners.” With the benefit of science that is now “unequivocal,” we know that it is impossible for our district to fulfill this goal until we change our middle and high school starting times. Our most important learning takes place during sleep, and particularly during the REM phase of sleep which occurs most often in the late morning for adolescents; the brain consolidates and practices what the student learned during the day, forms long-term memories, and connects and prunes synapses in ways that improve complex and abstract thought, mathematical capacity, logical reasoning, complex thought, and creativity.

As sleep scientist Wendy Troxel explained about late morning REM sleep in her recent TED talk, “I know that by waking up [my son up for school] hours before his natural biological clock tells him he’s ready, I’m literally robbing him of his dreams — the type of sleep most associated with learning, memory consolidation and emotional processing.

Even the valedictorian of Staples High School is a human. And as a matter of neuroscience, our school district has prevented this student from even coming close to reaching his or her full potential due to our current high school schedule.

Now some of you might still think, “Who cares? Being valedictorian is good enough.” It’s not when that student could have learned more and done even better. Staples High School, Fairfield County, and even the state of Connecticut is still, metaphorically speaking, a very small pond in our global community. Other students around the country and around the world are benefitting from later start times, and the number of students in this group is growing every year. For example, schools in the U.K and Finland typically start at 9:00 a.m. at the earliest. These are the peers that our students are competing with for college admissions and later, for jobs, among many other things.

In addition, as a community, we have acknowledged that we should improve our schools through programs like Westport 2025 and Westport’s guiding principles. As explained above, our students can’t meet goals in these programs like thinking critically, creatively and “synthesiz[ing] content and apply[ing] it to new situations” without the right amount of sleep at the right time of day - which for teens includes the last hours of their natural sleep cycle, which we rob them from every school day.

Other goals in Westport 2025 and our guiding principles include having our teens be “joyful about learning new things” and display “a sense of wonder that allows for deeper exploration of concepts.” Should we expect this from our teens when our school schedule, with our adolescents’ neurobiology, is equivalent to waking an adult up at 3:45 to start work at 4:30 a.m.?

In short, yes, Westport’s schools are amazing and a great source of pride for our town. But our
children also deserve better than a school district that prioritizes aspirational goals without first providing students with the basic, biological necessities they need to fully achieve these goals – which, for us, is later middle and high school start times.

Q: Our athletes are already amazing, so your information about improved athletic performance isn’t compelling to me.

A: As explained in the sports section of the Benefits page* and by sports medicine expert Dr. Karen Sutton in the video below, this information has been compelling to world-class student athletes at Stamford, professional athletes, and Michael Phelps, the most decorated Olympian in history. In addition, student athletes that don’t get enough sleep are 68% more likely to sustain an injury that requires medical treatment than their well-rested peers, who also derive more enjoyment out of participating in sports. Whether you are just learning a sport or breaking world records, obtaining enough sleep significantly improves our athletic success and overall experience playing. And as a matter of biology, our middle and high school athletes can’t obtain enough sleep to meet this baseline without changing school start times to 8:30 a.m. or later. 78

MYTHBUSTERS - Our sports teams are already the best and if start times are later they will get worse because we won’t have enough time to practice

presented by Rafael Pelayo, MD, Clinical Professor, Psychiatry and Behavioral Sciences, Stanford Center for Sleep Sciences and Medicine
How Later Middle and High School Start Times Benefit our Student Athletes

presented by Dr. Karen Sutton

Q: If teens are so sleep deprived, then when the clock “falls back” to standard time in November, why don’t adolescents use that “extra” hour for more sleep? Within a few days, my teenager has adjusted his bedtime to the same clock time (which is an hour later than he went to sleep before the switch back to standard time). Won’t adolescents also just stay up for an extra hour if we delay school start times by one hour?

A: There is no scientific consensus regarding what happens to the adolescent sleep cycle when clocks “fall back” to standard time. In fact, the premise of the question – that in general teens quickly fill the “extra” hour with wakeful pursuits rather than getting more sleep – might not be true.

To our knowledge there have been no peer-reviewed studies with objective measures on this issue.
Researchers are still studying how daylight savings time ("DST") affects the population at large, and these studies tend to exclude or control for adolescents because their sleep cycles are so different from those of adults.¹

The only study on DST and high school students concerned the effects of the “spring forward” to DST rather than the switch back to standard time. These students went to White Plains High School and started class at 7:40 a.m. The researchers found that after the clock moved forward to DST, the students never fully adjusted to the time change and lost a mean of 32 minutes of sleep each weeknight.² This caused “highly significant” declines in the students’ cognitive function, psychomotor vigilance, and reaction times.³

Regardless of what the scientific community eventually concludes regarding the effects of DST on teens, however, there is no reason to think that adolescents will stay up for an extra hour if we moved our school start times one hour later. In contrast to the paucity of research regarding teens and DST, so many studies in different settings by different experts have found that adolescents get more sleep with later school start times that there is “virtually unanimous agreement” among researchers on this point.⁴ In fact, as detailed throughout this website, “the findings are unequivocal”⁵ and “few, if any educational interventions are so strongly supported by research evidence from so many different disciplines and experts in the field.”⁶ That’s why the position statements of our nation’s leading medical and educational organizations and all of our local pediatricians don’t just note that adolescents need more sleep; they state that middle and high schools should start no earlier than 8:30 a.m.

So, how might moving start times later by an hour result in better-rested teens even if, hypothetically, the same doesn’t occur when the clock “falls back” to standard time? The information below is reasonable conjecture rather than scientific fact, but there are at least three reasons why the two scenarios might yield different results.

First, during the “fall back” from DST, every scheduled aspect of a teen’s life automatically shifts one hour later. These externally dictated schedules concretely affect the timing for bedtime, while no such constraints exist in the morning to wake up with the exception of school start time. And while some extracurricular activities might meet later in the day if school start times were later, post-school activities and responsibilities of teens might be accomplished in a more efficient manner, leaving more time for sleep.

For example, students with later school start times complete homework more efficiently⁷ because they are more alert, manage their time more effectively, and have improved attention, memory, abstract thinking, and verbal creativity.⁸ Sports coaches could get better results from their athletes with shorter practices because their athletes build and repair muscle more quickly, improve skills and learn team plays more easily, have faster reaction times, and are significantly less likely to get

https://sleepforsuccesswestport.com/common-concerns-counter-arguments/
injured \(^9, 10, 11\) – collegiate and professional athletes have found this to be the case and as a result many teams now hire sleep consultants and track athletes’ sleep. \(^12, 13, 14, 15\) Likewise, our musicians could learn the fine muscle movements needed to play their sonatas more quickly and our theatre stars could master their lines and blocking in less time. \(^16\) Adolescents with later school start times even spend less time watching television. \(^17, 18\) In sum, and as opposed to adjusting a clock while keeping the exact same daily schedule, moving school start times an hour forward is just that – a change to middle and high school hours. The other things that students seek to accomplish after school – including homework – might not take as long.

Second, residents of districts that have moved school start times later learned about the importance of sleep during that process and have a much better understanding of sleep science than the general population. Many people still view adequate sleep as something for the boring, weak, or the lazy. When there’s only 24 hours in the day and you have ambitions – academic, athletic, career, musical, social, or all of the above – sleep is usually the first thing to go. But when parents and students understand that sleep deprivation literally and figuratively prevents adolescents from fully achieving any dreams they might have, sleep becomes more of a priority.

In fact, to help ensure that sleep is prioritized, some districts also add sleep health education programs to their curriculum when they change to the recommended start times of 8:30 a.m. or later. For example, around the time when Menlo-Atherton High School changed its first bell from 7:45 a.m. to 8:45 a.m., with classes starting twice a week at 9:30 a.m., it also implemented an award-winning sleep education program in partnership with Stanford University. \(^19\) The average teen adjusting back to standard time in the fall does not have the same knowledge base.

Third, as mentioned previously, the only study using objective measures regarding adolescents and DST concluded that teens did not fully adjust to the “spring forward” to DST. \(^20\) And research on adults shows that, based on sunrise and sunset times the “fall back” to standard time may take place a month too late. \(^21\) In other words, it is possible that teens’ never fully adjust their bedtimes to DST and their circadian systems are primed to adjust back to standard-time bedtimes in November. This is a completely different scenario than moving school start times later. As any parent of an adolescent has observed, once their teen is asleep, if given the option he or she will usually occupy free time in the morning with more sleep.

In sum, what teens do or don’t do when clocks are adjusted as part of DST shouldn’t dissuade us from changing our middle and high school start times to 8:30 a.m. or later. The scenarios are different in many important ways, and there is a wealth of evidence – evidence that has been vetted and endorsed by our country’s leading medical organizations – proving that adolescents get more sleep with later school start times.
Q: Why don’t we implement a sleep health education program instead of moving middle and high school start times to 8:30 a.m. or later?

A: Westport should add a mandatory sleep health education to its curriculum, but this change would not be enough to ameliorate the health hazards caused by our current school schedules. As detailed throughout this website, the adolescent sleep cycle shift is a universal, neuro-biological stage of human development. Even if all our students somehow obtained PhDs in sleep science prior to graduating high school, they still generally would not be able to fall asleep until 11:00 p.m. at the earliest. And there’s simply not enough time between then and our current school start times for adolescents to get the sleep they need to be safe, healthy, and excel to their full potential.

If you think about it, adding sleep education alone under our current circumstances would be cruel. Our schools would be teaching students about the serious harm caused by sleep deprivation, while keeping a schedule where it isn’t possible for them to get enough sleep. The scenario would be analogous to teaching students about the dangers of mold exposure in a school where there’s mold.

Research on the efficacy of sleep health education programs demonstrates that schools must also have later start times for the programs to meaningfully improve student health: “the overall trend across studies was for an improvement in sleep knowledge but a null effect on sleep behaviors.” The exceptions – sleep education programs that helped increase students’ nightly sleep – took place in schools with later start times or with greater student flexibility in scheduling morning classes, including:

- A six-week sleep education curriculum that was part of the health course in a New Zealand High School, where classes typically start at 9:00 a.m.
- The award-winning Sleep Ambassadors program at Menlo-Atherton High School, where students from Yale University help educate high school students on the importance of sleep, and faculty from Yale give presentations to parents and teachers regarding the same,
- A program which included an information session, wearable sleep monitors, and personalized text messages each day based on each student’s sleep activity in a U.S. High School where first period started at 8:32 a.m. The only student group that did not experience increased sleep duration was the racial-ethnic minority students, some of whom may have been more likely to take advantage of the vocational training offered prior to first period,
If we want to improve the health and safety of our students and help students reach their full potential through a sleep education program, we should also implement school start times of 8:30 a.m. or later. Otherwise, we are giving students the knowledge they can use to improve their lives in the future without giving them a chance to fully implement this knowledge now – which might be too late for the teen who could have performed well enough to get into their preferred college with more sleep, the teen whose frontal lobe will never be able to assess risk accurately due to adolescent sleep deprivation or, in the worst case scenario, the teen that became addicted to substances, died in a car accident, or the teen that committed suicide.

Q: We shouldn't change school start times here because changing the times in Greenwich was problematic.

A: There was a good op-ed published in the Greenwich times regarding this issue, which you can see here. We’ve made some additional points and provided details below.

First - and in spite of the initial logistical difficulties which are addressed in more detail below – there’s no real evidence that the new schedule in Greenwich is unsuccessful. As the author of the op-ed explained, “[a]ll leading medical authorities and experts in the United States have spoken in one voice recommending an 8:30 start a.m. time or later” based on extensive evidence from multiple fields. Some parents have claimed that the 8:30 a.m. start time is worse than the old 7:30 a.m. start time, but this is anecdotal evidence. And there is just as much, if not more, anecdotal evidence from other parents indicating the opposite. For example, one mom of two high-achieving GHS students recently reported that (a) her kids get their homework done earlier because they are more alert and efficient (b) they go to bed at the same time or earlier, and (c) they have not had a single sick day. Another parent was thrilled that her son, an all-state musician, is sleeping more, learning new pieces faster, and performing better than ever.

What’s more, Greenwich High School’s sports teams and clubs have been unusually successful since the 8:30 a.m. start time was implemented. For example:

- A program at a U.S. liberal arts college that included information sessions, a sleep diary, and personalized feedback, where students that had slept less than 7 hours per night before the sleep education obtained significantly more sleep each night after the program, 13

- And a program at the University of Arizona where athletes were educated about the importance of sleep, received sleep tracker devices and diaries, and had 24-hour access to experts to answer any sleep health questions they might have. Even though this study focused on sleep duration and quality, which significantly improved for 100% of the student athletes, 89% of students reported improved athletic performance at the end of the study as well. 14
- The football team was undefeated in regular season – which hasn’t happened since 2006 – and made it to the state finals,
- The women’s volleyball team won both the state and FCIAC titles for the first time in program history,
- The women’s swimming and diving team won the FCIAC and state championships, with both individual swimmers and relays breaking long-standing state and team records,
- The men’s soccer team won the FCIAC championship,
- The women’s cross-country team won its first FCIAC title since 1981 and came in second at the state championships,
- The men’s crew team had their best results in the history of the program at the Head of the Charles,
- The Model UN Club won eight awards at the Princeton University Model United Nations Conference, and
- The GHS debate team came in first place at the Connecticut Debate Tournament

These outcomes make sense because students with later school start times get more sleep, and students that get more and better sleep perform better in academics and athletics.

Second, Greenwich experienced some unique logistical difficulties that probably would not occur at all or to the same extent in Westport.

- **General:** It is possible that the implementation team in Greenwich could have prevented some problems from occurring through better planning in the 14 months prior to the start of the 2017 – 2018 school year. The Greenwich School District had new administrators in key positions, including the Superintendent, Chief Operating Officer, and head of transportation. The start time project manager also left the school district and was never replaced. It is unlikely that our seasoned administrators and implementation committee would make the same mistakes, especially with the benefit of knowing the hiccups that occurred in other towns like Greenwich.

- **Transportation:** Some of the initial bussing problems in Greenwich could have been ameliorated by better planning. Reportedly, administrators made modifications to the school bus consultants’ plan on their own. Then there was no dry run of the new bus routes. Had this occurred, bus drivers probably wouldn’t have gotten lost or been late and administrators would have realized in advance that a main road needed to be repaved to accommodate some of the new, larger busses. As explained in the op-ed, transportation-related problems have been ironed out: “Bus ridership is up sharply, presumably because students no longer have to choose between catching a very early bus or driving to school so they can get more sleep. With the addition of three extra busses and some route fine-tuning, 100 percent of busses are now arriving before the bell time in the morning.”
■ **Traffic Congestion:** School start times aside, Greenwich High School has a difficult location for purposes of traffic, regardless of what time school starts and ends. The school is near I-95 and right off what is effectively Post Road in Greenwich. The town is also in a tough spot for purposes of traveling to games and competitions after school. Greenwich is on the western border of the FCIAC Conference, which means that travel to away games is always in the direction of rush hour traffic. Westport is more centrally located, and we can ask our independent school bus consultants to come up with start-time scenarios that are traffic neutral or possibly even improve traffic flow.

■ **Field Lighting:** The football team ended up having some post-regular-season practices with little daylight. With respect to field lighting, Greenwich High School is in a uniquely difficult situation due to more burdensome zoning regulations and a litigious neighbor. All officials were aware of these issues over a year before the 2017-2018 school year, but the school board didn’t approach the P&Z to install temporary field lights until October 2017 (this application hasn’t been decided and football season is over). And the district only recently decided to pursue litigation to relax the restrictions on the high school field lighting. The district could have started these efforts a year earlier or explored other solutions such as using nearby fields and lighting at Central Middle School, installing a temporary bubble over the GHS fields, or reducing the football’s team practice time from 3 hours to 2.5 hours. Sports are an important component of student life, and later school start times would improve our athlete’s performance dramatically. Our excellent school administrators work together and with local youth athletic organizations to iron out implementation logistics related to athletics.

■ **Missed Classes for Athletes:** As mentioned previously, Greenwich is on the western border of the FCIAC. The town’s sports teams already have to travel greater distances than Westport student athletes because Westport is more centrally located. And Greenwich makes every one of these trips in the direction of rush hour traffic. Our student athletes would not have to leave as early to get to away games. For the students that do have to leave early, however, why not use the new start times as impetus for having any class recorded that must be missed for athletes to attend away games. These classes would be known well in advance, so it wouldn’t be burdensome to plan, and the technology involved to do so is relatively inexpensive. If we could do this, our athletes might end up “missing” less class than they did before the start times changed.

Back To The Top