

**SPECIAL LEGISLATIVE
COMMISSION TO STUDY ALL
ASPECTS INVOLVED IN
CHANGING THE START TIME
OF RHODE ISLAND'S PUBLIC
HIGH SCHOOLS
FINAL REPORT**



**CHAIR JULIE CASIMIRO
HOUSE OF REPRESENTATIVES**

JULY 17, 2018

SCHOOL START TIMES COMMISSION REPORT
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Department of Education

2017-2018 Enabling Legislation

2017 - H 5888 SUBSTITUTE A: HOUSE RESOLUTION RELATING TO EDUCATION - SCHOOL COMMITTEES AND SUPERINTENDENTS

This resolution would establish a fifteen (15) member special legislative commission to study all aspects involved in changing the start time of Rhode Island's public high schools.

2018- H 7270: HOUSE RESOLUTION EXTENDING THE REPORTING AND EXPIRATION DATES OF THE SPECIAL LEGISLATIVE COMMISSION RELATING TO EDUCATION - SCHOOL COMMITTEES AND SUPERINTENDENTS

This resolution would extend the reporting and expiration dates of the special legislative commission relating to education – school committees and superintendents from January 31, 2018, to June 30, 2018, and said commission would expire on July 30, 2018.

2017 -- H 5888 SUBSTITUTE A

LC001988/SUB A

STATE OF RHODE ISLAND

IN GENERAL ASSEMBLY

JANUARY SESSION, A.D. 2017

HOUSE RESOLUTION

RELATING TO EDUCATION - SCHOOL COMMITTEES AND SUPERINTENDENTS

Introduced By: Representatives Casimiro, Donovan, Craven, McNamara, and Shekarchi

Date Introduced: March 09, 2017

Referred To: House Finance

1

RESOLVED, That a special legislative commission be and the same is hereby created

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consisting of fifteen (15) members: three (3) of whom shall be members of the House of

3

Representatives, not more than two (2) of whom shall be from the same political party, to be

4

appointed by the Speaker of the House; one of whom shall be the Rhode Island Commissioner of

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Elementary and Secondary Education, or designee; one of whom shall be the President of the

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Rhode Island Association of School Committees, or designee; three (3) of whom shall be

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Superintendents of Rhode Island school districts, one from a small district, one from a medium

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sized district, and one from a large school district, to be appointed by the Executive Director of

9

the Rhode Island School Superintendents' Association; one of whom shall be the President of the

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Rhode Island Chapter of the American Federation of Teachers, or designee; one of whom shall be

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the President of the Rhode Island Chapter of the National Education Association, or designee;

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one of whom shall be the Executive Director of the Rhode Island Interscholastic League, or

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designee; one of whom shall be the President of the Rhode Island League of Charter Schools, or

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designee; one of whom shall be the Chair of the Board of Directors at Rhode Island Mayoral

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Academies, or designee; one of whom shall be the Executive Director of the Rhode Island State

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Nurses Association, or designee; and one of whom shall be the President of the Rhode Island

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Medical Society, or designee.

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In lieu of any appointment of a member of the legislature to a permanent advisory

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commission, a legislative study commission, or any commission created by a General Assembly

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resolution, the appointing authority may appoint a member of the general public to serve in lieu

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of a legislator.

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The purpose of said commission shall be to study all aspects involved in changing the

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start time of Rhode Island's public high schools including, but not limited to, the fiscal impact on

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school districts, relevant health and educational issues, and the coordination of state-wide

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afterschool activities, and to make recommendations with respect thereto.

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Forthwith upon passage of this resolution, the members of the commission shall meet at

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the call of the Speaker of the House and organize and shall select, from among the legislators, a

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chairperson. Vacancies in said commission shall be filled in like manner as the original

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appointment.

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The membership of said commission shall receive no compensation for their services.

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All departments and agencies of the state shall furnish such advice and information,

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documentary and otherwise, to said commission and its agents as is deemed necessary or

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desirable by the commission to facilitate the purposes of this resolution.

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The Speaker of the House is hereby authorized and directed to provide suitable quarters

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for said commission; and be it further

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RESOLVED, That the commission shall report its findings and recommendations to the

17

House of Representatives no later than January 31, 2018, and said commission shall expire on

18

March 31, 2018.

LC001988/SUB A

LC001988/SUB A - Page 2 of 3

EXPLANATION
BY THE LEGISLATIVE COUNCIL
OF
HOUSE RESOLUTION
RELATING TO EDUCATION - SCHOOL COMMITTEES AND SUPERINTENDENTS

1

This resolution would establish a fifteen (15) member special legislative commission to

2

study all aspects involved in changing the start time of Rhode Island's public high schools. This

3

commission would report its findings and recommendations to the House of Representatives no

4

later than January 31, 2018, and would expire on March 31, 2018.

LC001988/SUB A

LC001988/SUB A - Page 3 of 3

2018 -- H 7270

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LC004028
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STATE OF RHODE ISLAND

IN GENERAL ASSEMBLY

JANUARY SESSION, A.D. 2018

HOUSE RESOLUTION

**EXTENDING THE REPORTING AND EXPIRATION DATES OF THE SPECIAL
LEGISLATIVE COMMISSION RELATING TO EDUCATION - SCHOOL COMMITTEES
AND SUPERINTENDENTS**

Introduced By: Representatives Casimiro, Vella-Wilkinson, Phillips, Donovan, and
McNamara

Date Introduced: January 24, 2018

Referred To: House Health, Education & Welfare

1 RESOLVED, That the special legislative commission created by resolution No. 314
2 passed by the House of Representatives at its January session, A.D. 2017, and approved June 13,
3 2017, entitled "House Resolution Relating to Education – School Committees and
4 Superintendents" is hereby authorized to continue its study and make a report to the House on or
5 before June 30, 2018, and said commission shall expire on July 30, 2018; and be it further

6 RESOLVED, That the time for reporting authorized by resolution No. 314 passed by the
7 House of Representatives at its January session, A.D. 2017, and approved June 13, 2017, be and
8 the same is hereby rescinded.

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LC004028
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EXPLANATION
BY THE LEGISLATIVE COUNCIL
OF
HOUSE RESOLUTION
EXTENDING THE REPORTING AND EXPIRATION DATES OF THE SPECIAL
LEGISLATIVE COMMISSION RELATING TO EDUCATION - SCHOOL COMMITTEES
AND SUPERINTENDENTS

1 This resolution would extend the reporting and expiration dates of the special legislative
2 commission relating to education – school committees and superintendents from January 31,
3 2018, to June 30, 2018, and said commission would expire on July 30, 2018.

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LC004028
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LC004028 - Page 2 of 2

List of Commission Members

- Chairwoman Representative Julie Casimiro: [House of Representatives](#)
- Representative Susan Donovan: [House of Representatives](#)
- Lieutenant Governor Daniel McKee: [Rhode Island Mayoral Academies](#)
- Dr. Phil Auger: [North Kingstown School District](#)
- Mr. Robert Mitchell: [Cumberland School District](#)
- Ms. Colleen Burns Jermain: [Newport School District](#)
- Ms. Donna Policastro: [Rhode Island State Nurses Association](#)
- Mr. Robert Walsh: [Rhode Island Chapter of the National Education Association \(NEARI\)](#)

- Dr. Colleen Callahan: [Rhode Island Board of Education](#)
- Mr. Thomas Mezzanotte: [Rhode Island Interscholastic League](#)
- Mr. Keith Oliveira: [Rhode Island League of Charter Schools](#)
- Mr. Andy Andrade: [Rhode Island Department of Education](#)
- Ms. Kelly Erinakes: [Rhode Island Chapter of the American Federation of Teachers \(RIFT\)](#)
- Mr. Steven Detoy: [Rhode Island Medical Society](#)

Meeting Agendas:

SPECIAL LEGISLATIVE COMMISSION TO STUDY ALL ASPECTS INVOLVED IN CHANGING THE START TIME OF RHODE ISLAND'S PUBLIC SCHOOLS

NOTICE OF MEETING

DATE: October 4, 2017

TIME: 4:00 PM

**PLACE: Room 101
Rhode Island Statehouse**

- I. Call Meeting to Order**
- II. Election of Chairperson and Vice Chairperson**
- III. Discussion of the Scope of the Commission**
- IV. Next Meeting & Adjournment**

***There will be no public testimony at this meeting**

Please contact Kendra Cervone Maynard at House Policy with questions

kcervone@rilegislature.gov (401)-528-1762

**SPECIAL LEGISLATIVE COMMISSION TO STUDY ALL
ASPECTS INVOLVED IN CHANGING THE START TIME OF
RHODE ISLAND'S PUBLIC SCHOOLS**

NOTICE OF MEETING

DATE: Tuesday October 31, 2017

TIME: 3:00 PM

**PLACE: Room 101
Rhode Island Statehouse**

- I. Call Meeting to Order**
- II. Presentation by Dr. Richard Millman**
- III. Next Meeting Date and Adjournment**

***No Public Testimony will be accepted at this meeting**

Please contact Kristen Dart with questions

kdart@rilegislature.gov (401) 528-1764

**SPECIAL LEGISLATIVE COMMISSION TO STUDY ALL ASPECTS
INVOLVED IN CHANGING THE START TIME OF RHODE ISLAND'S
PUBLIC SCHOOLS**

NOTICE OF MEETING

DATE: December 12, 2017

TIME: 4:00 PM

**PLACE: Room 101
Rhode Island Statehouse**

- I. Call Meeting to Order and Openings Remarks by Chair Casimiro**
- II. Presentation by Carolyn Mark, East Greenwich School Committee Chair**
- III. Michael B. Messoro III, Barrington Public Schools Superintendent**

***There will be no public testimony at this meeting**

Please contact Kendra Cervone Maynard at House Policy with questions

kcervone@rilegislature.gov (401)-528-1762

**SPECIAL LEGISLATIVE COMMISSION TO STUDY ALL ASPECTS
INVOLVED IN CHANGING THE START TIME OF RHODE ISLAND'S
PUBLIC SCHOOLS**

NOTICE OF MEETING

DATE: January 8th, 2018

TIME: 4:00 PM

**PLACE: Room 101
Rhode Island Statehouse**

- I. Call Meeting to Order**
- II. Public Testimony***

***Public testimony will be limited to two minutes.**

Please contact Kristen Dart with questions

kdart@rilegislature.gov (401) 528-1764

**SPECIAL LEGISLATIVE COMMISSION TO STUDY ALL ASPECTS
INVOLVED IN CHANGING THE START TIME OF RHODE ISLAND'S
PUBLIC SCHOOLS**

NOTICE OF MEETING

DATE: February 5, 2018

TIME: 4:00 PM

**PLACE: Room 205
Rhode Island Statehouse**

- I. Call Meeting to Order and Opening Remarks by Chair Casimiro**

- II. Commission Members Discussion of School Start Time Presentations and
Research To Date**

- III. Next Meeting & Adjournment**

***There will be no public testimony at this meeting**

Please contact Kendra Cervone Maynard at House Policy with questions

kcervone@rilegislature.gov (401)-528-1762

**SPECIAL LEGISLATIVE COMMISSION TO STUDY ALL ASPECTS
INVOLVED IN CHANGING THE START TIME OF RHODE ISLAND'S
PUBLIC SCHOOLS**

NOTICE OF MEETING

DATE: March 19, 2018

TIME: 10:00 AM

**PLACE: Room 101
Rhode Island Statehouse**

- I. Call Meeting to Order and Opening Remarks by Chair Casimiro**
- II. Presentation by Dimitris Bertsimas, Boeing Professor of Operations Research Co director, Operations Research Center, Massachusetts Institute of Technology**
- III. Presentation by Cynthia Brown, Director of Statewide Efficiencies, Rhode Island Department of Education Contact at the National Association of State Directors of Pupil Transportation Services**
- IV. Presentation by John Rivers, General Manager of Durham School Services**
- V. Next Meeting & Adjournment**

***There will be no public testimony at this meeting**

Please contact Kendra Cervone Maynard at House Policy with questions

kcervone@rilegislature.gov (401)-528-1762

**SPECIAL LEGISLATIVE COMMISSION TO STUDY ALL ASPECTS
INVOLVED IN CHANGING THE START TIME OF RHODE ISLAND'S
PUBLIC SCHOOLS**

NOTICE OF MEETING

DATE: April 30, 2018

TIME: 10:00 AM

**PLACE: Room 101
Rhode Island Statehouse**

- I. Call Meeting to Order and Opening Remarks by Chair Casimiro**

- II. Roundtable Discussion of Recommendations**

- III. Next Meeting & Adjournment**

***There will be no public testimony at this meeting**

Please contact Kendra Cervone Maynard at House Policy with questions

kcervone@rilegislature.gov (401)-528-1762

**SPECIAL LEGISLATIVE COMMISSION TO STUDY ALL ASPECTS
INVOLVED IN CHANGING THE START TIME OF RHODE ISLAND'S
PUBLIC SCHOOLS**

NOTICE OF MEETING

DATE: May 30, 2018

TIME: 12:00 PM

**PLACE: Room 101
Rhode Island Statehouse**

I. Call Meeting to Order and Opening Remarks by Chair Casimiro

II. Roundtable Discussion of Draft Report

III. Adjournment

***There will be no public testimony at this meeting**

Please contact Kendra Cervone Maynard at House Policy with questions

kcervone@rilegislature.gov (401)-528-1762

**SPECIAL LEGISLATIVE COMMISSION TO STUDY ALL ASPECTS
INVOLVED IN CHANGING THE START TIME OF RHODE ISLAND'S
PUBLIC SCHOOLS**

NOTICE OF MEETING

DATE: July 2, 2018

TIME: 11:00 AM

**PLACE: Room 101
Rhode Island Statehouse**

I. Call Meeting to Order and Opening Remarks by Chair Casimiro

II. Commission Discussion

III. Adjournment

***There will be no public testimony at this meeting**

Please contact Kendra Cervone Maynard at House Policy with questions

kcervone@rilegislature.gov (401)-528-1762

Data and Research

Numerous studies and surveys across the United States have been conducted with respect to the impact of a **later** start time for high school students. While the following excerpts from those studies and surveys do not provide a comprehensive analysis of this issue, it does provide a synopsis of the findings, and recurrent themes, derived from those studies and surveys.

According to *School Start Times, Sleep, Behavioral, Health, and Academic Outcomes: a Review of the Literature* by Anne G. Wheaton, PhD, et. al., the following were some findings:

Most adolescents need at least 9 hours sleep per night and fewer than 8% of high school students report getting this amount ¹.

Nearly all studies to date provide evidence that delaying school start time accomplishes the goal of increasing sleep duration among students, primarily by delaying rise times and most of the studies saw a significant increase in sleep duration even with relatively small delays in start times of half an hour or so. ¹

Later school start times also generally corresponded to improved attendance, less tardiness, less falling asleep in class, fewer depression symptoms, and fewer motor vehicle crashes. Although not all studies found that later start times corresponded to improved academic performance, no studies found a negative impact of later school start times on academics.¹

A solid body of literature has found that insufficient sleep in this young population is tied to poor mental health, including depression, depressive symptoms, and suicidal ideation. In addition, a few studies have shown an association between insufficient sleep and unhealthy risk behaviors including alcohol use, tobacco smoking, marijuana use, use of other illicit/prescription drugs, unhealthy weight control strategies, and recent sexual activity. Other factors that have been found to be associated with insufficient sleep include risk-taking behaviors, bullying, school violence-related behaviors, and physical fighting. Short sleep duration has also been found to be associated with a higher risk of unintentional injury. Also, students who do not get enough sleep also may be more likely to have problems paying attention and suffer from poor academic performance. ¹

¹ [Anne G. Wheaton, PhD, Daniel P. Chapman, PhD, and Janet B. Croft, PhD. \(2016\). School Start Times, Sleep, Behavioral, Health, and Academic Outcomes: a Review of the Literature. *Journal of School Health*, 86\(5\), 363-381.](#)

The following is according to *Sleep schedules and daytime functioning in adolescents. Child Development* by A.R. Wolfson and M.A. Carskadon.

A Sleep Habits Survey was administered in homeroom classes of 3,120 high school students at 4 public high schools from 3 Rhode Island school districts. Self-reported total sleep times (school and weekend nights) decreased by 40-50 minutes across ages 13-19. The sleep loss was due to increasingly later bedtimes, whereas rise times were more consistent across ages. Students who described themselves as struggling or failing school (C's, D's/F's) reported that on school nights they obtain about 25 minutes less sleep and go to bed an average of 40 minutes later than A and B students. In addition, students with worse grades reported greater weekend delays of sleep schedule than did those with better grades. Furthermore, this study examined adequate sleep habit groups versus less than adequate sleep habit groups on their daytime functioning. Students in the short school-night total sleep group (< 6 hours 45 minutes) and/or large weekend bedtime delay group (> 120 minutes) reported increased daytime sleepiness, depressive mood, and sleep/wake behavior problems versus those sleeping longer than 8 hours 15 minutes with less than 60 minutes weekend delay. Altogether, most of the adolescents surveyed do not get enough sleep, and their sleep loss interferes with daytime functioning.²

According to *Later High School Start Times May Benefit Teens' Mental Health* by Lynne Lamberg, A study in Rhode Island found that a delay in school start time was associated with improvements in high school students' alertness, mood, and health.

The study, which involved more than 200 students in grades 9 through 12 at a private school in Rhode Island, extends research showing that adjusting school schedules to adolescents' circadian rhythms and sleep needs benefits students' mental and physical health. Changes that occur in the biological clock at puberty make it hard for adolescents to fall asleep before 11 p.m., said Judith Owens, M.D., an associate professor of pediatrics at Brown University's Alpert Medical School, who directed the study.³

Chronic insufficient sleep undermines academic performance and boosts adolescents' risk of depressed mood and suicidal ideation, Owens said. It also contributes to drowsiness-related driving crashes, increased risk for weight gain and obesity, lack of exercise, and increased use of caffeine and other stimulants.³

With the later school start time, students in all grades slept 45 minutes longer on average on school nights. Mean sleep duration rose from 7 hours and 7 minutes to 7 hours and 52 minutes, more than researchers had anticipated. Some students reported they felt so much better with 30 minutes of extra sleep after the study began that they decided to go to bed earlier and sleep even longer. Before the change, only 16 percent of students reported sleeping at least eight hours a night; afterward, 55 percent did so. In both surveys, 12th graders slept about 40 minutes less than ninth graders. The researchers found depressive symptoms overall were inversely correlated with reported sleep duration. ³

² [Wolfson AR, Carskadon MA.](#) (1998). *Sleep schedules and daytime functioning in adolescents. Child Development*, 69(4), 875-87.

³ [Lynne Lamberg.](#) (2010). *Later High School Start Times May Benefit Teens' Mental Health. Psychiatric News.*

According to *The educational effects of school start times - Delaying secondary school start times can be a cost-effective policy to improve students' grades and test scores* by T.M. Shapiro, Hours of sleep are positively correlated with academic achievement, yet traditional secondary school schedules lead to sleep deprivation among adolescent students.⁴

Starting classes later in the morning improves grades in classes throughout the day and boosts standardized test scores. Even small adjustments in start time can have beneficial effects. Lower-ability students gain the most from delayed start times.⁴

Later start times are also shown to improve non-academic outcomes, such as mood and attendance, and reduce the frequency of automobile accidents.⁴

However, an optimal start time for secondary schools has not been determined. Starting school later will require ending school later, reducing the amount of time available for homework, jobs, and extracurricular activities. School districts that rely on one set of buses to serve all different levels of schools may need to purchase additional buses or change the start time for the other school levels. Reduced time for extracurricular activities may require scheduling adjustments or additional expenses. While changing start times is not costless, the benefits are likely to outweigh the costs.⁴

According to *Delayed high school start times later than 8:30 am and impact on graduation rates and attendance* by P.M. McKeever and L. Clark, Attendance rates and graduation rates significantly improved in schools with delayed start times of 8:30 am or later.⁵

According to *Insufficient Sleep in Adolescents and Young Adults: An Update on Causes and Consequences* by J. Owens, et al., Chronic sleep loss and associated sleepiness and daytime impairments in adolescence are a serious threat to the academic success, health, and safety of our nation's youth and an important public health issue. Adolescent sleep loss poses a serious risk to the physical and emotional health, academic success, and safety of our nation's youth. The prevalence and effects of insufficient sleep may be further magnified in high-risk adolescents.⁶

⁴ [Shapiro, T.M.](#) (2015, August). *The educational effects of school start times - Delaying secondary school start times can be a cost-effective policy to improve students' grades and test scores.*

⁵ [McKeever, P. M., Clark, L.](#) (2017). *Delayed high school start times later than 8:30 am and impact on graduation rates and attendance rates. Sleep Health, 3(2), 119-125.*

⁶ [Owens J; Adolescent Sleep Working Group; Committee on Adolescence. Au R, Carskadon M, Millman R, Wolfson A, Braverman PK, Adelman WP, Breuner CC, Levine DA, Marcell AV, Murray PJ, O'Brien RF.](#) (2014). *Insufficient Sleep in Adolescents and Young Adults: An Update on Causes and Consequences. Pediatrics, 134(3), e921-e932.*

According to *Sleep's effects on cognition and learning in adolescence* by MA. Carskadon, Strong evidence indicates that adequate sleep enhances memory consolidation and resistance to interference. Hence, insufficient sleep can also threaten learning by jeopardizing this part of the memory formation process.⁷

According to *Attention, Learning, and Arousal of Experimentally Sleep-Restricted Adolescents in a Simulated Classroom* by Dean W. Beebe, et al., Findings support the assertion that chronic sleep restriction during adolescence causes inattentive behaviors, poorer learning, and diminished arousal in the classroom. Coupled with previous questionnaire findings, these results suggest that the adverse effects of adolescent sleep restriction extend beyond basic sleepiness to include attention regulation and learning.⁸

According to *Sleep deprivation may be undermining teen health* by Siri Carpenter, Researchers at the University of Minnesota reported the results of a study of more than 7,000 high-school students whose school district had switched in 1997 from a 7:15 a.m. start time to an 8:40 a.m. start time. Compared with students whose schools maintained earlier start times, students with later starts reported getting more sleep on school nights, being less sleepy during the day, getting slightly higher grades and experiencing fewer depressive feelings and behaviors. Also troubling are findings that adolescent sleep difficulties are often associated with psychopathologies such as depression and attention deficit hyperactivity disorder (ADHD).⁹

According to *The sleep needs of adolescents* by BB Kelman, The amount of sleep affects the way adolescents perform, feel, think, learn, and remember. Some consequences of sleep deprivation include poor school performance, heightened risk of drug and alcohol use, increased irritability, and aggressive behavior, all of which can interfere with relationships with classmates, parents, and teachers.¹⁰

⁷ [Carskadon MA](#). (2011). *Sleep's effects on cognition and learning in adolescence*. *Progress in Brain Research*, 190, 137-43.

⁸ [Dean W. Beebe](#), PhD, [Douglas Rose](#), MD, and [Raouf Amin](#), MD. (2010) *Adolescent Health Brief: Attention, Learning, and Arousal of Experimentally Sleep-Restricted Adolescents in a Simulated Classroom*. *The Journal of Adolescent Health*, 47(5), 523-5.

⁹ [Siri Carpenter](#). (2001). *Sleep deprivation may be undermining teen health*. *Monitor on Psychology*, 32(9).

¹⁰ [Kelman BB](#). (1999). *The sleep needs of adolescents*. *The Journal of School Nursing*. 15(3), 14-9.

According to *Healthy School Start Times: Can We Do a Better Job in Reaching Our Goals?* By Richard Millman et al., A substantial body of evidence now supports the existence of significant health, mood, safety, and performance decrements associated with insufficient sleep in adolescents. Not only do chronic sleep loss and excessive daytime sleepiness in adolescents exist in epidemic proportions in the US, but these sleep decrements are associated with a wide range of impairments including higher rates of depression symptoms and suicidal ideation, increased risk-taking behaviors such as substance and alcohol use, poor school performance, more sports-related injuries, and an increased risk of motor vehicle accidents. ¹¹

In point of fact, numerous studies have now shown that delayed middle and high school start times are associated with increased sleep and lower self-reported daytime sleepiness, decreased tardiness and improved attendance, fewer depression symptoms, and improved academic performance and standardized test scores. Furthermore, a reduction in adolescent car crashes by as much as 65% to 70% in association with delayed start times has also been reported. ¹¹

According to *Benefits of later school start times* by Julie Boergers, Sleep deprivation has become virtually epidemic among American teenagers. Research suggests that adolescents require about 8.5 to 9.5 hours of sleep, but according to the National Sleep Foundation, only 14% achieve this goal, and approximately 70% of adolescents obtain less than 8 hours of sleep on a typical weeknight. This chronic sleep debt can have very serious consequences for the developing brain and body. Adolescents who do not achieve sufficient sleep are more irritable and depressed, and are at greater risk for suicidal ideation and suicide attempts than their peers. Chronic sleep deprivation can also undermine health, particularly metabolic and immune function, and can predispose adolescents to obesity. In addition to the effects on physical and mental health, research has also shown that inadequate sleep has a major impact on learning, memory, motivation, and academic performance. Sleep deprivation is associated with deficits in executive function, which includes organizational skill, working memory, and ability to apply sustained effort. ¹²

According to *Examining the Impact of Later High School Start Times on the Health and Academic Performance of High School Students: A Multi-Site Study* by Kyla Wahlstrom, et al., The results from this three-year research study, conducted with over 9,000 students in eight public high schools in three states, reveal that high schools that start at 8:30 AM or later allow for more than 60% of students to obtain at least eight hours of sleep per school night. Teens getting less than eight hours of sleep reported significantly higher depression symptoms, greater use of caffeine, and are at greater risk for making poor choices for substance use. Academic performance outcomes, including grades earned in core subject areas of math, English, science and social studies, plus performance on state and national achievement tests, attendance rates and reduced tardiness show significantly positive improvement with the later start times of 8:35 AM or later. Finally, the number of

¹¹ [Richard P. Millman, MD, Julie Boergers, PhD, and Judith Owens, MD, MPH.](#) (2016).

Healthy School Start Times: Can We Do a Better Job in Reaching Our Goals? *Sleep*, 39(2), 267-268.

¹² [Julie Boergers Ph.D.](#) (2015). *Benefits of later school start times.* *Brown University Child & Adolescent Behavior Letter*, 31(1), 1-6.

car crashes for teen drivers from 16 to 18 years of age was significantly reduced by 70% when a school shifted start times from 7:35 AM to 8:55 AM.¹³

According to *Changing Times: Findings From the First Longitudinal Study of Later High School Start Times* by Kyla Wahlstrom, In 1997 the seven comprehensive high schools in the Minneapolis Public School District shifted the school start time from 7:15 a.m. to 8:40 a.m. Numerous “beneficiaries” of a later high school start time emerge from the evidence in the study. The students benefited the most. For example, attendance rates for all students in grades 9, 10, and 11 improved in the years from 1995 to 2000, with the greatest rate of improvement for grade 9 students. Furthermore, students who did not have a pattern of continuous enrollment in the school district showed a marked improvement in their daily attendance rates after the initiation of the later start time in 1997–1998. Perhaps the most surprising finding was the discovery that Minneapolis high school students continue to get an hour’s more sleep each school night than is the case for students whose schools begin an hour earlier. The increased sleep was a finding after the first year of the late start, and it continued to be true 4 years into the change. 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 schools that start earlier in the day.¹⁴

According to *Sleep Patterns and Mental Health Correlates in US Adolescents* by Jihui Zhang, et al., A nationally representative cross-sectional survey of 10,123 US adolescents 13-18 years of age, the average weeknight bedtime was at 22:37 and sleep duration was 7.72 hours. Average weekend bedtime delay was 1.81 hours and average weekend oversleep was 1.17 hours. Later weeknight bedtime, shorter weeknight sleep duration, greater weekend bedtime delay, and both short and long periods of weekend oversleep were associated with increased odds of mood, anxiety, substance use, and behavioral disorders, as well as suicidality, tobacco smoking, and poor perceived mental and physical health.¹⁵

Suboptimal sleep patterns were associated with an array of mental disorders and other health-related outcomes among adolescents. In this large, nationally representative study of US adolescents, we found that the average weekday sleep duration of 7 hours 43 minutes was less than the 8-10 hours recommended by the National Sleep Foundation. Short sleep duration and later weekday bedtime were associated with mood, anxiety, substance use, and other behavior disorders, as well as smoking and poorer perceived mental and physical health.¹⁵

¹³ [Wahlstrom, Kyla; Dretzke, Beverly; Gordon, Molly; Peterson, Kristin; Edwards, Katherine; Gdula, Julie](#) (2014, February). *Examining the Impact of Later High School Start Times on the Health and Academic Performance of High School Students: A Multi-Site Study*. Retrieved from University of Minnesota Digital Conservancy website.

¹⁴ [Kyla Wahlstrom](#). (2002). *Changing Times: Findings From the First Longitudinal Study of Later High School Start Times*. *NASSP Bulletin*, 86(633), 3-21.

Adolescents with depressive symptoms reported later bedtimes and shorter sleep durations than their nondepressed counterparts. It was reported that adolescents with later (midnight or later) parent-set bedtimes were more likely to report depressive symptoms and suicidal ideation than adolescents with earlier (10:00 p.m. or earlier) parent-set bedtimes. It was also reported that late school year bedtimes among students in grades 7-12 were associated prospectively with emotional distress at 18-26 years of age. ¹⁵

In conclusion, we found that on average among US adolescents, weeknight sleep duration, and related patterns of sleep, such as later bedtime, weekend bedtime, and sleep delay, substantially deviate from recommended standards for optimal sleep. These suboptimal sleep patterns were associated with an array of DSM-IV disorders and other health-related outcomes among a representative sample of US adolescents.¹⁵

According to *Sleep Insufficiency, Sleep Health Problems and Performance in High School Students* by Xue Ming, et al., Advocacy for a delay in High School Start time will likely improve students' health, thereby maximizing their potential for academic achievement. ¹⁶

¹⁵ [Jihui Zhang, MD, PhD, Diana Paksarian, MPH, PhD, Femke Lamers, PhD, Ian B. Hickie, MD, Jianping He, MS, Kathleen Ries Merikangas, PhD.](#) (2016). Sleep Patterns and Mental Health Correlates in US Adolescents. *The Journal of Pediatrics*, 182, 137-143. .

¹⁶ [Xue Ming, Rebecca Koransky, Victor Kang, Sarah Buchman, Christina E. Sarris, and George C. Wagner](#) (2011). Sleep Insufficiency, Sleep Health Problems and Performance in High School Students. *Clinical Medicine Insights: Circulatory, Respiratory, and Pulmonary Medicine*.

Presentation Information

The following information is derived from presentations made before this Commission by various individuals and organizations:

1. Carolyn Mark, Chairperson of the East Greenwich School Committee, provided testimony to the Commission with respect to the following points:
 - In 2016, the implementation of a later school start time was included in the District's Strategic Priorities.
 - Prior to the change in school start times, East Greenwich utilized a three-tiered bus-system. The previous school start time for high school and middle school was 7:33 AM, the previous start time for two elementary schools was 8:20 AM and the previous start time for two other elementary schools was 9:10 AM.
 - The goal was to limit bus runs to 30 minutes.
 - In 2016, the District utilized a two-tiered system.
 - High school and middle school start times were changed to 8:00 AM and the elementary school start time was changed to 8:50 AM. Elementary school start time was then changed to 9:10 AM in 2017 at the request of the bus company. .
 - The estimated cost increase to the District for these changes was \$89,000.
 - The cost of the start time change would have been closer to \$200,000 if these changes had not been made simultaneously.
 - The first year, subsequent to the time changes, did not go smoothly as there were issues related to busses not getting to school on time and students spending more time on the bus.

2. Michael Messore, Barrington Public Schools Superintendent, provided testimony to the Commission with respect to the following points:
 - Barrington began Health and Wellness Committee in 2011.
 - In 2013-2014 an Implementation Committee was formed.
 - Barrington school start times are as follows: High School - 7:40 AM., Middle School - 7:50 AM, and Elementary School at 8:15 AM.
 - The 2015 School Committee recommended revisiting the 8:30 AM school start time implementation.
 - The 2016 ad-hoc committee was created.
 - There was a Service and Advisory panel with 2 School Committee members, and members that included school representation, transportation, administer of finance, 2 students, 4 parents, and a community member and this panel talked to school districts throughout New England about issues and challenges to athletics.
 - Special Education transportation was a concern In that Special Education students are picked up by neighborhood. Accordingly, adding Special Education transportation was costly.
 - Finding bus drivers and school bus monitors proved to be difficult.
 - Athletic practice schedules have also been an issue.
 - 2017- 2018 Implementation did not occur due to floating bond and million-dollar budget cut issues. They began looking at a cost neutral approach.

3. Ms. Rosengard, a clinical psychologist and public health practitioner who has dedicated her professional life to working with adolescents, testified, and provided written testimony, to the Commission with respect to the following points:
 - Many public health and educational professional organizations have called on school districts to schedule their bell times to allow adolescents to get adequate sleep.
 - The importance of sleep for all of us cannot be understated and inadequate sleep leads to a multitude of health habits, emotional/mental health challenges as well as greater sports injuries and motor vehicle accidents.
 - The circadian rhythms of adolescents often make it difficult to fall asleep at an appropriate time to get enough sleep before the alarm clock wakes them for school in the morning.
 - Ms. Rosengard noted that she would like to help the Commission understand the need for a state-wide effort in support of later school start times.
 - Ms. Rosengard provided the Commission with details of what she personally experienced in connection with this issue in the town of Barrington.
 - Ms. Rosengard would encourage this Commission to set an ambitious goal for later school start times across the State that would allow communities to engage in healthy discussion and preparation for this important and impactful change.
 - Ms. Rosengard added that: providing communities who are poised and ready to shift their bell times with challenge grants to fund transportation subcommittees and address bus route inefficiencies; providing forums for sports coordinators to discuss how to address scheduling practices and contests with the later school start times; and evaluating a streamlined process for vendors who are interested in providing before/after school childcare within school settings to be accredited by DCYF, would provide infrastructure and resources for those districts that want to make the change, but need a bit of a motivational push.
 - Ms. Rosengard indicated that State mandates are difficult when the individual realities of each district are considered. However, Ms. Rosengard also indicated that she would feel comfortable with the State requiring that all districts make this change (i.e., middle/high schools not starting before 8:30am) and requiring those districts who are not able to make the change before the applicable deadline provide a rationale for their inability to make such a change, develop a plan to address the factors that currently prevent them from making such a change, and provide a goal as to when such a change can occur.
4. With respect to the presentation by Dr. Richard Millman, M.D.: Please see Exhibit A, which is attached hereto and incorporated by reference herein.
5. With respect to the presentation by the Massachusetts Institute of Technology Operations Research Center: Please see Exhibit B, which is attached hereto and incorporated by reference herein.
6. With respect to the presentation by the Rhode Island Department of Education: Please see Exhibit C, which is attached hereto and incorporated by reference herein.

POTENTIAL CHALLENGES TO IMPLEMENTING LATER SCHOOL START TIMES; POTENTIAL SOLUTIONS

Potential Challenges to Implementing Later School Start Times	Potential Solutions
Transportation Costs and Logistics	<ol style="list-style-type: none"> 1. Assess the transportation system of any District that has implemented this program. 2. Consider issuing a Request for Proposal (RFP) in order to minimize related costs.
Financial impact	Evaluate existing budget and divert moneys associated with lower priorities to support the program.
Effects on Athletics and Extra-Curricular Activities	Evaluate a later start time for after-school activities.
Impact to elementary and middle school start times	Initiate discussion with school principals, teachers, parents, teacher unions and school committee.

COMMISSION POSITION:

The members of this Commission hereby support the initiative of later school start times for Rhode Island high schools and acknowledge and adopt the contents of this report, including the recommendations contained herein.

COMMISSION RECOMMENDATIONS:

Based on the testimony and information presented to this Commission and related discussions that the Commission members have held with presenters, and amongst themselves, with respect to the concept of later high school start times, this Commission proposes the following recommendations:

1. Develop a comprehensive engagement strategy that will provide all interested parties, including, but not limited to, parents, students, teachers, teacher unions, local officials, local elected officials, school committee members, principals, and superintendents with all of the pertinent information related to later school start times, including the impact that later school start times may have on athletic and other extracurricular activities.
2. Coordinate the efforts of at least one volunteer school district, the Massachusetts Institute of Technology Operations Research Center, and the Rhode Island Department of Education in connection with the initiation of a pilot program that will study and evaluate potential efficiencies related to later school start times.
3. Develop and gather pertinent data, utilizing an appropriate data-based software application or otherwise, in order to provide all interested parties to formulate fully-informed decisions with respect to later school start times.
4. School Districts should evaluate and analyze their budgets and any estimated savings to support local incentives upon initiating a later school start time.
5. Initiate and evaluate a longitudinal study in conjunction with a research-based university that measures the impact that later school start times have on academic performance and graduation rates.
6. Propose that the Rhode Island Department of Education (RIDE) include questions related to later school start times in its annual survey in order to gather and track pertinent information and data related to various school start times issues.
7. Consider legislation that will support and facilitate school districts adopting the recommendations set forth above as soon as possible.

APPENDIX A – LETTER FROM CHAIR JULIE CASIMIRO



State of Rhode Island and Providence Plantations

HOUSE OF REPRESENTATIVES

REPRESENTATIVE JULIE A. CASIMIRO *District 31*
Committee on Health, Education and Welfare
Committee on Veterans' Affairs

July 17, 2018

Dear Commission Member:

I would like to thank each of you for your efforts, time, contributions and participation on the Special Legislative Commission to Study All Aspects Involved in Changing the Start Time of Rhode Island's public Schools. I am truly honored to have been the Chair of this study commission on a topic that I am very passionate about.

This commission consisted of representatives from the House of Representatives, the Lieutenant Governor of Rhode Island who represented the Rhode Island Mayoral Academies, the superintendent from the North Kingstown School district, the superintendent from the Cumberland School District, the superintendent from the Newport School District, the Rhode Island State Nurses Association, the Rhode Chapter of the National Education Association (NEARI), the Rhode Island Board of Education, the Rhode Island Interscholastic League, the Rhode Island, the Rhode Island League of Charter Schools, the Rhode Island Department of Education, the Rhode Island Chapter of the American Federation of Teachers (RIFT), and the Rhode Island Medical Society.

Over the course of eight months, we held eight meetings and the commission had the great opportunity to learn a lot about this topic through numerous presentations, testimony from various individuals and extensive intellectual discussions and debate.

I appreciate all of you taking time out of your busy schedules to attend these meetings, being engaged in discussion and by bringing your expertise to the table.

Due to the immensely dedicated, skilled and experienced members, it is my belief that we have been able to conclude our work at this time.

Once again, I would like to thank all of you personally for serving on this noteworthy House Commission.

Sincerely,

Julie A. Casimiro
State Representative
Exeter/North Kingstown
District, 31

EXHIBIT A - Presentation material, Dr. Richard Millman, M.D.

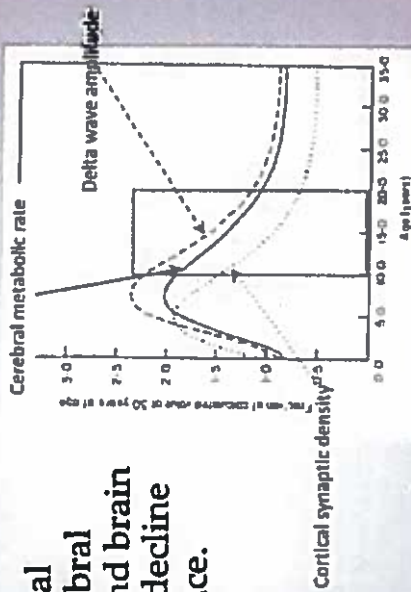
Changing School Start Times – Why Should You Care?

**Richard P Millman MD
Co-Director Hasbro Sleep Medicine Program
Professor of Medicine and Pediatrics
October 31, 2017**

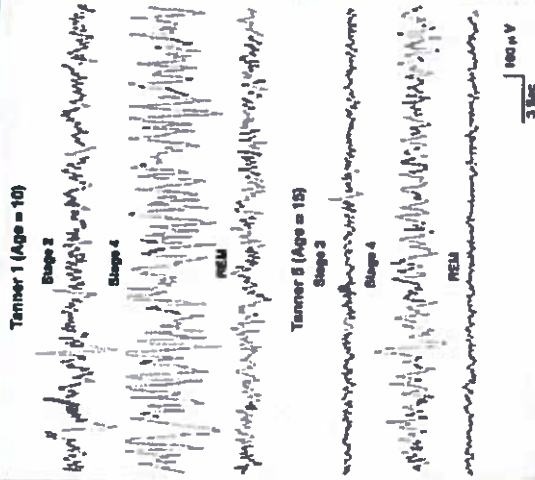


Adolescent Brain Changes

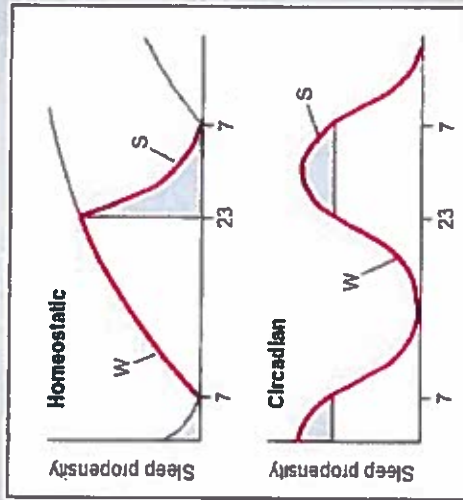
Density of neuronal connections, cerebral metabolic rate, and brain wave amplitude decline during adolescence.



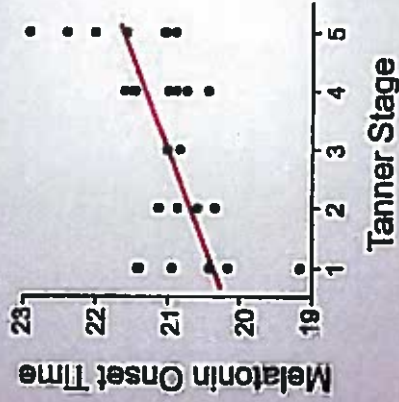
The "look" of sleep changes



Sleep regulation—2-process model (Borbély, 1982)



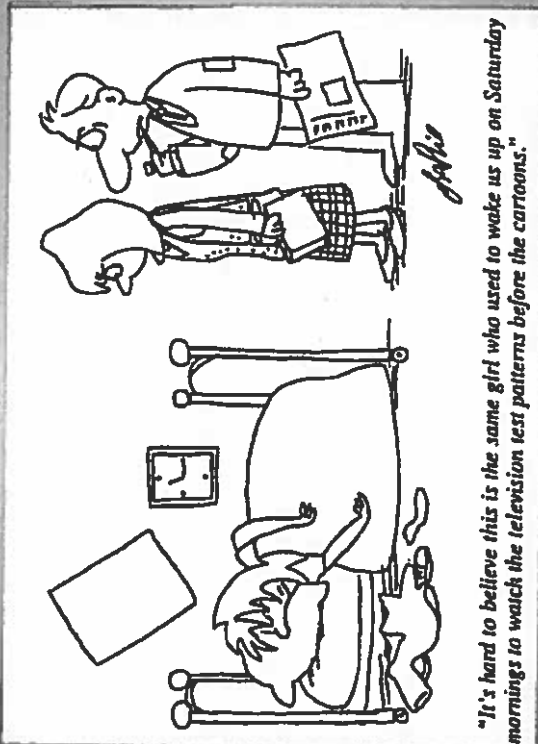
Melatonin Phase and Puberty Stage



- Melatonin = 'hormone of darkness'
- Melatonin = marks the brain's nighttime, gate for sleep
- Adolescence = later timing of melatonin

Major Developmental Trends in Adolescent Sleep Behavior

- Bedtime becomes later
- Rise time becomes later (weekends especially)
- Sleep amount decreases (school days especially)
- Weekday/weekend discrepancy increases



"It's hard to believe this is the same girl who used to wake us up on Saturday mornings to watch the television test patterns before the cartoons."

Other Factors Associated with Reduced Sleep

- 1. Blue light exposure from electronics
- 2. Before school and after school activities
- 3. Jobs
- 4. Increased caffeine ingestion
- 5. Alcohol and other substances

Consequences of Poor Sleep in Adolescents

- Excessive sleepiness
- Increased risk of unintentional injuries and death
- Increased automobile crashes
- Low grades and school performance
- Worse athletic performance
- Negative moods
- Increased suicides
- Increased likelihood of stimulant use
- Increased obesity
- Increased criminal activity after school

The Adolescent Health Paradox

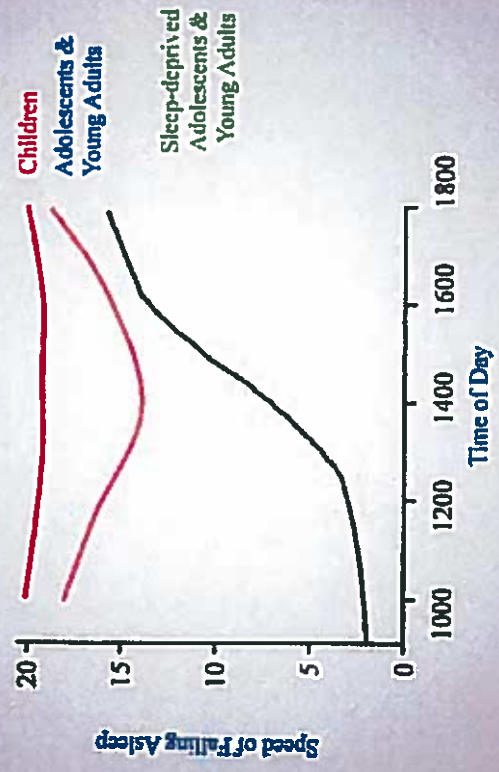
Paradox

- Adolescence is a developmental period of strength and resilience both physically and cognitively
- Yet, mortality rates increase by 200% in adolescents



(Dolan 2004)

Impact of Insufficient Sleep



Impact of Teen Driver Crashes

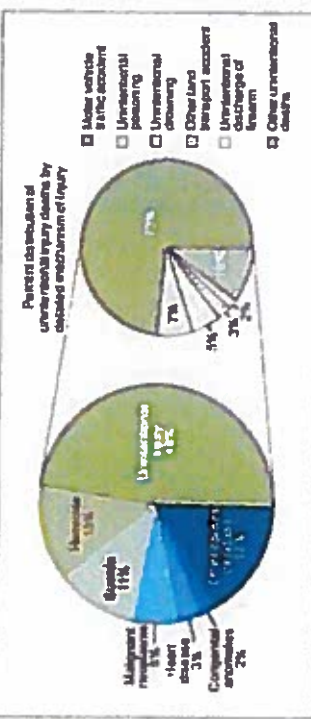
NHTSA Top 10 Leading Causes of Death in the United States in 2012, by Age

Rank	Cause and Number of Deaths									
	Infants Under 1	Toddlers 1-3	Young Children 4-7	Children 8-18	Young Adults 18-20	21-30	31-44	45-64	65-84	85+
1	Motor Vehicle Traffic 11,835	Accidental Drowning 323	Maligned Hip Fractures 360	Maligned Hip Fractures 763	Motor Vehicle Traffic 11,835	Motor Vehicle Traffic 11,835	Accidental Poisoning 7,737	Maligned Hip Fractures 10,158	Maligned Hip Fractures 10,158	Heart Disease 477,840
2	Chronic Diseases 4,899	Accidental Drowning 358	Motor Vehicle Traffic 1,124	Motor Vehicle Traffic 1,124	Motor Vehicle Traffic 4,899	Motor Vehicle Traffic 4,899	Substance Abuse 8,716	Heart Disease 18,429	Heart Disease 18,429	Maligned Hip Fractures 432,487
3	Heart Disease 235	Homecare 280	Accidental Poisoning 180	Homecare 180	Homecare 2,002	Homecare 2,002	Homecare 2,518	Homecare 2,518	Homecare 2,518	Chronic Liver Disease 141,049
4	Homecare 180	Maligned Hip Fractures 285	Accidental Poisoning 159	Homecare 319	Accidental Poisoning 830	Accidental Poisoning 830	Homecare 830	Accidental Poisoning 830	Accidental Poisoning 830	Chronic Liver Disease 122,375
5	Sepicemia 178	Maligned Hip Fractures 271	Homecare 159	Homecare 240	Maligned Hip Fractures 687	Maligned Hip Fractures 687	Maligned Hip Fractures 782	Maligned Hip Fractures 782	Maligned Hip Fractures 782	Stroke 100,127
6	Influenza/Pneumonia 159	Heart Disease 135	Eyesores to Smoke/Fire 78	Accidental Drowning 187	Heart Disease 528	Heart Disease 528	Heart Disease 564	Heart Disease 564	Heart Disease 564	Alzheimer's 82,680
7	Stroke 102	Maligned Hip Fractures 80	Heart Disease 58	Heart Disease 178	Accidental Drowning 180	Accidental Drowning 180	Accidental Drowning 221	Accidental Drowning 221	Accidental Drowning 221	Dementia 73,932

Source: National Highway Traffic Safety Administration, Motor Vehicle Traffic Deaths and Leading Causes of Death in the United States, 2002-2004; Hospital Mortality, 2002-2004.

What accounts for this paradox?

Figure 2. Percent distribution of all deaths to teenagers 12-19 years by cause of death, United States, 1995-2008

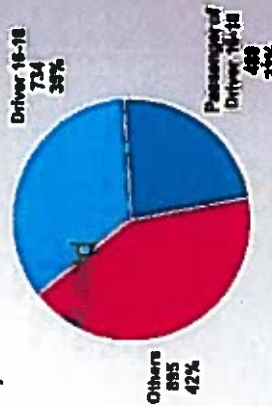
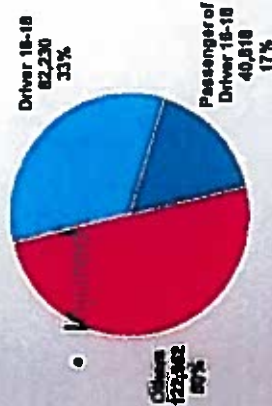


Source: National Highway Traffic Safety Administration, Motor Vehicle Traffic Deaths and Leading Causes of Death in the United States, 2002-2004; Hospital Mortality, 2002-2004.

CDC Data Brief #10

Impact of Teen Driver Crashes

- People Injured and Killed in Teen Driver Crashes
- (2015)



Data: Fatality Analysis Reporting System & General Inquiries System (NIS/ISVA)

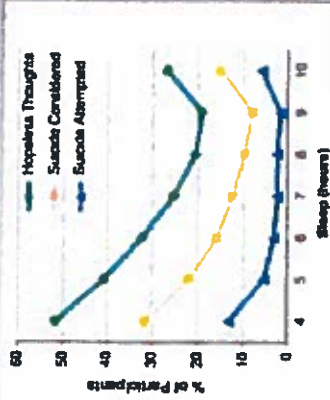
Sleep and Adolescent Suicide Behavior Lius Sleep 27:1351-8, 2004

	O.R. Suicidal Ideation	O.R. Suicide Attempts
<7 hours sleep	1.27	2.87
7-8 hours	1.04	2.89
8-9 hours	0.73	1.92
≥ 9 hours	1.00	1.00
Frequent Nightmares	1.75	2.43
Insomnia	1.30	1.24

N = 1362
 Mean age = 14.6 year
 Suicidal ideation 19.3%
 Suicide attempts 10.5%

Sleep and Suicide Risk

- 27,939 middle and high school students from Fairfax County
- Average sleep duration for high school students was 6.5 hours
- For each hour of lost sleep, there was a:
 - 38% increase in feeling sad/hopeless
 - 42% increase in considering suicide
 - 58% increase in suicide attempts



Sleepless in Fairfax: The Difference One More Hour of Sleep Can Make for Teen Hopelessness, Suicidal Mentation, and Substance Use

Winkler et al., 2015

Lack of Sleep is Associate with Obesity

Increased ghrelin production which tells your brain you are hungry
Decreased leptin which tells your brain you are full

It's not all about the morning...

- On school days, "prime time" for violent juvenile crime is from 3 PM to 6 PM.
- Also, when teens are most likely to be:
 - Victims of crime
 - Involved in a car crash (16-17 year olds)
 - Engage in other risky behaviors (e.g., sex, substance use)

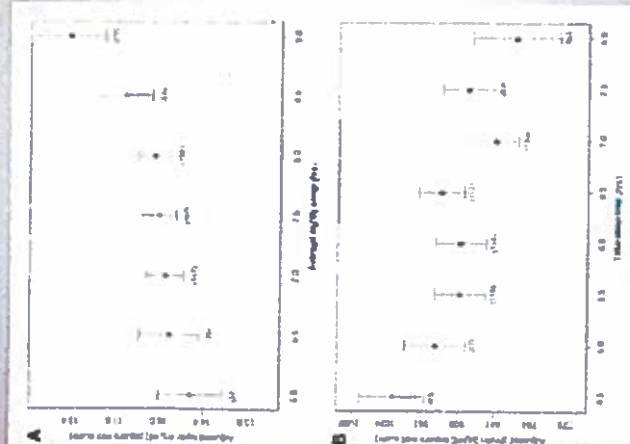
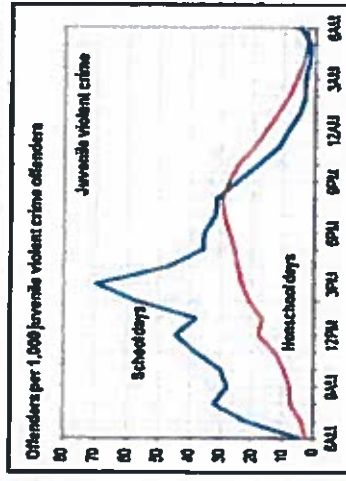


Figure 3. The Association between Sleep Duration and Striatal Lesion and Cerebral Levels

Taheri, PLoS Medicine 1:210-217, 2004

American Academy of Pediatrics Recommendations for School Start Times 2014

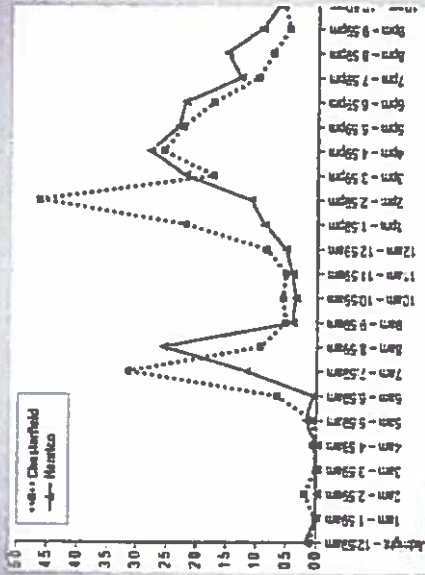
- The optimal length of sleep for adolescents is 8.5 – 9.5 hours of sleep
- To accomplish this they recommended that middle and high school students start class at 8:30 AM

Later Start Health Effects on Students

- Longer sleep duration (8+ hours)
- Less depression
- Less substance abuse
- Improved attendance
- Reduced tardiness
- Improved grades

Late Start Effects on Teachers

- 52% saw fewer students falling asleep in class
- Allows teachers time for better planning across subject areas
- Less than 1 in 5 teachers indicate middle and high school students are ready for learning before 8 AM
- Both elementary and secondary teachers note schedule changes affect their personal lives, but most say the benefits to students is worth it.



Impact of later school start times on crash rates

Weekday crash rate of 16 to 18-year age groups in Chesterfield County and Henrico County for School Year 2010-2011 (Sept. 2010-May 2011).
 Vorona et al / Clin Sleep Med 2014; 10:1169-1177

Later Start Time Impact on School Administrators

- Principals describe:
- 1. Less agitation in passing times
- 2. Fewer lunchroom incidents
- 3. Quieter "tone" to the entire building

School Start Time Impact on Parents

1. 92% of the parents say their child is "easier to live with"
2. Parents schedules need to be changed and they need adequate advance time to adjust their schedules

**So if Pushing Back School Start
Times is a Potential Solution Why
Hasn't it Happened**

- Inconvenience for families**
- School bus schedules have to be changed**
- Cost**
- Interference with athletics**
- Interference with afternoon jobs**
- Resistance of students**

The reality of Period Zero

Understanding Why Change is

Educational change: Difficult

- Slow and labor-intensive process
- Requires 3-5 years to be institutionalized
- Schools/Districts are self-contained systems—interfering with the rhythms of the system cause anxiety → resistance
- Stakeholders' beliefs that things are "better" after the change will ensure the change will persist.



Why Make the Change Statewide

1. One of the biggest push backs is in regards to athletics. If all the middle schools and high schools start and end at the same time sports can be better coordinated
2. Pulling resources across school districts may lead to innovation and better buy in

EXHIBIT B - Presentation material, Massachusetts Institute of
Technology Operations Research Center



Changing School Start Times

Empowering Leaders to Make Fair and Informed Decisions

Dimitris Bertsimas, Arthur Delarue, Sebastien Martin

Our Team



- ✓ **Dimitris Bertsimas**
 - Boeing Leaders for Global Operations Professor, MIT Sloan School of Management
 - Co-Director, MIT Operations Research Center
- ✓ **Arthur Delarue**, PhD Student
- ✓ **Sebastien Martin**, PhD Student



MIT Operations Research Center

- Established in 1953
- Almost 100 students and 50 faculty experts in **analytics** and **optimization**
- Mission: **data**, state-of-the-art **algorithms**, solve important problems



The bottleneck: School Transportation

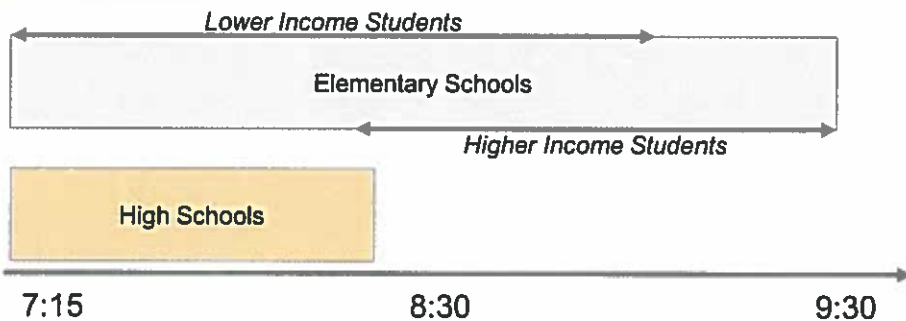


Boston Public Schools (BPS)

- 56,000 students
- 125 schools
- 20% students with disabilities
- 74% students are economically disadvantaged



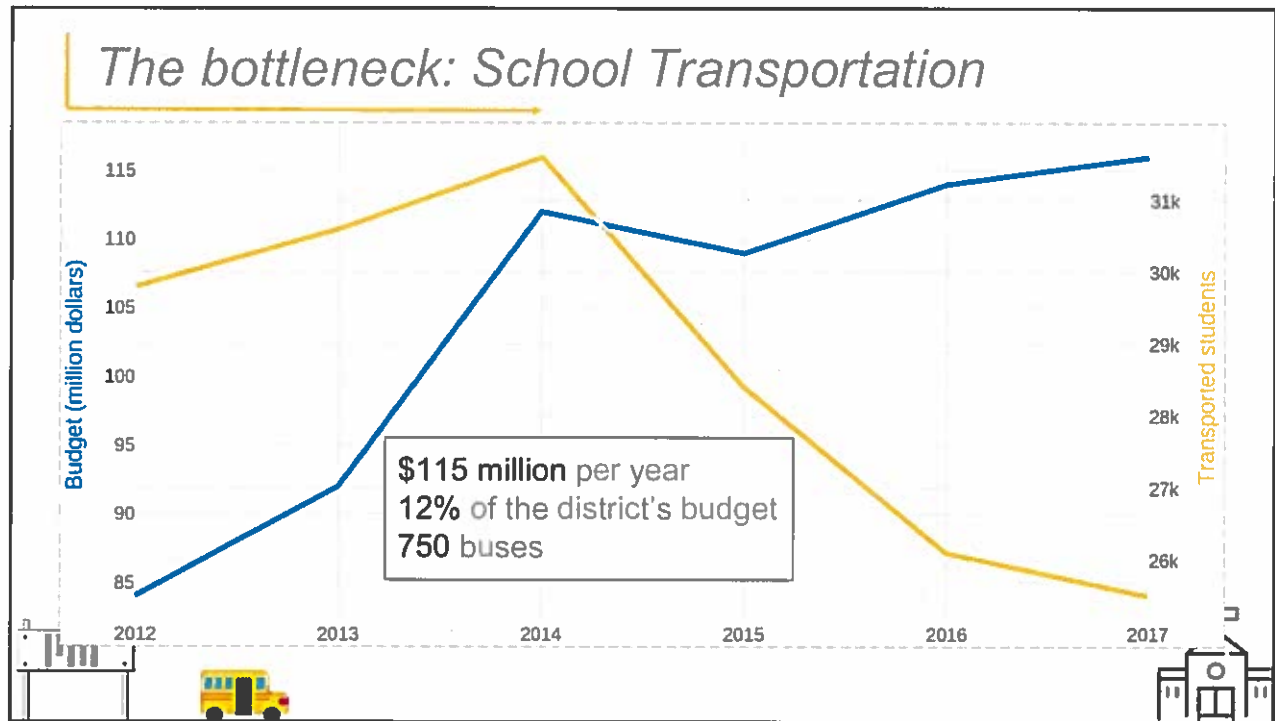
Boston: Why change current start times?




The Boston Globe

FEBRUARY 23, 2017

Let Boston high schoolers start school later









BPS Transportation Challenge



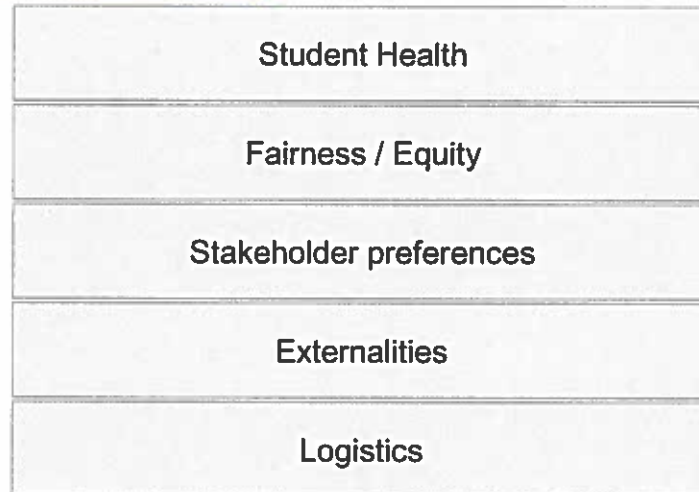
8-week hackathon

Apr-May 2017

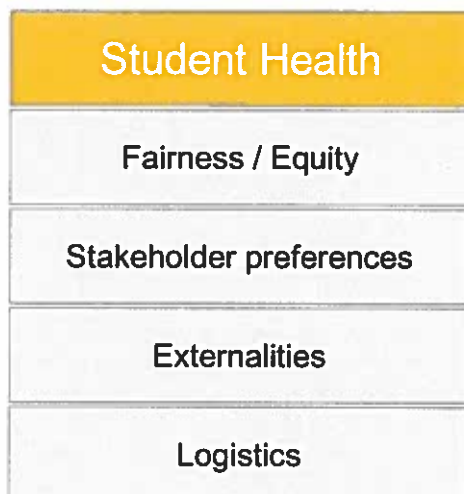
➤ Participants     ...

➤ Sponsors   ...

Changing Start Times: A Difficult Decision



Changing Start Times: A Difficult Decision



- Teenage sleep research
 - **Delaying school start time** leads to more sleep.
 - Impact on academic success and **mental health**.
 - Massive **economic consequences** in the long term.
- Special Education
 - Some students are more affected



Changing Start Times: A Difficult Decision

Student Health

Fairness / Equity

Stakeholder preferences

Externalities

Logistics

- Fairness
 - Across **communities** and neighborhoods.
 - Less "vocal" communities must also be heard.
- Equity
 - Using bell times as a tool to **help disadvantaged populations**.



Changing Start Times: A Difficult Decision

Student Health

Fairness / Equity

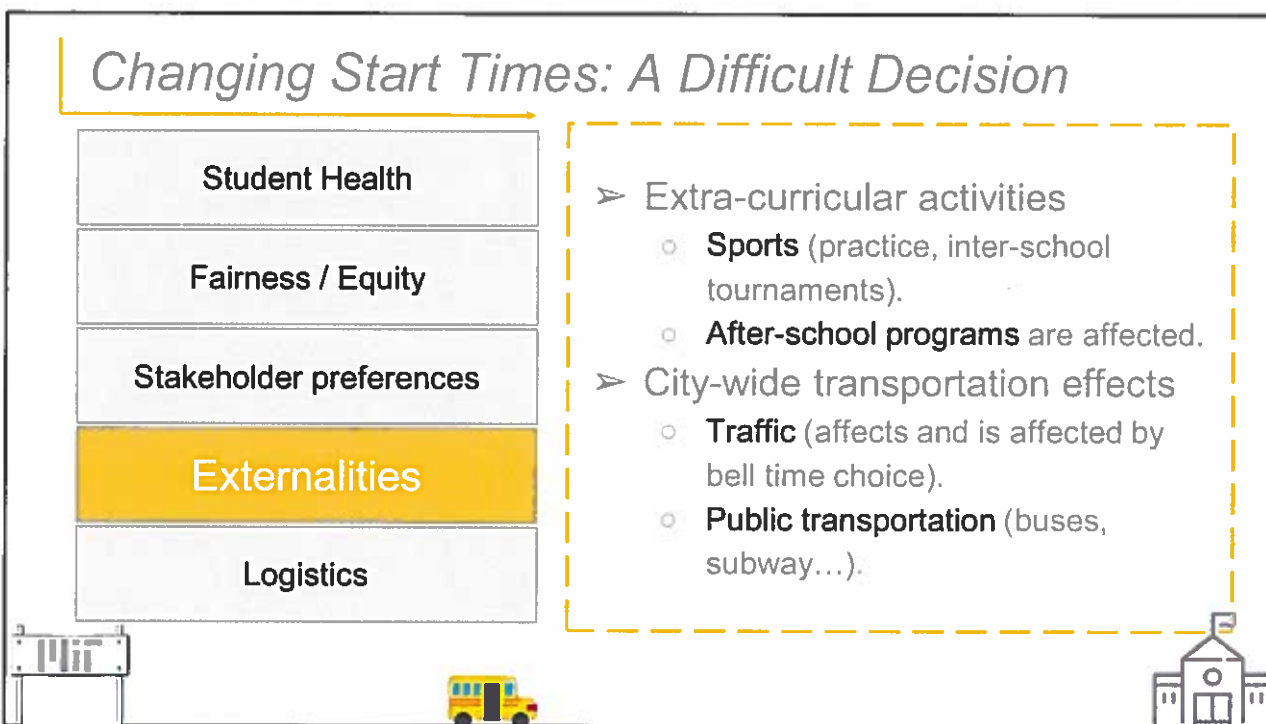
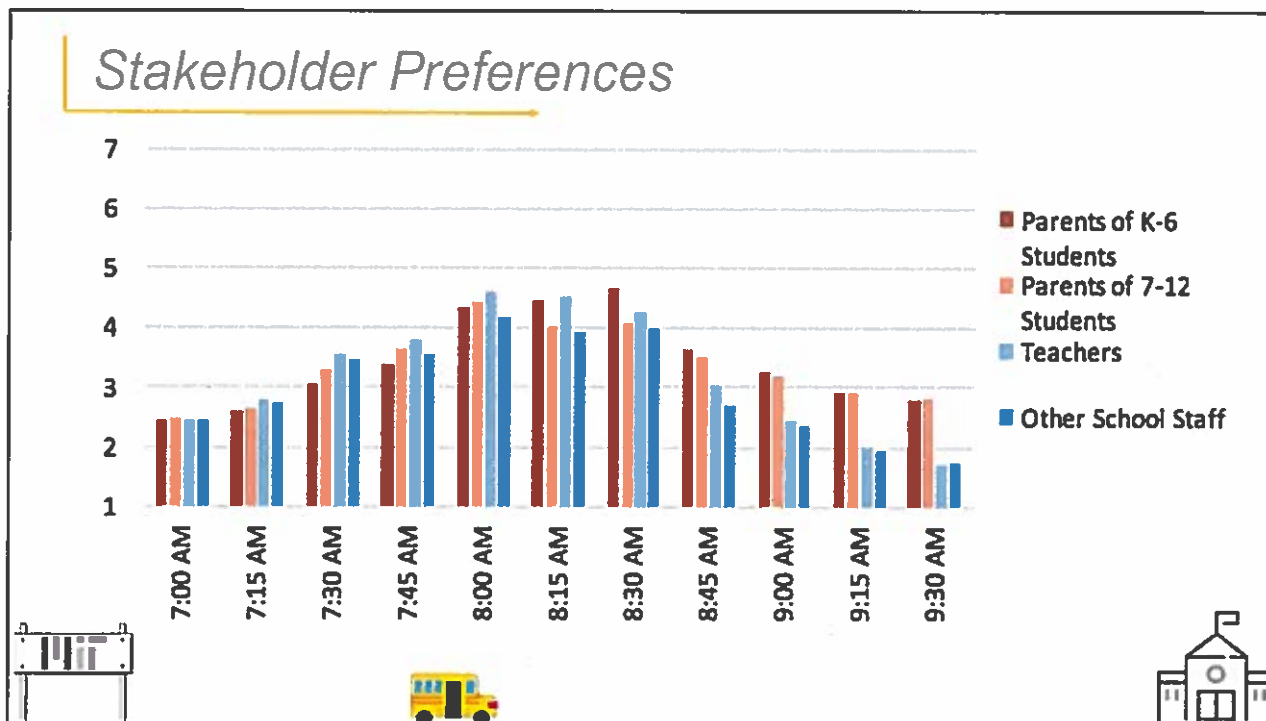
Stakeholders

Externalities

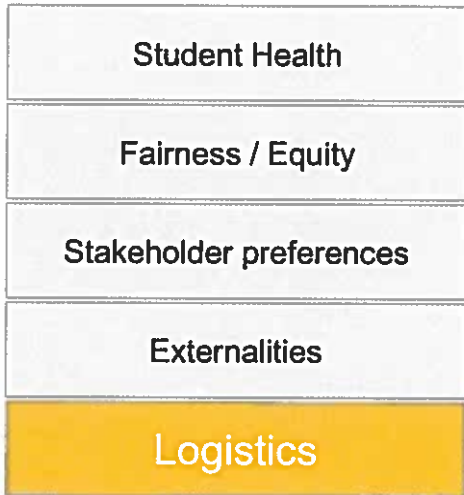
Logistics

- Preferences
 - **Staff/Teachers.**
 - **Parents** (esp. for young children).
 - **Students.**
- Interpretability and Education
 - An **understandable** bell time policy is easier to implement.





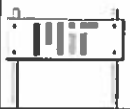
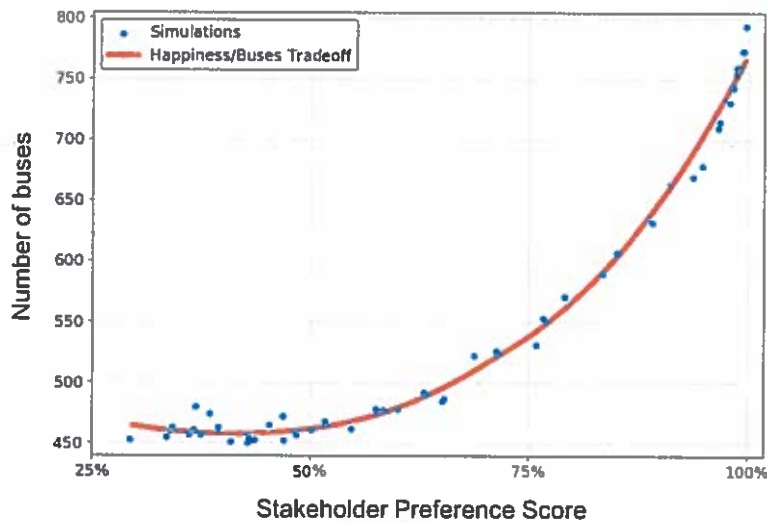
Changing Start Times: A Difficult Decision



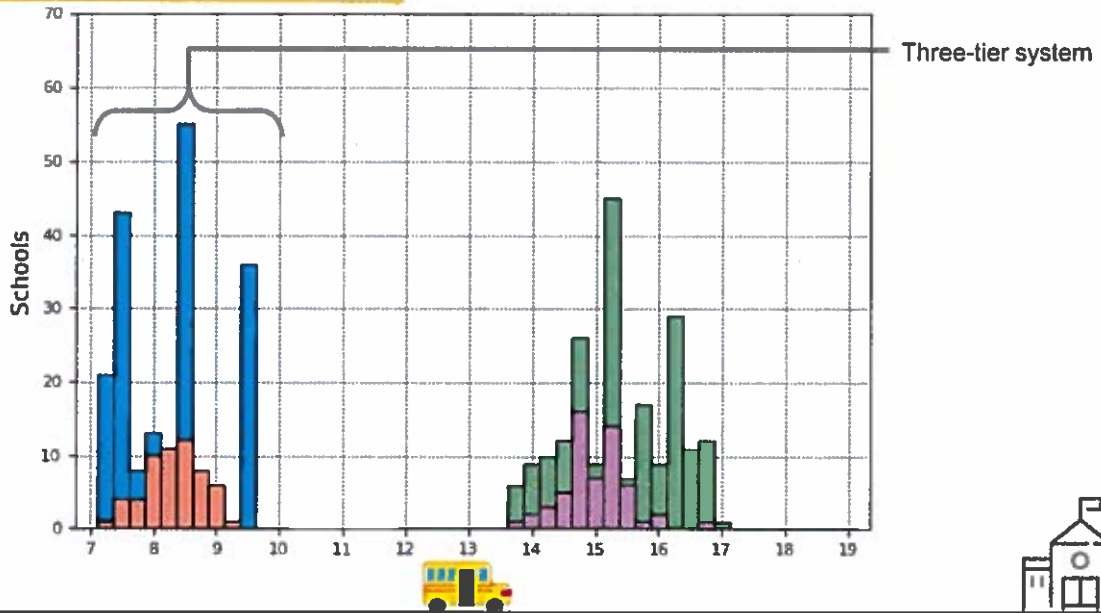
- Constraints and Limitations
 - State and federal regulations.
 - Tiered bell times.
 - Restrictions for specific schools.
- Minimal changes
 - Limiting the changes from the current start times can make implementation easier.



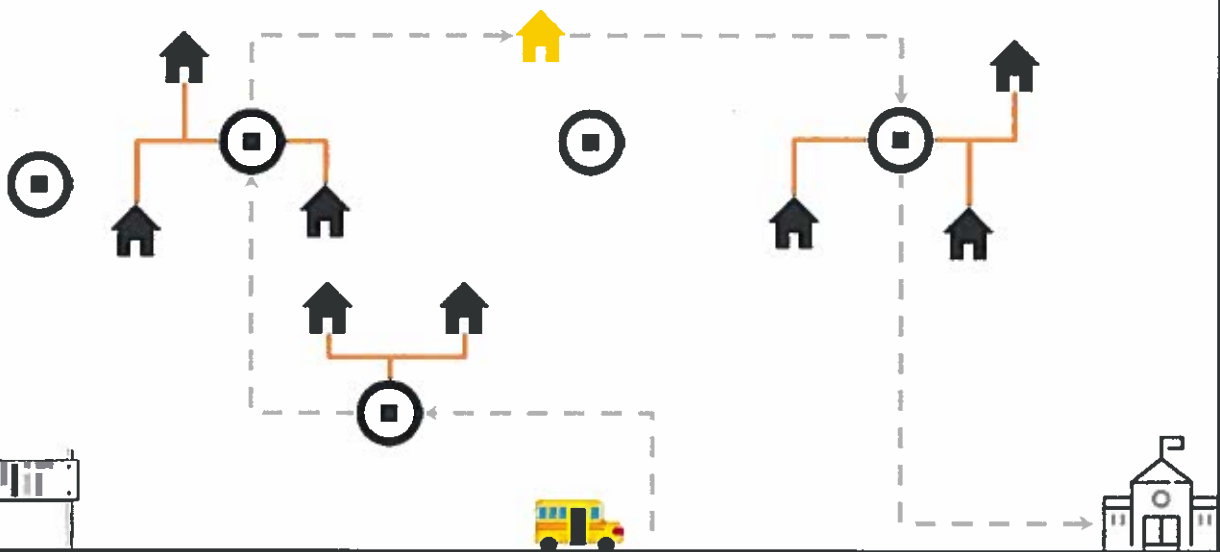
Impact of Bell Times on Transportation Costs



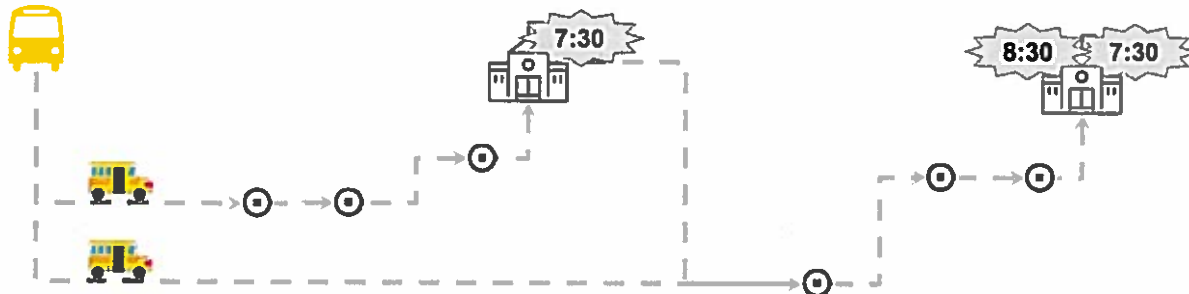
Current Bell Times in Boston



Routing Students to School



District-wide Routing



- > Staggering start times saves millions of dollars.
- > Changing start times must be done right to keep costs down.

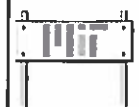


Problem Decomposition and Solution



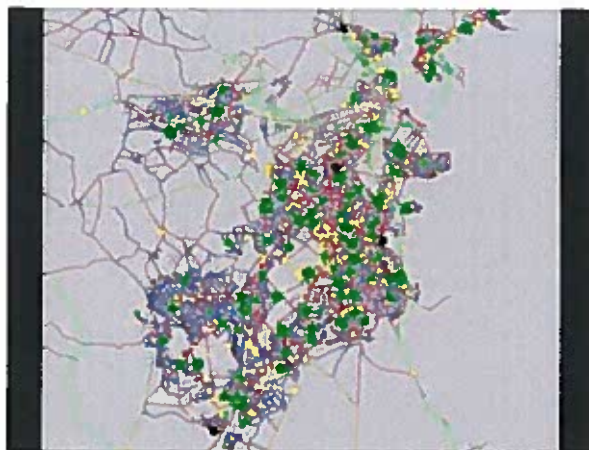
- > Decompose the routing problem into key components.
- > Assign students to corner stops balancing number of stops and walking distance.
- > Create varied, optimized routes for each school.
- > Connect routes between schools for optimal vehicle use.

Keywords: large-scale optimization, integer programming, randomized greedy heuristics, vehicle routing, constrained optimization, multi-stage mathematical formulation

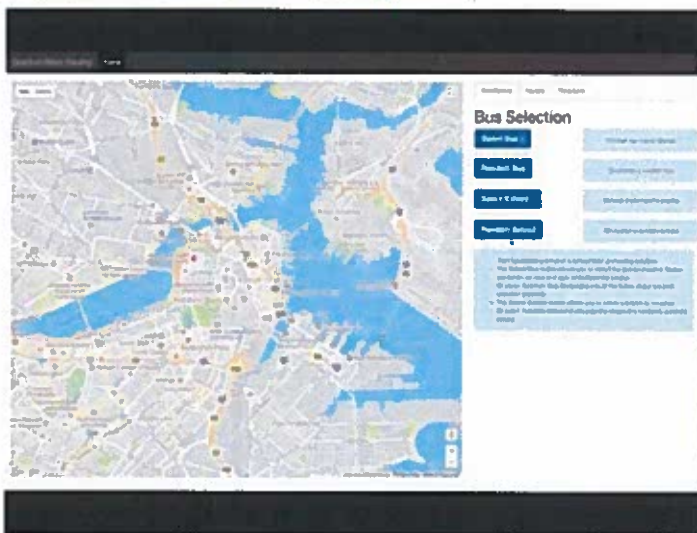


The Edge of Optimization

	BPS '16-17	MIT
Number of buses	650	520
Average time spent on bus	23 min	24 min
Average walking distance to stop	0.2 mi	0.2 mi
Computing time	6 weeks	3 hours
Computing resources	Team of 10	1 computer



Software



- Web interface to make manual final updates
- Smooth transition: start with **50 buses off the road** in 2017-2018



Boston Routing Implementation

THE WALL STREET JOURNAL. How Do You Fix a School-Bus Problem? Call MIT

An algorithm sorts out how to efficiently transport 30,000 Boston public-school students each day

90.9
wbur



2 MIT Engineers Use Math To Plot
A Path For Boston's School Buses



CREATING BETTER BUS ROUTES WITH ALGORITHMS

THE NEW ROUTES WILL SAVE THE BOSTON PUBLIC SCHOOL
DISTRICT MILLIONS.



Building a Bell Time Optimization Engine

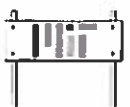
Transportation
Optimization



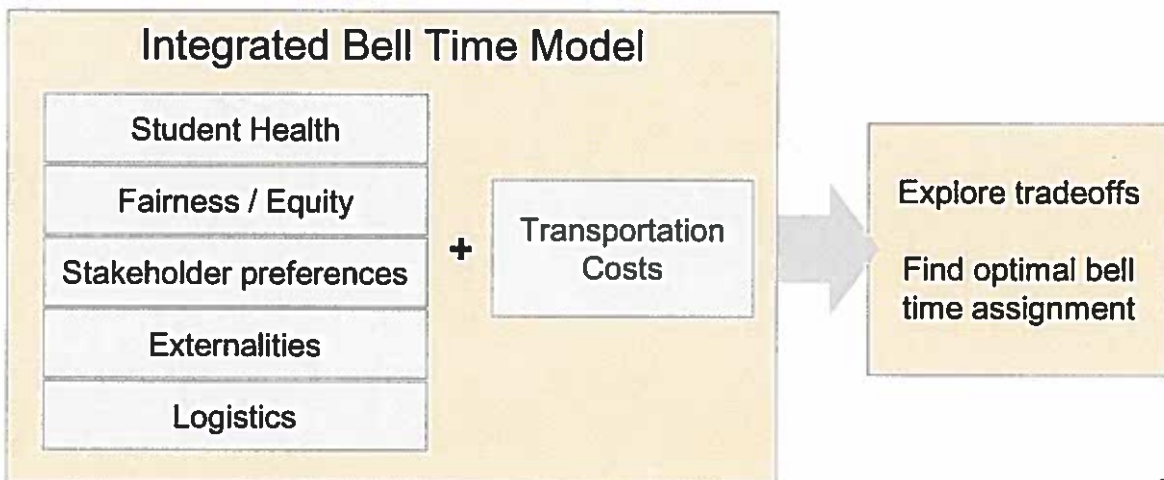
Bell Time
Optimization

- > Leverage transportation expertise to evaluate costs of different bell time assignments.
- > Mathematical formulation of objectives and constraints allows to find optimal bell time assignment.
- > Flexible approach tailored to community needs.

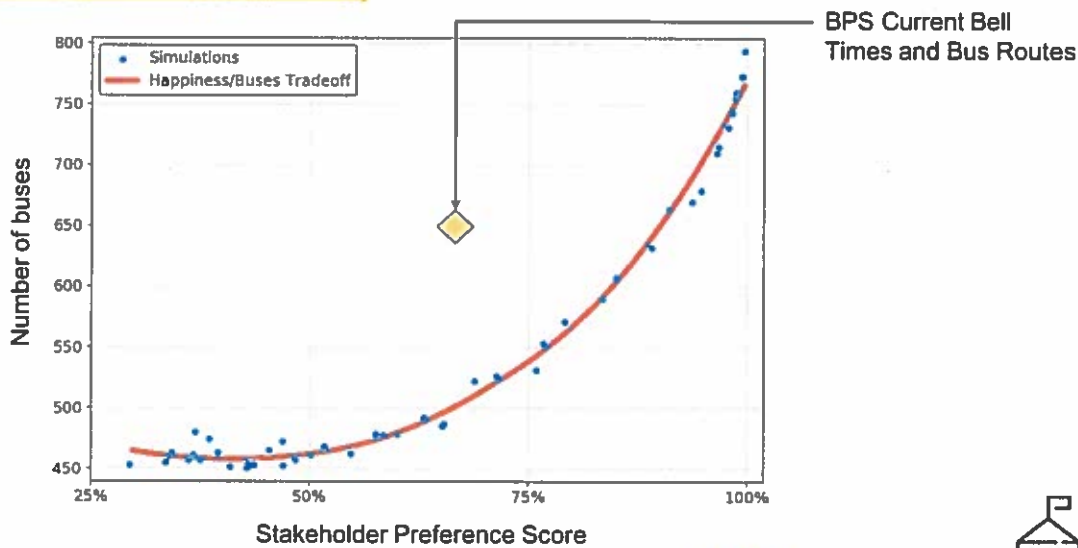
Keywords: quadratic assignment problem, multi-objective optimization, constraint formulation, objective definition, integer optimization, local improvement heuristics



Optimizing Bell Times



Exploring Tradeoffs Becomes Possible



Bell Time Optimization Engine

Community prioritizes bell time objectives

Transparent analytical process to balance priorities

Algorithm finds optimal bell times



Identifying Boston's priorities

An early start is bad for teenagers' health

Safety issues, spread out bell times of neighboring schools

Fair and equitable assignment

Working parents prefer earlier times

Stay-at-home parents prefer later times

MBTA: High school students can clutter the T and the buses

School staff preferences

Bell times should accommodate athletics

Reinvest Transportation money in schools

Young children should not finish too late

Boston traffic

Changing special education students' schedule can be difficult for them



School Committee Vote

City of Boston In School Committee

December 6, 2017

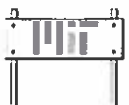
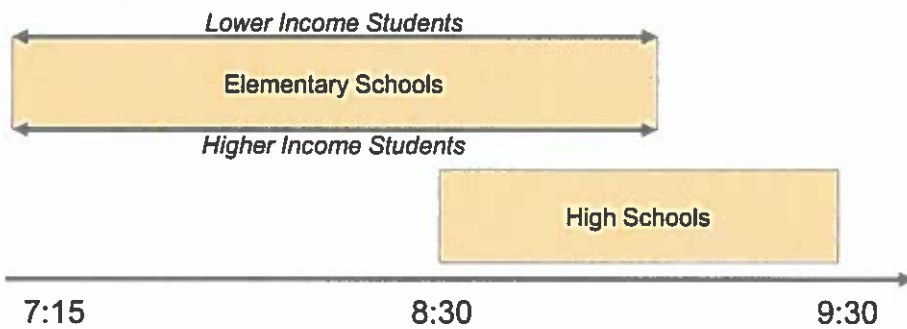
SCHOOL START TIMES REALIGNMENT

ORDERED, That the School Committee hereby approves a system-wide change for school start and end times that achieves the following goals:

- In line with research about start times that maximize learning, increase the number of secondary school students (with a specific goal of a majority of secondary school students) starting after 8 a.m.;
- Where possible, increase the number of elementary school students (with a specific goal of a majority of elementary school students) dismissing before 4 p.m.;
- Where possible, assign schools with higher concentrations of medically fragile students or students with autism or emotional impairment to bell times reflective of the needs of their student body;
- Where possible, do all of the above while maximizing reinvestment in schools.



Current Start Times vs. Algorithm Output



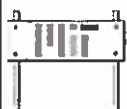
Achieving Later High School Start Times

	Previous Times	New Times
Elementary school students ending too late	33%	15%
High school students starting too early	73%	6%

+18M/year reinvested into schools

Reduced by a factor of 12

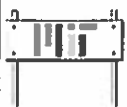
Reduced by a factor of 2

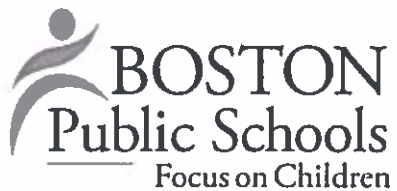


A Fair and Equitable Process

	Previous Times	New Times
White/Asian ES students starting after 8	~90%	~55%
Black/Hispanic ES students starting after 8	~70%	~55%

- Under the current system, black and Hispanic students are **three times more likely** to start school early than white/Asian students.
- Under the new system, all students are equally likely to start school early or late.



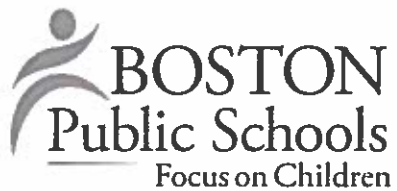


- **School Buses, 2018**
- **Start times, 2019**
- Coordinating the transportation of 50,000 homeless and special needs students across **Massachusetts.**



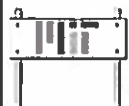
Thank you!



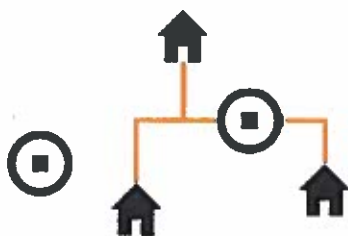


Appendix 1

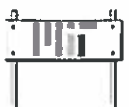
Transportation Optimization



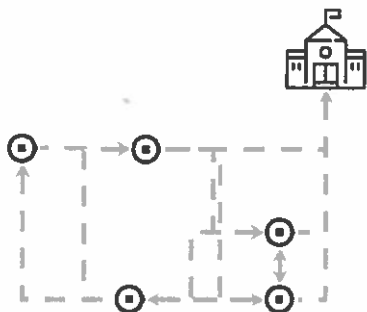
Step 1: Stop Assignment



	Stop Assignment
Objective	1) Minimize number of stops 2) Minimize total walking distance
Method	Integer optimization
Time	2 min

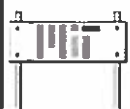


Step 2a: Route Generation

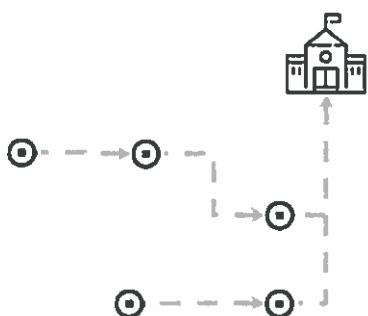


⚠ SUBFEASIBLE ⚠

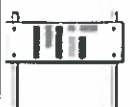
Route Generation	
Objective	Create a variety of optimized feasible routes
Method	Randomized greedy insertion heuristics
Time	Seconds



Step 2b: Single-School Optimization



Single-School Optimization	
Objective	1) Minimize number of buses for school 2) Minimize total time spent on bus
Method	Integer optimization (inspired by column generation)
Time	Minutes

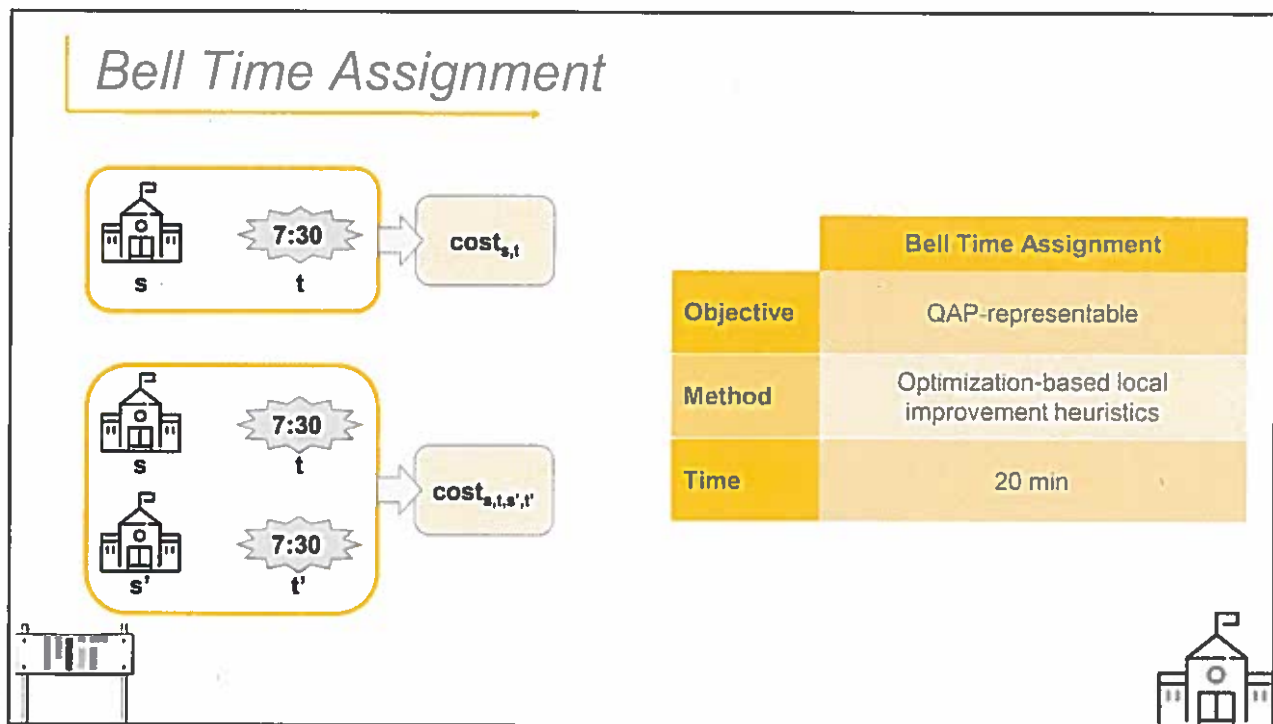
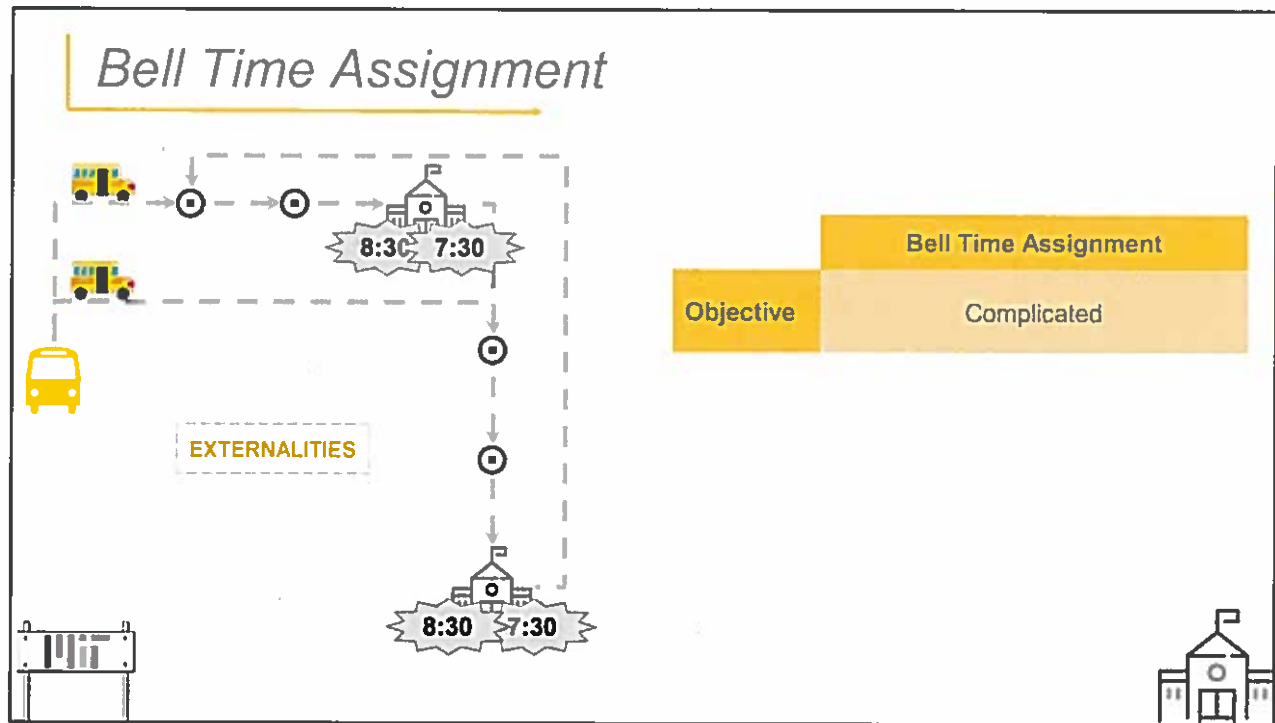


Step 3: Multi-School Optimization

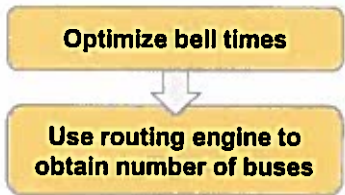
	Single-School Optimization
Objective	Minimize total number of buses
Method	Integer optimization (with network flow structure)
Time	30 min - 3 h

Appendix 2

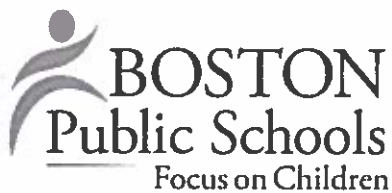
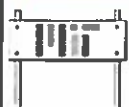
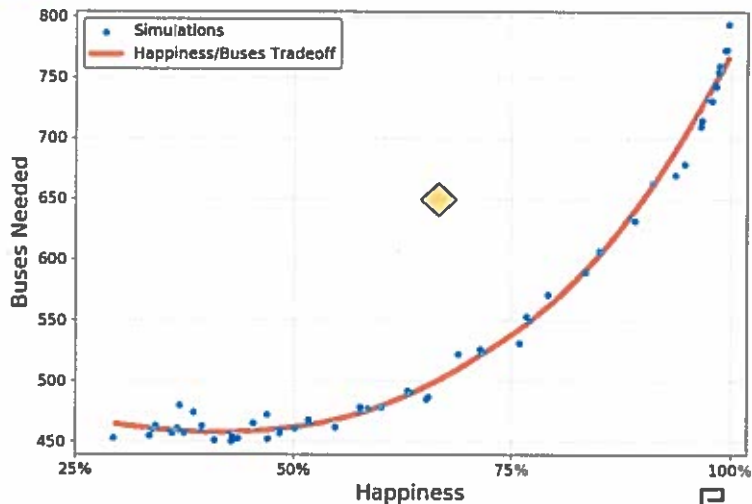
Bell Time Optimization



Optimizing Bell Times : Simple Model



	BPS '16-17	MIT ORC
Number of buses	650	430
Computing time	-	1 day

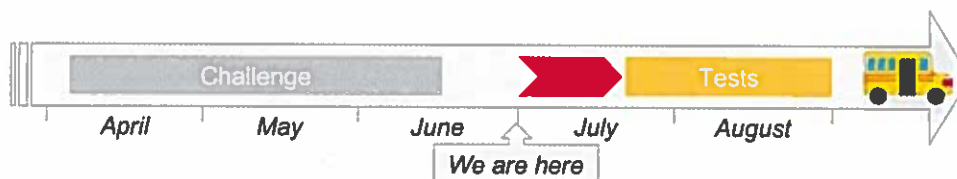
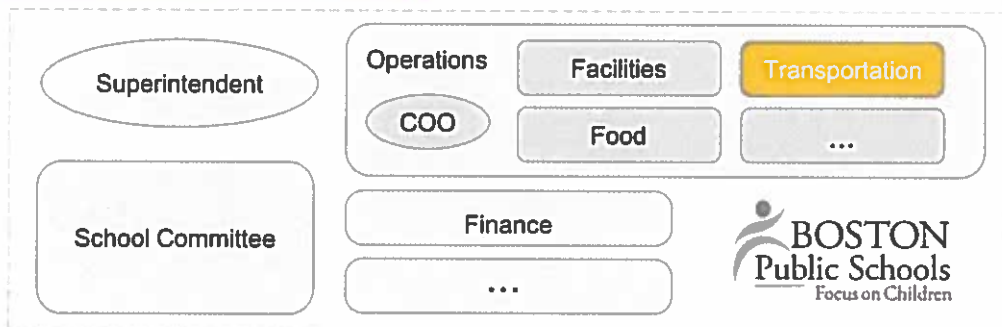


Appendix 3

Implementation Challenges



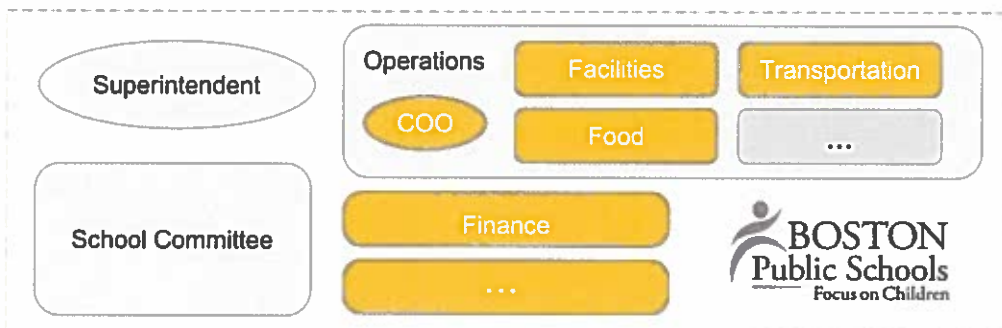
2017 Implementation



The Challenges of Implementation

- Walking distance constraints depending on neighborhood safety
 - Corner stops have fixed capacities
 - Four bus types with different capacities and compatibilities
 - Door-to-door students and students with wheelchairs have different loading times
 - Students cannot spend more than one hour on the bus
 - Schools have a fixed unloading time
 - Problem must be solved in the AM and PM
- **The solution needs to be entered in a commercial software that only accepts manual input.**
 - Enrollment changes daily, and the routing needs to be updated.
 - School bus monitors (adult supervisors) need to be routed and transferred.
 - >60% buses leave the yard late.
 - Some streets are too narrow for full-size buses.
 - Students have extra constraints (siblings...).
 - Some schools always release the kids too late.

Transferring the Bus Schedules



Hybrid Solution

	BPS '16-17	MIT ORC (not implementable)	BPS + MIT, '17-18
Number of buses	650	520	580
Average time spent on bus	23 min	24 min	23 min
Average walking distance to stop	0.2 mi	0.2 mi	0.2 mi
Computing time	6 weeks	3 hours	3 hours + 2 weeks
Computing resources	Team of 10	15 cores, 30GB RAM	Team of 3+10



Appendix 4

Why equity is difficult to achieve



Changing School Start Times

The Boston Globe JANUARY 01, 2018

Boston fails adolescents by relenting on school start times

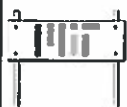


EXHIBIT C – Presentation material, Rhode Island Department
of Education

ALTERNATIVE BELL TIMES AND TRANSPORTATION OPPORTUNITIES

March 19, 2018



Key Impact Areas

- Cost & Efficiency
- Logistics
- Service Delivery
- "Soft Cost" Impacts –
- Other Considerations
- Transportation – Cost Saving Potential



Cost & Efficiency:

- Evaluate core rates and charge basis for school districts using contracted service providers
- Determine contractual minimum hours paid to bus drivers & aides
- Establish current actual baseline costs for each LEA
- Estimate costs based on logistical models and resource requirements

Logistics:

- Evaluate peak fleet deployment on “critical tier”
- Model optimal bell times
- Model optimal route linkages and PAX capacity-use ratios
 - Number of students per bus and how you link them together – balance with ride times and bell times
- Optimize service day length to minimize differences between school groups
 - Lengths of school days may vary – look at how they come together in the morning and afternoon
- Determine changes needed to and/or from feeder schools
- Viability of using “hub and spoke” collector and shuttle routes and mixed age groups etc.
- Use of alternative school vehicles for low-density areas and outlier students

Service Delivery:

- Student ride times
- Utilized seating capacity maximums by grade group
- Mixing grade ranges and schools on routes
- Arrival and departure time windows
- Earliest and latest pick-up/ drop-off time (light and traffic factors)
- Inclusion strategies for students with disabilities
- Scheduled deviations, e.g.; early dismissals

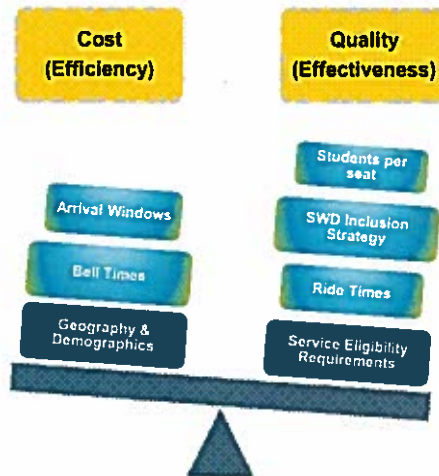
“Soft Cost” Impacts:

- Traditional, non-traditional and special education programs
- Professional and administrative staff bargaining unit agreements & other contractual constraints
- Student athletic programs
- Extracurricular activities and field trips
- Community factors: Student jobs, after school organizations, after school sibling care
- Impact - local traffic at peak hours

Other Considerations:

- Capability of school districts to make policy changes needed for implementation
- Capacity of transportation organizations to implement the changes
- Ability of school districts to finance any additional costs
- Feasibility of program enhancements & technology (GPS, student tracking)
- Cooperation of charter schools, non-public schools, other

Evaluation Approach:



Evaluation Steps:

1. Organize project committee/ outreach strategy
2. Discussion of issues, concerns, and alternative approaches
3. Develop base cost model
4. Define educational goals and parameters
5. Define transportation policies and service parameters
6. Model the current bell structure
7. Model current fleet deployment and capacity use
8. Define assumptions, constraints and guiding criteria
9. Develop specific bell time options
10. Model & evaluate cost or benefit of each option
11. Recommend implementation strategy

SBC Studies – Late HS Start:

- Bakersfield City Schools (CA)
- Danbury Public Schools (CT)
- Davenport Community School District (IA)
- Fairfax County Public Schools (VA)
- Greenwich Public Schools (CT)
- Lower Merion School District (PA)
- Masconomet Regional Schools (MA)
- Oregon School District (WI)
- Park City Schools (UT)
- Randolph Township Schools (NJ)
- Ridgefield Public Schools (CT)
- South Bend CSD (IN)
- State College Area School District (PA)
- Virginia Beach City Public Schools (VA)

Results of Past Studies :

- Of 14 studies, five (5) implemented changes to shift HS start times later
 - Fairfax VA, Greenwich CT, Bakersfield CA, South Bend, IN, Randolph NJ
 - Of the five, only one anticipated an improvement in cost/ efficiency - Bakersfield
 - One of the five shortened routes and added buses - Greenwich
- Most were incented to improve service, not reduce cost
- Potential savings are unique to each district:
 - Policies and service standards
 - Distribution of students across time tiers
 - Population density
 - Topographic configuration of school district
 - School locations

Cost-Savings Potential:

- “Fill the bus; use the bus” – maximize capacity, then link maximum runs to each bus
- Balance tiers to assign the same number of buses to each time tier
- For under-deployed tiers, add runs to shorten all run times and increase possible run linkages to each bus
- Link runs from adjacent school districts to proximal bus: Eliminate “stand-alone” single routes
- Employ vans/ vehicles for outlier stops
- Design combination runs serving multiple proximal schools; perhaps to more than one school district
- Apply intra-district routes for displaced and/or ESSA students

Cost-Savings Potential:

- Modify vendor contract language to create flexibility for student ADC's (add-drop-change) and appropriate fleet adjustments
- Establish minimum standards of performance for service delivery
- Conduct ridership analyses as the basis for changes in required transportation resources
- Evaluate enrollment boundaries for potential to modify/streamline transportation
- Assess student walking distance policies and practices to schools and stops to streamline or minimize transportation requirements
- Employ a third-party vendor for route planning and program administration

QUESTIONS?

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