

Using Twitter to Investigate the Change in Perceptions of California Senate Bill 328

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ABSTRACT

Sleep deprivation among adolescents is a growing issue that threatens the health and academic success of students in the country. California Senate Bill 328 (SB328) is the first U.S. statewide legislation to delay school start times (SSTs), which can affect not only students but parents and teachers. Understanding how society perceives delayed SSTs is crucial for understanding how delayed SSTs impact the affected community and for ameliorating policies that delay SSTs. This study uses Twitter to investigate the perceptions of SB328 over time to see how the bill's implication affected society's views on SB328. This study finds that the perception of SB328 improved over time, but were overall negative.

Introduction

Background

The American Academy of Sleep Medicine and the National Sleep Foundation recommends that adolescents get 8-10 hours of sleep every night for optimal health (Paruthi et al., 2016; Suni, 2022). However, a substantial body of research finds that adolescents are not getting enough sleep (Wheaton et al., 2016; Keyes et al., 2015). A study conducted using the Youth Risk Behavior Survey found that approximately 72.7% of American high school students admitted to not getting enough sleep (Wheaton et al., 2016). School start times (SSTs) play an important role in the duration of adolescent sleep as SSTs require students to wake up early, preventing them from getting the recommended amount of sleep. To address the growing issue of sleep deprivation, California passed Senate Bill 328 (SB328), which has pushed all California public middle and high schools, providing a unique opportunity to investigate the perceptions around it. This study uses Twitter to investigate the perceptions of California Senate Bill 328 and how they have changed before and after its implementation to see if the bill's impact had improved the perception and if barriers to delayed SSTs had been substantiated.

Literature Review

Development during adolescence leads to changes in biological processes such as the circadian rhythm. The circadian clock is essential for waking and sleeping as it interprets light signals over a 24-hour cycle to regulate sleep. The circadian rhythm naturally delays during adolescence, leading to later sleep and wake times. However, early SSTs force students to wake up at earlier times, misaligning with adolescents' circadian clocks. The biological change in adolescents' circadian clocks as well as early SSTs contribute to a common issue of Delayed Sleep Phase Syndrome (DSPS) among adolescents, a disorder in which one's sleep pattern is disrupted by two or more hours and has been linked with several adverse health effects such as depressive mood and sleepiness (Carskadon et al., 2004; Hagenauer

et al., 2009). Thus, it is recommended by the American Academy of Pediatrics as well as a large body of research that schools should start at 8:30 A.M. or later (Adolescent Sleep Working Group, 2014).

Several studies have examined the impact of delayed SSTs. A national survey, as well as telephone interviews, were used in a study conducted by Judith A. Owens, Daniel Droblich, Allison Baylor, and Daniel Lewin. The study found that multiple school districts that had delayed their SSTs identified improved standardized test scores, grades, and cost savings as benefits that came with delaying SSTs (Owens et al., 2014). A study conducted by Scott E. Carrell, Teny Maghakian, and James E. West has even identified a causal effect between SSTs on the academic achievement of adolescents. Findings demonstrated that early SSTs negatively affect student achievement, and that delaying SSTs leads to improvement in student achievement (Carrell & Maghakian & West, 2011). Extensive research on delayed SSTs has further supported the notion that delayed SSTs are linked to improved sleep, lower rates of depression, and less daytime sleepiness (Wheaton et al., 2016; Minges & Redeker, 2016; Boergers et al., 2014). Inversely, early SSTs have been linked with negative academic implications such as tardiness to class and poorer academic achievement (Owens et al., 2014; Becker et al., 2008; Edwards, 2012; Carrell & Maghakian & West, 2011; Heissel & Norris, 2016). As research identifies positive implications for students' health and academic performance, several studies advance the notion that SSTs should be delayed (Owens et al., 2014; Carrell & Maghakian & West, 2011; Kim, 2022; Boergers et al., 2014). However, there may be barriers to delaying SSTs. Previous research on potential barriers to pushing SSTs has identified after-school extracurricular attendance as well as change in parent and teacher work schedules as challenges associated with delaying SSTs (Owens et al., 2014; Fitzpatrick et al., 2020).

On October 13, 2019, California passed the first U.S. statewide legislation to delay SSTs, Senate Bill 328 (SB328). SB328 requires California public middle and high schools to start no earlier than 8:00 A.M. and 8:30 A.M. respectively by July 1, 2022. Given that 1.) as of 2020, California has the largest number of public schools (10,378) in the U.S. (National Center for Education Statistics, 2020) and 2.) the deadline for schools to push their start times has passed and the 2022-2023 school year has started, there is a valuable opportunity to investigate the change in perceptions of SB328 before and after its implementation to see if concerns associated with delayed SSTs had substantiated after SB328's implementation.

This study attempts to investigate these perceptions using Twitter, a popular social networking service. Carlos Castillo, Marcelo Mendoza, and Barbara Poblete analyzed the information credibility of news spread through Twitter. They explained that newsworthy topics tend to include URLs and have deep propagation trees (Castillo and Mendoza and Poblete, 2011). However, a study conducted by Klaus Solberg Sjøilen, Gérson Tontini, and Ulf Aagerup investigated if Twitter is a source of useful information by surveying 220 intelligence professionals to understand their perceptions of Twitter. The study hypothesized that although Twitter may not have valuable information, an analysis of data from Twitter can provide valuable information (Sjøilen and Tontini and Aagerup, 2017). Thus, this study follows Terra Ziporyn and a team of well-known sleep researchers and their recommendations for future research on California using social media as a means for data collection (Ziporyn et al., 2022).

The information presented in this study is important to policymakers and stakeholders as it can entail perceived limitations to delayed SSTs, in which case, students, parents, and teachers can be informed of how to approach these issues. Additionally, it will inform policymakers of challenges to delaying school start times. This study may also support the notion that delaying SSTs lead to little to no perceived limitations. In either case, policymakers can use this to influence decision-making for bills similar to SB328.

As of 2014, 93% of high schools in the U.S. started before 8:30 A.M. (Centers for Disease and Control, 2014). Given the substantial number of schools that start before 8:30 A.M., perceptions and experiences of students, parents, and teachers on delayed SSTs are low. Thus, this study's objective is to shed light on the societal perceptions of SB328 in hopes of finding whether barriers to delayed SSTs have been substantiated. Furthermore, this study addresses a gap in the current topic as it provides insight into the changes in perceptions of a delay in SSTs. Furthermore, this study takes a look into perceptions as a whole society rather than focusing on the benefits and costs of students. By looking into the changes in perception of SB328, this study attempts to investigate if SB328's implementation had positively or negatively impacted society, which would be reflected in their perceptions of the bill. However, Twitter

users may not be representative of California and its population. Thus, the change in perception seen may not be due to the bill's effect. Future research should focus on the impact of policies that delay SSTs like SB328 on society as a whole using data collection that more accurately represents the affected population.

Methods

Research Design

In this study, a combination of sentiment and conventional content analysis was used. Sentiment analysis refers to the extraction, conversion, and interpretation of opinions from a text and the classification of the text into positive, negative, or neutral sentiments (Drus and Khalid, 2019). Content analysis is a process in which researchers organize and elicit meaning as well as draw realistic conclusions from the data collected (Bengtsson, 2016). Content analysis is often used to describe a phenomenon (Hsieh and Shannon, 2005), in this case, the impact of SB328 through the change in perceptions of SB328. This study provides sentiment and conventional content analysis on Twitter comments under tweets on SB328. Sentiment analysis was used in this study because by determining how many tweets were positive, negative, and neutral, an understanding of the societal perception of SB328 is gained. A content analysis was used in this study because codes generated can explain the perceptions found.

After sentiment and content analyses were conducted, values generated were put in a chi-square test of independence. A chi-square test is used to find if there is any correlation among non-numeric variables that are frequently used in statistical studies (Kothari, 2007). The chi-square test is used to judge the significance of the association or relationship between two variables. In my study, a chi-square test was performed to see if there was an association between the time tweets were posted and the sentiment expressed in comments. The null hypothesis (H_0) is that there is no significant association between the time tweets were posted and the sentiment expressed in comments. The alternative hypothesis (H_1) is that there is a significant association between the time tweets were posted and the sentiment expressed in comments. In a chi-square test, degrees of freedom, p-value, and X^2 value are found. Degrees of freedom (DF) refers to the number of independent variables in the study. The P-value is the probability of how likely the observed difference is due to chance. X^2 value measures the difference between the observed and expected values. The X^2 value is calculated through the equation: $X^2 = \sum(O_i - E_i)^2 / E_i$. O_i is the observed value. E_i is the expected value.

Data Collection

All tweets and comments used in this study were publicly available and did not involve human subjects. An advanced search was done on Twitter to find tweets that included the words "California," "sleep," and "school." From these tweets, those that were from an account that was verified, had over 10 comments, included a link, and were related to SB328 were selected. In total, 16 tweets met these criteria and were used in this study.

Tweets gathered were put in a web scraping tool called Apify. Web scraping is the process of extracting data from a website. Comments from tweets were extracted and exported onto a spreadsheet. Apify was additionally used to organize the tweets and comments in order by time published. This study did not include human subjects and was not subject to institutional review board jurisdiction.

Procedure/Analysis

Tweets were first organized in the order they were posted. Then, tweets were categorized into three separate groups: tweets before SB328's implementation, tweets within 1 month after SB328's implementation, and tweets after 1 month after SB328's implementation. The tweets after SB328's implementation were split into separate groups because

SB328's effect would likely not be seen immediately. Accordingly, comments were grouped and analyzed within their group. The frequency of positive, negative, and neutral comments of posts before, within 1 month, and after 1 month after SB328's implementation was put in a chi-square test to assess whether there was an association between the date a tweet was posted and the overall sentiment expressed in the comments. In this study, O_i would be the frequency of negative, neutral, or positive comments. E_i is found by calculating row total * column total / N. N is the sample size.

Results

Sentiment Analysis

A total of 791 comments were scraped. Of these, a total of 763 comments were analyzed. Comments that did not express any relation to SB328, such as bots promoting an ad, were excluded because they did not contribute to the question raised. Overall, 517 (67.8%) comments were negative, 74 (9.7%) were neutral, and 172 (22.5%) were positive (Figure 1).

To investigate how this perception changed, there were 395 comments under tweets posted before SB328's implementation. Of these, 329 (83.3%) were negative, 15 (3.8%) were neutral, and 51 (12.9%) were positive (Figure 2).

There were 264 comments under tweets within 1 month after SB328's implementation. Of these, 141 (53.4%) were negative, 35 (13.3%) were neutral, and 88 (33.3%) were positive (Figure 3).

There were 104 comments under tweets after 1 month after SB328's implementation. Of these, 47 (45.2%) were negative, 24 (23.1%) were neutral, and 33 (31.7%) were positive (Figure 4).

Content Analysis

There was a total of 11 negative codes generated, 8 neutral codes, and 11 positive codes (Table 1). Table 1 displays the list of codes as well as the frequency, sentiment, and an example of each code. The top five most recurring codes were all negative codes: "Ineffective," in which Twitter users expressed their opinion that SB328 was ineffective or/and would not lead to students getting more sleep, "Catering," in which Twitter users expressed their opinion that SB328 caters and makes students lazy, "Disappointment," in which Twitter users expressed their opinions that people should not expect much from SB328 or the politicians that passed it, "Issue with Implementation," in which Twitter users expressed their issue with how SB328 was being implemented such as a lack of involvement in its legislative process, and "Concern with Potential Drawbacks," in which Twitter users expressed their concerns for societal changes such as parents and teacher schedules or a lack of time for extracurriculars. The most recurring neutral code was "Personal or Comparative Experience," in which Twitter users expressed their sleep schedules or other places where later SSTs exist. The most recurring positive code was "Necessity," in which Twitter users expressed their opinions that SB328 is needed or a bill that should have been passed already. It is important to note that some codes are repeated with different sentiments. For example, "Personal or Comparative Experience" is a code put in with a negative, neutral, and positive sentiment. Negative comments that fit with this code described their own schedules and how SB328 will not/would not work for them. Neutral comments that fit this code described their own sleep schedules or other examples of where later SSTs exist. Positive comments that fit this code described their own sleep schedules and how SB328 has/will work well for them.

Table 1. This table provides a list of codes generated, the frequency of each code, examples of tweets illustrating each code, and the sentiment of each code.

Code	Frequency	Tweet Example	Sentiment
Issue with Implementation	56	“this truly is something that should be decided at the school district level. News flash: Not everything has to be a state or federal law”	Negative
Disappointment	57	“Just when you thought this state couldn’t get worse.”	Negative
Catering	132	“Oh this will be great when they have to attend college or get a job... they’ll just oversleep. Sad.”	Negative
Concern with Potential Drawback	48	“So now parents have to be late for their jobs”	Negative
Research Opposition	1	“I’m science-driven, but I have a hard time believing the "data" is sound, The release of melatonin could be environment related. Your body adapts to the environment, case in point is different time zones, jet lag, etc. A teens biology isn't dependent on a clock. It can't be.”	Negative
Unsuccessful Implementation	5	“The later high school start in my area conflicted with elementary busing. My teen students now get up 30 minutes earlier to take a bus that drops them at 7:15am to school that begins at 8:30am.”	Negative
Suggestion	2	“Now if we could just get @GavinNewsom to require all school districts provide school busses for children to get to school. Parents required to drop off/pick up to as many as 3 schools everyday. This hurts the families and the environment.”	Negative
Ineffective	147	“So they can be stuck at school even later in the day and start their homework even later resulting in probably the same amount of sleep”	Negative

Code	Frequency	Tweet Example	Sentiment
Personal or Comparative Experience	7	“I utilized early morning classes that started at 6 and 7 to free up my afternoons so I could work my last two years of high school. This would have sucked for me.”	Negative
Frustration	24	“I don't have to start now until 8:30? Great - Now I can stay up a half hour later! Wait - that doesn't really solve the problem, does it? How ridiculous.”	Negative
Poor Parenting	38	“Maybe the parents should just have their kids go to bed earlier? #MondayMotivation”	Negative
Suggestion	17	“How about noonish ?”	Neutral
Question	12	“So what time are they starting? It doesn't say.”	Neutral
Personal or Comparative Experience	21	“The last time I slept in late was during elementary school where I slept from 9-7:30”	Neutral
Interest in Results	3	“Then sports are pushed later. Guess we will see if it works.”	Neutral
Addressing Concerns	2	“Parents will have to take them to daycare because they have to be at work by 8 usually”	Neutral
Unaware	3	“Gotta be honest I had no idea most H.S.'s started so early. I graduated in 2005 (San Antonio) and we started at 9am.”	Neutral
Additional Information	6	“Yes, it's true. This bill was sponsored by Start School Later, a grassroots non-profit run entirely by volunteers who joined forces with the California State PTA and a nationwide network of passionate scientists and health care professionals to make history! #startschoollater”	Neutral
Positive and Negative	11	“This is good for teens, because their brains apparently don't wake up that fast, but boy, how are parents supposed to navigate work and school schedules?”	Neutral

Code	Frequency	Tweet Example	Sentiment
Addressing Concerns	31	“This is about the physical,mental well being of the students NOT about anyone or any organization. And to call what many students are fed food is an insult to food.”	Positive
Envy	28	“Wish they did this when I went to hs”	Positive
Potential Benefit	7	“This benefits parents too who work...”	Positive
Necessity	37	“As an educator, I’ve been saying this for the last 20+ years.”	Positive
Praise	31	“Wonderful! Better rested students to disrupt class and not be suspended! Thank you PTA. Thank you CTA for sitting on your hand holding union dues! And local worthless so-called "Teachers" unions.”	Positive
Scientifically-Backed	9	“Talk about science checking up with society!”	Positive
Optimistic for Further Changes	6	“Agreed, I really hope we go back to a 4 day work week too, Would love to see you do an episode on how more productive workers are in country's who do this”	Positive
Personal or Comparative Experience	10	“When I was in high school we started at 7:20. The same high school now starts at 8:40. I think it's great to see schools recognizing the need to start later for the health of students.”	Positive
Slight Benefit	4	“Yay! This will help with my morning commute.”	Positive
Proud of Decision	6	“We walked so they could run 🏃🏃🏃”	Positive
Suggestion	3	“9:00 would be even better!”	Positive

Chi-Square Test

The content analysis was followed by a chi-square test of independence to investigate the association between the date a tweet was posted and the sentiment expressed through comments under the tweet. The relation between these variables was significant, $X^2(4, N = 763) = 100.5109, p < .001$. Thus, the null hypothesis is rejected, and the alternative hypothesis is accepted, which is that there is an association between the date a tweet was posted and the sentiment expressed through comments under the tweet.

Discussion

Results indicate that there was an overall negative sentiment regarding SB328. To compare the comments from before, within 1 month, and after SB328's implementation, the percentage of negative comments dropped from 83.3% to 53.4% (29.9% decrease) to 45.2% (8.2% decrease) or an overall 38.1% decrease in the negative sentiment expressed. The decrease in negative perception aligns with previous research that suggests that delayed SSTs are beneficial. The decrease in negative sentiment over time represents a change in perception that may have occurred due to the bill's effect and implementation. A key detail that should be pointed out, however, is that the comments were still overall negative before, within 1 month, and after 1 month after SB328's implementation.

Content analysis of the Twitter comments revealed that the top five recurring codes were "Ineffective," "Catering," "Disappointment," "Issue with Implementation," and "Concern with Potential Drawbacks." Existing literature found similar perceived barriers to delayed SSTs such as a lack of time for extracurricular activities (Fitzpatrick et al., 2020). These codes support the negative perception found from sentiment analysis by providing an explanation of what a majority of Twitter users commented and felt. These results show that Twitter users often held perceptions that SB328 would not cause students to get more sleep and was ultimately making students lazy. Furthermore, barriers to delayed SB328 are expressed through their issues and concerns with implementation and drawbacks. Concerns about parents being able to get sleep and go to work in the morning were often expressed. Additionally, issues with school schedules being delayed but the rest of society maintaining its original schedules and the lack of time due to this was also often expressed. This indicates that there needs to be refinement in education policies that delay SSTs to address these issues and concerns.

The chi-square test was used to investigate the association between the date a tweet was posted, and the sentiment expressed through comments under the tweet. The findings of the test support the trend that over time, the perception of SB328 got better. The X^2 value of 100.5109 indicates the deviation between observed and expected values under the null hypothesis. A high X^2 value of 100.5109 suggests that there is a significant association between the date a tweet was posted, and the sentiment expressed in the comments. Furthermore, the p-value was $< .00001$. This indicates that there is a statistically significant relationship between the date a tweet was posted, and the overall sentiment expressed in the comments of that tweet and that this was very unlikely due to chance. This strengthens the findings from the sentiment analysis. As the sentiment analysis showed that there was a decrease in the percentage of negative tweets over time, the results of this chi-square test support this by suggesting that the decreasing negative sentiment was likely due to the change from before and after SB328's implementation. This somewhat addresses the assumption that the change in perception is due to SB328's implementation and effect as it provides evidence that the change in sentiment was likely because of the change in time.

Conclusion

Implications

The findings of this research have assisted in furthering the understanding of the societal perception of delayed SSTs. As mentioned previously, the American Academy of Sleep Medicine and the National Sleep Foundation recommend that adolescents get 8-10 hours of sleep every night (Paruthi et al., 2016; Suni, 2022). However, a study conducted using the Youth Risk Behavior Survey found that approximately 72.7% of American high school students admitted to not getting enough sleep (Wheaton et al., 2016). The evidence indicates that sleep deprivation is a prominent issue all around the country. This points to delaying SSTs because early SSTs force students to wake up earlier, misaligning their circadian rhythms. And previous research suggests benefits to delaying school start times such as improved sleep, lower rates of depression, and less daytime sleepiness (Wheaton et al., 2016; Minges & Redeker, 2016; Boergers et al., 2014). However, there is a lack of research on the impact of delayed SSTs on society as a whole. In the Consensus Statement on SB328, adolescent sleep deprivation and the negative consequences of early SSTs are addressed. However, there is a lack of consideration and research investigating the overall impact of SB328. For example, there is little consideration for the impact of delayed SSTs on parent schedules. While this study does not directly investigate the impact of SB328, the findings of this study are important because they provide an analysis of the societal perceptions of SB328, which can provide an understanding of barriers such as a change in parent schedules.

The findings of this study can be used to inform policymakers and future decision-making of education policies. The overall negative sentiment expressed through Twitter users' comments as well as the codes generated suggests that the barriers of SB328 have not been fully addressed, even after its implementation. Results from this study can be used to address the lack of research on the impact of SB328 on a societal viewpoint. It is important to note that some opinions expressed on SB328 may not be interested in what is beneficial for adolescent health. Policymakers should consider this when drafting or revising education policies to maintain the efficacy of delayed SSTs on adolescent sleep while also addressing barriers.

Additionally, this understanding can be important for school districts as well as the parent, teachers, and students. As the existing literature supports delayed SSTs, more schools across the U.S. are taking on delayed SSTs. School districts, parents, teachers, and students can be informed of the experiences of those already affected to be knowledgeable about potential changes they may face and how to adjust to them. From the analysis of comments, many held concerns with issues that existing literature answers. For example, one of the most recurring codes was "Catering." A significant amount of comments stated that adolescents should just put their phones down and go to sleep earlier. However, existing research suggests that students' biological clocks naturally delay during adolescence. This means that during adolescence, it is harder for adolescents to sleep earlier and easier for them to sleep later. Additionally, many comments voiced opinions that students would use the time saved from delayed SSTs ineffectively. However, existing research indicates that students use the time to sleep in (Wahlstrom et al. 1998). Thus, it is also important to be informed about existing literature on sleep and SB328 in order to answer misconceptions.

Limitations

It is important to recognize the limitations that may have impacted the results. For this study, Twitter data was used. Although methodology recommendations were given by Ziporyn and other well-known sleep researchers (Ziporyn et al. 2022) and although Sjøilen, Tontini, and Aagerup established that an analysis of Twitter data can provide valuable information, Twitter users may not accurately represent the California population. An assumption made in this study is that the change in perception of SB328 before and after the bill's implementation is due to the bill's effect and impact. And despite the chi-square test suggesting that there is an association between the sentiment expressed and the date the tweet was posted, the sentiment expressed may not be related to SB328's impact. Twitter users may be

outside of California, where SB328 affects, and therefore are not affected by SB328. Thus, the overall negative sentiment seen before and after SB328's implementation may be due to the lack of accurate representation of California residents.

Additionally, the Twitter accounts that posted the tweets used in this study were mostly from news channels. Each of these news channels may have an audience with a political bias and either support or oppose SB328. As California's state government is majority Democratic, news channels with a broad Democratic audience may express comments that support SB328 overall whereas news channels with a broad Republican audience may express comments that overall oppose SB328. This can influence the findings as the change in perception seen in this study may not be due to SB328's effect but because the news channels selected before and after SB328's implementation held an overall Republican audience.

There is also a limitation grounded in sentiment and content analysis. As this study did not conduct follow-up interviews to get a deeper understanding of tweets, there may be an interpretation bias in the sentiment analysis and coding process. This can influence the findings found from sentiment and content analyses as they rely on the interpretation of the comments. This further influences the chi-squared test as the improper interpretation of comments leads to an improper frequency count, which is needed for the chi-squared test.

Future Directions

While this study focused on Twitter data, future research could focus on means of data collection that accurately represent an affected population of delayed SSTs. This could allow for a better and more focused understanding of the effects of delayed SSTs on society. This would address the limitations seen in this study as there would be no political bias. A more accurate representation of an affected population would mean that a change in perceptions before and after SB328 would more likely be due to its effect on society. Overall, more research will need to be conducted in order to further understand and combat barriers to delayed SSTs.

Furthermore, with the understanding of barriers expressed in the perceptions found in this study, further research should be conducted to investigate ways to refine education policies such as SB328 so that delayed SSTs can be kept while also addressing barriers. This would be very important as its implications and the addressing of barriers to SB328 could change lives. Parents who struggle to maintain work schedules and get their children to school and students who struggle to maintain their schedules after getting out of school later will be able to enjoy the benefits of delayed SSTs without having to face the barriers.

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