Boost Research Report

Nudging Assignment Submission

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EXECUTIVE SUMMARY

Getting students to complete their assignments on time is an enduring concern for teachers at all levels - and for good reason. On-time assignment submission predicts students’ retention and success (Bawa, 2016). As more school districts and universities adopt learning management systems (LMS) to organize and deliver course content, educators are introduced to new tools to support students as they complete (and hopefully turn in) assignments. Boost, which syncs with a course’s LMS, aims to help educators and motivate students to complete their work on time by sending students’ notifications of upcoming assignment deadlines with periodic motivational messages. Over time, nudges from Boost change students’ behavior so they complete assignments before the due date. The goal is for students to give themselves enough time to not only do the work but to do it well. An added bonus of the tool is that it requires little to no extra work on the teacher’s end. If they are posting assignments in the LMS, there is nothing additional needed for Boost notifications to be delivered.
Boost first rolled out in university settings and showed positive effects on submission rates (Motz, Mallon, & Quick, 2021). In 2021, Boost partnered with WGU Labs to better understand how middle and high school students engage with the tool and if the system of notifications and encouragements improves on-time assignment submission.

This report summarizes the findings from a multi-method study that assessed how students’ experience using Boost and how using Boost relates to change in procrastination behavior and assignment submission. Findings also provide insight on potential differences in use between middle and high school students, highlighting the uniqueness of these two academic environments.

At the beginning of the Fall 2021 school year, 312 students from a large suburban middle and high school downloaded Boost and were randomly-assigned into either the control group, where they received standard LMS notifications, or the experimental group, where they received the Boost notifications reminding them of assignment deadlines. At the end of the term, 41 of these students completed an online survey measuring their use of Boost, and their self-reported academic self-regulation skills and procrastination behavior. 10 students (1 from the high school, 9 from the middle school) participated in focus groups to further understand the student experience with Boost.

Findings from both the survey and focus group highlighted the following:

- **Easy and fun to use:** Overall, students found Boost easy to use and would use it again in the future. 71% of surveyed students said they would use Boost again if given the choice, with even more students saying they would use it again in future grades. From the focus groups, students reported generally having an easy time understanding how the application worked, even adding in their own assignments or additional reminders to customize the notifications they received.

- **Students more organized:** Students vary in the self-regulatory behaviors they use to complete assignments in a timely fashion. Focus group participants listed a number of different techniques for organizing

**RESULTS AT A GLANCE**

- Overall, students found Boost easy to use and would use it again in the future.
- Students vary in the self-regulatory behaviors they use to complete assignments in a timely fashion.
- Boost positively changed students’ tendencies to procrastinate.
and completing their schoolwork, from using sticky notes to remember assignments and deadlines, to filling out a school-issued agenda and enacting specific “study times” during the school week. This aligns with the survey findings, which showed that although students generally agreed to having strong self-regulation skills, the majority did not think they were able to accomplish the goals they set for themselves. This speaks to a potential mismatch between having the skills/behavior and actually implementing them. Boost has the potential to address this misalignment, as the application contains settings that allow the student to create customized notifications, add in assignments, and set additional assignment reminders, giving them the opportunity to take more agency in organizing their work.

• **Less procrastination:** Survey results showed that most students believe they do not engage in procrastination behavior ($M = 2.05$, $SD = 0.82$), though half did say that they often start things at the last minute. Boost directly impacts procrastination behavior, as it reminds students up to 24 hours before the deadline and can even be individually customized to remind students up to a week beforehand. Focus group findings show that Boost did, in fact, positively change students’ tendencies to procrastinate. Some of the middle school students specifically remarked that using Boost helped them procrastinate less, as the notification reminders motivated them to start their assignments earlier compared to before they had access to the tool.

In addition to these findings, the focus groups also shed light on the different features that could be added to Boost, giving insight into the types of support students seek. For example, one student mentioned potentially adding in links to online assignments directly into the Boost notification, further streamlining the process of getting to their schoolwork. Another student said they would appreciate a feature that gives them a notification that an assignment has been graded or other types of follow-up notifications. On the whole, though, students seemed generally content with the current functionality of Boost and the resources provided by their school.

This exciting first implementation of Boost in the K-12 academic setting provides us with a foundational view of how middle and high schoolers use the tool. Future studies can further explore how Boost usage may differentially impact students in these two settings. As with many educational technology tools, the functionality and usability of a tool differs student by student and is also impacted by the culture of technology adoption at the school more generally. By conducting further research to understand the various use cases and how different environments shape technology usage, Boost can continue to uncover how it shapes assignment submission behavior and, ultimately, course success and retention.
BACKGROUND

On-time assignment submission is a significant predictor of retention and student success (Bawa, 2016). When students do not procrastinate on their assignments, they are more likely to produce higher quality work and persist in their courses (Chickering & Gamson, 1987; Cerezo, Esteban, Sanchez-Santillan, & Nunez, 2017). However, despite the benefits of on-time assignment submission, instructors still find that students have trouble turning in assignments in a timely manner.

One technology that takes a proactive approach to helping students complete their work on time is Boost. This innovative tool was designed to integrate with a classroom’s Learning Management System (LMS) and send mobile app nudges to students to remind them of upcoming assignment deadlines. These nudges, known as ‘educative nudges’ (Hertwig and T. Grüne-Yanoff, 2017), trigger and empower an internal behavioral change in students. In using Boost, students are empowered to complete and turn in their assignments in time. The reminders of which assignments are due and when the deadline submission is serve as models for the students in how to scaffold their goal-setting to complete work on time.
The Boost team previously studied the impact of the platform in a higher education setting and found that the reminders improved students’ on-time assignment submission and grades (largely due to on-time assignments) relative to more customary LMS notifications (Motz, Mallon, & Quick, 2021). To better understand the breadth of the application’s impact, the current study examines Boost in a middle and high school setting and asks:

• Does the implementation of Boost in middle and high school also lead to improved grades and more on-time assignment submission?
• What is the student user’s experience with Boost? Did they find notifications overwhelming? Helpful? Distracting?
• Did these reminders lead students to feel more agency in their own learning?

The transition from elementary to middle school, especially, can be difficult, as students must learn to take more individual initiative as they approach a new social and emotional academic environment (Eccles et al., 1989). We hypothesize that with the support of Boost and its assignment reminders, middle and high school students will feel empowered to direct their own learning and success.

In addition, we explored whether there were different contexts in which Boost is more or less helpful. For example, an exploratory study found that when given the opportunity, students who were earning lower grades than their peers were more likely to opt into Boost’s nudges (Andrew, Motz, Israel, & Leary, 2020). This suggests that the tool might be particularly helpful for students who are traditionally stigmatized in the education setting and must overcome academic challenges imposed by the system.

More details of the study can be found on the Open Science Framework.
METHODS & SAMPLE

All 1,909 students enrolled in middle and high school at a large suburban school district were invited to download Boost to receive assignment reminders. Of these students, 312 downloaded the application. The Boost application linked to Canvas, the learning management system (LMS) used by the school district, where assignments are assigned and submitted. Students who downloaded Boost received assignment reminders prior to the deadline if they had not yet submitted their assignment. Of these 312 students, half identified as female (52.2%, \( n = 163 \)), and the majority of students identified as White (66.0%, \( n = 206 \)) and a native English speaker (94.2%, \( n = 294 \)). Students were roughly equally-distributed among the different grades, though more 9th-graders used Boost (25.0%, \( n = 78 \)) compared to all other grades. See Table 1 for full demographic details of the sample.
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<th>Control Group (N=156)</th>
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*Table 1. Demographics of the student sample who downloaded Boost.*
After downloading the Boost application, Boost administrators randomly-assigned students to either the experimental or control condition (see Appendix A for more information on study design). Students in the experimental condition received reminders that their assignment deadlines were coming up, alongside messages motivating them to complete these assignments. Students in the control group received notifications mirroring those that appeared in the LMS (e.g., messages notifying the student that an assignment was added or that a date was changed for an exam; see Fig. 1 for examples of both messages). Prior studies of Boost found that these control group messages do not motivate the student as much as the experimental group messages (Motz, Canning, Green, Mallon, & Quick, 2021).

At the end of the semester, WGU Labs research sent students an online survey, which assessed their user experience with the following measures (see Appendix B for full survey measures):

- **Student Experience**
  - School Support
  - Academic Self-Efficacy
  - Self-Regulation
  - Happiness
  - Procrastination
  - Academic Stress

- **Boost Experience**
  - Ease of Use
  - Satisfaction with Use

Because all participants were under the age of 18, parental consent was required in order for students to receive the survey link. Of all 312 students who downloaded Boost, 41 students received parent consent and completed the online survey. Table 2 illustrates the demographics of students who completed the survey.¹ To supplement the survey findings, we conducted 4 total focus groups with 1-4 students each, representing grades 6 and 7 from the middle school, and grade 12 from the high school. These focus groups were conducted during school hours during students’ study period. Students had received parental consent to participate. See Appendix B for questions and prompts used in the focus groups.

¹ We received 86 surveys in total but only 41 of those respondents also downloaded the Boost app. For descriptive statistics and analyses presented here, we focus only on the 41 respondents for whom we can verify that they downloaded and used Boost.
<table>
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<td>Middle School</td>
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*Table 2. Demographics of the student sample who completed the survey.*
THE ‘BOOST’ STUDENT EXPERIENCE

We implemented a multi-method approach to better understand the student experience of using Boost. In both surveys and focus groups, we assessed students’ general assignment completion strategies, how they use Boost, whether they found it helpful, and any recommendations for how to improve the application.

Given the limited sample size of 41 students, the following survey results are presented as descriptive illustrations of students’ experience with the platform. It is unclear if there is bias in the responding sample (e.g., did the best 41 students across the two schools respond to the survey?); thus, we caution against drawing prescriptive conclusions from the results. Additional descriptive analyses presented in Appendices C and D.
BOOST IMPROVES STUDENTS’ ORGANIZATION, DECREASING PROCRASTINATION

On the whole, survey respondents said they felt they possessed the necessary skills to complete their academic tasks successfully. Responses on the academic self-efficacy survey (Bandura, 2006) specifically showcase this, with students averaging above the scale median ($M = 3.57$ out of 5; $SD = 0.93$), indicating that many believe they have the skills and abilities to achieve their academic goals. For this measure, students indicated how capable they felt completing a number of different academic tasks and skills, such as finishing their homework on time, concentrating on their schoolwork, motivating themselves to complete their work, and arranging a place to stay at home without distractions (Fig. 2).

**How well can you...**

![Survey Results](image)

**Figure 2. Student responses on the Academic Self-Efficacy measure.**
These findings are somewhat mirrored in the results for the self-regulation measure (Neal & Carey, 2005), which assessed the student's specific ability to engage in goal-directed behavior (Fig. 3). Though students generally agreed to having strong self-regulation skills ($M = 3.11$, $SD = 0.54$), the majority of them strongly disagreed with the statement that they were able to accomplish the goals they set for themselves.

**Self-Regulation Skills**

If I make a resolution to change something, I pay a lot of attention to how I'm doing.
When I'm trying to change something, I pay a lot of attention to how I'm doing.
I set goals for myself and keep track of my progress.
I have an easy time setting goals for myself.
I have personal standards and try to live up to them.
I am able to accomplish goals I set for myself.
I usually keep track of my progress toward my goals.
I do not have trouble making plans to help me reach my goals.
As soon as I see a program or challenge, I start looking for possible solutions.

**Figure 3. Student responses on the Self-Regulation measure.**
Perhaps one reason for this—not being able to accomplish academic goals despite knowing they have the skills to do—is students’ falling prey to procrastination behavior. We assessed how much students engaged in four specific types of procrastination (starting things at the last minute, difficulty completing activities once started, running late to get things done, and failing to accomplish goals set for themselves; Choi & Moran, 2009). Though survey respondents on average reported that they did not engage in all procrastination behavior ($M = 2.05$, $SD = 0.82$), half of them did specifically say that they often start things at the last minute (Fig. 4). Without a comparison to the beginning of the term, it is difficult to know whether or not the use of Boost helped improve these scores.

From the focus group discussions, however, we learned that some of the students felt their organization skills did improve after using the application. That is, they felt they had a better grasp of when assignments were due because of the notification reminders, which then enabled them to better organize their schoolwork and complete assignments on time. One student even commented that the Boost notifications reminded and motivated her to complete assignments on the weekends, saying that if she gets notification “and don’t have anything to do, I’ll do it [the assignment] right away.” Students generally agreed that using Boost helped with remembering assignments when they might have previously forgotten to complete them.

**Figure 4. Student responses on the Procrastination measure.**
EFFECTIVENESS AND USAGE VARIES COURSE BY COURSE, STUDENT BY STUDENT

As with many educational technology tools, the effectiveness of the tool varies at the individual level. When asked what courses were most helpful to receive Boost notifications in, students did not overwhelmingly agree on the type of courses (e.g., core courses, elective courses). One middle school student said that receiving the Boost notifications in her elective courses—like orchestra—was most helpful, because assignments were dealt out more randomly in this course compared to her core classes like Math and English and it was easier to forget that they had been assigned. Another focus group student, however, said that receiving Boost notifications were more useful in her classes where assignments were more consistent, because “the teacher doesn’t nudge as much on shorter-term things, or if it’s a project due in a couple days [compared to longer-term projects], making it easier to forget the assignment is due.

These findings highlight how Boost can vary in effectiveness for different students, depending on their classroom environment and the student’s own preference for how to organize their schoolwork. Settings within Boost give students the agency to customize the tool to suit their needs—for example, by adding in their own assignments for courses that may not use Canvas and adding in additional notifications.

Despite the different use cases, students agreed that it was easy learning how to use the tool (Davis, 1989). A strong majority reported having an easy time learning how to use and using Boost, with over 70% of the survey respondents indicating that the tool was easy to use across multiple dimensions (Fig. 5). That said, between 1 in four and 1 in five students did find

![Figure 5. Student responses on the Ease of Use measure.](image-url)
the tool hard to figure out. A deeper dive into who these students are and what they struggled with may be warranted to move toward universal access and usage, which will be important to teachers who are introducing Boost to younger students like middle schoolers.

Similarly, most surveyed students reported being satisfied with the Boost application (Planas et al., 2007). The majority of students indicated that they found Boost useful in their current courses and that if given the choice, they would be happy using Boost again in future grades (Fig. 6).

### UNDERSTANDING UNIQUE NEEDS OF SCHOOL ENVIRONMENT WILL STRENGTHEN BOOST IMPACT

Since this study was the first analysis of Boost implementation within the K-12 setting, we were interested in exploring how differences between middle and high school academic environments might contribute to disparate usage and uptake by students in those respective grades. More high schoolers than middle schoolers downloaded Boost but our visit to

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**Figure 6. Student responses on the Satisfaction measure.**
the school revealed important grade level differences hidden behind these download statistics.

An administrator in the district explained that the middle school instructors were historically more receptive than the high school instructors to new technology in their classroom. The focus groups with middle schoolers reflected their instructors' interests in education technology. The middle school students seemed very familiar with the Boost tool and its different functionalities, and often mentioned how they personalized the notifications they received and had interesting feedback for adding features and functionality to the tool.

While this finding may be specific to the research site, it may also be indicative of the developmental stage of middle schoolers. Research shows that the transition to middle school can be especially difficult for students, as they move from the consistency of one primary classroom to having to navigate multiple classrooms and teachers for different subjects, while simultaneously adjusting to the academic and social demands of a new school (Eccles et al., 1989; Jackson & Davis, 2000). While the support from middle school to high school may be similarly fraught with anxiety (Mizelle & Irvin, 2000; Morgan & Hertzog, 2001), students are not necessarily needing to learn new schools—rather, they can continue practicing those skills they utilized in middle school. As such, Boost may be particularly impactful for middle school students who are just learning how to organize schoolwork on their own and needing to take individual initiative in completing their coursework.

The effectiveness of Boost also depends on the culture of technology adoption at the school. Given that the tool connects to the classroom's LMS, its success depends on teachers using the LMS. That is, teachers must upload assignments and assign deadlines for this information to be sent out in the Boost notifications. Without teacher input, Boost does not have the information necessary to remind the student and consequently motivate them to turn in assignments on time.

Additionally, we learned from school administrators and students alike that there were a number of programs already implemented at the schools that served similar functions to Boost. Middle school students mentioned a ‘homework hotline’, where parents and students could call in to find out more information about assignments. The middle school teachers also maintained a shared document with homework assignments that they started in the early days of COVID closures. When there are several avenues for accessing the same information, students may not fully commit to one; as such, these redundancies in technology may have diluted the effect of Boost.

Phone usage is another factor determining Boost usage. We learned that some middle school students do not yet have personal phones—possibly one reason we saw fewer middle schoolers downloading Boost. Among the middle school focus group students, two students accessed Boost on their iPad and one even noted that she used her parent's phone to access the application. These students who did not use their own phones had less consistent access to their notifications than students with phones. In addition, the school barred middle school students from their phones during the day, and most either kept their phones in their lockers during the school day or glanced sporadically throughout the day, limiting the times of day at which students accessed notifications.
NUDGING ASSIGNMENT SUBMISSION

The variability in usage described above raises questions about the impact of Boost reminder nudges (over and above what students typically receive from Canvas) on assignment completion and, ultimately, course grades. Using the data collected by Canvas, we analyzed the effect of receiving Boost's assignment reminders on assignment completion and submission rates. Canvas collected the following data for students (see Table 3):

- Boost Notifications Read
  - Both control group and experimental group students received Boost notifications. Control students only received notifications from the Daily Digest and Planner Notes, which are standard notifications within Canvas. These are not often sent out, as evidenced by the near-zero mean. Experimental group students, by contrast, received Boost reminders of upcoming assignments.

- Unique Assignments Student Received Boosts Reminders For
  - Boost reminders were only sent to students in the experimental group. These reminders notified students of upcoming assignment deadlines.

- Possible Assignments:
  - All assignments posted in Canvas.

- Missing Assignments:
  - These assignments were never submitted and marked ‘missing’ by Canvas.

- Late Assignments
  - These assignments were submitted past the deadlines and marked ‘late’ by Canvas.

Students in both the experimental and control groups had an average of around 30 assignments that were posted in Canvas. For experimental group students, an average of 19 of these assignments had associated Boost reminders. In total, students in the experimental group received an average of 98 Boost notifications.
### Table 3. Descriptive statistics of Boost notification and assignment submissions for experimental and control group students.

<table>
<thead>
<tr>
<th></th>
<th>Control Group (N=156)</th>
<th>Experimental Group (N=156)</th>
<th>Overall (N=312)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boost Notifications Read</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>0.167 (0.818)</td>
<td>98.1 (62.1)</td>
<td>49.1 (65.8)</td>
</tr>
<tr>
<td>Median [Min, Max]</td>
<td>0 [0, 9.00]</td>
<td>107 [0, 239]</td>
<td>1.00 [0, 239]</td>
</tr>
<tr>
<td><strong>Unique Assignments with Boost Reminders</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>0 (0)</td>
<td>19.0 (18.1)</td>
<td>9.49 (15.9)</td>
</tr>
<tr>
<td>Median [Min, Max]</td>
<td>0 [0,0]</td>
<td>15.0 [0, 78.0]</td>
<td>0 [0, 78.0]</td>
</tr>
<tr>
<td><strong>Possible Assignments</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>30.3 (21.3)</td>
<td>32.7 (21.3)</td>
<td>31.5 (21.3)</td>
</tr>
<tr>
<td>Median [Min, Max]</td>
<td>30.0 [0, 78.0]</td>
<td>32.0 [0, 75.0]</td>
<td>32 [0, 78.0]</td>
</tr>
<tr>
<td><strong>Missing Assignments</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>0.519 (1.06)</td>
<td>0.513 (1.13)</td>
<td>0.516 (1.09)</td>
</tr>
<tr>
<td>Median [Min, Max]</td>
<td>0 [0, 6.00]</td>
<td>0 [0, 8.00]</td>
<td>0 [0, 8.00]</td>
</tr>
<tr>
<td><strong>Late Assignments</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>3.76 (4.31)</td>
<td>5.46 (6.25)</td>
<td>4.61 (5.43)</td>
</tr>
<tr>
<td>Median [Min, Max]</td>
<td>2.00 [0, 24.0]</td>
<td>4.00 [0, 34.0]</td>
<td>3.00 [0, 34.0]</td>
</tr>
<tr>
<td><strong>Assignment Submission Rate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>96.1 (13.6)</td>
<td>97.0 (8.57)</td>
<td>96.6 (11.4)</td>
</tr>
<tr>
<td>Median [Min, Max]</td>
<td>100 [0, 100]</td>
<td>100 [33.0, 100]</td>
<td>100 [0, 100]</td>
</tr>
<tr>
<td>Missing</td>
<td>4 (2.6%)</td>
<td>5 (3.2%)</td>
<td>9 (2.9%)</td>
</tr>
<tr>
<td><strong>On-Time Assignment Submission Rate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>84.3 (17.0)</td>
<td>81.1 (17.5)</td>
<td>82.7 (17.3)</td>
</tr>
<tr>
<td>Median [Min, Max]</td>
<td>89.0 [0, 100]</td>
<td>85.0 [23.0, 100]</td>
<td>88.0 [0, 100]</td>
</tr>
<tr>
<td>Missing</td>
<td>4 (2.6%)</td>
<td>5 (3.2%)</td>
<td>9 (2.9%)</td>
</tr>
<tr>
<td><strong>Hours Submitted Before Assignment Submission Deadline</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School</td>
<td>2.45 (3.18)</td>
<td>2.19 (2.04)</td>
<td>2.32 (2.67)</td>
</tr>
<tr>
<td>Middle School</td>
<td>1.60 [0, 26.0]</td>
<td>1.50 [0, 11.4]</td>
<td>1.50 [0, 26.0]</td>
</tr>
<tr>
<td>Missing</td>
<td>4 (2.6%)</td>
<td>5 (3.2%)</td>
<td>9 (2.9%)</td>
</tr>
</tbody>
</table>
To examine the potential impact of Boost notifications on assignment submission, we compared the experimental and control groups on the following assignment dimensions:

- **Assignment Submission Rate**
  - The number of total assignments divided by the number of assignments submitted.

- **Average “On Time” Assignment Submission Rate**
  - The number of total assignments divided by assignments submitted before the due date.

- **Early Submission Time**
  - Number of hours the assignment was submitted before the due date.

No differences appeared between the two groups on any of the three assignment dimensions (all $p > .10$). Students in the experimental group submitted 97.01% ($SE = 0.70$) of all their assignments, and students in the control group submitted 96.12% ($SE = 1.10$) of all total assignments. However, this was not a statistically significant difference. The average ‘on-time’ submission rate did not differ either, with students in the control group submitting an average of 84.26% ($SE = 1.42$) of their assignments on-time, and students in the experimental group submitting an average of 81.09% ($SE = 1.42$) of their assignments on-time. On average, students in both groups submitted assignments between 2-2.5 hours before the deadline (experimental group: $M = 2.19$, $SE = 0.17$; control group: $M = 2.45$, $SE = 0.27$).

We also did not detect differences in the final term grades for the students in the experimental and control conditions. This was true across middle or high school and controlling for key demographic variables like race/ethnicity, gender, and FRPL status.

In considering why Boost nudges did not translate into increases in student assignment completion and course performance, it is important to consider the high variability of Canvas usage by teachers and Boost usage by students. In addition, students reported that teachers used other mechanisms for alerting them to due dates (e.g., announcement during class, a shared document with assignment deadlines), potentially diluting the effect of Boost notifications. Students also mentioned that they faced few, if any, consequences for turning in late assignments, lessening the significance of Boost nudges. All of these conditions potentially interfered with the impact of Boost on both assignment completion and course grades.
BUILDING A BETTER BOOST

The fundamental operation of Boost is to send students reminders of upcoming assignments uploaded in their course’s LMS. There are settings within the application, though, that give students the opportunity to add onto this base feature, from customizing how far in advance they would like to receive notifications (e.g., the default reminder is set for 2 hours ahead of time—students have the option to change this to receive a notification as far as a week in advance) to adding in their own assignments for courses that do not use the LMS.
As evidenced through the focus groups, some students took advantage of these settings. However, we learned through our discussions a few recommendations for features that could further improve students’ experience with Boost and enhance how motivational the nudges are:

- **Tutorial on customization features**: While some students in the focus groups indicated that they had explored the application and found the settings where they could customize notifications, other students were not aware these settings were available. One potential update for Boost is to include a more detailed orientation for students to fully maximize the tool’s potential.
- **Ability to return to assignments**: Students remarked on wanting the option to return to an assignment to potentially revise or edit (i.e., an essay) before the submission date. For example, the student could customize a notification reminding them they have an assignment that they had wanted to read over again.
- **Estimate time needed for assignment**: In addition to customization around notification features, students also offered suggestions on different ways to further encourage them to complete assignments. One such suggestion was to add into the notification an estimate of how long the assignment would take. With this information, students would have a better sense of how to organize their time to complete the necessary assignments. By knowing that an assignment will take just 15 minutes, students might be more motivated to complete it in the moment instead of delaying it for later.
- **Indicate the % of classmates who have completed the assignment**: Another proposed idea for how to make Boost notifications more motivating was to add data showing how many of the student’s peers had already completed the assignment. This type of information could establish classroom norms around how soon students finish assignments, further encouraging them to finish assignments earlier to ‘fit in’ with their peers.
- **Customize the appearance of Boost phone notifications**: Students reported being confused at times whether or not they were seeing a Boost notification or a Canvas notification. When it is unclear which platform the notification arrives from, it is more likely that students ignore it. Coupled with the fact that given the myriad of applications they have downloaded on their devices, students may suffer from ‘notification fatigue’, leading to Boost notifications being overlooked. By customizing the appearance of notifications and making them more distinct from the more standard phone notification, Boost may be able to increase student engagement and follow-through with their notifications.
CONCLUSION

This exciting first implementation of Boost in the K-12 academic setting provides us with a foundational view of how middle and high schoolers use the tool. On the whole, students in the research study seemed eager to use Boost for its assignment reminder functionality and found the tool generally easy to operate. From both survey and focus group findings, using Boost did seem to positively impact how organized students felt about their coursework and in some cases, motivate them to complete assignments on time—assignments that might have previously been overlooked or turned in late.

Given that this study followed students for only one school term, future studies may conduct more longitudinal analyses to determine whether the educative nudging mechanism of Boost shapes student behavior more permanently, such that continued use of the tool leads to an enduring change in student procrastination and assignment submission. Additionally, future studies can examine the impact of Boost in courses where teachers consistently post assignments—do students in these courses earn higher grades in that course compared to past students? It would also be interesting to investigate whether students who interact with Boost more—open more notifications, enable more customized settings—show more positive academic outcomes.
Through the mixed-methods approach utilized in this study, we were able to holistically assess the Boost experience and unearth important insights that can be used to improve effectiveness and usage of both this tool and education technology in general.

Understand the Culture of Technology Adoption at School Site: The use of Boost in the classroom is not limited to how students respond to the notifications. Rather, it is important to acknowledge that part of Boost’s effectiveness derives from how the teacher engages with the LMS—that is, if the teacher does not input assignments and actively use the LMS, then students will not receive notifications and ultimately, the impact of Boost is lost. The culture of technology adoption and how school leadership encourages technology use affect technology uptake on the students’ end. The effect of Boost, and education technology more generally, has the potential to be enhanced by thoroughly understanding the significant role of these dependencies and the context of implementation.

Usage Metrics May Belie the Actual Student Experience: Canvas metrics showed that more high school students download Boost. At first glance, this may indicate that high schoolers were more engaged with the tool. However, our conversations with students and administrators highlighted that those in the middle school were actually more receptive to the new technologies introduced in the classroom. Middle-school students in the focus groups spoke animatedly about how they customized notifications within the Boost tool and used the tool to better organize their schoolwork. Had usage metrics been the only source of data, it would have been difficult to unearth the true engagement of middle school users.

Be Mindful of Students’ Access and Use of Technology: Boost is currently downloadable as a phone or tablet application. While this should mean that most students have access to Boost—a 2019 survey found that 69% of 12-year-olds in the United States own a smartphone (Rideout & Robb, 2019)—it does not factor in that students may not always have access to their phones to see the Boost notifications. Students in the focus groups said that they do not usually use their phones during the school day, that they would either leave their phones in their lockers or quickly glance at them during a break in school instruction. If students are not always on their phones or if there is a deluge of notifications appearing on their screens, then it may be the case that Boost notifications are being missed or overlooked. When the education technology is mainly concentrated on access to phones, it is important to be mindful of how and when students have access to their device.

As with many educational technology tools, the usability and effectiveness of a tool differs student by student and is also impacted by the culture of technology adoption at the school more generally. By conducting further research to understand the various use cases and how different environments shape technology usage, Boost can continue to uncover how it shapes assignment submission behavior and, ultimately, course success and retention.
REFERENCES

APPENDIX A: SURVEY DESIGN AND MEASURES

DATA COLLECTION
This research was approved by the South Fayette School District school board and the Human Resources Research Organization (HumRRO) Institutional Review Board. Since all students were under the age of 18 at the time of data collection, students’ parents were sent electronic consent forms where they would indicate consent for their child to participate in the survey and/or focus groups. At the end of the semester, students whose parents had indicated consent for their participation in the survey were emailed the online Qualtrics survey. Emails were sent out to students whose parents had provided consent for focus group participation; focus groups were conducted during school hours the following semester.

SURVEY MEASUREMENT
Measurement was mostly composed of previously standardized and/or validated scales. Estimates of internal consistency (α) are calculated for all scales.

Support (adapted from Kirby, Tabac, Ilac, & Cheryan, 2020) (α = .86)
1. How much do you think that your school cares about the experience of its students?
2. How much do you feel like your school cares about its students?
3. How much do you think your school would provide you with support you might need?
4. To what extent do you believe that your school would be invested in helping you overcome obstacles you might encounter during your time as a student?
5. To what extent do you believe you can find social support at your school?
6. How much do you think that your school cares about your experience?

1 = Not at all; 2 = Only a little; 3 = To some extent; 4 = Rather much; 5 = Very much

Self-Efficacy for Self-Regulated Learning (Bandura, 2006) (α = .88)

How well can you...
1. Finish homework assignments on time?
2. Study when there are other interesting things to do?
3. Concentrate on your school work?
4. Plan your school work?
5. Organize your school work?
6. Remember information presented in class and textbooks?
7. Arrange a place to study at home without distractions?
8. Motivate yourself to do schoolwork?
9. Participate in class discussions?

1 = Not well at all; 2 = Somewhat well; 3 = Average; 4 = Well; 5 = Very well

**Self-Regulation** (Goal Setting factor) *(Neal & Carey, 2005)*
(*α* = .85)

- I usually keep track of my progress toward my goals.
- I am able to accomplish goals I set for myself.
- I have personal standards, and try to live up to them.
- As soon as I see a program or challenge, I start looking for possible solutions.
- I have a hard time setting goals for myself.
- When I'm trying to change something, I pay a lot of attention to how I'm doing.
- I have trouble making plans to help me reach my goals.
- I set goals for myself and keep track of my progress.
- If I make a resolution to change something, I pay a lot of attention to how I'm doing.
- I know how I want to be.

1 = Strongly disagree; 2 = Somewhat disagree; 3 = Neither agree nor disagree; 4 = Somewhat agree; 5 = Strongly agree

**Subjective Happiness** *(Lyubomirsky & Lepper, 1999)*
(*α* = .81)

- In general, I consider myself (1) Not a very happy person - (7) A very happy person
- Compared to my peers, I consider myself (1) Less happy - (7) More happy
- Some people are generally very happy. They enjoy life regardless of what is going on, getting the most out of everything. To what extent does this characterization describe you? (1) Not at all - (7) A great deal
- Some people are generally not very happy. Although they are not depressed, they never seem as happy as they might be. To what extent does this characterization describe you? (1) Not at all - (7) A great deal

**Active Procrastination** (‘ability to meet deadlines’ factor) *(Choi & Moran, 2009)*
(*α* = .85)

1. I often start things at the last minute and find it difficult to complete them on time.
2. I often fail to accomplish goals that I set for myself.
3. I'm often running late when getting things done.
4. I have difficulty finishing activities once I start them.

1 = Strongly disagree; 2 = Somewhat disagree; 3 = Neither agree nor disagree; 4 = Somewhat agree; 5 = Strongly agree

**Perceptions of Academic Stress** *(adapted from Bedewy & Gabriel, 2015)*
(*α* = .82)

1. I am confident that I will be a successful student.
2. I fear failing courses this year.
3. I can make academic decisions easily.

1 = Strongly disagree; 2 = Somewhat disagree; 3 = Neither agree nor disagree; 4 = Somewhat agree; 5 = Strongly agree

**Academic Stress** *(adapted from Struthers, Perry, & Menec, 2000)*

(α = .82)

1. I feel worried about how I will do in this class.
2. I feel stressed about how I will do in this class.
3. I feel helpless about how I will do in this class.

1 = Not at all; 2 = A little; 3 = Sometimes; 4 = Often; 5 = A lot

**Perceived Ease of Use** *(adapted from Technology Acceptance Model; Davis, 1989)*

(α = .94)

1. Learning to operate Boost was easy for me.
2. I found it easy to get Boost to do what I wanted to do.
3. It was easy for me to become skillful at using Boost.
4. I found Boost easy to use.

1 = Strongly disagree; 2 = Somewhat disagree; 3 = Neither agree nor disagree; 4 = Somewhat agree; 5 = Strongly agree

**Satisfaction** *(adapted from Bourgonjon et al., 2010; Planas et al., 2013)*

(α = .93)

1. I would be happy using Boost in other courses.
2. I found Boost useful in my course.
3. If I had the choice, I would use Boost again.

1 = Strongly disagree; 2 = Somewhat disagree; 3 = Neither agree nor disagree; 4 = Somewhat agree; 5 = Strongly agree
APPENDIX B: FOCUS GROUP PROMPTS

FOCUS GROUP DISCUSSION GUIDELINES

The following questions helped guide the focus group discussions:
1. Did students find Boost useful for meeting assignment deadlines?
   a. Were students excited about its potential?
2. Was Boost easy to use/understand?
3. Were there any features that could be added that would improve the student experience? How can Boost be improved?

Below are a sample of the questions presented to students:
• Have you ever had to cram at the last minute to finish an assignment? Can you give me an example? Why do you think you ended up cramming?
• Why did you decide to download Boost?
• Were the notifications more helpful for some assignments than others? If yes, when were the nudges particularly helpful?
• Even if you mostly liked Boost, what would you suggest the company change or add to the app?
APPENDIX C: SURVEY ANALYSES, BY MIDDLE AND HIGH SCHOOL

For the survey items of Self-Regulation, Self-Efficacy, Procrastination, Ease of Use, and Satisfaction, we parsed out how responses differed by whether students were in middle or high school. Due to the low sample size ($n_{\text{Middle School}} = 31$, $n_{\text{High School}} = 38$), no statistical analyses can be conducted predicting differences between these two groups. However, for illustrative purposes, we have graphically represented the differences in responses by school group.

### Self-Efficacy, by School

<table>
<thead>
<tr>
<th>Item</th>
<th>Middle School</th>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrange a place to study at home without distractions?</td>
<td>17%</td>
<td>14%</td>
</tr>
<tr>
<td>Concentrate on your school work?</td>
<td>6%</td>
<td>50%</td>
</tr>
<tr>
<td>Finish homework assignments on time?</td>
<td>6%</td>
<td>14%</td>
</tr>
<tr>
<td>Motivate yourself to do schoolwork?</td>
<td>17%</td>
<td>43%</td>
</tr>
<tr>
<td>Organize your school work?</td>
<td>18%</td>
<td>21%</td>
</tr>
<tr>
<td>Participate in class discussions?</td>
<td>11%</td>
<td>21%</td>
</tr>
<tr>
<td>Plan your school work?</td>
<td>17%</td>
<td>50%</td>
</tr>
<tr>
<td>Remember information presented in class and textbooks?</td>
<td>0%</td>
<td>29%</td>
</tr>
<tr>
<td>Study when there are other interesting things to do?</td>
<td>22%</td>
<td>43%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
</tr>
</tbody>
</table>

**Response**
- Not well at all
- Somewhat well
- Average
- Well
- Very well
Ease of Use, by School

- I found Boost easy to use.
  - High School: 22%, Strongly agree: 78%
  - Middle School: 23%, Strongly agree: 77%

- I found it easy to get Boost to do what I wanted to do.
  - High School: 22%, Strongly agree: 78%
  - Middle School: 30%, Strongly agree: 70%

- It was easy for me to become good at using Boost.
  - High School: 19%, Strongly agree: 81%
  - Middle School: 27%, Strongly agree: 73%

- Learning to use Boost was easy for me.
  - High School: 14%, Strongly agree: 86%
  - Middle School: 23%, Strongly agree: 77%
For the survey items of Self-Regulation, Self-Efficacy, and Procrastination, we parsed out how responses differed by whether students were in the control group, experimental group, or did not use Boost. This third group is defined as those students who completed the survey but did not download the Boost application (this occurred because the survey was sent to all students, not just those who downloaded Boost). We did not conduct statistical analyses due to the low sample size among groups (all $n < 45$), but below we present graphical representations for illustrative purposes.
Procrastination, by Group

- I am often running late to get things done.
  - No Boost: 78% (Strongly disagree), 22% (Strongly agree)
  - Experimental Group: 67% (Somewhat disagree), 33% (Strongly agree)
  - Control Group: 80% (Strongly disagree), 20% (Strongly agree)

- I have difficulty finishing activities once I start them.
  - No Boost: 78% (Somewhat disagree), 22% (Somewhat agree)
  - Experimental Group: 61% (Somewhat disagree), 39% (Somewhat agree)
  - Control Group: 73% (Somewhat disagree), 27% (Somewhat agree)

- I often fail to accomplish goals that I set for myself.
  - No Boost: 84% (Strongly disagree), 16% (Strongly agree)
  - Experimental Group: 70% (Strongly disagree), 22% (Strongly agree)
  - Control Group: 87% (Strongly disagree), 13% (Strongly agree)

- I often start things at the last minute and find it difficult to complete them on time.
  - No Boost: 57% (Strongly disagree), 43% (Strongly agree)
  - Experimental Group: 44% (Strongly disagree), 56% (Strongly agree)
  - Control Group: 67% (Strongly disagree), 33% (Strongly agree)
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Boost is a personal notification assistant for students on their smartphones. Boost connects directly to a student’s Canvas account, and is easy and effective with no new work for administrators, instructors, or students. Students who use Boost are 3% more likely to pass their class, earn 4% higher grades, and are 6% more likely to turn in any given assignment.