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ABSTRACT

College success requires students to engage with their institution academically and administratively. Missteps with administrative processes can threaten student persistence and success. Through two experimental studies, one exploratory (N=13,657) and one pre-registered and confirmatory (N=11,561), we assessed the effectiveness of an artificially intelligent, text-based chatbot that proactively reached out to students to support navigation of administrative processes and use of campus resources. Across two-year and four-year college contexts, outreach was most effective when focused on discrete administrative processes–such as filing financial aid forms and managing registration holds–which were acute and time-sensitive and for which outreach could be targeted to those for whom it was relevant. We situate these experiments in the context of similar efforts targeting college students to formulate testable hypotheses about their effective use for promoting college success. Specifically, we hypothesize that proactive outreach will be most effective when: (1) framed as from a trusted source with whom students would expect to communicate; (2) targeted using data to ensure that communication is relevant to students' personal circumstances; and (3) focused on well-defined, required, and often acute tasks.

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A randomized controlled trials registry entry is available at
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Conditions under which college students can be responsive to text-based nudging

INTRODUCTION

Most US high school graduates pursue some form of postsecondary education (Irwin et al., 2021), however, many exit with no degree or credential. For example, among those who entered college in 2014 as first-year, full-time bachelor's degree seeking students, only 64 percent completed their degree within six years. Corresponding rates are even lower at two-year institutions.[1] Given increasing income inequality in the US, differences in degree attainment by socioeconomic status are a particular concern. Students from wealthier backgrounds are not only more likely to access college, but conditional on enrollment, they also are more likely to complete (Cohen et al., 2024; Kena et al., 2014; McFarland et al., 2017). In fact, for college entrants from low-income backgrounds, obtaining some postsecondary education but no degree or credential is the modal outcome (Kena et al., 2014). Compounding this problem, many low-income students take out loans to attend (Cameron et al., 2023). A trend in which students enter but do not complete college has the potential to exacerbate income inequality if students from low-income backgrounds disproportionately assume college debt without the labor market payoff of a college credential.

In response, institutions have sought to better support students to navigate college and earn a credential. Investment in comprehensive supports for undergraduates can improve persistence and degree attainment (see Dynarski et al., 2023, for a recent review). However, providing such support can prove challenging for resource-constrained campuses. Indeed, diminishing institutional resources have contributed to declining completion rates (Bound, Lovenheim & Turner, 2010) and inhibit the implementation of intensive support efforts. This context motivates

[1] U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), Winter 2020–21, Graduation Rates component. See Digest of Education Statistics 2021, tables 326.10 and 326.20.

the question of the extent to which universities can leverage low-cost and more narrowly defined strategies to improve students' postsecondary outcomes.

To succeed in college, students must engage with their institution academically and administratively. Challenges in either domain can hinder students' postsecondary progress. Administrative hurdles can impede college-intending students—particularly those from low-income backgrounds—even before they enroll (Castleman & Page, 2014). Among those who do enroll, students may lose access to financial aid by failing to (re)file the Free Application for Federal Student Aid (FAFSA; Bird & Castleman, 2016) or may face fines for missing deadlines for enrolling in or dropping courses. Such short-term administrative missteps may jeopardize students' long-term performance, standing, and persistence—potentially contributing to the completion differentials noted above.

Since 2016, Georgia State University (GSU) has employed an artificially intelligent, text-based, conversational chatbot to proactively support would-be first-year students as they navigate administrative processes required for enrollment. This text-message outreach improved GSU-committed students' completion of several required pre-matriculation tasks and increased their timely matriculation at GSU by a significant 3.3 percentage points (Page & Gehlbach, 2017). Given this success, the university scaled its matriculation chatbot as a standard means of communication with students through their summer transition to GSU. The university then asked whether the same technology could improve undergraduates' navigation and completion of administrative processes and engagement with campus support resources once enrolled. That such a communication tool would benefit already enrolled students is not a given. By virtue of living on (or near) campus, students have better access to relevant administrative offices and may not

need additional outreach and encouragement to engage with them. Here, we report on GSU's expansion of the chatbot tool to undergraduates enrolled at their two- and four-year campuses.

Specifically, we experimentally tested chatbot implementation on GSU's four-year Atlanta campus (hereafter, GSU-Atlanta) in academic year (AY) 2018-19 and on GSU's two-year Perimeter College campuses (GSU-Perimeter) in AY 2020-21 to assess the intervention's generalizability across contexts. In both settings, GSU tailored outreach to student needs where possible. General messages were sent to all students (e.g., messages providing information on course add/drop deadlines); customized campaigns targeted individual students according to their specific needs (e.g., messages regarding registration holds were sent only to students with holds to resolve). Across the two campuses, campaigns targeted similar administrative domains and were similarly customized.[2]

Through two randomized trials—an initial, exploratory implementation and a pre-registered replication—we estimate causal impacts of this chatbot communication on completion of specific, targeted actions and on overall measures of persistence and success. To preview our findings, the chatbot outreach most consistently affected student behavior when it addressed "acute" administrative processes. In other words, it was most effective for resolving issues that were serious, time-sensitive, or both, such as managing registration holds and outstanding balances, filing the FAFSA, and registering for next-semester courses. In contrast, communication encouraging students to utilize supplemental supports—meeting with advisors, attending course-specific supplemental instruction, and other less obviously acute issues—yielded little to no effect. Outreach also did not influence overall indicators of academic success, including credit hours

[2] At GSU-Atlanta, the messaging ran from October 2, 2018 through May 10, 2019. Please see Appendix Tables A1 and A2 for a comprehensive listing of messaging topics and associated outcome measures for GSU-Atlanta. At GSU-Perimeter, the messaging ran from September 10, 2020 through June 10, 2021. Appendix Tables A3 and A4 report analogous message-level information for GSU-Perimeter.

attempted / earned, term GPA, or next-semester persistence. Despite the lack of impact on overall measures of student persistence and success, GSU judged the impacts on navigation of administrative processes to be sufficiently compelling that at the end of each experiment they scaled the administrative chatbot to all of their enrolled undergraduates on both campuses the following academic year.

BACKGROUND

Recent scholarship on administrative burden provides a useful theoretical framework for this investigation. Herd and Moynihan (2018) define administrative burdens as the "learning, psychological, and compliance costs that citizens experience in their interactions with government" (p. 22). This definition translates well to characterize interactions between students and their universities, public and private; students must know about their administrative requirements, be motivated to navigate them, and have the wherewithal, skills and time to do so. Herd and Moynihan argue that administrative burdens are worthy of the policymaker's attention, because they are consequential and distributive. Consequential, as burdens shape whether and how individuals access services and opportunities that can make a difference in their lives; distributive, as burdens can affect individuals differentially and, as a result, can reinforce societal inequality. In more recent work, Gándara and colleagues (2024) draw on this and related work from Ray, Herd and Moynihan (2023) to advocate for a racialized lens on this framework in considering administrative burden in the context of higher education.

Indeed, in this context, administrative missteps can affect students' persistence unequally. First-generation, low-income, and minoritized students can face substantial, unique challenges to college completion (Jack, 2019). As articulated in social and cultural capital frameworks, students'

access to informational networks and resources affects their engagement with postsecondary systems. These students, in particular, may lack sufficient cultural capital to navigate complex postsecondary education processes and systems (Bourdieu, 1983; Carter, 2005; Perna, 2006).

That administrative burdens could hinder students' access to and success in college is far from theoretical. Approximately 10 percent of academically qualified, first-year Pell grant recipients fail to refile the FAFSA for their sophomore year, forfeiting an average of $3,550 in federal aid (Bird & Castleman, 2016). These FAFSA filing patterns can be worse for students at two-year institutions with fewer financial resources (Goolsbee et al., 2019). While some 85 percent of students starting at a public four-year college persist into their second year, only 62 percent of students at two-year institutions do so (NSC, 2021).

Behavioral science strategies can help students navigate administrative aspects of college-going (Dynarski et al., 2023). Filing the FAFSA together with annual tax filing and offering college entrance exams during the regular school day are two examples of how reducing the learning and compliance costs have increased completion of these key college-going tasks with subsequent effects on college enrollment and persistence (Bettinger et al., 2012; Hurwitz, Smith, Niu & Howell, 2015; Hyman, 2017). Efforts to reduce uncertainty about college admissions and financial aid by guaranteeing generous financial support, conditional on enrollment (Dynarski et al., 2021), or by directly admitting students to institutions for which they are qualified (Odle & Delaney, 2023) have also shown positive effects. Odle and Delaney (2023) caution, however, that the promise of admission without an accompanying commitment of financial aid likely has limited potential for substantially affecting college access, given the magnitude of perceived and actual financial barriers that students and their families can face.

Nudging: early promise and learning from efforts to scale

In addition to reducing uncertainty and procedural complexity, proactively communicating with, supporting, and "nudging" students toward task completion also can be an effective approach (Thaler & Sunstein, 2009). Several studies document the success of such low-touch interventions to support students through the administrative steps required to apply to and enroll in college, to file or refile financial aid applications, and to take up basic needs supports (Avery et al., 2021; Castleman et al., 2017; Castleman & Page, 2015, 2016; Goldrick-Rab et al., 2021; Hoxby & Turner, 2013; Hyman, 2020).

Despite this work's early promise, subsequent efforts to scale these strategies or apply them to a broader range of behaviors paint a more complicated picture. From this growing body of research, together with the experiments on which we report here, we have developed a set of hypotheses related to the conditions under which student behavior is responsive to such outreach. First, we hypothesize that nudges designed to shape student behavior are most effective when outreach comes from a trusted, local source with which students have a relationship. For example, outreach framed as coming from a student's high school counselor appears more promising for affecting completion of key college-going tasks than outreach from a more distal sender, such as The College Board (Avery et al., 2021). Similarly, in large-scale, state and national efforts to bolster FAFSA filing and reapplications, impacts on FAFSA submission and completion are modest to null (Bird et al., 2021; Page et al., 2022). Bird and colleagues note that in their intervention, outreach was framed as coming from a centralized entity with which students had no affiliation. They conclude that scaling of such efforts needs to happen "locally," institution by institution, rather than "globally" through a centralized organization.

Second, we hypothesize that local organizations also may be better positioned to nudge students, because they have better insight into the contexts in which students are operating, the tasks they need to complete, the required timing of those tasks, and students' status with respect to the required processes. In short, familiarity enables local organizations to craft tailored, relevant outreach. By leveraging administrative data, organizations can target communication only to students for whom specific messages are relevant e.g., in GSU's first chatbot experiment (Page & Gehlbach, 2017).

Finally, Oreopoulos and Petronijevic (2019) report on nudge interventions designed to shape more sustained student behaviors (as opposed to discrete, well-defined tasks). The authors' interventions focused on (1) goal setting; (2) mindset; and (3) student-success coaching—processes with different foci, more complex components, and longer time horizons. The authors emerge with a pessimistic view of the potential for light-touch strategies to improve student academic performance, although they note that coaching led to modest increases in study time and other non-academic outcomes, including students' feelings of support and well-being. Nevertheless, the magnitude of the effects on these outcomes was not sufficient to translate to improvements in academic outcomes such as course performance and credit attainment. This work points to the third hypothesis that nudges are effective when they target discrete, time-bound tasks but hold less efficacy for sustaining behavioral change over time—a quality that likely is needed for driving outcomes like academic performance. If so, this conclusion aligns with earlier work on incentivizing academic achievement; for example, Fryer (2011) found that well-defined educational inputs can be shifted effectively by incentives, but that incentivizing outputs without guidance on the steps necessary to attain improved academic achievement yields little to no effect.

In sum, several hypotheses emerge from this growing body of literature. First, outreach will be most effective when framed as coming from a trusted source with whom students would expect to communicate. Trust will be greater the stronger the student-entity relationship and/or the more "local" the entity is to the student. Second, outreach will be most effective when targeted using data to ensure that students are receiving communication that is relevant to their personal needs and circumstances. Third, outreach will be most successful when it focuses on well-defined, required tasks. If the consequences of inaction are ambiguous, students may be less likely to respond or less willing or able to prioritize the encouraged behavior.

To be clear, the present experimental studies do not test these hypotheses specifically. Rather, our findings are consistent with them, and—as we will return to in the discussion section—we propose that they are ready for a well-powered confirmatory test.

RESEARCH SITES AND INTERVENTION DESIGN

Georgia State University (GSU) is a large, public university system that serves a diverse student population broadly representative of the student populations that are often the focus of postsecondary educational interventions. GSU-Atlanta serves approximately 28,000 bachelor's-level students, more than half of whom received federal Pell grants and approximately 63 percent of whom identify as Black, Hispanic / Latine, or of two or more races. In 2016, the University System of Georgia Board of Regents consolidated then Georgia Perimeter College (GPC) and GSU, and GPC was renamed Perimeter College. Today, Perimeter College—so named for its physical locations being situated on the perimeter of the greater metropolitan area of Atlanta—is the two-year college system within GSU. Perimeter College serves approximately 15,000 students on five separate campuses as well as online. The racial / ethnic composition of Perimeter's student

population mirrors GSU's Atlanta campus. Across all GSU campuses, a substantial share of students are the first in their families to attend college.

Our two experiments represent a continuation of GSU's campus-specific chatbot efforts, run through GSU's National Institute for Student Success (NISS).[3] In summer 2016, GSU first contracted with Mainstay to build "Pounce," an artificially intelligent chatbot with the persona of the GSU mascot, to provide text-message based outreach and support to GSU-Atlanta admitted students.[4] Pounce outreach supported students to navigate the set of well-defined and time-sensitive administrative tasks required for on-time matriculation to GSU, including submitting a high school transcript, paying a housing deposit, RSVPing for and attending orientation, submitting immunization records, filing FAFSA, navigating FAFSA verification holds, accepting loans, completing loan counseling, and setting up a tuition payment plan. For each task, GSU texted data-informed reminders, provided step-by-step guidance on completing these tasks, and prompted students to ask questions. Enabled with artificial intelligence (AI) capacities, the platform also responded to students' questions. Questions that matched to information in the system knowledge base were answered immediately. When the AI could not answer a question with a sufficiently high probability of success, the question was emailed to a university staff member. The staff member's response was then routed back through the system platform to respond to the student and to update the knowledge base.[5] Pounce outreach increased students' completion of pre-matriculation requirements and enrollment in GSU (Page & Gehlbach, 2017).

Building on the success of the matriculation chatbot to improve rates of on-time enrollment, GSU deployed Pounce to provide proactive outreach and support to *enrolled* students

[3] For more information on GSU's NISS, see niss.gsu.edu.
[4] For more information on Mainstay, see www.mainstay.com.
[5] For more information on the technical details of this system, please see: https://patents.google.com/patent/US20180131645A1/en.

across their campuses. Specifically, GSU implemented chatbot communication to target three primary domains, as follows: [6]

- **Administrative processes.** These campaigns aimed to raise awareness of administrative processes, many of which were financially related and/or were required for students to remain in good standing with GSU (e.g., FAFSA filing, resolving an overdue balance).
- **Academic engagement processes.** These messages included reminders about ongoing persistence tasks related to academics (e.g., course registration) and more acute tasks (e.g., addressing a registration hold due to academic performance). Messaging typically encouraged students to meet with an advisor to complete these tasks collaboratively.
- **Personal/professional supports.** These campaigns aimed to raise engagement in supports that relate to students' academic success (e.g., participating in supplemental instruction), and other non-academic opportunities (e.g., career services events).[7]

Some campaigns were directed to all students; others targeted outreach only to those for whom it was relevant by integrating the platform with the university's administrative data. For example, initial messages about course registration were sent to all students, whereas campaigns related to registration holds were sent only to those with holds to resolve. In situations when students had

[6] During the 2018-2019 academic year, GSU-Atlanta chatbot implementation involved three full-time staff members. A project director within the university's Office of Enrollment Management and Student Success oversaw and directed the work. A full-time project associate facilitated data gathering and management for chatbot implementation and research purposes. Finally, a full-time administrative coordinator monitored and triaged incoming messages. Subsequent chatbot implementation at the GSU-Perimeter campuses during the 2020-21 academic year involved no additional staff members—although the chatbot took upfront time to develop, adapting it to the GSU-Perimeter context required considerably less staff effort. At the time of GSU-Perimeter implementation, the chatbot could respond to student queries with greater confidence due to maturation of the knowledge base through implementation at GSU-Atlanta. As a result, there was limited need for staff to answer student questions in the context of the GSU-Perimeter implementation, despite the expansion of the tool to many more students.

[7] These also included reminders about social, community-building events, such as a Thanksgiving feast for international students and (for the GSU-Perimeter chatbot) reminders about campus COVID-19 testing and vaccine resources. GSU also launched additional campaigns in the GSU-Perimeter administration to understand students' adaptation to online learning and instructional modality preferences; these campaigns were designed to collect student feedback rather than designed to change student behavior.

multiple holds, the university staff running the chatbot prioritized messaging students about the hold which would involve the greatest likelihood of needing to speak with a staff member, the logic being that in these complicated situations, the best use of the chatbot was to direct a student to connect with a human better equipped to help them navigate their complex situation.

Messages informed students of tasks that needed completion and identified actionable steps. A common message structure included the *what* ("looks like you have a balance hold on your account"), the *consequence* ("this will stop you from registering for summer & fall"), and a *call to action* ("You can take care of this hold through your account. For questions, email XXX"). In Appendix Tables A1 - A4, we provide date and topic information for all campaigns (Tables A1 and A2 report on GSU-Atlanta messages; Tables A3 and A4 report on GSU-Perimeter messages). We also detail whether the outreach was sent to all students or to a targeted subset. Finally, we indicate whether we report outcome data related to the behavior the outreach sought to encourage.

In this study, the key experimental contrast considers outcomes for students who received chatbot outreach in addition to any corresponding "business-as-usual" communication compared to outcomes for those who received non-chatbot, business-as-usual communication only. "Business-as-usual" prior to the chatbot meant students received timely, targeted outreach centered around known obstacles to progression (such as balances or lack of registration). This outreach was delivered primarily via email and was escalated to telephone calls should students not take action in response to the email communication. Such outreach rarely was coordinated across university administrative units to ensure message clarity and consistency as well as guidance on which action to take first if multiple tasks were required. This often resulted in administrative offices jockeying for student attention.

Throughout the studies, students continued to receive these directed emails and calls from key offices (e.g., registrar, financial aid, student accounts, advisement). In addition to these targeted emails, students also received regular communication from other units across campus (e.g., athletics, recreation, academic departments, student engagement offices, etc.), often leaving students with a full email inbox and little guidance regarding which GSU communication most required their attention. In contrast, not all units were able to communicate with students via the chatbot. Instead, the chatbot implementation team prioritized messages they deemed critical to students' continued persistence and success, and they would customize which messages students received based on their most pressing need.

RESEARCH DESIGN, DATA, AND ANALYSIS

We evaluated the impact of the GSU-Atlanta and GSU-Perimeter retention chatbots through separate randomized controlled trials. The GSU-Atlanta implementation took the form of an exploratory design and analysis, piloting messages and exploring what student tasks were best aligned with chatbot outreach. Following best practices in open science (Gehlbach & Robinson, 2018, 2021; Reich, 2021), we preregistered the GSU-Perimeter experiment as a confirmatory study.[8] Leveraging insights from the GSU-Atlanta implementation, we focused GSU-Perimeter messages on key administrative processes to examine the generalizability of the retention chatbot effectiveness on an associate-degree intending student body. Here, we describe the randomization process, data, and analytic samples for each site.

GSU-Atlanta Sample and Analysis

[8] See Registry of Efficacy and Effectiveness Studies—Registry ID 8740. We registered the study after the intervention concluded but prior to outcome data analysis

On the GSU-Atlanta campus, we included students in the study in two waves. Beginning in the Fall 2018 semester, the wave 1 sample included 7,580 GSU-Atlanta students (just over one-quarter of all undergraduates). These students were at various stages of their undergraduate career, but with greater shares of first-time freshmen and recent transfers to GSU. Wave 1 students received their first message on October 2, 2018. In March 2019, midway through the spring semester, the university expanded the sample with an additional 6,076 students (an addition of approximately a fifth of all undergraduates), after judging the system ready to handle additional student volume. Separately by wave, we randomized students into treatment and control conditions.

Within each wave, after randomization we checked for balance on baseline characteristics including indicators of student race/ethnicity, gender, financial aid status and prior academic achievement. We present descriptive statistics for the wave 1 and 2 samples by treatment status in Table 1. Mean treatment-control differences are substantively small and statistically indistinguishable from zero (Deaton & Cartwright, 2018). Thus, we will attribute subsequent treatment-control outcome differences to the chatbot communication. Treatment students received text-based outreach from Pounce in addition to business-as-usual communication, whereas control students received business-as-usual university communication only.

Across waves, students were largely similar on socio-demographic characteristics. In both, the sample was approximately 13 percent Hispanic, 45 percent Black, and 30 percent White. About one-quarter of students were first-generation college-goers, and half qualified for a Pell Grant. The sample was about 60 percent female, in line with continued trends of women outpacing men in college enrollment (Goldin, Katz & Kuziemko, 2006). The two waves differed in their age and

associated year in college, due to most incoming freshmen being included in the wave 1 sample. The typical wave 1 student was approximately 20 years old (23 years old in wave 2).

To assess the impact of treatment on student outcomes, we use regression and linear probability models of the following general form:

$$Y_{ij} = \alpha_j + \beta \times Treatment_{ij} + \boldsymbol{X\gamma} + \varepsilon_{ij} \quad (1)$$

where for student i in randomization wave j, α_j is a fixed effect for randomization wave, $Treatment_{ij}$ is an indicator equal to 1 if student i is randomized to treatment and zero otherwise, $\boldsymbol{X}$ is a vector of baseline covariates, including those in Table 1, and ε_{ij} is the individual error term. Our coefficient of interest, β, represents the intent-to-treat effect of assignment to the text-communication treatment group on outcome Y_{ij}. In our results, we report intent-to-treat (ITT) effects estimated with and without baseline covariate controls.[9] The primary purpose of including baseline controls is to improve precision of our estimates (Lin, 2013; Murnane & Willett, 2010).

Treatment-assigned students did not always receive all the messages intended for them due to circumstances such as opt out, changed phone numbers, and students temporarily "pausing" chatbot engagement, as described below. Although we cannot observe whether a student received and read a message, we can observe whether it was successfully distributed. Discrepancies between the students targeted for messaging and those to whom messages were distributed were small in practice. Although such differences can be handled with a two-stage least squares instrumental variables (IV) analytic strategy, opt-out / pause rates were sufficiently low and message distribution rates sufficiently high that these additional analyses do not yield new or different insights. Rather, ITT and IV results differ modestly, if at all, across outcomes. In addition,

[9] To the extent that there could be spillover whereby control group students learn about and are affected by the content of the treatment group outreach, our estimates represent a lower bound of the true effect of treatment.

ITT results are arguably most policy relevant for GSU and other institutions interested in adopting a similar communication strategy. For these reasons, present ITT estimates only.

GSU-Perimeter Sample and Analysis

The GSU-Perimeter study sample included 11,561 students (approximately three-quarters of Perimeter students) at various stages in their undergraduate career, randomized in a single wave at the start of the 2020-21 academic year (see Table 1). Because the 2020-21 academic year was in the midst of the Covid-19 pandemic, some messages pertained to Covid-19 related protocols and vaccination opportunities. Nevertheless, in-person courses and administrative offices were operating at the time of the study. The first study message was distributed on September 10, 2020.

We again observe balance across baseline characteristics (Table 1). The average age of the GSU-Perimeter sample is about 23. Compared to GSU-Atlanta, the share of students who are Black is slightly higher (51 percent), and slightly more students qualified for the Pell grant (57 percent) at GSU-Perimeter. The most striking difference is in prior academic performance—the average high school GPA was 3.5 for the GSU-Atlanta students versus about 2.8 for the GSU-Perimeter students. The admissions criteria for GSU-Atlanta are higher than for GSU-Perimeter, and students who do not meet admissions criteria for GSU-Atlanta are automatically offered GSU-Perimeter admission. These differences enable us to examine the extent to which similar message content has a consistent effect on a different student population in a distinct context. For the GSU-Perimeter sample, we fit models similar to the form expressed in equation (1) but without fixed effects for randomization wave.

Conditional Analysis

On both campuses, some messages were directed to all treatment students, whereas others were targeted to the subset for whom they were relevant. To assess impact in these targeted

instances, we first condition the sample on whether the message topic is relevant and then estimate the treatment effect within this conditional sample. For example, in the case of a message related to an unpaid bill, we first condition the sample (both treatment and control) on having an unpaid bill at the time of the campaign and then estimate the effect of assignment to treatment within this subsample. This means that selection into a conditional sample occurs after randomization, prompting concern about baseline imbalance in these conditional samples. In general, sample sizes remained balanced between conditional treatment and control groups. In Appendix Tables A5 (GSU-Atlanta) and A6 (GSU-Perimeter), we examine differences between message-eligible treatment and control group students on our set of covariates and run omnibus tests of joint orthogonality for each targeted message. We fail to reject the null hypothesis of joint orthogonality (that is, individual covariates do not appear to collectively predict the likelihood of being targeted by a messages) in eight out of ten targeted messages at GSU-Atlanta (Table A5) and in eight out of twelve targeted messages at GSU-Perimeter (Table A6). Further, in groups where we find suggestive evidence of demographic differences between eligible treatment and control students for a targeted message, the number of significant differences on individual covariates are minimal (typically between 1-4 of 19 tested covariates). Finally, as reported in the results below, treatment effects estimated with and without covariate controls are similar. In sum, we conclude that selection is not driving the results of these subgroup analyses.

RESULTS

We now turn to results across the two experimental studies. We begin with measures of system use and engagement and then consider impacts on the student behaviors that were directly

prompted by the chatbot outreach. Finally, we present results associated with overall measures of student academic performance, credit attainment and persistence.

System use and engagement

In Table 2, we present platform usage and student engagement metrics across both campuses. There was no control group crossover, and so system usage and engagement data pertain only to treatment-assigned students. Column 1 lists overall counts of outgoing (from Pounce to students) and incoming (from students to Pounce) messages. During the GSU-Atlanta intervention, the system distributed nearly a quarter-million messages to treatment students. Most of these messages were planned outreach campaigns. Another 5,000 messages were generated by the AI capabilities of the system in response to student inquiries. Nearly 800 messages to students were "triaged" responses such that a member of the chatbot team directly intervened and responded to a student inquiry, and only a handful of the messages were staff responses to messages escalated to them.[10] Throughout the year, students sent approximately 16,000 text messages into the Pounce system. Most commonly, these were responses to closed-ended questions (e.g., answering a yes/no question), but students also sent over 5,000 open-ended questions into the system. The number of student inquiries escalated to staff exceeds the number of times staff responded through the system, as staff members could communicate with the student via channels other than the text platform.

In the remaining columns of Table 2, we present measures of average student engagement, by wave. For GSU-Atlanta, wave 1 students received outreach throughout the entire 2018-19 academic year, whereas wave 2 students were added midway through the spring term. Here, we

[10] Escalation occurred when student messages were too specific or nuanced for the AI system to answer directly. In instances of escalation, the message was manually forwarded to the most relevant administrative unit among the following: Advising Office, Career Services, Financial Aid, International Student and Scholar Services, Registrar Office, and Student Success. In most cases, responses flowed back through the chatbot system to further update the system knowledge base.

focus our discussion on wave 1 results and note that wave 2 results are largely consistent but reflective of outreach over a shorter duration. The typical wave 1 treatment student received approximately 57 outreach messages. These consisted primarily of pre-planned campaign messages, a small number of automatic responses generated by the system's AI capabilities, and an even smaller number of messages sent by staff members through the system. The typical student sent approximately three messages to Pounce, with two of these being responses to close-ended survey questions and one being an open-ended question.

We observe substantial heterogeneity in system use. For example, although many students primarily received the general outreach directed to all students, the most engaged student received a total of 170 text messages and sent nearly 100 texts during the year. Of these incoming messages, the majority were open-ended questions that the system handled automatically. Further, many of the messages encouraged follow up with a campus office directly rather than communicating through the text system. As we show below, the targeted outreach was highly successful in eliciting this type of response.

Finally, when students indicated that they no longer wished to interact with Pounce, the system prompted them to text "#PAUSE" and asked them to choose if they wanted to pause outreach temporarily for two weeks or permanently. Among wave 1 treatment students, approximately 5 percent opted out of receiving outreach entirely and another 8 percent paused temporarily at some point. As would be expected for the shorter-duration intervention, opt out and pause rates are lower among students in the wave 2 sample. In general, opt out rates are on par with those from the shorter duration summer intervention (Page & Gehlbach, 2017) and suggest that students generally are willing to receive ongoing university text communications.

From the GSU-Perimeter implementation, we observe similar distribution and response patterns. The GSU-Perimeter implementation distributed about 298,000 messages and received about 21,000 replies from students. The average treatment student received about 52 messages throughout the academic year and sent about four messages. Fewer messages required escalation to staff. Students at GSU-Perimeter were much less likely to fully opt out, and about 4.4 percent of treatment students paused their campaign at least once.

Impact analysis

We present impacts on student behaviors thematically rather than sequentially. Although the messages targeted consistent domains of student behavior, they were tailored to align with students' needs and specific campus contexts. For these reasons, the Atlanta and Perimeter campus messages sometimes encourage somewhat different student behaviors and/or target distinct subgroups of students.

For each outcome, we present results tables organized as follows: In column 1, we report the control group average – either for the full control group or the subset of the control group who would have been targeted for a given campaign were they assigned to the treatment condition. In columns (2) and (3), we report ITT effects with and without baseline covariate controls. In column (4), we report the number of students for whom the message was relevant (i.e., the size of the sample included in treatment effect estimation). We present results for the GSU-Atlanta intervention in Panel A and for the GSU-Perimeter intervention in Panel B.

Impact of messaging on completion of administrative processes – financial management

In Table 3, we examine whether the chatbot communication affected whether or when students filed the FASFA—among the most important but daunting administrative tasks students must navigate. GSU sent tailored FAFSA messages to students in the middle of each month of the

spring semester. About 59 percent of control students in the GSU-Atlanta sample filed the FAFSA by the end of the spring semester, with treatment students about three percentage points more likely to do so. At GSU-Perimeter, about 47 percent of control students filed the FAFSA by the end of the spring semester, with the chatbot increasing filing by about two percentage points. We also found significant differences in FAFSA filing rates at earlier points in the semester. There may be high value to shifting not only whether but when students complete certain tasks; for example, there may be more financial aid available earlier in an application cycle (Bird, 2016), and clarity about aid available may make it easier for students to plan their next semester.

At GSU-Perimeter we also observed the effect of a targeted message about FAFSA verification, a federally mandated process in which selected students are required to verify information reported on their FAFSA. The verification process is a canonical example of administrative burden that reinforces social inequality by requiring students to learn about their verification flag, comply with providing additional documentation, and navigate the psychological cost of having their FAFSA data questioned and needing to re-attest to their financial situation. FAFSA verification disproportionately affects low-income students (e.g., would-be Pell grant recipients) and imposes substantial administrative costs on postsecondary institutions, with little improvement to the efficiency of aid distribution (Guzman-Alvarez & Page, 2021; Wiederspan, 2019). Students who fail to verify their FAFSA information lose access to several sources of financial aid (Cochrane et al., 2010). In the GSU-Perimeter sample, messaging about a verification hold was relevant for 453 students. For this group, outreach had a positive effect: relative to 22 percent of control group students, their treatment group counterparts were about 8 percentage points more likely to complete verification processes.[11]

[11] At GSU-Atlanta, one focus of spring semester outreach was financial aid-related holds. These messages pertained to FAFSA verification as well as other missing documents. This outreach affected hold resolution at a similar

Chatbot outreach also improved students' management of financial account issues for students who faced them. If a student begins a semester with an unresolved balance, they risk being required to withdraw. In Table 4, Panel A, we show that few GSU-Atlanta students had an outstanding balance at the start of the fall or spring semester (*N*s = 374 and 257, respectively). In the fall, 22 percent of control group students resolved their balance early in the semester, whereas treatment students were 8 percentage points more likely to do so and 10 percentage points less likely to be required to withdraw for non-payment within a week of receiving a chatbot reminder. In the spring, about 55 percent of control students resolved their balance early in the semester; treatment students were 18 percentage points more likely to resolve their balance the week following chatbot outreach and 9 percentage points more likely to have done so within two weeks. After two weeks, the treatment-control difference is no longer statistically significant but still practically meaningful in magnitude. Although the magnitude of this effect fades, *early* completion of such consequential administrative processes likely carries benefit. Students with outstanding balances can be dropped from courses and lose access to online materials while resolving this issue. Further, the overall improvement in cognitive bandwidth by resolving a balance earlier may enable students to direct more attention to their studies and start the semester on better footing (Mullainathan & Shafir, 2013). Institutions may also benefit from earlier resolution of these processes if they are required to track down fewer students and are able to finalize enrollments earlier in the term.

At Perimeter (Table 4, Panel B), fewer students began the term with an unpaid balance in the fall (N = 365) than in the spring (N = 1,984). Across both semesters, we observe a reduction in balance-related withdrawals and an increase in the likelihood of never being dropped or being

magnitude to the Perimeter verification messaging, although these effects were not precisely enough estimated to achieve statistical significance.

reinstated after being dropped. Perimeter also messaged selected students about additional financial aid for which they were eligible. Here, we find mixed results with an increased take-up of one-time, pandemic-related emergency aid and a negative (but not significant) effect on student take-up a college completion grant.

Impact of messaging on completion of administrative processes – academic planning

The campuses also used chatbot outreach to remind students to complete key administrative processes related to academics. In Table 5 we report on the effect of chatbot outreach on students' take-up of advising support services and resolution of academic holds. At GSU-Atlanta, the chatbot sent all treatment students a fall reminder to meet with their academic advisor. These reminders had a small but statistically significant effect on students meeting with their advisor within one week of the outreach, but no effect on ever meeting with their advisor. Notably, the control means are quite low for take-up of advisor meetings.

In contrast, messages that notified students about specific registration holds on their account significantly increased the likelihood of students attending academic advising and resolving these holds. At GSU-Atlanta, messages about registration holds increased the likelihood that treatment students resolved the hold by about eight percentage points in the fall and the spring, relative to the control group (37 percent in the fall and 23 percent in the spring). Similarly, GSU-Perimeter messages targeting students with fall registration holds increased advisor meetings by about seven percentage points (over a control group rate of 54 percent) and reduced the prevalence of students having such a hold at the end of the semester. In contrast, more general messaging to all GSU-Perimeter students in the spring semester had no effect on either advisor meetings or resolution of holds.

During the spring semester, students received monthly messages reminding them to enroll in classes for the following fall. At GSU-Atlanta, about two-thirds of control students had registered for the next academic year by mid-June; the chatbot increased course registration by almost three percentage points (Table 6). At GSU-Perimeter, outreach increased next-fall registration by about two percentage points, relative to the control group rate of 28 percent by mid-June. At GSU-Atlanta, the chatbot was even more effective at encouraging early registration – improving registration as of mid-April by 4.7 percentage points relative to 2.8 percentage points as of mid-June.

Impact of messaging on take-up of academic and career-related supports

The campuses also used chatbot outreach to encourage students to take up supplemental academic- and career-related supports (Table 7). At GSU-Atlanta, outreach pertaining to graduate school or career fairs had little to no effect on student attendance at these events beyond the notably low take-up of these opportunities among control students. Similarly, across contexts, we find little evidence that outreach regarding supplemental instruction (SI) opportunities increased take-up. We note that student use of SI services was low at both sites – only about a quarter of students in the control group who met the "target" criteria at GSU-Atlanta ever attended SI; at GSU-Perimeter, attendance rates were even lower (about 10 percent of control students in the fall, 13 percent in the spring).[12]

At GSU-Perimeter, academic support messages also took the form of encouraging participation in academic coaching meetings. In the fall, these messages targeted students who were on "early alert" based on their academic performance. This fall outreach had no effect on

[12] SI messages were targeted to students enrolled in courses with high rates of students earning a D, F, or withdrawing.

students' likelihood of meeting with a coach.[13] In contrast, similar spring coaching messaging to a more targeted group increased coaching visits and enrollment in the campus "Comeback Camp" program – a series of extra support services targeting students with GPAs below 1.99. Treatment students were 6-7.5 percentage points more likely to meet with their academic coach in the spring (relative to 27 percent of control group students) and 12 percentage points more likely to enroll in Comeback Camp compared to a control group rate of about 22 percent.

Impact of messaging on summative outcomes

Finally, in Table 8, we present impacts on summative outcomes including fall and spring GPA and credits earned as well as indicators for whether students graduated by the end of the intervention year and whether they graduated in or persisted (either graduated, enrolled, or, for GSU-Perimeter, transferred to GSU-Atlanta) into the following fall. The outreach did not affect these summative outcomes. We also ran subsample analyses to examine whether the messaging generated impacts on academic outcomes for (a) the subsample of students who received targeted messaging about time-sensitive tasks that had the potential to derail their academic progress (e.g., those with financial holds) and (b) demographic groups who face differential challenges to academic persistence. Our first insight is that most students were eligible for a targeted message about a roadblock in their academic progress – at GSU-Atlanta, for example, 62% of wave 1 students were targeted for a message about resolving a financial hold, about registration holds, or about the need to meet with an academic advisor to discuss maintaining satisfactory academic progress; at GSU-Perimeter, the share was 93%. This indicates that while the sample for any given targeted message was small (e.g., only 365 students at GSU-Perimeter had an outstanding balance on their fall bill), the majority of students faced some type of administrative setback over the course

[13] These messages followed this general form: "Hi XX, looks like you might need some help in one of your classes. Your academic coach can help <link>. Are you ready to meet with <Name>, your academic coach and make a plan?"

of an academic year. Given that most of the overall sample was eligible for targeted messaging, our subgroup analyses for the targeted sample do not yield significantly different results than our overall analysis.[14] For demographic subgroups, we examined whether there were impacts on academic performance for freshmen, female students, Black students, first-generation students, or Pell grant recipients and found no notable treatment differences for any subgroups at GSU-Atlanta or GSU-Perimeter.[15]

Given that the outreach was particularly beneficial in helping targeted sets of students to navigate required administrative tasks, and no outreach dealt directly with students' core academic responsibilities, it is perhaps unsurprising that the chatbot outreach, as implemented, did not translate to improvement in overall academic performance metrics such as GPA or course credits earned. These administrative barriers are likely not the primary drivers of academic performance, and institutions likely need different intervention approaches to tackle the suite of constraints on these metrics. Finally, we note that, because GSU perceived substantial benefits from the intervention, they scaled the outreach to all students (treatment and control) just prior to the start of the following fall semester, and this may have attenuated any potential persistence effects.

DISCUSSION AND CONCLUSION

Across two studies, we experimentally assessed GSU's efforts to use an AI-enabled text message chatbot to provide support to undergraduates on their four-year Atlanta campus during the 2018-19 academic year and on their two-year Perimeter campuses during the 2020-21 academic year. We regard the GSU-Atlanta experiment as exploratory and the GSU-Perimeter

[14] We did observe one statistically significant effect: a reduction in semester 2 graduation rates for the subsample of targeted students at GSU-Atlanta. Full results available upon request.
[15] We observed one statistically significant effect: an increase in semester 3 persistence for first-generation college students at GSU-Perimeter. Full results available upon request.

experiment as confirmatory, as indicated by preregistration of the Perimeter study. We situate this work within ongoing conversations regarding the importance of replication studies for guiding policy development around consistent empirical trends (Makel & Plucker, 2014; Plucker & Makel, 2021).

A key limitation of this study is that, because of the way that the text messaging system operates, we could observe whether the outreach messages were distributed but not whether they were actually received. In addition, even if messages are received on students' phones, we could not observe whether they were read by students. A risk of this type of repeated outreach is that students learn to ignore the messages over time if they regard the messages as unhelpful. Overall, we are not able to capture information on students' perceived value of the outreach. That the outreach affects student behavior into the spring semester leads us to believe that students are still paying attention to the communication, but this is an assumption.

Our findings underscore that studies focused on low-touch communication interventions in educational contexts have reached a level of maturity where we can formulate hypotheses about some of the characteristics that make nudges effective in shaping undergraduate students' behaviors. Our results also signal where such strategies appear limited in their effectiveness. We note that characteristics of effective outreach for college students are likely to differ from those for outreach to, for example, parents regarding activities with their preschool (e.g., Doss, Fahle, Loeb & York, 2019; York, Loeb & Doss, 2019) or school-aged (e.g., Kraft & Dougherty, 2013) children. Whereas parents of young children may be more future oriented, traditionally-aged college students may succumb comparatively more to limited attention and present bias.

Our estimated impacts show consistency across the two- and four-year GSU campuses. Furthermore, they are congruent with several hypotheses, informed by prior research, about the

conditions under which college students are responsive to this type of communication. We focus on hypotheses in three specific domains: the extent of the existing relationship between the student and the entity aiming to motivate student behavior; the relevance of outreach to the student's immediate needs and circumstances; and the urgency of the student behaviors that the messaging encourages.

First, we hypothesize that text-based outreach is most effective when the sender is known and trusted and when the communication is congruent with the student-sender relationship. In the interventions reported here, outreach was framed as coming from Pounce, a friendly embodiment of the university central administration. Anecdotally, GSU staff reported receiving many "thank you" messages from students receiving chatbot communication. At GSU-Atlanta, among students in the first wave of randomization (e.g., those targeted for outreach for the entire 2018-19 academic year), approximately 5 percent opted out, and another 8 percent paused outreach at some point during the year.[16] Such opt out (and pause) rates are in line with prior text-based interventions where the outreach was from a trusted source and one from whom students would expect to hear, given the topical focus of the messaging. In contrast, opt out rates tend to be higher in response to outreach from less well-known sources or from ones with which the student may not expect to communicate (e.g., Avery et al., 2021; Page et al., 2022). Thus, a key testable hypothesis is that the ostensible sender of a message matters, with students likely to be more receptive to communication from organizations and / or individuals with which they are affiliated (e.g., Debnam, 2017).

A second hypothesized condition of successful outreach is that carefully tailoring communication to be relevant to the student is a key ingredient. High relevance will help to foster

[16] Opt out and pause rates were lower for GSU-Atlanta students in the wave 2 randomization who received outreach over a shorter duration of time and were, on average, further along in their studies than wave 1 students.

a student's trust in and attention to communication. As text-based outreach becomes more common and students become increasingly inundated with messages, they may pay less attention, the potency of individual messages may get diluted, or students may opt out entirely. If outreach is generic and not well tailored to a given student's needs, these risks may increase. One strategy for personalizing outreach is to integrate communication systems with the institution's student information system. By incorporating student data into proactive messaging efforts, institutions can increase message relevance and credibility, target messaging appropriately to students when needed, and provide students with more specific guidance. Such targeting has been used successfully in this effort as well as prior efforts focused on FAFSA filing (Page, Castleman & Meyer, 2019; Avery et al., 2021) and the summer college transition (Page & Gehlbach, 2017) as well as in targeting outreach to students in the context of more comprehensive student success programs (e.g., Page, Kehoe, Castleman & Sahadewo, 2019).

Nevertheless, using a centralized communication platform such as Pounce, could require substantially more and different data sharing procedures across university administrative offices absent a robust, centralized student information system. Such data sharing routines and procedures are an important foundation to the successful implementation of a chatbot tool that relies on student-level data (Nurshatayeva et al., 2021) but may be challenging to implement for resource-constrained institutions or those that otherwise are operationally siloed.

Third, our results are consistent with the hypothesis that for college students, text-based nudging is particularly effective when focused on discrete, required tasks and processes that carry a sense of urgency and for which the consequences of inaction are immediate and tangible. Examples of these types of "acute" tasks include managing an unpaid portion of a tuition bill or resolving registration holds—if left unattended, these would result in a student being unenrolled.

Within text-based nudging studies focused on the transition from high school to college, multiple tasks (e.g., FAFSA completion and verification, placement testing, vaccinations, tuition payment, etc.) can be characterized in this way (Castleman & Page, 2015; 2017; Page & Gehlbach, 2017). Thus, text-based outreach may be best for encouraging discrete, high-stakes actions or else may need to communicate more explicitly about the consequences of inaction / the benefits of action. For example, GSU-Perimeter advising messages were more effective when coupled with information about students having a registration hold on their account. Similarly, Perimeter's spring coaching messages may have more effectively induced coaching take-up because the outreach included "Comeback Camp" information that provided students with a concrete reason for how meeting with a coach could help to improve their academic standing.[17] In contrast, messages that encouraged students to take up career services supports or supplemental instruction did not lead students to take up the encouraged action. These messages may have lacked a sense of urgency, as the immediate consequences of inaction were likely less obvious. In future iterations, messages on such topics might be more effective the more explicit they are about what students stand to gain or lose in the short run.

The hypotheses that we lay out here would benefit from confirmatory tests. These tests will be even stronger and more compelling to the extent that process data can help us better understand what proportion of messages are received and learn (perhaps qualitatively) how students internalize those messages. This type of future research could lead to additional insights into the conditions under which nudges are most effective.

[17] The spring coaching encouragement may also have been more effective than fall messages; fall messages targeted students who were behind in the semester but had not yet faced any final grade consequences. In the spring, messages took the general form of "Hi XX. If Fall didn't go how you expected or you want to learn the best way to stay on track in your classes your academic coach can help." Those spring messages referenced students back to their final grades from the fall, and students may have been more motivated by their prior semester final grades than their to-date performance in the current semester to attend coaching.

Despite the consistent positive effects that we observe on student management of various administrative processes, we find no effects on summative measures of student academic success. Perhaps this lack of overall effect in the academic domain is unsurprising, however, as the outreach was not integrated into students' core academic experiences. That is, it did not directly relate to university curricula and assigned course work. Where outreach did engage with academics, it pertained to supplemental curricular opportunities for students who were struggling academically and to administrative procedures for students who were failing to meet Satisfactory Academic Progress. Outreach on such topics has the potential to feel stigmatizing to students and, if sent centrally, may feel detached from students' experiences with their course faculty. The lack of impact that we observe on academic actions (e.g., participation in supplemental instruction) and outcomes (e.g., GPA and credit attainment) aligns with findings from Oreopoulos and Petronijevic (2019) and Collier, Fitzpatrick and Nichols (2021). However, in neither of those studies nor this one were course faculty ostensibly involved with communication to students. Per our hypothesis about known, trusted, expected senders of messages, when outreach is from course faculty and thoughtfully aligned with important course milestones (e.g., Carrell & Kurlaender, 2023; Balaban & Conway, 2020; Smith et al., 2018), it has more effectively influenced students' academic engagement and performance. Indeed, GSU has recently partnered with faculty to adapt this chatbot technology for use in specific, large-enrollment courses, with promising initial results (Meyer et al., 2023).

In our investigation, we find that centralized, text-based outreach to students regarding required (and, often, time sensitive) administrative tasks was effective for improving students' attention to and success with navigating administrative burdens that impede their progress. Across this and other studies, impacts on the order of magnitude that we observe on administrative

processes can be considered impressive, given the tool's low cost and potential for scale. At the same time, these impacts can be considered modest in absolute terms, as many students still did not overcome administrative hurdles, despite the additional outreach. It may be that such proactive outreach could be even more effective if coordinated and incorporated into multi-pronged systems of support that account for the several dimensions—financial, academic, social, administrative—along which students can falter on the path to college success. As administrators and policymakers consider how such efforts may fit into their own student-support context, they face a challenging task of sifting through studies on different populations, set in different contexts, and implemented in different ways. Our findings replicate across the two experiments and cohere with hypotheses informed by prior literature. We hope these results give practitioners and policymakers confidence regarding the promise and limitations for how such strategies can be deployed for supporting students to navigate their undergraduate careers.

Of course, a final challenge in the context of this intervention is the pace of development and change of artificial intelligence. Generative, conversational AI is evolving rapidly such that the specific tool and system we study here may not generalize far into the future. For this reason, it is even more important to establish and test the core principles and hypotheses such as those we lay out here.

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TABLES AND FIGURES

Table 1: GSU-Atlanta and GSU-Perimeter Analytic Samples

	GSU-Atlanta (N=13,656)				GSU-Perimeter (N=11,561)	
	Wave 1 (N=7,580)		Wave 2 (N=6,076)			
	Control	Treatment	Control	Treatment	Control	Treatment
Freshman	0.53	0.52	0.10	0.10	0.22	0.22
Sophomore	0.27	0.27	0.19	0.19		
Junior	0.07	0.06	0.41	0.41		
Senior	0.13	0.14	0.30	0.30		
Transfer	0.08	0.09			0.06	0.06
Female	0.59	0.59	0.62	0.61	0.64	0.64
Hispanic	0.14	0.13	0.12	0.12	0.16	0.16
Asian	0.16	0.17	0.12	0.13	0.11	0.10
Black	0.42	0.43	0.47	0.46	0.51	0.52
Multi-racial	0.09	0.08	0.08	0.08	0.07	0.07
White	0.30	0.29	0.29	0.30	0.26	0.25
Age (years)	20.24	20.26	23.48	23.45	23.70	23.87
	(5.34)	(5.21)	(6.97)	(6.81)	(7.92)	(7.90)
First-generation college goer	0.24	0.24	0.27	0.25	0.25	0.24
Filed FAFSA	0.93	0.93	0.88	0.89	0.82	0.81
Received Pell grant	0.48	0.47	0.49	0.51	0.58	0.57
High school GPA	3.47	3.47			2.84	2.83
	(0.33)	(0.34)			(0.56)	(0.57)
GSU GPA	2.04	2.03	2.96	2.96	2.03	2.00
	(1.59)	(1.60)	(0.82)	(0.82)	(1.36)	(1.36)
N Students	3,856	3,724	3,037	3,039	5,781	5,780

+p < 0.10 *p < 0.05 **p<0.01, ***p<0.001

Source: GSU administrative records.

Notes: Each cell reports sample average. For continuous measures, standard deviation reported in parentheses. Statistically significant differences in baseline characteristics assessed by regressing each baseline characteristic on an indicator of treatment assignment and fixed effects for group within which randomization was conducted. We observe balance on all baseline measures (for GSU-Atlanta we observe balance on all baseline measures when assessed for the waves separately and for the data pooled across waves). FAFSA filing refers to the year prior to intervention.

Table 2: Chatbot engagement and opt-out

	GSU-Atlanta			GSU-Perimeter	
Outcome	Total N	Wave 1 Average	Wave 2 Average	Total N	Average
N outgoing messages	244,673	56.721 (0.345)	10.950 (0.088)	298,382	51.623 (0.308)
N outgoing campaign messages	233,265	54.243 (0.332)	10.240 (0.077)		
N outgoing auto-response messages	5,554	1.133 (0.050)	0.434 (0.029)		
N outgoing triage messages	777	0.136 (0.008)	0.089 (0.007)		
N outgoing staff response messages	16	0.004 (0.001)	0.001 (0.000)		
N incoming messages	15,980	3.323 (0.077)	1.178 (0.040)	21,325	3.689 (0.068)
N incoming survey response messages	9,056	1.894 (0.041)	0.656 (0.018)		
N incoming question	5,555	1.134 (0.050)	0.434 (0.029)		
N incoming messages escalated to staff member	42	0.010 (0.002)	0.002 (0.001)	34	0.005 (0.0009)
Opt out		0.048 (0.004)	0.011 (0.002)		0.0007 (0.0003)
Pause participation		0.080 (0.004)	0.048 (0.004)		0.044 (0.003)
N		7,580	6,076		11,561

Source: GSU administrative records. Notes: Each row reports results from fitting equation (1) to outcome data for outcomes reported in first column. No covariates were included in modeling these outcomes. Robust standard errors in parentheses.

Table 3: Experimental effects of text-based outreach on financial aid outcomes

			(1)	(2)		(3)		(4)
Sample	Campaign Topic	Outcome	Control Mean	ITT effect		ITT effect		N
Panel A: Atlanta								
Full	2019-2020 FAFSA reminder (sent monthly)	Filed FAFSA by mid-March	0.406	0.009		0.007		13,656
				(0.008)		(0.008)		
		Filed FAFSA by mid-April	0.553	0.037	***	0.033	***	13,656
				(0.008)		(0.008)		
		Filed FAFSA by end of spring semester	0.591	0.037	***	0.033	***	13,656
				(0.008)		(0.008)		
Targeted	Financial Aid Award hold	Resolve financial aid hold	0.229	0.060		0.058		438
				(0.042)		(0.042)		
Panel B: Perimeter								
Full	2021-2022 FAFSA reminder (sent monthly)	Filed FAFSA by mid-March	0.337	0.023	**	0.027	***	11,561
				(0.009)		(0.008)		
		Filed FAFSA by mid-April	0.383	0.028	**	0.033	***	11,561
				(0.009)		(0.008)		
		Filed FAFSA by end of spring semester	0.472	0.015	+	0.021	**	11,561
				(0.009)		(0.008)		
Targeted	Financial Aid Award hold due to required verification	Resolve FAFSA verification	0.224	0.079	+	0.082	*	453
				(0.041)		(0.041)		
		Covariates				X		

+p < 0.10**p < 0.05 **p<0.01 ***p<0.001

Source: GSU administrative records. Notes: Each row reports on a series of regression models to assess the impact of chatbot outreach on a given outcome. Each row reports the topical focus of the campaign as well as the specific outcome assessed. Results columns 1 and 2 report the control average outcome and ITT effect from a regression without any covariates (and that includes only fixed effects for groups within which randomization was conducted for the Atlanta sample). Column 3 reports covariate controlled ITT effects from a model including all campus covariates listed in Table 1. Robust standard errors in parentheses.

Table 4: Experimental effects of text-based outreach on financial balance outcomes

			(1)	(2)		(3)		(4)
Term	Campaign Topic	Outcome	Control Mean	ITT effect		ITT effect		N
Panel A: Atlanta								
Fall	Outstanding balance on fall term bill	Resolved balance, one week later	0.222	0.090	*	0.077	+	374
				(0.045)		(0.046)		
		Withdrawn for nonpayment, one week later	0.206	-0.101	**	-0.103	**	374
				(0.036)		(0.036)		
Spring	Outstanding balance on spring term bill	Resolved balance, one week later	0.550	0.173	**	0.181	**	257
				(0.061)		(0.061)		
		Resolved balance, two weeks later	0.725	0.087		0.091		257
				(0.055)		(0.055)		
Panel B: Perimeter								
Fall	Outstanding balance on fall term bill	Withdrawn for nonpayment, end of term	0.247	0.079	+	0.051		365
				(0.047)		(0.048)		
		Held end of term balance	0.169	0.003		0.003		365
				(0.039)		(0.040)		
Spring	Outstanding balance on spring term bill	Withdrawn for nonpayment, end of term	0.185	-0.063	***	-0.062	***	1,984
				(0.016)		(0.016)		
		Never dropped or reinstated	0.901	0.032	**	0.030	**	1,984
				(0.012)		(0.012)		
	Inform about additional financial aid available	Accepted GEER grant	0.182	0.102	+	0.119	*	237
				(0.055)		(0.058)		
		Accepted College Completion grant	0.515	-0.098		-0.065		128
				(0.089)		(0.099)		

+p < 0.10**p < 0.05 **p<0.01 ***p<0.001

Source: GSU administrative records. Notes: Each row reports on a series of regression models to assess the impact of chatbot outreach on a given outcome. Each row reports the topical focus of the campaign as well as the specific outcome assessed. Results columns 1 and 2 report the control average outcome and ITT effect from a regression without any covariates (and that includes only fixed effects for groups within which randomization was conducted for the Atlanta sample). Column 3 reports covariate controlled ITT effects from a model including all campus covariates listed in Table 1. Robust standard errors in parentheses.

Table 5: Experimental effects of text-based outreach on academic progress

			(1)	(2)		(3)		(4)
Term	Campaign Topic	Outcome	Control Mean	ITT effect		ITT effect		N
Panel A: Atlanta								
Fall	Meet with academic advisor	Meet with advisor within 1 week	0.071	0.019	**	0.020	***	7,580
				(0.006)		(0.006)		
		Ever met with advisor	0.217	-0.011		-0.010		7,580
				(0.009)		(0.009)		
	Maintaining Satisfactory Academic Progress	Attended SAP meeting	0.000	0.007	*	0.008	*	1,085
				(0.004)		(0.004)		
	Registration hold(s)	Resolve hold(s)	0.368	0.081	***	0.074	***	1,670
				(0.023)		(0.023)		
Spring	Maintaining Satisfactory Academic Progress	Attended SAP meeting	0.050	0.019		0.018		425
				(0.023)		(0.023)		
	Academic Improvement Plan hold	Resolve hold	0.228	0.076	*	0.071	+	529
				(0.039)		(0.039)		
Panel B: Perimeter								
Fall	Registration hold(s)	Ever met with advisor	0.541	0.069	**	0.066	**	1,332
				(0.027)		(0.027)		
		Had hold at end of term	0.789	-0.056	**	-0.057	**	1,332
				(0.023)		(0.023)		
Spring	Meet with academic advisor	Ever met with advisor	0.466	0.012		0.012		10,683
				(0.010)		(0.010)		
		Had hold at end of term	0.228	-0.003		-0.007		10,683
				(0.008)		(0.007)		
		Covariates				X		

+p < 0.10**p < 0.05 **p<0.01 ***p<0.001

Source: GSU administrative records. Notes: Each row reports on a series of regression models to assess the impact of chatbot outreach on a given outcome. Each row reports the topical focus of the campaign as well as the specific outcome assessed. Results columns 1 and 2 report the control average outcome and ITT effect from a regression without any covariates (and that includes only fixed effects for groups within which randomization was conducted for the Atlanta sample). Column 3 reports covariate controlled ITT effects from a model including all campus covariates listed in Table 1. Robust standard errors in parentheses.

Table 6: Experimental effects of text-based outreach on course registration

			(1)	(2)		(3)		(4)
Sample	Campaign Topic	Outcome	Control Mean	ITT effect		ITT effect		N
Panel A: Atlanta								
Full	Fall 2019 registration (sent monthly)	Registered for fall by April	0.495	0.047	***	0.043	***	13,657
				(0.008)		(0.008)		
		Registered for fall by May	0.631	0.032	***	0.029	***	13,657
				(0.008)		(0.008)		
		Registered for fall by June	0.659	0.028	***	0.025	***	13,657
				(0.008)		(0.008)		
Panel B: Perimeter								
Full	Fall 2021 registration (sent monthly)	Registered for fall by April	0.096	0.018	***	0.020	***	11,561
				(0.006)		(0.006)		
		Registered for fall by May	0.234	0.027	***	0.029	***	11,561
				(0.008)		(0.008)		
		Registered for fall by June	0.284	0.021	**	0.024	**	11,561
				(0.008)		(0.008)		
		Covariates				X		

+p < 0.10**p < 0.05 **p<0.01 ***p<0.001

Source: GSU administrative records. Notes: Each row reports on a series of regression models to assess the impact of chatbot outreach on a given outcome. Each row reports the topical focus of the campaign as well as the specific outcome assessed. Results columns 1 and 2 report the control average outcome and ITT effect from a regression without any covariates (and that includes only fixed effects for groups within which randomization was conducted for the Atlanta sample). Column 3 reports covariate controlled ITT effects from a model including all campus covariates listed in Table 1. Robust standard errors in parentheses.

Table 7: Experimental effects of text-based outreach on academic and career support services

			(1)	(2)		(3)		(4)
Sample	Campaign Topic	Outcome	Control Mean	ITT effect		ITT effect		N
Panel A: Atlanta								
Fall	Career Fair, Fall	Attended fair	0.033	0.010	*	0.010	*	7,580
				(0.004)		(0.004)		
	Graduate and Professional School Fair, Fall	Attended career fair	0.012	-0.004		-0.004		1,517
				(0.005)		(0.005)		
	SI Encouragements	Attended SI	0.257	-0.008		-0.007		2,659
				(0.017)		(0.017)		
Spring	Career Week, Spring	Attended career week	0.011	0.000		0.000		6,780
				(0.003)		(0.003)		
Panel B: Perimeter								
Targeted	SI Encouragements	Attended SI	0.098	0.027		0.029		828
				(0.022)		(0.022)		
	Coaching	Attended coaching	0.126	0.022		0.023		1,619
				(0.017)		(0.017)		
	SI Encouragements	Attended SI	0.133	0.022		0.016		474
				(0.032)		(0.031)		
	Coaching	Attended coaching	0.268	0.058		0.075	+	419
				(0.045)		(0.044)		
		Attended comeback camp	0.217	0.122	**	0.123	**	419
				(0.043)		(0.044)		
		Covariates				X		

+p < 0.10**p < 0.05 **p<0.01 ***p<0.001

Source: GSU administrative records. Notes: Each row reports on a series of regression models to assess the impact of chatbot outreach on a given outcome. Each row reports the topical focus of the campaign as well as the specific outcome assessed. Results columns 1 and 2 report the control average outcome and ITT effect from a regression without any covariates (and that includes only fixed effects for groups within which randomization was conducted for the Atlanta sample). Column 3 reports covariate controlled ITT effects from a model including all campus covariates listed in Table 1. Robust standard errors in parentheses.

Table 8: Experimental effects of text-based outreach on overall outcomes

	GSU-Atlanta			GSU-Perimeter		
	Control Mean	ITT Effect	N	Control Mean	ITT Effect	N
Fall semester credits earned	48.434	-0.005	7,580	36.054	-0.215	11,561
		(0.150)			(0.475)	
Fall semester GPA	2.916	0.015	7,580	2.150	-0.003	11,561
		(0.023)			(0.024)	
Spring semester credits earned	71.670	0.071	13,656	41.592	-0.210	11,561
		(0.139)			(0.492)	
Spring semester GPA	2.712	-0.009	13,656	1.624	0.017	11,561
		(0.020)			(0.027)	
Spring semester graduated	0.046	-0.004	13,656	0.038	0.004	11,561
		(0.003)			(0.004)	
Following fall semester graduated	0.033	0.005	13,656	0.037	0.000	11,561
		(0.003)			(0.003)	
Following fall semester persistence	0.802	0.005	13,656	0.572	0.004	11,561
		(0.007)			(0.009)	
Covariates included		X			X	

+p < 0.10 *p < 0.05 **p<0.01, ***p<0.001

Source: GSU administrative records. Notes: Each row reports on a series of regression models to assess the impact of chatbot outreach on a given outcome. Each row reports the outcome assessed. GSU-Atlanta began the intervention with a smaller wave of students before adding additional students in the second implementation semester, hence the smaller sample size for semester 1 outcomes. Semester three persistence defined as graduating in semester 2, graduating the summer between semesters 2 and 3, graduating in semester 3, enrolling in semester 3, or (for students at GSU-Perimeter) transferring to GSU-Atlanta through the end of semester 3. Results in columns 1 and 2 report the control average outcome and ITT effect from a regression without covariates (and that only includes fixed effects for groups within which randomization was conducted for the Atlanta sample). Column 3 reports covariate-controlled ITT effects from a model including all campus covariates listed in Table 1. Robust standard errors in parentheses.

ONLINE APPENDIX TABLES

Table A1. Schedule of Fall 2018 GSU-Atlanta Text Campaigns

Date	**Message topic**	**Domain**	**Target**	**Outcome(s)**
October 2	Launch Message	General	All students	No measurable outcome expected
October 2	All Majors Career & Internship Fair 2018	Non-academic supplemental	All students	Fair attendance
October 4	Outstanding balance on student bill	Administrative	Students with balance of $258 or more as of 10/4	Open case with Financial Services within 1 week; withdraw as of 10/12 (withdrawal deadline)
October 5	Withdrawal deadline	General	All students	No measurable outcome expected
October 9	Midterm time	General	All students	No measurable outcome expected
October 11	Supplemental Instruction Campaign	Academic supplemental	All students enrolled in supplemental instruction course(s)	Attendance in supplemental instruction; course/term GPA
October 16	FAFSA filing	Administrative	Students who filed 2018-2019 FAFSA	FAFSA filing
October 18	Career Services intro campaign	Non-academic supplemental	All students	Aggregate use of career services
October 18	Registration hold campaign	Administrative	Students with administrative hold(s) on registration as of 10/16	Hold resolution
October 22	Registration for spring semester (seniors only)	Administrative	All seniors who are not planning to graduate in Spring	Spring registration
October 24	Graduate and professional school fair campaign	Non-academic supplemental	Juniors and seniors	Fair attendance
October 25	Maintaining SAP information session	Academic supplemental	Students at risk of not meeting SAP and losing financial aid in next semester	SAP information session attendance

Date	Message topic	Domain	Target	Outcome(s)
October 26	Registration for spring semester (non-seniors)	Administrative	All non-senior students	Spring registration
November 1	Nudge: financial literacy (freshman)	Non-academic supplemental	All freshmen	No measurable outcome expected
November 1	Financial Literacy (seniors)	Non-academic supplemental	All seniors	No measurable outcome expected
November 1	Financial Literacy (transfer/transition)	Non-academic supplemental	Fall 2018 new transfer and transition students	No measurable outcome expected
November 2	Nudge: meet with your advisor (Fall 2018)	Academic supplemental	All students	Meeting with academic advisor (whether / when)
November 5; December 5	Registration for spring semester	Administrative	Students not yet registered for Spring	Spring registration
November 6	International Education Week	Non-academic supplemental	All students	No measurable outcome expected
November 8	International Thanksgiving Feast	Non-academic supplemental	International students	No outcome (target N too small)
November 14	Spring financial aid award	Administrative	All students	No measurable outcome expected
November 15	Portfolium	Non-academic supplemental	Students who had not created a Portfolium account	Creation of Portfolium account
November 19	Fall break	General	All students	No measurable outcome expected
December 3	Last day of classes	General	All students	No measurable outcome expected
December 11	End of term, grade reporting	General	All students	No measurable outcome expected

Table A2. Schedule of Spring 2019 GSU-Atlanta Text Campaigns

Date	**Message topic**	**Domain**	**Target**	**Outcome**
January 7, 17	Spring 2019 registration – Students with/without holds	Administrative	Students who have not yet registered for Spring	Spring registration
January 7, 22	Spring 2019 registration – balance reduction	Administrative	Students who have registered but have remaining balances on their accounts	Resolution of student balance
January 14	First day back: Spring 2019	General	All students	No measurable outcome expected
January 20	MLK Day	General	All students	No measurable outcome expected
January 21; February 28	Internship & Co-Op Fair	Non-academic supplemental	Sophomores and juniors	Event registration and attendance
February 7 (& monthly)	FAFSA filing	Administrative	All students; messages targeted over time to subset not filed	FAFSA filing (whether / when)
February 8, 13	AIP hold (warning, supervision, probation)	Administrative	Students with an AIP-related hold	Hold resolution
February 11, 20	Financial aid award flag	Administrative	Students with flags that would prevent them from receiving financial aid for Spring term and are at risk of being withdrawn for non-payment	Flag resolution
February 14	Study abroad	General	All students	No measurable outcome expected
February 18, 25	Career Week	Non-academic supplemental	All students	Event registration and attendance
February 26; April 23	Registration for summer semester	Administrative	All continuing students	Registration outcome
March 4	UAC Mini Major Fair	Academic supplemental	Students with undeclared major	No outcome (target N too small)

Date	Message topic	Domain	Target	Outcome
March 5	Withdrawal deadline	General	All students	No measurable outcome expected
March 8, 19	ISSS & ISAC Cross-Cultural Trip	Non-academic supplemental	International students and students who have participated in Summer 2018 study abroad program	No measurable outcome expected
March 12	Spring 2019 launch	General	Wave 2 students	No measurable outcome expected
March 14	Spring break/Study Abroad IG link	General	All students	No measurable outcome expected
March 25	Commencement fair	Non-academic supplemental	Degree candidates for Spring 2019 graduation	Fair attendance and graduation outcome
March 26 (& monthly)	Fall 2019 registration	Administrative	All continuing students. Messages targeted over time to subset not registered	Registration outcome
April 1	International Spring Festival	Non-academic supplemental	International students	No measurable outcome expected
April 2, 5, 16	Registration hold resolution	Administrative	Students with one or more administrative holds on registration	Hold resolution
April 10	SAP (Satisfactory Academic Progress) warning	Academic supplemental	Students at risk of not meeting SAP and losing financial aid in next semester	Open case with Financial Services
April 15	Summer Part-Time Job Fair	Non-academic supplemental	All students who are not graduating seniors	Event registration and attendance
April 29	Final exams	General	All students	No measurable outcome expected
May 2	Commencement	General	Degree candidates for Spring 2019 graduation	Degree award status
May 10	Grade posting	General	All students	No measurable outcome expected

Table A3. Schedule of Fall 2020 GSU-Perimeter Text Campaigns

Date	**Message topic and target**	**Domain**	**Outcome(s)**
September 10	Introducing the bot to students	General	N/A
September 16	Encourage students to take care of their balance	Administrative	Contact financial services
September 22	Encourage students to visit advising early to take care of their AIP hold	Administrative	Visit advising
September 23	Encourage students to visit supplemental instruction for their class(es)	Academic supplemental	Attend SI
September 24	Encourage students to visit advising early to take care of their AIP hold	Administrative	Visit advising
September 24	Encourage students to visit advising early to take care of their AIP hold	Non-academic supplemental	Visit advising
September 25	Checking in with students in at least 1 online class	General	Survey response
September 30	Inform students who had not logged into their online PCO 1020 class (into to college course) that it counts as part of their GPA	Academic supplemental	N/A
October 1	Survey asking enrolled students their preferred Spring 2021 course modality (in person, blended, online)	General	Survey response
October 2	Encourage students not enrolled in PCO 1020 introduction to college course to complete academic advising	Administrative	Visit advising
October 5	Informing students the 21/22 FAFSA application is open	Administrative	File FAFSA
October 6	Encourage students on Early Alert status to make an appointment with their specific academic coach	Administrative	Visit coaching
October 8	Survey asking enrolled students their preferred online learning structure for Spring 2021 (synchronous/asynchronous)	General	Survey response
October 12	Encourage students to meet with their advisor and take care of their advising hold before registration	Administrative	Visit advising
October 12	Encourage transfer students to meet with their advisor	Administrative	Visit advising
October 14	Follow-up reminder about supplemental instruction	Academic supplemental	Attend SI
October 15	Informing students the Spring 2021 course schedule is available	General	Register for classes
October 16	Reminding students who are close to graduating to apply for graduation	Administrative	Apply for graduation
October 20	Encourage students to visit advising to take care of their hold	Administrative	Visit advising
October 20	Encourage students to contact financial aid/pay their balance to take care of their hold	Administrative	Contact financial services

Date	Message topic and target	Domain	Outcome(s)
October 20	Encourage students to contact the Dean of Students office to take care of their hold	Administrative	Contact Dean of Students
October 20	Encourage students to contact the International Student & Scholar Services office to take care of their hold	Administrative	Contact IS&SS
October 20	Encourage students to take care of their advisement and balance holds	Administrative	Contact financial services
October 22	Follow-up to students on early alert to meet with their academic coach and make a plan	Administrative	Visit coaching
November 5	Encourage students to contact Admissions to take care of their hold	Administrative	Contact Admissions
November 6	Reminding students of the deadlines to apply to graduate	Administrative	Apply for graduation
November 9	Informing students of the free COVID-19 testing on campus	Non-academic supplemental	N/A
November 10	Encouraging freshmen not enrolled in math to register for math to stay on track	Administrative	Register for math
November 10	Encouraging freshmen not enrolled in English to register for English to stay on track	Administrative	Register for English
November 12	Nudging students without holds to register for spring	Administrative	Register for classes
November 13	Encourage students to make a virtual appointment with Financial Aid to fix FAFSA errors	Administrative	Contact financial services
November 13	Encourage students enrolled for Spring 2021 to complete a 20/21 FAFSA	Administrative	File FAFSA
November 13	Nudging graduates to sign up for tickets to the graduation ceremony	Administrative	Sign up for graduation tickets
November 16	Asks students to set up a preferred refund method in their account	Administrative	Contact financial services
November 16	Nudging active, not currently enrolled students to register for Spring 2021	Administrative	Register for classes
November 18	Encourage students with a hold to take care of their hold and register for Spring 2021	Administrative	Register for classes
November 18	Encourage students to get free COVID-19 testing prior to the Thanksgiving break	Non-academic supplemental	N/A
November 20	Encourage note before Thanksgiving & reminding students to complete the 21/22 FAFSA	Administrative	File FAFSA
December 1	Encourage students to register for Spring 2021	Administrative	Register for classes
December 3	Encourage students with a hold to take care of their hold and register for Spring 2021	Administrative	Register for classes

Date	Message topic and target	Domain	Outcome(s)
December 7	Encourage students to register for Spring 2021	Administrative	Register for classes
December 8	Wishing students encouragement on their finals	General	N/A
December 9	Encourage active students not enrolled Fall 20 to register for Spring 2021	Administrative	Register for classes
December 10	Letting students know they're registered for a course that might not be eligible for fin aid	Administrative	Contact financial services
December 11	Encourage students to get free COVID-19 testing prior to winter break	Non-academic supplemental	N/A
December 15	Wishing students a good break and Encourage them to register for Spring 2021	Administrative	Register for classes
December 15	Encourage message to registered students withing them a good break	General	N/A
December 17	Encourage Spring 2021 registered students to complete the 20/21 FAFSA	Administrative	File FAFSA
December 17	Encourage students with aid awards to register for Spring 2021	Administrative	Register for classes
October 27 – November 22	Inform enrolled students of the Spring 2021 registration date changes	Administrative	N/A

Table A4. Schedule of Fall 2020 GSU-Perimeter Text Campaigns

Date	**Message topic and target**	**Domain**	**Outcome(s)**
January 4	Encourage students to register for spring	Administrative	Register for classes
January 5	Inform students they were registered for a course they previously passed and might not be eligible for aid	Administrative	Adjust registrations
January 6	Engage registered students the week before spring classes started	Administrative	N/A
January 11 2021	Engage registered students on the first day of classes	General	N/A
January 11	Encourage students to register for spring during late registration	Administrative	Register for classes
January 11	Nudge students to take care of their spring balance	Administrative	Resolve balance
January 13	Encourage active students not enrolled fall to register for spring	Administrative	Register for classes
January 14	Nudge students to take care of their spring balance	Administrative	Resolve balance
January 14	Nudge students to complete missing information and schedule a virtual Student Financial Services appointment	Administrative	Contact financial services
January 15	Nudge students to accept available financial aid to cover their balance	Administrative	Resolve balance
January 19	Encourage students to take advantage of the online career closet	Non-academic supplemental	Visit career closet
January 20	Nudge students dropped for balance to take care of their balance and be reinstated for the semester	Administrative	Resolve balance
January 25	Target students with a balance and eligible for additional forms of aid	Administrative	Resolve balance
January 28	Encourage students not engaged in iCollege to log in regularly to their classes	General	Log in regularly
January 29	Ask students dropped for nonpayment if they planned to take care of their balance and reinstate their courses	Administrative	Resolve balance
January 29	Ask students if they planned to pay their balance and stay in classes prior to being dropped. Campaign sent to wrong students in error-additional notes in main document	Administrative	Resolve balance
February 1	Nudge eligible students to accept funds from the College Completion Grant	Administrative	Accept financial aid

Date	Message topic and target	Domain	Outcome(s)
February 3	Final reminder to students to take care of their spring balance	Administrative	Resolve balance
February 4	Notify additional students to accept funds from College Completion Grant	Administrative	Accept financial aid
February 8	Encourage students to visit supplemental instruction	Academic supplemental	Visit SI
February 11	Encourage students to take advantage of Study Abroad free passport program	General	Apply for passport
February 16	Ask students with an AIP Supervision hold if they planned to make an appointment with their advisor to resolve it	Non-academic supplemental	Visit advising
February 18	Ask students with an AIP Probation hold if they planned to make an appointment with their advisor to resolve it	Non-academic supplemental	Visit advising
February 23	Ask students if they planned to complete the 21/22 FAFSA by the priority deadline	Administrative	File FAFSA
February 24	Ask targeted students if they were ready to make an appointment with their academic coach. Spring coaching campaigns also nudged students toward 'Comeback Camp' success initiative	Academic supplemental	Schedule coaching
February 25	Nudge students on SAP warning status to make a virtual Student Financial Services appointment	Administrative	Contact financial services
March 1	Ask targeted students if they were ready to make an appointment with their academic coach. Spring coaching campaigns also nudged students toward 'Comeback Camp' success initiative	Academic supplemental	Schedule coaching
March 3 2021	Ask students with an AIP Warning hold if they planned to make an appointment with their advisor to resolve it	Non-academic supplemental	Visit advising
March 9	Encourage eligible students to take advantage of Governor's Emergency Education Relief (GEER) program	Administrative	Accept financial aid
March 9	Nudge students to take care of their active registration holds	Administrative	Resolve holds
March 19	Encourage targeted students to apply for summer or fall graduation	Administrative	Apply for graduation
March 19	Provide graduation information to spring graduates	Administrative	N/A
March 22	Notify students the fall 21 schedule was posted	General	Register for classes

Date	Message topic and target	Domain	Outcome(s)
March 23 2021	Ask students if they attended supplemental instruction and if they needed extra academic assistance	Academic supplemental	Visit SI
March 24	Ask students if they planned to get the COVID-19 vaccine on campus when available	General	N/A
March 25	Encourage students to take care of their SAP appeal and schedule a virtual Student Financial Services appointment	Administrative	Contact financial services
March 29	Inform students about the start of fall 21 registration and encourage them to visit advising drop-ins	Administrative	Visit advising
March 30	Inform students they might be missing a key English or Math course and encourage them to meet with their advisor to get on track	Non-academic supplemental	Visit advising
March 31	Ask students if they planned get the COVID-19 vaccine. Students who responded "no" or "unsure" were asked to provide a reason (multiple choice)	General	N/A
April 1	Encourage targeted students to apply for summer graduation	Administrative	Apply for graduation
April 2	Nudge students to take care of their AIP advisement hold	Administrative	Resolve holds
April 6	Encourage eligible students to apply for the English 1101 Accelerator Academy	Academic supplemental	Apply for accelerator
April 6	Nudge students to complete 21/22 FAFSA verification	Administrative	File FAFSA
April 7	Remind students to complete their free passport application before the end of the program	General	Apply for passport
April 8	Nudge students to complete 21/22 FAFSA	Administrative	File FAFSA
April 12	Remind eligible students to apply for the English 1101 Accelerator Academy	Academic supplemental	Apply for accelerator
April 13	Ask students with holds if they planned to take care of their holds and register for fall	Administrative	Resolve holds
April 15	Encourage eligible students in additional courses to apply for Accelerator Academy	Academic supplemental	Apply for accelerator
April 16	Ask students if they planned to register for fall and linked to a video message encouraging them to register early	Administrative	Register for classes
April 19	Encourage active students not enrolled spring to register for fall	Administrative	Register for classes

Date	Message topic and target	Domain	Outcome(s)
April 20	Inform eligible students the Accelerator Academy application deadline was extended	Academic supplemental	Apply for accelerator
April 21	Ask students their course modality preference for fall. "Online" respondents were asked if they preferred completely online or hybrid and students with no plans to return were asked for a reason.	General	N/A
April 23	Encourage students to take care of their SAP appeal and meet with Student Financial Services	Administrative	Contact financial services
April 26	Encourage students on spring finals	General	N/A
April 28	Ask students to provide a reason why they hadn't registered yet for fall	Administrative	Register for classes
May 4	Nudge students to complete additional financial aid documents for fall	Administrative	File FAFSA
May 5	Nudge students to take care of their Semester balance	Administrative	Resolve balance
May 5	Ask students not registered for fall if they needed help	Administrative	Register for classes
Ma7 6	Nudge students to complete 21/22 FAFSA	Administrative	File FAFSA
May 7	Remind eligible students to apply for Accelerator Academy	Academic supplemental	Apply for accelerator
May 11	Encourage 2nd group of eligible students to apply for Accelerator Academy	Academic supplemental	Apply for accelerator
May 17	Encourage 3rd group of eligible students to apply for Accelerator Academy	Academic supplemental	Apply for accelerator
May 19	Nudge students to meet with their advisor & register for additional hours to be eligible for aid	Non-academic supplemental	Visit advising
May 19	Encourage students to register for summer classes	Administrative	Register for classes
May 20	Remind eligible students to apply for Accelerator Academy	Academic supplemental	Apply for accelerator
May 26	Nudge students to take care of their summer balance and accept aid if eligible	Administrative	Resolve balance
June 3	Nudge students to take care of their summer balance and accept aid if eligible	Administrative	Resolve balance
June 7	Remind students to take care of their summer balance prior to being dropped for nonpayment	Administrative	Resolve balance

Date	Message topic and target	Domain	Outcome(s)
June 10	Ask students if they planned to stay in summer classes and provide payment resources	Administrative	Resolve balance

Table A5: Covariate balance and test of joint orthogonality between treatment and control conditions among students eligible for targeted campaigns, Atlanta campus

	Financial aid award hold	Outstanding balance on fall term bill	Outstanding balance on spring term bill	Maintain SAP, fall	Had registration hold, fall
Freshman	-0.01	-0.04	0.07	-0.04	0.00
	(0.044)	(0.051)	(0.057)	(0.028)	(0.024)
Continuing	0.01	0.04	-0.07	0.04	0.00
	(0.044)	(0.051)	(0.057)	(0.028)	(0.024)
Transfer	0.00	0.00	0.00	0.00	0.00
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Resident	0.00	0.00	0.00	0.00	0.00
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female	0.02	-0.04	-0.03	0.06 +	0.03
	(0.047)	(0.051)	(0.059)	(0.030)	(0.024)
Age	0.09	-0.13	-0.08	0.32	-0.28
	(0.381)	(0.538)	(0.178)	(0.534)	(0.263)
Hispanic	0.03	-0.04	-0.01	0.02	0.00
	(0.027)	(0.033)	(0.034)	(0.019)	(0.016)
Asian	0.01	0.03	-0.04	0.01	-0.01
	(0.026)	(0.027)	(0.050)	(0.019)	(0.016)
Black	-0.03	0.02	0.08	0.00	0.03
	(0.047)	(0.050)	(0.062)	(0.030)	(0.024)
White	0.02	0.02	-0.02	0.05 *	0.02
	(0.040)	(0.038)	(0.051)	(0.025)	(0.022)
Multiple race	0.01	-0.05	-0.04	-0.04 **	-0.04 **
	(0.031)	(0.032)	(0.034)	(0.015)	(0.014)
First generation	-0.01	0.05	-0.05	-0.02	0.02
	(0.041)	(0.046)	(0.052)	(0.027)	(0.021)
Filed FAFSA	0.01	0.01	-0.03	0.01	0.01
	(0.024)	(0.028)	(0.027)	(0.022)	(0.014)
Pell eligible	-0.01	0.01	-0.11 +	0.01	-0.01
	(0.048)	(0.048)	(0.062)	(0.030)	(0.024)
High school GPA	0.00	-0.01	0.26	0.00	0.06
	(0.163)	(0.162)	(0.219)	(0.000)	(0.080)
Missing high school GPA	0.01	0.01	-0.08	0.00	-0.02
	(0.048)	(0.049)	(0.062)	(0.000)	(0.023)
College GPA	0.00	-0.04	-0.12	0.01	-0.03
	(0.148)	(0.141)	(0.204)	(0.034)	(0.071)
Joint orthogonality test	0.9956	0.5424	0.5490	0.0137	0.3564
N targeted	438	374	257	1085	1670

Table A5: Covariate balance and test of joint orthogonality between treatment and control conditions among students eligible for targeted campaigns, Atlanta campus (continued)

	Maintain SAP, spring		Had registration hold, spring		Fall graduate fair encouragement	Fall SI encouragement	Spring career fair encouragement
Freshman	-0.02		-0.05		0.00	-0.03	-0.01
	(0.029)		(0.042)		(0.000)	(0.019)	(0.012)
Continuing	0.02		0.05		0.00	0.03	0.01
	(0.029)		(0.042)		(0.000)	(0.019)	(0.012)
Transfer	0.00		0.00		0.00	0.00	0.00
	(0.000)		(0.000)		(0.000)	(0.000)	(0.000)
Resident	0.00		0.00		0.00	0.00	0.00
	(0.000)		(0.000)		(0.000)	(0.000)	(0.000)
Female	0.01		-0.01		0.00	-0.01	-0.01
	(0.049)		(0.044)		(0.025)	(0.019)	(0.012)
Age	0.28	+	0.45		-0.05	-0.02	0.10
	(0.160)		(0.461)		(0.459)	(0.102)	(0.118)
Hispanic	-0.01		0.00		0.01	0.02	0.00
	(0.034)		(0.029)		(0.015)	(0.014)	(0.008)
Asian	-0.01		0.03		0.00	0.00	0.00
	(0.028)		(0.027)		(0.017)	(0.016)	(0.009)
Black	0.03		-0.05		0.04	0.00	0.01
	(0.049)		(0.043)		(0.026)	(0.019)	(0.012)
White	0.02		0.09	**	-0.02	0.01	-0.01
	(0.042)		(0.037)		(0.023)	(0.017)	(0.011)
Multiple race	-0.03		-0.07	**	-0.01	-0.01	-0.01
	(0.033)		(0.024)		(0.013)	(0.011)	(0.007)
First generation	0.05		0.04		0.02	-0.02	0.00
	(0.041)		(0.038)		(0.023)	(0.016)	(0.010)
Filed FAFSA	0.00		-0.05	*	0.02	0.01	0.00
	(0.000)		(0.024)		(0.019)	(0.008)	(0.006)
Pell eligible	0.01		-0.08	+	-0.01	-0.03	-0.01
	(0.049)		(0.043)		(0.026)	(0.019)	(0.012)
High school GPA	-0.10		-0.20		0.00	-0.06	0.00
	(0.137)		(0.141)		(0.000)	(0.068)	(0.042)
Missing high school GPA	0.03		0.06		0.00	0.02	0.00
	(0.042)		(0.043)		(0.000)	(0.019)	(0.012)
College GPA	0.01		0.01		0.00	0.07	-0.01
	(0.113)		(0.112)		(0.031)	(0.064)	(0.039)
Joint orthogonality test	0.8866		0.0260		0.8956	0.6090	0.9479
N targeted	425		529		1517	2659	6780

+p < 0.10, **p < 0.05, **p<0.01, ***p<0.001

Source: GSU administrative records. Notes: Each row reports on a series of regression models to assess the impact of treatment assignment on a student-level covariate for a given messaging campaign in each column. The joint orthogonality test row reports

the p-value from a joint test of significance of each covariate predicting treatment assignment. Robust standard errors in parentheses.

Table A6: Covariate balance and test of joint orthogonality between treatment and control conditions among students eligible for targeted campaigns, Perimeter campus

	Not yet completed FAFSA verification	Outstanding balance on fall term bill		Outstanding balance on spring term bill		Eligible for GEER grant		Eligible for College Completion grant		Not registered for Fall 2019	
Freshman	-0.013	-0.042		0.036	*	-0.012		0.003		0.028	*
	(0.042)	(0.048)		(0.017)		(0.065)		(0.087)		(0.013)	
Non-traditional freshman	0.005	0.000		0.002		0.024	+	0.017		0.000	
	(0.012)	(0.008)		(0.002)		(0.014)		(0.017)		(0.003)	
Continuing	0.005	0.046		-0.043	*	0.002		-0.025		-0.023	+
	(0.045)	(0.051)		(0.019)		(0.065)		(0.089)		(0.014)	
Transfer	-0.011	-0.013		0.001		0.014		0.021		-0.003	
	(0.020)	(0.023)		(0.010)		(0.035)		(0.035)		(0.007)	
Resident	-0.014	-0.019		-0.011		-0.036		-0.020		-0.006	
	(0.030)	(0.039)		(0.015)		(0.039)		(0.065)		(0.010)	
Female	0.044	0.107	*	0.016		-0.009		0.161	+	-0.004	
	(0.042)	(0.051)		(0.022)		(0.064)		(0.088)		(0.014)	
Age	-0.243	0.319		0.175		-0.714		-0.302		-0.104	
	(0.663)	(0.472)		(0.350)		(0.598)		(0.910)		(0.198)	
Hispanic	0.027	0.097	**	0.021		0.000		-0.012		0.010	
	(0.037)	(0.037)		(0.016)		(0.042)		(0.065)		(0.011)	
Asian	-0.047	-0.035	+	-0.006		0.019		0.008		0.001	
	(0.030)	(0.020)		(0.013)		(0.027)		(0.043)		(0.009)	
Black	0.002	0.036		-0.036		-0.073		0.084		0.007	
	(0.046)	(0.047)		(0.022)		(0.061)		(0.083)		(0.015)	
White	0.013	0.012		0.051	**	0.039		-0.030		0.002	
	(0.036)	(0.031)		(0.020)		(0.045)		(0.060)		(0.013)	
Multiple race	0.012	-0.037		-0.003		-0.029		-0.005		-0.004	
	(0.023)	(0.031)		(0.011)		(0.037)		(0.050)		(0.007)	
First generation	-0.002	-0.018		0.014		-0.052		0.000		-0.015	
	(0.044)	(0.045)		(0.019)		(0.056)		(0.077)		(0.012)	
Filed FAFSA	0.003	0.050		-0.012		-0.012		-0.035		-0.005	
	(0.016)	(0.035)		(0.019)		(0.023)		(0.032)		(0.011)	
Pell eligible	-0.012	-0.005		-0.007		0.003		-0.140	+	0.001	
	(0.035)	(0.050)		(0.022)		(0.052)		(0.076)		(0.014)	
High school GPA	0.101	-0.028		-0.024		0.104		-0.010		-0.031	
	(0.112)	(0.104)		(0.058)		(0.148)		(0.174)		(0.036)	
Missing high school GPA	-0.054	0.010		0.007		-0.033		-0.032		0.010	
	(0.035)	(0.035)		(0.019)		(0.050)		(0.057)		(0.012)	
College GPA	-0.156	0.069		-0.133	**	0.001		-0.155		-0.101	**
	(0.132)	(0.118)		(0.056)		(0.182)		(0.228)		(0.040)	
Prior bot exposure	0.054	0.047		0.052	**	0.031		0.038		0.028	*

	(0.046)	(0.051)	(0.020)	(0.065)	(0.088)	(0.014)
Joint orthogonality test	0.5144	0.0168	0.1681	0.0000	0.0000	0.5422
N targeted	453	365	1984	237	128	4757

+p < 0.10 *p < 0.05 **p<0.01, ***p<0.001

Table A6: Covariate balance and test of joint orthogonality between treatment and control conditions among students eligible for targeted campaigns, Perimeter campus (continued)

	Had registration hold, fall		Had registration hold, spring	Fall SI Encouragement	Fall Coaching encouragement	Spring SI encouragement		Spring coaching encouragement
Freshman	0.001		0.003	-0.027	0.014	0.027		-0.030
	(0.004)		(0.008)	(0.029)	(0.024)	(0.035)		(0.025)
Non-traditional freshman	0.000		0.001	0.000	-0.001	0.004		0.007
	(0.000)		(0.002)	(0.007)	(0.004)	(0.004)		(0.013)
Continuing	0.008		-0.006	0.014	-0.021	-0.051		0.023
	(0.008)		(0.009)	(0.031)	(0.025)	(0.041)		(0.022)
Transfer	0.000		0.002	0.006	0.010	0.020		0.000
	(0.000)		(0.005)	(0.014)	(0.011)	(0.025)		(0.000)
Resident	0.004		-0.010	-0.012	-0.006	-0.064	+	0.036
	(0.016)		(0.006)	(0.025)	(0.017)	(0.033)		(0.031)
Female	0.029		0.006	-0.018	-0.028	0.021		-0.003
	(0.027)		(0.009)	(0.034)	(0.024)	(0.045)		(0.049)
Age	0.322		0.151	0.172	0.029	-0.506		-0.027
	(0.329)		(0.152)	(0.445)	(0.291)	(0.649)		(0.195)
Hispanic	0.002		0.004	0.034	0.010	0.006		0.031
	(0.019)		(0.007)	(0.025)	(0.018)	(0.035)		(0.039)
Asian	-0.020		-0.001	0.014	0.009	0.018		0.038
	(0.014)		(0.006)	(0.025)	(0.013)	(0.034)		(0.027)
Black	0.049	+	0.011	0.027	0.006	-0.005		-0.078
	(0.027)		(0.010)	(0.035)	(0.024)	(0.046)		(0.048)
White	-0.006		-0.010	-0.045	-0.013	0.008		0.040
	(0.021)		(0.008)	(0.028)	(0.019)	(0.039)		(0.039)
Multiple race	-0.008		-0.001	0.000	-0.001	-0.006		0.003
	(0.015)		(0.005)	(0.019)	(0.012)	(0.022)		(0.023)
First generation	-0.003		-0.012	0.046	-0.033	0.021		-0.036
	(0.022)		(0.008)	(0.030)	(0.021)	(0.040)		(0.042)
Filed FAFSA	0.011		-0.008	-0.002	0.009	0.016		-0.022

	(0.024)		(0.008)		(0.025)		(0.017)		(0.034)		(0.023)	
Pell eligible	-0.003		-0.006		-0.004		-0.001		-0.021		-0.094	*
	(0.027)		(0.010)		(0.034)		(0.024)		(0.045)		(0.047)	
High school GPA	-0.033		-0.024	*	-0.208	*	-0.015		0.027		0.027	
	(0.062)		(0.025)		(0.086)		(0.052)		(0.119)		(0.063)	
Missing high school GPA	0.015		0.005		0.046	+	0.011		-0.023		0.021	
	(0.022)		(0.008)		(0.027)		(0.018)		(0.036)		(0.017)	
College GPA	0.001		-0.035		0.059		-0.068		-0.200	+	0.015	
	(0.034)		(0.026)		(0.097)		(0.063)		(0.120)		(0.059)	
Prior bot exposure	0.019		0.004		-0.010		0.009		0.025		-0.015	
	(0.018)		(0.009)		(0.032)		(0.025)		(0.040)		(0.032)	
Joint orthogonality test	0.6913		0.8069		0.1070		0.8644		0.0000		0.3893	
N targeted	1332		10683		828		1619		474		419	

+p < 0.10, **p < 0.05, **p<0.01, ***p<0.001

Source: GSU administrative records. Notes: Each row reports on a series of regression models to assess the impact of treatment assignment on a student-level covariate for a given messaging campaign in each column. The joint orthogonality test row reports the p-value from a joint test of significance of each covariate predicting treatment assignment. Robust standard errors in parentheses.