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# ABSTRACT

## Using Goals to Motivate College Students: Theory and Evidence from Field Experiments*

Will college students who set goals for themselves work harder and perform better? In theory, setting goals can help time-inconsistent students to mitigate their self-control problem. In practice, there is little credible evidence on the causal effects of goal setting for college students. We report the results of two field experiments that involved almost four thousand college students in total. One experiment asked treated students to set goals for performance in the course; the other asked treated students to set goals for a particular task (completing online practice exams). We find that performance-based goals had no discernible impact on course performance. In contrast, task-based goals had large and robust positive effects on the level of task completion, and task-based goals also increased course performance. Further empirical analysis indicates that the increase in task completion induced by setting task-based goals caused the increase in course performance. We also find that task-based goals were more effective for male students. We develop new theory that reinforces our empirical results by suggesting two key reasons why task-based goals might be more effective than performance-based goals: overconfidence and uncertainty about performance. Since task-based goal setting is low-cost, scaleable and logistically simple, we conclude that our findings have important implications for educational practice and future research.

JEL Classification: I23, C93

Keywords: goal, goal setting, higher education, field experiment, self-control, present bias, time inconsistency, commitment device, loss aversion, reference point, task-based goal, performance-based goal, self-set goal, performance uncertainty, overconfidence, student effort, student performance, educational attainment, MOOC

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# 1 Introduction

Researchers and policy-makers worry that college students exert too little effort, with consequences for their performance in courses, their graduation prospects, and ultimately their labor market outcomes. With this in mind, attention has focused on policies and interventions that could increase student effort by introducing financial incentives, such as making student aid conditional on meeting GPA cutoffs and paying students for improved performance. However, these programs are typically expensive and often yield disappointing results.[1]

In this paper we aim to discover whether goal setting can motivate college students to work harder and perform better. We focus on goal setting for three main reasons. First, in contrast to financial incentives, goal setting is low-cost, scaleable and logistically simple. Second, students might lack self-control. Although students might set out to exert their preferred level of effort, when the time comes to attend class or review for a test they might lack the self-control necessary to implement these plans. The educational psychology literature finds that self-control correlates positively with effort, which supports the idea that some students under-invest in effort because of low self-control (e.g., Duckworth and Seligman, 2005, and Duckworth et al., 2012). Third, the behavioral economics literature suggests that agents who lack self-control can use commitment devices to self-regulate their behavior.[2] Goal setting might act as an effective internal commitment device that allows students who lack self-control to increase their effort.[3]

We gather large-scale experimental evidence from the field to investigate the causal effects of goal setting on the effort and performance of college students. We compare the effects of self-set goals that relate to performance in a course and self-set goals that relate to a particular study task (completing practice exams online). We study goals that are set by students themselves, as opposed to goals set by another party (such as a counselor or professor), because self-set goals can

[1] Studies using randomized experiments and natural experiments to evaluate the effects of financial incentives on the performance of college students have been inconclusive: Henry et al. (2004), Cha and Patel (2010), Scott-Clayton (2011), De Paola et al. (2012) and Castleman (2014) report positive effects; while Cornwell et al. (2005), Angrist et al. (2009), Leuven et al. (2010), Patel and Rudd (2012) and Cohodes and Goodman (2014) do not find significant effects. Although there is little consensus on the reason behind the failure of many incentive programs, Dynarski (2008) notes that the incentives may be irrelevant for many students, and Angrist et al. (2014) report that one-third of the students in their study failed to fully understand a relatively simple grade-based incentive scheme. In other experiments on college students, academic support services have been combined with financial incentives. Results on the performance effects of these interventions are again mixed: Angrist et al. (2009) and Barrow et al. (2014) report strong effects; Angrist et al. (2014) find weak effects; and Miller et al. (2011) find no significant effects. Financial incentives are also controversial due to concerns that they might crowd out intrinsic incentives to study (see, e.g., Cameron and Pierce, 1994, and Gneezy et al., 2011). See Lavecchia et al. (2016) for a survey of financial incentives in higher education.

[2] These include purchase-quantity rationing of vice goods (Wertenbroch, 1998), deadlines (Ariely and Wertenbroch, 2002), commitments to future savings (Thaler and Benartzi, 2004), long-term gym membership contracts (DellaVigna and Malmendier, 2006), restricted access savings accounts (Ashraf et al., 2006) and Internet blockers (Patterson, 2016), while Augenblick et al. (2015) show that experimental subjects in the laboratory who are more present biased in the domain of work effort are more likely to use a commitment device. See Bryan et al. (2010) for a survey.

[3] A small and recent literature in economics suggests that goal setting can influence behavior in other settings. Harding and Hsiaw (2014) find that goal setting can influence consumption: energy savings goals reduced energy consumption. Choi et al. (2016) find that goal setting can affect savings: goal-based cues increased savings into 401k accounts. Finally, goals can increase worker performance even in the absence of monetary incentives for achieving the goal (see Corgnet et al., 2015, for laboratory evidence, Goerg and Kube, 2012, for field evidence, and Goerg, 2015, for a concise survey). Although not focused on education, several psychologists argue for the motivational benefits of goals more generally (see, e.g., Locke, 1968, Locke et al., 1981, Mento et al., 1987, Locke and Latham, 2002, and Latham and Pinder, 2005).

be personalized to each student's degree of self-control. The comparison between performance-based and task-based goals is motivated by recent research by Allan and Fryer (2011) and Fryer (2011) that suggests that financial incentives for grade-school-aged children work better when they are tied to task completion (e.g., reading a book) rather than performance (e.g., doing well on a test). We supplement our experimental evidence with new theory to understand how these different types of goal can help students to mitigate their self-control problem.

We administered two field experiments with almost four thousand college students in total. The subjects were undergraduate students enrolled in a semester-long introductory course at a public university in the United States. In one experiment, students were randomly assigned to a Treatment group that was asked to set goals for their performance in the course or to a Control group that was not: we refer to these as 'performance-based goals'. The performance measures for which goals were set included the overall course letter grade and scores on the midterm exams and final exam. In the other experiment, students were randomly assigned to a Treatment group that was asked to set goals for the number of online practice exams that they would complete in advance of each midterm exam and the final exam or to a Control group that was not: we refer to these as 'task-based goals'. The online practice exams were made salient to the students in both the Treatment and Control groups. Importantly, we can observe how many online practice exams students completed. In each experiment, the treated students were reminded of their goal and were told that the course instructor would not see their goal.

Our analysis yields two main findings. Our first experiment suggests that performance-based goals have little or no impact on the performance of college students: our estimates are close to zero and are far from statistical significance. Our second experiment, by contrast, suggests that task-based goals are effective. Asking students to set task-based goals for the number of practice exams to complete increased the number of practice exams that students completed. This positive effect of task-based goals on the level of task completion is large, statistically significant and robust. Furthermore, task-based goals also increased course performance, although our estimates here are on the margins of statistical significance. The obvious explanation for this last result is that the increase in task completion induced by setting task-based goals caused the increase in performance. Independent evidence that the increase in task completion caused the increase in performance comes from an estimate of the performance returns to completing practice exams. We obtained this estimate from a fixed effects estimator that exploits within-student variation in performance and practice exam completion in the Control group (who were not asked to set goals). Together, our results suggest that: (i) if tasks are chosen appropriately, then task-based goals can improve educational performance as well as induce greater task-specific investments; and (ii) performance-based goals are not an effective way to increase student performance.

Interestingly, we also find that task-based goals were more effective for male students than for female students, both in terms of the impact on the number of practice exams completed and on performance in the course. This finding is consistent with evidence from other educational environments that suggests that males have less self-control than females (e.g., Duckworth and Seligman, 2005, Buechel et al., 2014, and Duckworth et al., 2015) and with Duckworth et al. (2015)'s conjecture that educational interventions aimed at improving self-control may be especially beneficial for males.

We develop a model of goal setting to help understand our findings. We start with a baseline model in which either type of goal can help students to mitigate their self-control problem. At period one the 'student-planner' sets a goal for her future self, at period two the 'student-actor' chooses how hard to work, and at period three performance in the course is realized. The student is present biased, and so in the absence of a goal the student exhibits a self-control problem due to time inconsistency: when the time comes to work the student-actor works less hard than the student-planner would like. By acting as salient reference points, the theory suggests that self-set goals can serve as an internal commitment device that helps students who anticipate their self-control problem to steer their effort toward its optimal level.

We then use this model to explain why task-based goals can be more effective than performance-based goals. This finding emerges naturally if we relax either of two strong assumptions made in the baseline model, namely that students understand perfectly the relationship between effort and performance and that this relationship involves no uncertainty. First, if practice exams are more productive than those tasks that an overconfident student would select for herself, then task-based goals will be more effective than performance-based goals.[4] Second, a stochastic relationship between effort and performance ('performance uncertainty') makes performance-based goals risky: when performance turns out to be low the student fails to achieve her goal. Anticipating this possibility, the student scales back the performance-based goal that she sets for her future self, which decreases the effectiveness of goal-setting. In contrast, these effects of performance uncertainty are not present in the case of task-based goals because the student directly controls the number of practice exams that she completes and so can guarantee that she achieves her task-based goal.

Our paper makes two contributions to the literature. The main contribution is to use experiments to provide causal estimates of the impact of self-set goals on the effort and performance of college students. These estimates suggest that self-set performance goals are ineffective while self-set task-based goals help college students to overcome their self-control problem. Our finding that performance-based goals are ineffective stands in stark contrast to a literature in educational psychology that uses non-causal correlations to suggest that performance-based goals can motivate college students (see, e.g., Zimmerman and Bandura, 1994, Harackiewicz et al., 1997, Elliot and McGregor, 2001, Barron and Harackiewicz, 2003, Linnenbrink-Garcia et al., 2008 and Darnon et al., 2009).[5] A handful of papers in psychology use experiments to study the effects of self-set goals on the behavior of college students (Morgan, 1987; Latham and Brown, 2006; Morisano et al., 2010; Chase et al., 2013); however, in contrast to our analysis, these studies rely on small samples, do not study the impact of performance-based goals on performance or

[4]Our overconfidence explanation implies that students have incorrect beliefs about the best way to increase their academic achievement. This is consistent with the explanation given by Allan and Fryer (2011) for why performance-based financial incentives appear less effective than task-based financial incentives.

[5]Relying on correlations based on non-experimental variation in our sample, rather than on the causal effects estimated solely from variation induced by our experimental interventions, would give a misleading impression of the effectiveness of performance-based goals. This is because we reproduce the correlational finding from the educational psychology literature that college students who set ambitious performance-based goals perform better. Specifically, conditional on student characteristics, the correlation in our sample between course performance (measured by total number of points scored out of one hundred) and the level of the goal is 0.203 ($p = 0.000$) for students who set performance-based goals. For students who set task-based goals the corresponding correlation is 0.391 ($p = 0.000$), which is also in line with correlational findings from educational psychology (see, e.g., Elliot and McGregor, 2001, Church et al., 2001, and Hsieh et al., 2007).

of task-based goals on task completion, and do not compare performance-based and task-based goals.[6,7] Our second contribution is to develop new theory based on the idea that students lack self-control to understand the mechanisms by which performance-based and task-based goals can affect student performance differently. To the best of our knowledge, we are the first to study the impact of overconfidence and performance uncertainty on the ability of students to use goals to overcome their self-control problem.

Our analysis breaks new ground in understanding the impacts of self-set goals on college performance. In particular, our experimental findings, supported by new theory, suggest that task-based goals could be an especially effective method of mitigating self-control problems for college students. As we explain in detail in the Conclusion of this paper, our findings have important implications for educational practice and future research. Many colleges already offer a range of academic advising programs, including mentors, study centers and workshops. These programs often recommend goal setting, but only as one of several strategies that students might adopt to foster academic success. Our findings suggest that academic advising programs should give greater prominence to goal setting, and that students should be encouraged to set task-based goals for activities that are important for educational success. Our findings also suggest that courses should be designed to give students opportunities to set task-based goals. In courses with some online components (including fully online courses), it would be especially easy to incorporate task-based goal setting into the technology used to deliver course content; in traditional classroom settings, students might be encouraged to set task-based goals in consultation with instructors, who are well placed to select productive tasks. In conjunction with our experimental findings, these possibilities illustrate that task-based goal setting is a scaleable and logistically simple intervention that could help to improve college outcomes at low cost. This is a promising insight, and we argue in the Conclusion that it ought to spur further research into the effects of task-based goal setting in other college contexts (e.g., two-year colleges) and for other tasks (e.g., attending lectures or contributing to online discussions).

The paper proceeds as follows. Section 2 describes our field experiments; Section 3 presents our experimental results; Section 4 develops a model of goal setting to help interpret our experimental findings; and Section 5 concludes by discussing the implications of our findings.

[6] Closest to our paper, Morgan (1987) ran an experiment using one-hundred and eighty college students and found that asking students to set themselves goals for study time, pages to read and topics to cover increased performance in the course. Using a sample of seventy-seven college students, Schunk and Ertmer (1999) studied teacher-set instead of self-set goals: they directed students who were acquiring computer skills to think about outcomes (that the students had already been asked to achieve) as goals.

[7] A literature in psychology uses small-scale experiments to look at the effects of teacher-set goals on the learning of grade-school-aged children (e.g., LaPorte and Nath, 1976, Schunk, 1983, Schunk, 1984, Schunk and Rice, 1991, Schunk and Swartz, 1993, Schunk, 1996, and Griffee and Templin, 1997). There are important differences between teacher-set goals for grade-school-aged children and self-set goals for college students: first, college students can use self-set goals to regulate optimally their own behavior given their private information about the extent of their self-control problem; and second, in the school environment children are closely monitored by teachers and parents, which gives extrinsic motivation to reach goals (for instance, children might worry about explicit and implicit penalties, monetary or otherwise, for failing to achieve the goal set for them). Using a sample of eighty-four fourth-grade children, Shih and Alexander (2000) explore experimentally the effects of self-set goals (in particular, they study the effects of self-set goals for the number of fractions to solve in class on the ability to solve fractions in a later test).

## 2 Design of our field experiments

### 2.1 Description of the sample

We ran our field experiments at a public university in the United States. Our subjects were undergraduate students enrolled in a large semester-long introductory course. As described in Section 2.2, we sought consent from all our subjects (the consent rate was ninety-eight percent). Approximately four thousand students participated in total. We employed a between-subjects design: each student was randomized into the Treatment group or the Control group immediately on giving consent. Students in the Treatment group were asked to set goals while students in the Control group were not asked to set any goals. As described in Section 2.3, in the Fall 2013 and Spring 2014 semesters we studied the effects of performance-based goals on student performance in the course (the 'performance-based goals' experiment). As described in Section 2.4, in the Fall 2014 and Spring 2015 semesters we studied the effects of task-based goals on task completion and course performance (the 'task-based goals' experiment).[8]

Table 1 provides statistics about participant numbers and treatment rates. We have information about participant demographics from the university's Registrar data: Tables SWA.1, SWA.2 and SWA.3 in Supplementary Web Appendix I summarize the characteristics of our participants and provide evidence that our sample is balanced.[9]

| | All semesters | Fall 2013 & Spring 2014 (Performance-based goals) | Fall 2014 & Spring 2015 (Task-based goals) |
|---|---|---|---|
| Number of participating students | 3,971 | 1,967 | 2,004 |
| Number of students in Treatment group | 1,979 | 995 | 984 |
| Number of students in Control group | 1,992 | 972 | 1,020 |
| Fraction of students in Treatment group | 0.50 | 0.51 | 0.49 |

Notes: The number of participating students excludes: students who did not give consent to participate; students who formally withdrew from the course; students who were under eighteen at the beginning of the semester; students for whom the university's Registrar data does not include SAT or equivalent aptitude test scores; and one student for whom the Registrar data does not include information on gender.

Table 1: Participant numbers and treatment rates.

### 2.2 Course structure

In all semesters, a student's letter grade for the course was based on the student's total points score out of one hundred.[10] Points were available for performance in two midterm exams, a final exam and a number of online quizzes. Points were also available for taking an online syllabus quiz and a number of online surveys. For the Fall 2013 semester Figure 1 gives a timeline of

[8] We also ran a small-scale pilot in the summer of 2013 to test our software.

[9] For each characteristic we test the null that the difference between the mean of the characteristic in the Treatment Group and the Control group is zero, and we then test the joint null that all of the differences equal zero. The joint test gives $p$-values of 0.636, 0.153 and 0.471 for, respectively, all semesters, Fall 2013 and Spring 2014 (the performance-based goals experiment), and Fall 2014 and Spring 2015 (the task-based goals experiment). See Tables SWA.1, SWA.2 and SWA.3 for further details.

[10] The grade key is at the bottom of Figure SWA.1 in Supplementary Web Appendix II.

the exams, quizzes and surveys, and the number of points available for each. As described in Sections 2.3 and 2.4, the course structure in other semesters was similar.

Each student had access to a private personalized online gradecard that tracked the student's performance through the course and that was available to view at all times. After every exam, quiz or survey, the students received an email telling them that their gradecard had been updated to include the credit that they had earned from that exam, quiz or survey. The gradecards also included links to answer keys for the online quizzes. Figure SWA.1 in Supplementary Web Appendix II shows an example gradecard for a student in the Control group in the Fall 2013 semester.

We sought consent from all of our subjects using an online consent form. The consent form appeared immediately after students completed the online syllabus quiz and immediately before the online start-of-course survey. Figure SWA.2 in Supplementary Web Appendix II provides the text of the consent form.

| | |
|---|---|
| **Syllabus quiz and start-of-course survey** | |
| Syllabus quiz | 2 points for completion |
| Consent form | For treated and control students |
| Start-of-course survey | Treated students set goal for letter grade in course<br>2 points for completion |
| **Online quizzes** | |
| 10 online quizzes throughout the semester<br>Each scored from 0 to 3 points | |
| **Midterm exam 1** | |
| Scored from 0 to 30 points<br>Only maximum of midterm 1 & 2 scores counts for letter grade | |
| **Midterm exam 2** | |
| Scored from 0 to 30 points<br>Only maximum of midterm 1 & 2 scores counts for letter grade | |
| **Final exam** | |
| Scored from 0 to 34 points | |
| **End-of-course survey** | |
| 2 points for completion | |

Figure 1: Fall 2013 semester timeline

## 2.3 Performance-based goals experiment

In the Fall 2013 and Spring 2014 semesters we studied the effects of performance-based goals on student performance in the course. In the Fall 2013 semester treated students were asked to set a goal for their letter grade in the course. As outlined in Figure 1, treated students were asked to set their goal during the start-of-course survey that all students were invited to take.[11] In the Spring 2014 semester treated students were asked to set goals for their scores in the two

[11] Treated students set their goal after the quiz on the syllabus. In every semester the syllabus gave the students information about the median student's letter grade in the previous semester.

midterm exams and the final exam. As outlined in Figure 2, the treated students were asked to set a goal for their score in a particular exam as part of a mid-course survey that all students were invited to take.[12]

Figures SWA.3 and SWA.4 in Supplementary Web Appendix II provide the text of the goal-setting questions. In each case, the treated students were told that their goal would be private and that: "each time you get your quiz, midterm and final scores back, your gradecard will remind you of your goal." Figures SWA.5 and SWA.6 illustrate how the goal reminders were communicated to the treated students on the online gradecards. The gradecards, described in Section 2.2, were a popular part of the course: the median number of times students viewed their gradecard during the Fall 2013 and Spring 2014 semesters was twenty-three.

| | |
|---|---|
| **Syllabus quiz and start-of-course survey** | |
| Syllabus quiz | 1 point for completion |
| Consent form | For treated and control students |
| Start-of-course survey | 1 point for completion |
| **Online quizzes** | |
| 9 online quizzes throughout the semester<br>Each scored from 0 to 3 points | |
| **Mid-course survey 1** | |
| Treated students set goal for score in midterm exam 1<br>2 points for completion | |
| **Midterm exam 1** | |
| Scored from 0 to 30 points<br>Only maximum of midterm 1 & 2 scores counts for letter grade | |
| **Mid-course survey 2** | |
| Treated students set goal for score in midterm exam 2<br>2 points for completion | |
| **Midterm exam 2** | |
| Scored from 0 to 30 points<br>Only maximum of midterm 1 & 2 scores counts for letter grade | |
| **Mid-course survey 3** | |
| Treated students set goal for score in final exam<br>2 points for completion | |
| **Final exam** | |
| Scored from 0 to 34 points | |
| **End-of-course survey** | |
| 1 point for completion | |

Figure 2: Spring 2014 semester timeline

[12]The students were invited to take the mid-course survey three days before the exam. When the mid-course survey closed, the students received an email telling them that their online gradecard had been updated to include the credit that they had earned from completing that mid-course survey. As explained below, the gradecards included a reminder of the goal set in the mid-course survey.

### 2.4 Task-based goals experiment

In the Fall 2014 and Spring 2015 semesters we studied the effects of task-based goals on task completion and course performance. Specifically, we studied the effects of goals about the number of practice exams to complete on: (i) the number of practice exams that students completed (which we call the 'level of task completion'); and (ii) the students' performance in the course. The experimental design was identical across the Fall 2014 and Spring 2015 semesters.

The course structure in the Fall 2014 and Spring 2015 semesters was the same as that outlined in Figure 2 for the Spring 2014 semester, except that before each of the two midterm exams and the final exam: (i) all of the students had the opportunity to complete up to five practice exams online;[13] and (ii) instead of setting performance-based goals, the treated students were asked to set a goal for the number of practice exams to complete before that particular exam (the treated students were asked to set the goal as part of a mid-course survey that all students were invited to take). All students received question-by-question feedback while they completed a practice exam.[14] The opportunity to take the online practice exams was communicated to all of the students in the course syllabus, in the mid-course surveys (see Figure SWA.7 in Supplementary Web Appendix II) and in reminder emails before each exam (see Figure SWA.8). Figures SWA.9 and SWA.10 show the practice exam instructions and feedback screens.[15]

Figure SWA.7 in Supplementary Web Appendix II provides the text of the goal-setting question. The treated students were told that their goal would be private and that: "when you take the practice exams you will be reminded of your goal." Figures SWA.9 and SWA.10 illustrate how the goal reminders were communicated to the treated students when attempting the practice exams. The treated students also received a reminder of their goal in the reminder email about the practice exams that all students received (see Figure SWA.8).

## 3 Results from our field experiments

In this section we describe the results of our field experiments. Section 3.1 presents some descriptive statistics on the goals that the treated students set and on how successful on average the treated students were in achieving their goals. In Section 3.2 we find no evidence of any impact of performance-based goals on student performance in the course. In Section 3.3 we show that task-based goals successfully shifted task completion. In Section 3.4 we show that task-based goal setting also improved student performance in the course. Finally, in Section 3.5 we use independent quantitative evidence to argue that the increase in task completion elicited by task-based goal setting caused the improvement in student performance.

[13] In the Fall 2013 and Spring 2014 semesters (the performance-based goals experiment) the students had the opportunity to complete practice exams in their own time by downloading past exams and answer keys from the course website.

[14] For each question, the feedback screen replicated the question screen and highlighted both the correct answer and the student's answer. The student was also given her score at the end of each practice exam.

[15] The students were invited to take the mid-course survey five days before the relevant exam. Practice exam reminder emails were sent three days before the exam, at which time the practice exams became active. The practice exams closed when the exam started.

### 3.1 Descriptive statistics on goals

Table 2 presents some descriptive statistics on the goals that the treated students set and on how successful on average the treated students were in achieving their goals. Looking at the first row of Panel I, we see that the vast majority of treated students chose to set at least one goal, irrespective of whether the goal was performance based or task based. Looking at the second row of Panel I, we see that on average students in the performance-based goals experiment set performance goals of ninety percent (as explained in the notes to Table 2, all performance goals have been converted to percentages of the maximal performance) while on average students in the task-based goals experiment set task goals of four out of five practice exams. The third row of Panel I tells us that these goals were generally a little ambitious: achievement lagged somewhat behind the goals that the students chose to set. Given that the goals were a little ambitious, many students failed to achieve their goals: the fourth row of Panel I shows that each performance-based goal was reached by about one-quarter of students while each task-based goal was reached by about one-half of students.[16] Panels II and III show that the same patterns hold for both male and female students.

[16]Within the performance-based goals experiment, goals and goal achievement varied little according to whether the students set a goal for their letter grade in the course or set goals for their scores in the two midterm exams and the final exam.

| Panel I: All students in the Treatment group | | |
|---|---|---|
| | Performance-based goals | Task-based goals |
| Fraction who set at least one goal | 0.99 | 0.98 |
| Mean goal | 89.50 | 4.05 |
| Mean achievement | 78.40 | 3.14 |
| Fraction of goals achieved | 0.24 | 0.53 |
| **Panel II: Male students in the Treatment group** | | |
| | Performance-based goals | Task-based goals |
| Fraction who set at least one goal | 0.99 | 0.97 |
| Mean goal | 90.35 | 4.03 |
| Mean achievement | 79.50 | 3.03 |
| Fraction of goals achieved | 0.25 | 0.50 |
| **Panel III: Female students in the Treatment group** | | |
| | Performance-based goals | Task-based goals |
| Fraction who set at least one goal | 0.99 | 0.99 |
| Mean goal | 88.68 | 4.07 |
| Mean achievement | 77.34 | 3.23 |
| Fraction of goals achieved | 0.24 | 0.55 |

Notes: The fraction who set at least one goal is defined as the fraction of students in the Treatment group who set at least one goal during the semester. A student is considered to have set a goal for her letter grade in the course if she chose a goal better than an E (an E can be obtained with a total points score of zero). Other types of goal are numerical, and a student is considered to have set such a goal if she chose a goal strictly above zero. The mean goal, mean achievement and fraction of goals achieved are computed only for the students who set at least one goal. The mean goal is calculated by averaging over the goals set by each student (that is, one, two or three goals) and then averaging over students (goals for the letter grade in the course are converted to scores out of one hundred using the lower grade thresholds on the grade key, and goals for scores in the midterms and final exam are rescaled to scores out of one hundred). Mean achievement is calculated by averaging within students over the outcome that is the object of each set goal and then averaging over students (outcomes that correspond to performance-based goals are converted to scores out of one hundred as described previously for the performance-based goals themselves). The fraction of goals achieved is calculated by averaging within students over indicators for the student achieving each set goal and then averaging over students.

Table 2: Descriptive statistics on goals for students in the Treatment group

## 3.2 Impact of performance-based goals on student performance

In this section we present the results from the performance-based goals experiment. Table 3 shows that we find no evidence of any impact of performance-based goals on student performance in the course. We first explain the structure of the table and we then describe the results reported in the table.

We consider three measures of performance: (i) credit in the course, measured by students' total points score in the course (out of one hundred) that determines their letter grade; (ii) the probability that students achieved an A– or better; and (iii) the probability that students achieved a B+ or better.[17] The first column of Table 3 reports ordinary least squares (OLS) regressions of credit on an indicator for the student having been randomly allocated to the Treatment group in the performance-based goals experiment. The second column, titled 'Median', reports unconditional quantile regressions for the median of credit on the same indicator.[18] The third and fourth columns report OLS regressions of, respectively, an indicator for the student having achieved an A– or better and an indicator for the student having achieved a B+ or better on the same indicator as in the first two columns. To give a feel for the magnitude of the effects, the second row in each panel reports the effect size as a proportion of the standard deviation of the dependent variable in the Control group in the performance-based goals experiment, while the third row reports the average of the dependent variable in the same Control group.

We can see from Table 3 that we find no statistically significant effect of asking students to set performance-based goals on student performance in any of our specifications. The $p$-values are never close to the thresholds for statistical significance at conventional levels and the effect sizes are generally small.[19] These observations apply to the whole sample in the performance-based goals experiment in Panel I and also when we break the sample down by gender in Panels II and III. The regressions in Table 3 control for student characteristics: when we do not condition on student characteristics, we continue to find no statistically significant effects (see Table SWA.4 in Supplementary Web Appendix I).

[17] B+ was the median letter grade across the four semesters of our study.

[18] The median results were obtained using the estimator of Firpo et al. (2009), which delivers the effect of the treatment on the unconditional median of credit.

[19] Within the performance-based goals experiment, neither goals for letter grades in the course nor goals for scores in the two midterms and the final exam had an effect on student performance: for each of the four specifications reported in Panel I, and using the ten-percent-level criterion, we find no statistically significant effect of either type of performance-based goal, and we find no statistically significant difference between the effects of the two types of goal. For the case of OLS regressions of credit on the treatment, the $p$-values for the two effects and the difference are, respectively, $p = 0.234$, $p = 0.856$, and $p = 0.386$.

Panel I: All students in the performance-based goals experiment

| | Total points score | | Pr(Grade ≥ A–) | Pr(Grade ≥ B+) |
|---|---|---|---|---|
| | OLS | Median | OLS | OLS |
| Effect of asking students to set performance-based goals | 0.300 | 0.118 | 0.002 | 0.001 |
| | (0.398) | (0.459) | (0.020) | (0.021) |
| | [0.452] | [0.797] | [0.931] | [0.978] |
| Effect / (SD in Control group) | 0.028 | 0.011 | 0.004 | 0.001 |
| Mean of dependent variable in Control group | 83.220 | 83.220 | 0.389 | 0.498 |
| Observations | 1,967 | 1,967 | 1,967 | 1,967 |

Panel II: Male students in the performance-based goals experiment

| | Total points score | | Pr(Grade ≥ A–) | Pr(Grade ≥ B+) |
|---|---|---|---|---|
| | OLS | Median | OLS | OLS |
| Effect of asking students to set performance-based goals | 0.430 | 0.576 | 0.008 | 0.028 |
| | (0.594) | (0.618) | (0.030) | (0.030) |
| | [0.469] | [0.352] | [0.796] | [0.352] |
| Effect / (SD in Control group) | 0.041 | 0.055 | 0.016 | 0.057 |
| Mean of dependent variable in Control group | 83.644 | 83.644 | 0.403 | 0.511 |
| Observations | 933 | 933 | 933 | 933 |

Panel III: Female students in the performance-based goals experiment

| | Total points score | | Pr(Grade ≥ A–) | Pr(Grade ≥ B+) |
|---|---|---|---|---|
| | OLS | Median | OLS | OLS |
| Effect of asking students to set performance-based goals | 0.181 | -0.330 | -0.004 | -0.025 |
| | (0.536) | (0.642) | (0.028) | (0.029) |
| | [0.736] | [0.607] | [0.894] | [0.392] |
| Effect / (SD in Control group) | 0.017 | -0.031 | -0.008 | -0.049 |
| Mean of dependent variable in Control group | 82.864 | 82.864 | 0.377 | 0.487 |
| Observations | 1,034 | 1,034 | 1,034 | 1,034 |

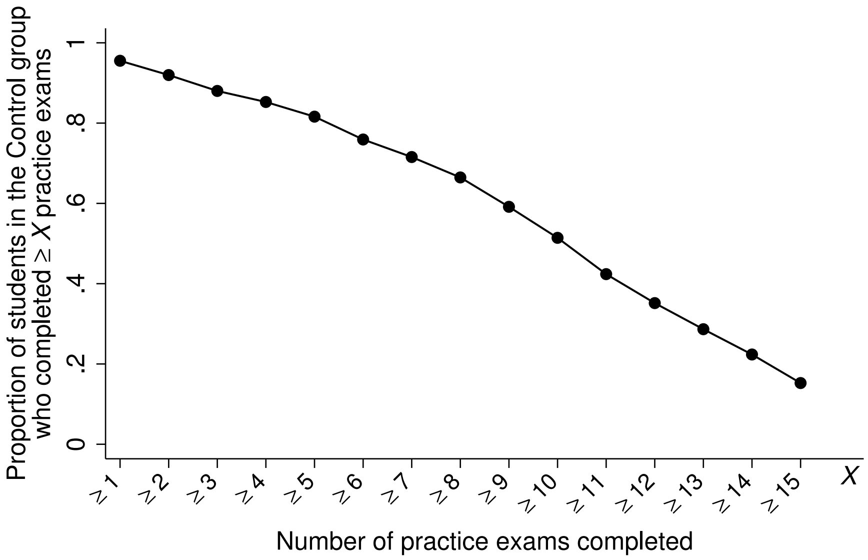
Notes: The first column reports OLS regressions of total points score on an indicator for the student having been randomly allocated to the Treatment group in the performance-based goals experiment. The second column reports unconditional quantile regressions for the median of total points score on the same indicator. The third and fourth columns report OLS regressions of, respectively, an indicator for the student having achieved an A– or better and an indicator for the student having achieved a B+ or better on the same indicator as in the first two columns. 'SD in Control group' refers to the standard deviation of the dependent variable in the Control group. We control for the student characteristics defined in Table SWA.1 in Supplementary Web Appendix I: (i) letting $\mathcal{Q}$ denote the set containing indicators for the binary characteristics other than gender (race-based categories, advanced placement credit, Fall semester) and $\mathcal{Z}$ denote the set containing the non-binary characteristics (age, SAT score, high school GPA, first login time), we include $j \in \mathcal{Q}$, $k \in \mathcal{Z}$, $k \times l$ for $k \in \mathcal{Z}$ and $l \in \mathcal{Z}$, and $j \times k$ for $j \in \mathcal{Q}$ and $k \in \mathcal{Z}$; and (ii) the models in Panel I further include gender together with gender interacted with every control variable defined in (i). Heteroskedasticity-consistent standard errors are shown in round brackets and two-sided $p$-values are shown in square brackets. $^{*}$, $^{**}$ and $^{***}$ denote, respectively, significance at the 10%, 5% and 1% levels (two-sided tests).

Table 3: Effects of performance-based goals on student performance

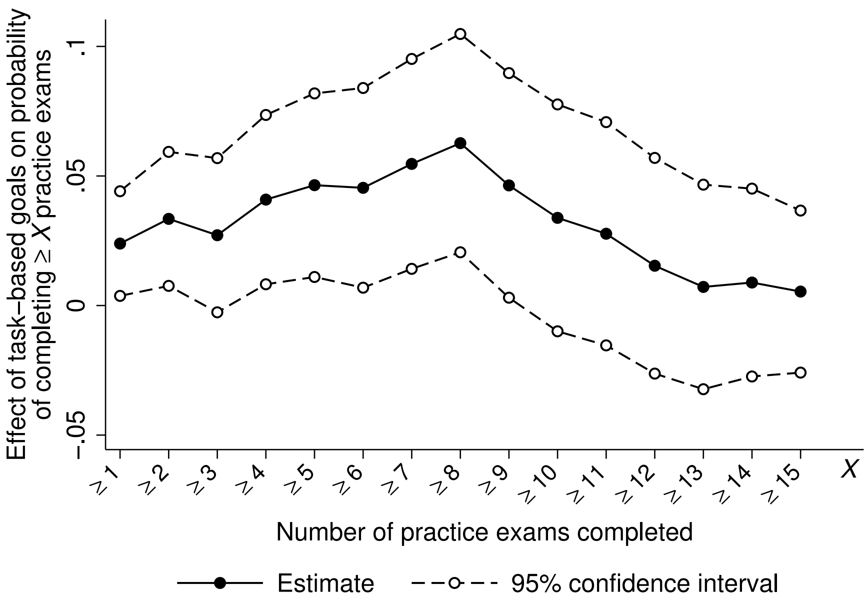
### 3.3 Impact of task-based goals on task completion

We now turn to the results from the task-based goals experiment. In this section we study the impact of task-based goals on the level of task completion, defined as the number of practice exams that the student completed during the course. Recall that all students in the task-based goals experiment had an opportunity to complete up to five practice exams online before each of two midterms and the final exam, giving a maximum of fifteen practice exams. As explained in Section 2.4, all students received question-by-question feedback while they completed a practice exam. To preview our results, we find that asking students to set task-based goals for the number of practice exams to complete successfully increased task completion. The positive effect of task-based goals on task completion is large, statistically significant and robust.

We start by looking at the effects of task-based goals on the pattern of task completion. Figure 3(a) shows the pattern of task completion for the students in the Control group, who were not asked to set goals. For example, Figure 3(a) shows that almost all students in the Control group completed at least one practice exam during the course while around fifteen percent of the students in the Control group completed all fifteen of the available practice exams. Figure 3(b) shows how task-based goal setting changed the pattern of task completion. In particular, Figure 3(b) shows that the task-based goals intervention had significant effects on the bottom and the middle of the distribution of the number of practice exams completed: for example, task-based goals increased the probability that a student completed at least one practice exam by more than two percentage points ($p$-value $= 0.020$) and increased the probability that a student completed eight or more practice exams by more than six percentage points ($p$-value $= 0.004$).




(a) Number of practice exams completed for students in the Control group of the task-based goals experiment




(b) Effects of task-based goals on the number of practice exams completed

Notes: The effects shown in Panel (b) were estimated using OLS regressions of indicators of the student having completed at least $X$ practice exams for $X \in \{1, .., 15\}$ on an indicator for the student having been randomly allocated to the Treatment group in the task-based goals experiment. The 95% confidence intervals are based on heteroskedasticity-consistent standard errors.

Figure 3: Effects of task-based goals on the pattern of task completion

Next, we look at how task-based goals changed the average level of task completion. Table 4 reports OLS regressions of the number of practice exams completed during the course on an indicator for the student having been randomly allocated to the Treatment group in the task-based goals experiment. To give a feel for the magnitude of the effects, the second row reports the effect size as a proportion of the standard deviation of the number of practice exams completed in the Control group in the task-based goals experiment, while the third row reports the average number of practice exams completed in the same Control group. From the results in the first column, which were obtained from an OLS regression that includes controls for student characteristics, we see that task-based goals increased the mean number of practice exams that students completed by about 0.5 of an exam (the effect has a $p$-value of 0.017). This corresponds to an increase in practice exam completion of about 0.1 of a standard deviation, or almost six percent relative to the average number of practice exams completed by students in the Control group. From the second column we see that these results are quantitatively similar when we omit the controls for student characteristics.

| All students in the task-based goals experiment | | |
|---|---|---|
| | Number of practice exams completed | |
| | OLS | OLS |
| Effect of asking students to set task-based goals | 0.491** | 0.479** |
| | (0.205) | (0.208) |
| | [0.017] | [0.022] |
| Effect / (SD in Control group) | 0.102 | 0.100 |
| Mean of dependent variable in Control group | 8.627 | 8.627 |
| Controls for student characteristics | Yes | No |
| Observations | 2,004 | 2,004 |

Notes: Both columns report OLS regressions of the number of practice exams completed during the course (out of a maximum of fifteen) on an indicator for the student having been randomly allocated to the Treatment group in the task-based goals experiment. In the first column we control for student characteristics as described in the notes to Table 3 while in the second column we do not control for student characteristics. 'SD in Control group' refers to the standard deviation of the dependent variable in the Control group. Heteroskedasticity-consistent standard errors are shown in round brackets and two-sided $p$-values are shown in square brackets. $^{*}$, $^{**}$ and $^{***}$ denote, respectively, significance at the 10%, 5% and 1% levels (two-sided tests).

Table 4: Effects of task-based goals on the average level of task completion

As we discussed in the Introduction, evidence from other educational environments suggests that males have less self-control than females. This motivates splitting our analysis by gender to examine whether self-set task-based goals act as a more effective commitment device for male students than for females. In line with this existing evidence on gender differences in self-control, Table 5 shows that the effect of task-based goals is mainly confined to male students. We focus our discussion on the first column of results, which were obtained from OLS regressions that include controls for student characteristics (the second column of results shows that our findings are robust to omitting these controls). Panel I shows that task-based goals increased the number of practice exams that male students completed by about one exam. This corresponds to an increase in practice exam completion of about 0.2 of a standard deviation, or almost eleven percent relative to the average number of practice exams completed by male students in the Control group. This positive effect of task-based goals on the level of task completion for male students is statistically significant at the one-percent level. Panel II shows that for female students task-based goals increased the number of practice exams completed by less than 0.2 of an exam, and this effect is far from being statistically significant.

Interestingly, in the Control group female students completed more practice exams than males, and our task-based goals intervention eliminated most of the gender gap in practice exam completion. Specifically, in the Control group females completed seventeen percent more practice exams than males, while in the Treatment group females completed only seven percent more practice exams than males.

| Panel I: Male students in the task-based goals experiment | | |
|---|---|---|
| | Number of practice exams completed | |
| | OLS | OLS |
| Effect of asking students to set task-based goals | 0.893*** | 0.809*** |
| | (0.300) | (0.306) |
| | [0.003] | [0.008] |
| Effect / (SD in Control group) | 0.190 | 0.172 |
| Mean of dependent variable in Control group | 7.892 | 7.892 |
| Controls for student characteristics | Yes | No |
| Observations | 918 | 918 |

| Panel II: Female students in the task-based goals experiment | | |
|---|---|---|
| | Number of practice exams completed | |
| | OLS | OLS |
| Effect of asking students to set task-based goals | 0.156 | 0.217 |
| | (0.281) | (0.281) |
| | [0.578] | [0.441] |
| Effect / (SD in Control group) | 0.033 | 0.045 |
| Mean of dependent variable in Control group | 9.239 | 9.239 |
| Controls for student characteristics | Yes | No |
| Observations | 1,086 | 1,086 |

Notes: The regressions are the same as those reported in Table 4, except that we now split the sample by gender. Heteroskedasticity-consistent standard errors are shown in round brackets and two-sided $p$-values are shown in square brackets. $^{*}$, $^{**}$ and $^{***}$ denote, respectively, significance at the 10%, 5% and 1% levels (two-sided tests).

Table 5: Gender differences in the effects of task-based goals on task completion

### 3.4 Impact of task-based goals on student performance

We saw in Section 3.3 that task-based goal setting successfully increased the students' level of task completion. Table 6 provides evidence that asking students to set task-based goals also improved student performance in the course, although our effects are on the margins of statistical significance. As in Section 3.2, we consider three measures of performance: (i) credit in the course, measured by students' total points score in the course (out of one hundred) that determines their letter grade; (ii) the probability that students achieved an A– or better; and (iii) the probability that students achieved a B+ or better.[20] The first column of Table 6 reports OLS regressions of credit on an indicator for the student having been randomly allocated to the Treatment group in the task-based goals experiment. The second column, titled 'Median', reports unconditional quantile regressions for the median of credit on the same indicator.[21] The third and fourth columns report OLS regressions of, respectively, an indicator for the student having achieved an A– or better and an indicator for the student having achieved a B+ or better on the same indicator as in the first two columns. To give a feel for the magnitude of the effects, the second row in each panel reports the effect size as a proportion of the standard deviation of the dependent variable in the Control group in the task-based goals experiment, while the third row reports the average of the dependent variable in the same Control group.

Panel I of Table 6 shows that, across male and female students, asking students to set goals for the number of practice exams to complete improved performance by about 0.1 of a standard deviation on average across the four specifications. The median regression of credit on the treatment gives an effect that is statistically significant at the five-percent level, while the three other specifications yield effects that are significant at the ten-percent level (the tests are all two-sided). Panels II and III show that task-based goals were effective for male students but not for females. For male students task-based goals improved performance by almost 0.2 of a standard deviation on average across the four specifications. This corresponds to an increase in credit of almost two points and an increase in the probability of achieving a A– or better of almost ten percentage points. The effects of task-based goal-setting on the performance of male students are strongly statistically significant (three of the four specifications give significance at the one-percent level, while the fourth gives significance at the five-percent level). On the other hand, Panel III shows that task-based goals were ineffective in raising performance for female students. On average across the four specifications, task-based goals improved the performance of female students by only 0.02 of a standard deviation (and the effect of task-based goals on the performance of female students is statistically insignificant in all four specifications).

The regressions in Table 6 control for student characteristics: the results are quantitatively similar but precision falls when we do not condition on student characteristics (see Table SWA.5 in Supplementary Web Appendix I).

[20] B+ was the median letter grade across the four semesters of our study.

[21] The median results were obtained using the estimator of Firpo et al. (2009), which delivers the effect of the treatment on the unconditional median of credit.

| Panel I: All students in the task-based goals experiment | | | | |
|---|---|---|---|---|
| | Total points score | | Pr(Grade ≥ A–) | Pr(Grade ≥ B+) |
| | OLS | Median | OLS | OLS |
| Effect of asking students to set task-based goals | 0.742* | 1.044** | 0.038* | 0.049** |
| | (0.431) | (0.446) | (0.021) | (0.021) |
| | [0.086] | [0.019] | [0.072] | [0.019] |
| Effect / (SD in Control group) | 0.068 | 0.096 | 0.077 | 0.098 |
| Mean of dependent variable in Control group | 83.111 | 83.111 | 0.393 | 0.493 |
| Observations | 2,004 | 2,004 | 2,004 | 2,004 |

| Panel II: Male students in the task-based goals experiment | | | | |
|---|---|---|---|---|
| | Total points score | | Pr(Grade ≥ A–) | Pr(Grade ≥ B+) |
| | OLS | Median | OLS | OLS |
| Effect of asking students to set task-based goals | 1.787*** | 1.714*** | 0.092*** | 0.069** |
| | (0.657) | (0.642) | (0.031) | (0.031) |
| | [0.006] | [0.008] | [0.003] | [0.025] |
| Effect / (SD in Control group) | 0.159 | 0.153 | 0.187 | 0.138 |
| Mean of dependent variable in Control group | 83.285 | 83.285 | 0.417 | 0.529 |
| Observations | 918 | 918 | 918 | 918 |

| Panel III: Female students in the task-based goals experiment | | | | |
|---|---|---|---|---|
| | Total points score | | Pr(Grade ≥ A–) | Pr(Grade ≥ B+) |
| | OLS | Median | OLS | OLS |
| Effect of asking students to set task-based goals | -0.128 | 0.449 | -0.008 | 0.033 |
| | (0.571) | (0.613) | (0.028) | (0.029) |
| | [0.822] | [0.464] | [0.779] | [0.255] |
| Effect / (SD in Control group) | -0.012 | 0.043 | -0.016 | 0.065 |
| Mean of dependent variable in Control group | 82.966 | 82.966 | 0.373 | 0.463 |
| Observations | 1,086 | 1,086 | 1,086 | 1,086 |

Notes: The first column reports OLS regressions of total points score on an indicator for the student having been randomly allocated to the Treatment group in the task-based goals experiment. The second column reports unconditional quantile regressions for the median of total points score on the same indicator. The third and fourth columns report OLS regressions of, respectively, an indicator for the student having achieved an A– or better and an indicator for the student having achieved a B+ or better on the same indicator as in the first two columns. 'SD in Control group' refers to the standard deviation of the dependent variable in the Control group. We control for student characteristics as explained in the notes to Table 3. Heteroskedasticity-consistent standard errors are shown in round brackets and two-sided $p$-values are shown in square brackets. *, ** and *** denote, respectively, significance at the 10%, 5% and 1% levels (two-sided tests).

Table 6: Effects of task-based goals on student performance

### 3.5 Did the increase in task completion cause the increase in performance?

So far we have shown that task-based goals increased the level of task completion and improved student performance, with larger effects for male students than for females. A natural explanation for our results is that the increase in task completion induced by task-based goal setting caused the improvement in student performance. A final round of analysis provides independent evidence that supports this explanation. In particular, if the effect of goal setting on performance was caused by the increase in task completion, then this performance effect of goal setting should be comparable in magnitude to the effect of goal setting on the number of practice exams completed multiplied by the effect of completing a practice exam on performance. We show that this is the case by estimating the performance effect of completing a practice exam using a fixed effects estimation strategy. This strategy leverages within-student variation in the number of practice exams completed across the two midterms and the final exam among students in the Control group in the task-based goals experiment (who were not asked to set goals).

In more detail, we estimate the performance effect of completing a practice exam using a fixed effects regression of points scored in one of the midterms or the final exam (which enters the total points score as described in Section 2.4) on the number of practice exams completed in preparation for that midterm or final exam. Each student-exam pair is an observation and we include a fixed effect for each student. The estimation sample includes only students from the Control group of the task-based goals experiment. Thus the fixed effects estimate measures the performance returns to practice exams for students in the Control group who varied the number of practice exams that they completed across the different exams (the vast majority did so). Since students in the Control group were not asked to set goals, we estimate the effect of completing a practice exam uncontaminated by any effects of our goal-setting intervention.

The fixed effects estimates reported in Table 7 suggest that completing a practice exam increased the performance of students in the Control group by 1.486 points. If we multiply this estimate by the effect of goal setting on the number of practice exams completed (0.491 exams, from the first column of Table 4), we predict an effect of goal setting on performance of 0.730 points. This is remarkably close to the effect of goal setting on performance that we estimated previously from a treatment-control comparison of the students in the task-based goals experiment (0.742 points, from the first column of Panel I of Table 6). The equivalent calculations using our estimates for male students and for female students also line up reasonably well: for males the predicted performance effect of task-based goal setting is 1.241 points ($1.389 \times 0.893$) versus an estimated effect of 1.787 points, while for female students the predicted effect of task-based goal setting is 0.247 points ($1.579 \times 0.156$) versus an estimated effect of -0.128 points. Overall, our fixed effects estimates of the performance returns to completing practice exams support the hypothesis that the increase in task completion induced by task-based goal setting caused the improvement in student performance in the course.[22]

| Students in the Control group of the task-based goals experiment | | | |
|---|---|---|---|
| | Points scored in one of the midterms or the final exam | | |
| | All students | Male students | Female students |
| Effect of each completed practice exam | $1.486^{***}$ | $1.389^{***}$ | $1.579^{***}$ |
| | (0.095) | (0.139) | (0.128) |
| | [0.000] | [0.000] | [0.000] |
| Effect/(SD in Control group) | 0.221 | 0.193 | 0.250 |
| Mean of dependent variable in Control group | 23.413 | 23.491 | 23.349 |
| Student fixed effects | Yes | Yes | Yes |
| Observations (student-exam pairs) | 3,060 | 1,389 | 1,671 |

Notes: Each column reports fixed effects panel regressions of points scored in one of the midterms or the final exam on the number of practice exams completed in preparation for that midterm or final exam. Each student-exam pair is an observation (giving three observations per student). We include a fixed effect for each student, and the fixed effects absorb any effects of student characteristics on student performance. The sample includes only students from the Control group of the task-based goals experiment, who were not asked to set goals. 'SD in Control group' refers to the standard deviation of the dependent variable in the Control group. Heteroskedasticity-consistent standard errors (with clustering at the student level) are shown in round brackets and two-sided $p$-values are shown in square brackets. $^{*}$, $^{**}$ and $^{***}$ denote, respectively, significance at the 10%, 5% and 1% levels (two-sided tests).

Table 7: Fixed effects estimates of the effect of completed practice exams on student performance

# 4 Interpreting our results using a model of goal setting

We now develop a model of goal setting to help interpret our experimental findings. We start by motivating the model in Section 4.1. We present the model of goal setting in Section 4.2, considering first performance-based goals in Section 4.2.1, and then modifying the model to capture goal setting for task-based goals in Section 4.2.2. Finally, we use the model to interpret our experimental results in Sections 4.3, 4.4 and 4.5.

[22]Further evidence for the hypothesis that the increase in task completion induced by task-based goal setting caused the improvement in student performance comes from results showing that goal-setting did not affect another aspect of student behavior: participation in the course. In more detail, we construct an index of course participation, which measures the proportion of course components that a student completed weighted by the importance of each component in determining total points score in the course. We regress our index of course participation on an indicator of the student having been randomly allocated to the Treatment group in the task-based goals experiment. We find that the effects of the treatment on course participation are small and far from being statistically significant. The $p$-values for OLS regressions of this index on the treatment are 0.668, 0.367 and 0.730 for, respectively, all students, male students, and female students.

## 4.1 Motivation

Our analysis of goal setting is motivated by two literatures in behavioral economics: the literature on present bias and the literature on loss aversion. The first literature suggests that people lack self-control because they are present biased (Strotz, 1956).[23] Unlike exponential discounters, present-biased discounters place more weight on utility at time $t$ relative to utility at time $t+1$ the closer is $t$ to the present. Present-biased discounters exhibit time inconsistency: time preferences at different dates are not consistent with one another. In the context of education, a present-biased student might set out to exert her preferred level of effort, but when the time comes to attend class or review for a test she might lack the self-control necessary to implement these plans (under exponential discounting this self-control problem disappears). Strotz (1956) and Pollak (1968) were the first to analyze how time-inconsistent agents make choices anticipating the different time preferences of their future selves. As noted by Strotz (1956), present-biased agents can mitigate their self-control problem by using commitment devices to bind their future self.[24] The second literature emphasizes the importance of loss aversion: people dislike falling behind a salient reference point (Kahneman and Tversky, 1979).[25] In the context of education, a loss-averse student might work particularly hard in an attempt to achieve a salient reference level of performance in her course.

Together, these two literatures suggest that, by acting as salient reference points, self-set goals might serve as an effective commitment device that helps present-biased agents to mitigate their self-control problem and so steer their effort toward its optimal level. Indeed, Koch and Nafziger (2011) developed a simple model of goal setting based on this idea. Unlike us, however, Koch and Nafziger (2011) did not use their model to compare the effects of performance-based and task-based goals.[26]

## 4.2 Baseline model of goal setting

### 4.2.1 Performance-based goals

At period one the student sets a goal $g \geq 0$ for performance $f \geq 0$; we call the student at period one the *student-planner*. At period two the student works on one or more tasks and chooses effort $e \geq 0$; we call the student at period two the *student-actor*. The student-actor incurs a cost $C(e) = ce^2/2$, with $c > 0$. At period three performance is realized and the student incurs

[23] Present bias has been proposed as an explanation for aspects of many behaviors such as addiction (Gruber and Kőszegi, 2001), early retirement (Diamond and Kőszegi, 2003), smoking (Khwaja et al., 2007), welfare program participation (Fang and Silverman, 2009) and credit card borrowing (Meier and Sprenger, 2010). See Dhami (2016) for a recent comprehensive survey of the literature on present bias.

[24] We provide examples of such commitment devices in footnote 2 in the introduction.

[25] Loss aversion has been proposed as a foundation of a number of phenomena such as the endowment effect (Kahneman et al., 1990), small-scale risk aversion (Rabin, 2000), the disposition effect (Genesove and Mayer, 2001), and the role of expectations in single-agent decision-making (Bell, 1985; Kőszegi and Rabin, 2006) and in strategic interactions (Gill and Stone, 2010; Gill and Prowse, 2012).

[26] Koch and Nafziger (2011)'s simple model also differs from ours because agents in their model choose from only two possible effort levels, while our model allows students to choose both effort and goals from a continuum. Again without comparing the effects of performance-based and task-based goals, Jain (2009) also studies theoretically how present-biased agents can use goals as reference points; in Jain (2009)'s model utility is discontinuous at the reference point, rather than kinked as in Kahneman and Tversky (1979)'s model of loss aversion that we use. Heath et al. (1999) and Wu et al. (2008) linked goals to loss aversion, but did not make the connection to present bias. Finally, a theoretical literature studies expectations as goals (Suvorov and Van de Ven, 2008; Hsiaw, 2013; Hsiaw, 2016; Koch and Nafziger, 2016).

any disutility from failing to achieve her goal; we call the student at period three the *student-beneficiary*. Performance increases one-to-one in effort exerted by the student-actor at period two, i.e., $f(e) = e$, and the student-beneficiary's utility increases one-to-one in performance. Furthermore, the student-beneficiary is loss averse around her goal: she suffers goal disutility that depends linearly on how far performance falls short of the goal set by the student-planner at period one. The student-beneficiary's goal disutility is given by $-l \max\{g - f(e), 0\}$.[27] The parameter $l > 0$ captures the strength of loss aversion, which in our context we call the 'strength of goal disutility'.

The student is also present biased. In particular, the student exhibits quasi-hyperbolic discounting, with $\beta \in (0, 1)$ and $\delta \in (0, 1]$: the student discounts utility $n$ periods in the future by a factor $\beta\delta^n$.[28] Under quasi-hyperbolic discounting the student-planner discounts period-two utility by a factor $\beta\delta$ and period-three utility by a factor $\beta\delta^2$, and so discounts period-three utility by $\delta$ relative to period-two utility. The student-actor, on the other hand, discounts period-three utility by $\beta\delta$ relative to immediate period-two utility. Since $\beta\delta < \delta$, the student-planner places more weight on utility from performance at period three relative to the cost of effort at period two than does the student-actor. As a result, in the absence of a goal the student-planner's desired effort is higher than the effort chosen by the student-actor: that is, the student exhibits a self-control problem due to time inconsistency.[29]

**Remark 1**
*In the absence of a goal the student exhibits time inconsistency:*
*(i) The student-actor chooses effort* $\underline{e} = \beta\delta/c$.
*(ii) The student-planner would like the student-actor to exert effort* $\hat{e} = \delta/c > \underline{e}$.

**Proof.** See Supplementary Web Appendix III.1. ■

To alleviate her self-control problem due to time-inconsistency, the student-planner might choose to set a goal. Goals can be effective by increasing the student-actor's marginal incentive to work in order to avoid the goal disutility that results from failing to achieve the goal.

We solve for the subgame-perfect Nash equilibria of the game outlined above, in which the players are the student-planner and student-actor. We do so by backward induction. First, we analyze the effort choice of the student-actor at period two for any goal set by the student-planner at period one. The student-actor's utility is given by:

$$u_{act}(e|g) = \beta\delta[f(e) - l \max\{g - f(e), 0\}] - C(e) \quad (1)$$

$$= \beta\delta[e - l \max\{g - e, 0\}] - \frac{ce^2}{2}. \quad (2)$$

[27]Given that there is no uncertainty about how effort translates into performance, it is possible that goal disutility could be incurred at period two by the student-actor (who anticipates how far she will fall short of her goal) instead of at period three by the student-beneficiary when performance is realized. However, when we introduce uncertainty in Section 4.3 the student-actor will not know how far she has fallen short of her goal. In any case, it is straightforward to show that the results in this section would remain qualitatively unchanged if goal disutility was incurred at period two.

[28]Laibson (1997) was the first to apply the analytically tractable quasi-hyperbolic (or 'beta-delta') model of discounting to analyze the choices of present-biased time-inconsistent agents. Like us, Laibson (1997) finds the equilibria of a dynamic game among a sequence of temporal selves.

[29]When $g = 0$, goal disutility is zero since $\max\{g - f(e), 0\} = 0$, and so $g = 0$ is equivalent to the absence of a goal.

Proposition 1 shows how the student-actor's effort responds to the goal.

**Proposition 1**

*Let $\overline{e} = \beta\delta(1+l)/c$ and recall from Remark 1 that $\underline{e} = \beta\delta/c < \overline{e}$ denotes the student-actor's effort in the absence of a goal.*

*(i) When $g \leq \underline{e}$, the student-actor exerts effort $e^* = \underline{e}$.*

*(ii) When $g \in [\underline{e}, \overline{e}]$, the student-actor exerts effort $e^* = g$.*

*(iii) When $g \geq \overline{e}$, the student-actor exerts effort $e^* = \overline{e}$.*

**Proof.** See Supplementary Web Appendix III.1. ■

Proposition 1 tells us that, perhaps unsurprisingly, the goal does not raise effort when it is set lower than the student-actor's optimal level of effort in the absence of a goal $\underline{e}$. Intermediate goals are effective: intermediate goals induce the student-actor to work hard enough to achieve the goal in order to avoid disutility from falling short of the goal. Beyond a certain point the marginal cost of effort outweighs the marginal reduction in goal disutility, and so the goal induces an increase in effort only to an upper bound $\overline{e}$. Goals above the upper bound leave the student-actor to suffer some goal disutility. This upper bound increases as the time-inconsistency problem becomes less severe (higher $\beta$) and as the strength of goal disutility $l$ goes up. The maximal increase in effort from setting a goal as a proportion of the student-actor's effort in the absence of a goal, $(\overline{e} - \underline{e})/\underline{e}$, is given by the strength of goal disutility $l$.

Having established how the student-actor's effort responds to any goal set by the student-planner, we now consider the student-planner's optimal choice of goal. Letting $e^*(g)$ represent the student-actor's optimal effort given a goal $g$, the student-planner's utility is given by:

$$u_{plan}(g|e^*(g)) = \beta\delta^2[f(e^*(g)) - l\max\{g - f(e^*(g)), 0\}] - \beta\delta C(e^*(g)) \tag{3}$$

$$= \beta\delta^2[e^*(g) - l\max\{g - e^*(g), 0\}] - \beta\delta\frac{c[e^*(g)]^2}{2}. \tag{4}$$

**Proposition 2**

*Recall from Remark 1 that $\underline{e} = \beta\delta/c$ and $\hat{e} = \delta/c$ denote, respectively, student-actor effort and student-planner desired effort in the absence of a goal.*

*Recall from Proposition 1 that $\overline{e} = \beta\delta(1+l)/c$ denotes maximal student-actor effort in the presence of a goal.*

*(i) The optimal choice of goal for the student-planner is given by $g^* = \min\{\hat{e}, \overline{e}\}$.*

*(ii) When $\beta(1+l) < 1$, $g^* = \overline{e}$.*

*(iii) When $\beta(1+l) \geq 1$, $g^* = \hat{e}$.*

*(iv) Effort of the student-actor $e^* = g^* > \underline{e}$, and so the student-actor works harder than in the absence of goal.*

**Proof.** See Supplementary Web Appendix III.1. ■

We know from Proposition 1 that goals in the range $[\underline{e}, \overline{e}]$ induce the student-actor to work to achieve the goal, but that higher goals are ineffective in raising effort above $\overline{e}$. Thus, the student-planner will never set a goal higher than $\overline{e}$, since higher goals are not effective but leave the student-actor to suffer some goal disutility from failing to achieve the goal. If the student-planner could simply impose a level of effort on the student-actor, then we know from Remark 1 that she would choose $\hat{e}$. When $\beta(1+l)$ is big enough, $\hat{e} \leq \overline{e}$, and so the student-planner achieves her desired level of effort by setting $g^* = \hat{e}$. This case holds when the time-inconsistency problem is not too severe (high $\beta$) or the strength of goal disutility $l$ is sufficiently high. When her desired level of effort is not achievable, the student-planner sets $g^* = \overline{e}$, and so the student-planner uses the goal to induce as much effort from the student-actor as she is able to. In either case, the optimal goal induces the student to work harder than she would in the absence of a goal and the student always achieves her goal in equilibrium.

### 4.2.2 Task-based goals

We now modify the model to capture task-based goal setting. At period one the student-planner sets a goal $g \geq 0$ for the number of units of the task to complete. We let $z$ denote the number of units of the task that the student actually completes, and we call $z$ the 'level of task completion'. At period two the student-actor works on the task and chooses effort $a \geq 0$. The student-actor incurs a cost $C(a) = \kappa a^2/2$, with $\kappa > 0$. The level of task completion $z$ increases one-to-one in effort exerted by the student-actor: $z(a) = a$.[30] Furthermore, at period two the student-actor suffers goal disutility that depends linearly on how far the level of task completion falls short of the goal set by the student-planner at period one: she suffers goal disutility of $-\lambda \max\{g - z(a), 0\}$, where the loss parameter $\lambda$ captures the strength of goal disutility.[31] At period three performance is realized. Performance increases linearly in the level of task completion: $f(a) = \theta \times z(a) = \theta a$, with $\theta > 0$; while the student-beneficiary's utility increases one-to-one in performance. The student exhibits quasi-hyperbolic discounting as described in Section 4.2.1. Thus the student-actor's utility is given by:

$$
\begin{aligned}
u_{act}(a|g) &= \beta\delta f(a) - [\lambda \max\{g - z(a), 0\} + C(a)] && (5)\\
&= \beta\delta\theta a - \left[\lambda \max\{g - a, 0\} + \frac{\kappa a^2}{2}\right]; && (6)
\end{aligned}
$$

and, letting $a^*(g)$ represent the student-actor's optimal effort given a goal $g$, the student-planner's utility is given by:

$$
\begin{aligned}
u_{plan}(g|a^*(g)) &= \beta\delta^2 f(a^*(g)) - \beta\delta[\lambda \max\{g - z(a^*(g)), 0\} + C(a^*(g))] && (7)\\
&= \beta\delta^2\theta a^*(g) - \beta\delta\left[\lambda \max\{g - a^*(g), 0\} + \frac{\kappa[a^*(g)]^2}{2}\right]. && (8)
\end{aligned}
$$

When we solve the game by backward induction, we get results that are qualitatively similar

[30] Implicitly, we now define a unit of effort to be the amount of effort needed to increase the level of task completion by one unit, while for performance-based goals in Section 4.2.1 we defined a unit of effort to be the amount of effort needed to increase performance by one unit. This explains why we use new notation for effort $a$ and the cost of effort parameter $\kappa$.

[31] We use new notation for the parameter that measures the strength of goal disutility $\lambda$ because the units used to measure the level of task completion are different from the performance units in Section 4.2.1. Note also that goal disutility is incurred at period two here because the student-actor observes how far she is from the task-based goal immediately on exerting the effort that influences the level of task completion. For performance-based goals in Section 4.2.1 goal disutility is incurred at period three when performance is realized (see also the discussion in footnote 27).

to those for performance-based goals in Section 4.2.1. The formal results and proofs are relegated to Supplementary Web Appendix III.2. The three relevant thresholds now become:

$$\underline{a} = \frac{\beta\delta\theta}{\kappa}; \qquad \hat{a} = \frac{\delta\theta}{\kappa} > \underline{a}; \qquad \overline{a} = \frac{\beta\delta\theta + \lambda}{\kappa} > \underline{a}. \tag{9}$$

Mirroring Remark 1, in the absence of a goal the student exhibits time inconsistency: the student-actor chooses effort $\underline{a}$, which is smaller than the student-planner's desired level of effort $\hat{a}$. The upper bound on student-actor effort in the presence of a goal is given by $\overline{a}$. Mirroring Proposition 1, this upper bound increases as the time-inconsistency problem becomes less severe (higher $\beta$) and as the strength of goal disutility $\lambda$ goes up. Mirroring Proposition 2, the optimal choice of goal for the student-planner is given by $g^* = \min\{\hat{a}, \overline{a}\}$ and the optimal goal induces the student-actor to exert effort $a^* = g^* > \underline{a}$; once again, the optimal goal induces the student to work harder than she would in the absence of a goal and the student always achieves her goal in equilibrium. When $\beta\delta\theta + \lambda \geq \delta\theta$, $\hat{a} \leq \overline{a}$, and so the student-planner achieves her desired level effort by setting $g^* = \hat{a}$. Just like in Proposition 2, this case holds when the time-inconsistency problem is not too severe (high $\beta$) or the strength of goal disutility $\lambda$ is sufficiently high.

## 4.3 Why were task-based goals more effective than performance-based goals?

The baseline model outlined in Section 4.2 suggests that goal setting can improve course performance. Our experimental data show that task-based goals are more effective at raising students' performance than performance-based goals (Tables 3 and 6), and that task-based goals are more frequently achieved than performance-based goals (Table 2).[32] Using the framework of the baseline model, we now consider three possible explanations for why task-based goals are more effective than performance-based goals (we view these explanations as complementary).

### 4.3.1 Overconfidence

We start by relaxing the strong assumption made in the baseline model that students understand perfectly the relationship between effort and performance. Suppose instead that some students are overconfident. An overconfident student believes that the production function is given by $f(\cdot)$, when in fact performance is given by $h(\cdot)$ with $h(\cdot) < f(\cdot)$. Such overconfidence could be driven by a student's biased beliefs about her ability level, by incorrect beliefs about the difficulty of the course or by overconfidence about the productivity of the tasks that the student chooses to work on.[33]

[32]It is possible that some students in the Control group (who were not invited to set goals) might already use goals as a commitment device. However, since we find that task-based goals are successful at increasing performance, we conclude that many students in the Control group did not use goals or set goals that were not fully effective. We note that asking students to set goals might make the usefulness of goal setting as a commitment device more salient and so effective. Reminding students of their goal, as we did, might also help to make them more effective.

[33]The education literature supports the idea that students face considerable uncertainty about the educational production function, and that this uncertainty could lead to students holding incorrect beliefs about the performance impacts of particular tasks (e.g., Romer, 1993, and Fryer, 2013). Furthermore, the broader behavioral literature shows that people tend to be overconfident when they face uncertainty (e.g., Weinstein, 1980, Camerer and Lovallo, 1999, and Park and Santos-Pinto, 2010), while also providing a number of theoretical underpinnings for overconfidence (e.g., Brunnermeier and Parker, 2005, Johnson and Fowler, 2011, and Gossner and Steiner, 2016).

An overconfident student will act as if the production function is given by $f(\cdot)$, and so the model in Section 4.2 describes her choice of goal and effort. However, the student's actual performance with goal setting and in the absence of a goal will fall below what the student expects. In the case of performance-based goals, the unexpectedly low performance that follows from overconfidence results in the student unexpectedly failing to achieve her performance-based goal. In the case of task-based goals, however, an overconfident student continues to achieve her goal. This is because the overconfidence that we are describing concerns the relationship between effort and performance, and not the the relationship between effort and task completion.

We just explained how overconfidence can help to explain why task-based goals are more frequently achieved than performance-based goals. Depending on the source of overconfidence, task-based goals might also be more effective at raising students' performance. In particular, suppose that the student is overconfident about the average productivity of the tasks that she chooses to work on, and further suppose that the practice exams are more productive than the tasks that the overconfident student would select for herself under performance-based goals.[34] Then task-based goal setting directs overconfident students to set goals for tasks that have particularly high returns, and so the extra effort that goal setting induces has a bigger impact on performance in the case of task-based goals than in the case of performance-based goals. In other words, fixing the student's overconfident belief about the production function at $f(\cdot)$, task-based goal setting moves the actual production function $h(\cdot)$ closer to $f(\cdot)$, which in turn boosts the impact of goal setting on performance. Plausibly, teachers have better information about which tasks are likely to be productive, and asking students to set goals for productive tasks is one way to to improve the power of goal setting for overconfident students.[35]

In summary, overconfidence can help to explain why task-based goals are more frequently achieved than performance-based goals and why task-based goals are more effective at raising students' performance than performance-based goals.

#### 4.3.2 Performance uncertainty

Next, we relax a further strong assumption made in the baseline model, namely that the relationship between effort and performance involves no uncertainty: the student knows for sure how her effort translates into performance and her goal is always achieved in equilibrium. In practice, the relationship between effort and performance is likely to be noisy and, as in our experiments, goals are not always reached.

To introduce uncertainty about performance in a simple way, suppose that the student is risk neutral and that with known probability $\pi \in (0, 1)$ her effort translates into performance according to $f(\cdot)$ as in Section 4.2, while with probability $1 - \pi$ performance $f = 0$ (since we

[34] Overconfidence about the average productivity of the tasks that the student chooses to work on might flow from overconfidence about the ability to process information. In particular, the student might overestimate the quality of signals that she receives about the productivity of available tasks.

[35] It is conceivable but unlikely that the goals set by the students did not motivate them and that, instead, task-based goals improved performance simply because they signaled to students in the Treatment group that practice exams were an effective task or because they directed students in the Treatment group toward practice exams. We think that this is unlikely because: (i) we were careful to make the practice exams as salient as possible to the Control group; (ii) students in the Control group in fact completed many practice exams; and (iii) it is hard to understand why only men would respond to the signal or direction.

assume that $\pi$ is known, the student is neither overconfident nor underconfident).[36] The student could face uncertainty about her ability or about the underlying productivity of the task or tasks that she works on. Fixing ability and task productivity, the student might also get unlucky: for instance, the draw of questions on the exam might be unfavorable or the student might get sick near the exam. All such sources of uncertainty are captured by the uncertainty parameter $\pi$.

For task-based goals, when we solve the game by backward induction the results are qualitatively unchanged from those for the case without uncertainty described in Section 4.2.2. The formal details are relegated to Supplementary Web Appendix III.3. Quantitatively, the uncertainty reduces the student-actor's marginal incentive to exert effort, which reduces by a factor $\pi$ both the equilibrium goal set by the student-planner and the equilibrium effort exerted by the student-actor. As in the model without uncertainty, goal setting increases the student's effort and the student always achieves her goal in equilibrium.

For performance-based goals the effects of uncertainty are more complex. Once again, the formal details are relegated to Supplementary Web Appendix III.3. Just like for task-based goals, the uncertainty directly reduces the student-actor's marginal incentive to exert effort, which in turn reduces the equilibrium goal and equilibrium effort. But now an extra effect comes into play: performance-based goals are risky because when performance turns out to be low the student fails to achieve her goal and so suffers goal disutility that increases in the goal.[37] Anticipating the goal disutility suffered when performance turns out to be low, the student-planner further scales back the goal that she sets for the student-actor, which in turn further lowers the student-planner's equilibrium effort.[38,39] Thus, the uncertainty makes goal setting less effective at raising the student's performance in the case of performance-based goals compared to the case of task-based goals. Furthermore, when performance turns out to be low the student fails to achieve her performance-based goal. The extra effect of uncertainty is not present in the case of task-based goals because the student-actor controls the number of units of the task that she completes and so can guarantee to hit her task-based goal.

In summary, performance uncertainty can help to explain why task-based goals are more effective at raising students' performance than performance-based goals and why task-based goals are more frequently achieved than performance-based goals.

[36] We can think of $f = 0$ as a baseline level of performance that the student achieves with little effort even in the absence of goal setting.

[37] With uncertainty, in contrast to the case of overconfidence discussed in Section 4.3.1, goal failure is not unexpected: the student facing uncertainty anticipates that she will not always achieve her performance-based goal.

[38] Formally, the extra effect adds the second term to the numerator in the expression for $\tilde{e}$ in Proposition SWA.4 in Supplementary Web Appendix III.3 that is not present for task-based goals. Proposition SWA.4 in Supplementary Web Appendix III.3 focuses on the case in which uncertainty is not too big. When the student faces a lot of uncertainty, in the case of performance-based goals the student-planner could prefer not to set a goal at all.

[39] This scaling back of goals is not necessarily at odds with the fact that the performance-based goals that we see in the data appear ambitious. First, without any scaling back the goals might have been even higher. Second, the overconfidence that we discuss in Section 4.3.1 could keep the scaled-back goal high. Third, we explain in Section 4.4 below that students likely report as their goal an 'aspiration' that is only relevant if, when the time comes to study, the cost of effort turns out to be particularly low: the actual cost-specific goal that the student aims to hit could be much lower than this aspiration.

### 4.3.3 Timing of goal disutility

Returning to the baseline model in Section 4.2, a further reason why performance-based goals might be less effective at raising students' performance than task-based goals flows from the timing of goal disutility. In particular, recall that in the case of performance-based goals any goal disutility is suffered when performance is realized in period three, while in the case of task-based goals any goal disutility is suffered when the student-actor exerts effort on the task in period two. Thus, avoiding goal disutility motivates the student-actor more in the case of task-based goals, which in turn increases the extent to which the student-planner can use goals to motivate the student-actor.[40]

## 4.4 Why were task-based goals not always achieved?

In the baseline model outlined in Section 4.2 goals are always achieved. In Sections 4.3.1 and 4.3.2 we explained how overconfidence and performance uncertainty can result in a student's failure to achieve her performance-based goal. A puzzle remains: even though task-based goals are more frequently achieved than performance-based goals, our experimental results show that task-based goals are not always achieved (Table 2).

Failure to achieve task-based goals emerges naturally if we relax the assumption made in the baseline model that costs are known with certainty. In particular, suppose that the student-actor's cost of effort parameter ($c$ or $\kappa$) can be high or low, and that the student-actor draws her cost of effort parameter in period two before she decides how hard to work (the analysis extends naturally to any number of possible cost draws). For example, the cost uncertainty could be driven by uncertainty about the set of leisure activities available to the student during the time that she planned to study. Anticipating this cost uncertainty, we allow the student-planner to set a goal for both possible cost draws. The optimal goal for a given cost draw is just as in the model in Section 4.2 with no uncertainty, and the student-actor always works hard enough to achieve the cost-specific goal. Of course, we ask the student to report only one goal: we assume here that the student-planner reports to us only her goal for the low-cost draw. This goal is like an aspiration: if the cost turns out to be high, the goal is scaled down to reflect the higher cost of effort. Because we as the experimenter observe only the reported aspiration, when the cost is high we observe a failure to achieve the reported aspiration, even though the student achieves her cost-specific goal.

## 4.5 Why were task-based goals more effective for men than for women?

Our data show that task-based goals are more effective for men than for women. More specifically: in the Control group without goal setting men completed fewer practice exams than women (Table 5); and task-based goals increased performance and the number of practice exams completed more for men than for women (Tables 6 and 5). In the context of our baseline

[40]Formally, we can see this effect by comparing the expression for $\overline{e}$ in the case of performance-based goals to the expression for $\overline{a}$ in the case of task-based goals (see Section 4.2). In the first expression the parameter measuring the strength of goal disutility $l$ is multiplied by a discount factor $\beta\delta < 1$, while in the second expression the strength of goal disutility parameter $\lambda$ is undiscounted. We note that this timing difference between task-based goals and performance-based goals matters even when there is modest temporal distance between when the student exerts effort and when performance is realized. This is because quasi-hyperbolic discounters discount the near future relative to the present by a factor $\beta$ even if $\delta = 1$ over the modest temporal distance.

model of task-based goal setting (Section 4.2.2), a simple explanation for this finding is that the male students in our sample are more present biased than the female students (i.e., the men have a lower $\beta$ parameter).[41,42]

First, note that the student-actor's effort in the absence of a goal $\underline{a}$ is increasing in $\beta$: the more present biased the student, the fewer practice exams he or she completes without a goal. Thus, if men are more present biased than women, then their higher degree of present bias will push down their level of task completion in the Control group relative to that of women. Second, the increase in task completion induced by goal setting also depends on the degree of present bias: in particular, the difference between the student-planner's desired level of effort $\hat{a}$ and the student-actor's effort in the absence of a goal $\underline{a}$ is decreasing in $\beta$. Thus, if men are more present biased than women, then goal setting will tend to be more effective at increasing the number of practice exams that men complete, which in turn feeds into a larger effect on performance.

# 5 Conclusion

To recap, our first field experiment suggests that performance-based goals have little or no impact on the performance of college students: our estimates are close to zero and are far from statistical significance. This causal finding stands in stark contrast to the correlational evidence that dominates the educational psychology literature. In contrast, our second field experiment suggests that task-based goals are effective. In particular, asking students to set goals for the number of practice exams to complete increased the number of practice exams that students completed and increased course performance. Further empirical analysis supports the most obvious explanation for this finding: task-based goal setting induces greater task-specific investment, which in turn increases course performance. These empirical results are reinforced by our theoretical analysis, which suggests two key reasons why task-based goal setting might be more effective than performance-based goal setting: overconfidence and uncertainty about performance.

Our analysis suggests that task-based goal setting is an intervention that can improve college outcomes. This raises the question of how best to incorporate task-based goal setting into the college environment. Academic advising services could be a particularly promising vehicle for promoting the benefits of task-based goal setting. American colleges already offer a panoply of academic advising services to students. These include counselors and mentors, campus centers that students can visit, and student success programs and courses that students are encouraged

[41] Existing empirical evidence supports the idea that men are more present biased than women. In the introduction we referred to evidence from educational environments that females have more self-control than males (e.g., Duckworth and Seligman, 2005, Buechel et al., 2014, and Duckworth et al., 2015). Consistent with gender differences in self-control, incentivized experiments suggest that men may be more present biased than women. When the earliest payment is immediate (no 'front-end delay'), which provides a test of quasi-hyperbolic discounting, McLeish and Oxoby (2007) and Prince and Shawhan (2011) find that men are more present biased than women, while Tanaka et al. (2010) find no gender difference in present bias for rural Vietnamese. When rural Malawians are given an unexpected opportunity to reverse an earlier commitment, Giné et al. (forthcoming) find that men are more likely to reverse their earlier choice and instead choose an earlier but smaller payment. When the earliest payment is not immediate ('front-end delay'), no gender differences have been found (see Bauer and Chytilová, 2013, for rural Indians and Harrison et al., 2005, where the earliest payment is delayed by a month).

[42] Interestingly, in a laboratory experiment in which goals were set by the experimenter rather than by the subjects themselves, Smithers (2015) finds that goals increased the work performance of men but not that of women.

or required to follow (e.g., as part of academic remediation activities). Students in receipt of these services are often advised that goal setting is an essential study skill. For example, the college that provides the course that we study has a "Teaching Center" that provides academic advising services to students. These services include online resources that recommend that students implement five "essential study strategies", one of which is to "Set Goals". Another example is CUNY's Accelerated Study in Associate Programs (ASAP), which encourages first-year students to attend seminars that explicitly cover goal setting, alongside other study skills (Scrivener et al., 2015).[43]

These academic advising services often present goal setting as one of many strategies that students might try. Moreover, they do not prescribe the particular types of goals that students should set (e.g., performance- or task-based).[44] Our results suggest that advising services should consider giving greater prominence to goal setting and should consider encouraging task-based goal setting at the expense of performance-based goal setting. For example, advisors could encourage students to set goals for the number of lectures that they will attend in a semester rather than the grade they will achieve on a course. Advisors could also encourage students to set task-based goals in consultation with course instructors, who have the information necessary to advise students on which tasks will likely be most productive (e.g., reviewing lecture notes versus studying the course textbook).

The most direct way to incorporate task-based goal setting into the college environment would be for instructors to design courses that promote task-based goal setting. In a traditional course format, an instructor could encourage students to set goals for particular tasks by devoting lecture time or a section of the syllabus to a discussion of study strategies. In a course that required students to complete certain tasks online (e.g., homework assignments or class discussion), the opportunity to set goals could be built into the technology used to deliver these course components (similarly to the way that we built goal setting into the surveys that preceded the online practice exams that students completed as part of the course that we studied). In a fully online course, it would be especially easy to incorporate task-based goal setting into the technology used to deliver course content. For example, students could be invited to set goals for the number of end-of-module questions they will answer correctly before progressing to the next module.

This discussion suggests that task-based goal setting could easily be incorporated into the college learning environment. Coupled with our analysis, this suggests that task-based goal setting is a low-cost, scaleable and feasible intervention that could improve college outcomes. This is a promising finding, and it suggests several lines of interesting future research. First, it would be interesting to conduct similar experiments in other types of college. For example, our subjects (who attend a four-year college) are likely more able than two-year college students (e.g., as reflected in SAT scores). If they also possess more self-control than these two-year college students, then goal setting might be even more effective at two-year colleges. Second, assuming that our findings generalize across settings, it would be interesting to examine the effects of self-set goals for other tasks such as attending class, contributing to online discussions or working

[43]The ASAP have received a lot of attention for their large effects on student retention (Scrivener et al., 2015).

[44]For example, the online resources provided by the "Teaching Center" in the college that provides the course that we study advise students to set goals that are Specific, Measurable, Attainable, Realistic and Timely (SMART). There is no mention of whether goals should be performance- or task-based.

through textbook chapters. This type of research could uncover important relationships between task characteristics and the effects of task-based goal-setting. For example, some tasks are public (e.g., attending class, contributing to online discussion) whereas others are private (e.g., working through textbook chapters); it would be useful to discover whether public or private tasks are more responsive to goal setting.[45] A useful byproduct of this type of research is that it can advance our knowledge of the production function for course performance. Specifically, if task-based goal setting increases course performance only through the effects of goal setting on task-specific investments, then assignment to the goals treatment is an instrument that can be used to identify the performance effects of these investments. It would be interesting to compare the causal effects of different task-specific investments, such as attending class, working through lecture notes and completing practice exams.[46]

To summarize, we believe that our study marks an important step toward a better understanding of the role that self-set goals could play in motivating college students to work harder and perform better. Research in psychology and economics provides reason to expect that college students, like other agents in the economy, will lack self-control. Our results break new ground by suggesting that self-set goals can act as an effective commitment device that helps college students to self-regulate behavior and mitigate these self-control problems. Specifically, our empirical findings (supported by our theoretical analysis) suggest that task-based goal setting (but not performance-based goal setting) could be an especially effective method of mitigating self-control problems and thereby improving college performance. Since task-based goal setting could easily be incorporated into the college environment, our findings have important implications for educational practice. As noted above, future research should probe the effects of task-based goal setting in other contexts and for other tasks.

[45] On the one hand, we might expect the costs of failing to meet goals to be larger for public tasks (e.g., if these are more salient to students). On the other hand, these costs may be lower if there is an "anti-nerd" class culture.

[46] There is already a small literature on the performance effects of attending class. For example, Dobkin et al. (2010) and Arulampalam et al. (2012) exploit quasi-experiments to estimate the effects of attendance on college course performance.

## References


**Allan, B.M.** and **Fryer, R.G.** (2011). The power and pitfalls of education incentives. *Policy Paper, Hamilton Project*

**Angrist, J.**, **Lang, D.**, and **Oreopoulos, P.** (2009). Incentives and services for college achievement: Evidence from a randomized trial. *American Economic Journal: Applied Economics*, 1(1): 136–163

**Angrist, J.**, **Oreopoulos, P.**, and **Williams, T.** (2014). When opportunity knocks, who answers? New evidence on college achievement awards. *Journal of Human Resources*, 49(3): 572–610

**Ariely, D.** and **Wertenbroch, K.** (2002). Procrastination, deadlines, and performance: Self-control by precommitment. *Psychological Science*, 13(3): 219–224

**Arulampalam, W.**, **Naylor, R.A.**, and **Smith, J.** (2012). Am I missing something? The effects of absence from class on student performance. *Economics of Education Review*, 31(4): 363–375

**Ashraf, N.**, **Karlan, D.**, and **Yin, W.** (2006). Tying Odysseus to the mast: Evidence from a commitment savings product in the Philippines. *Quarterly Journal of Economics*, 121(2): 635–672

**Augenblick, N.**, **Niederle, M.**, and **Sprenger, C.** (2015). Working over time: Dynamic inconsistency in real effort tasks. *Quarterly Journal of Economics*, 130(3): 1067–1115

**Barron, K.E.** and **Harackiewicz, J.M.** (2003). Revisiting the benefits of performance-approach goals in the college classroom: Exploring the role of goals in advanced college courses. *International Journal of Educational Research*, 39(4): 357–374

**Barrow, L.**, **Richburg-Hayes, L.**, **Rouse, C.E.**, and **Brock, T.** (2014). Paying for performance: The education impacts of a community college scholarship program for low-income adults. *Journal of Labor Economics*, 32(3): 563–599

**Bauer, M.** and **Chytilová, J.** (2013). Women, children and patience: Experimental evidence from Indian villages. *Review of Development Economics*, 17(4): 662–675

**Bell, D.E.** (1985). Disappointment in decision making under uncertainty. *Operations Research*, 33(1): 1–27

**Brunnermeier, M.K.** and **Parker, J.A.** (2005). Optimal expectations. *American Economic Review*, 95(4): 1092–1118

**Bryan, G.**, **Karlan, D.**, and **Nelson, S.** (2010). Commitment devices. *Annual Review of Economics*, 2(1): 671–698

**Buechel, B.**, **Mechtenberg, L.**, and **Petersen, J.** (2014). Peer effects and students' self-control. *SFB 649 Discussion Paper 2014-024, Humboldt University*

**Camerer, C.** and **Lovallo, D.** (1999). Overconfidence and excess entry: An experimental approach. *American Economic Review*, 89(1): 306–318

**Cameron, J.** and **Pierce, W.D.** (1994). Reinforcement, reward, and intrinsic motivation: A meta-analysis. *Review of Educational research*, 64(3): 363–423

**Castleman, B.L.** (2014). The impact of partial and full merit scholarships on college entry and success: Evidence from the Florida Bright Futures Scholarship program. *EdPolicyWorks Working Paper, University of Virginia*

**Cha, P.** and **Patel, R.** (2010). Rewarding progress, reducing debt: Early results from Ohio's performance-based scholarship demonstration for low-income parents. *Technical Report, MDRC*

**Chase, J.A.**, **Houmanfar, R.**, **Hayes, S.C.**, **Ward, T.A.**, **Vilardaga, J.P.**, and **Follette, V.** (2013). Values are not just goals: Online ACT-based values training adds to goal setting in improving undergraduate college student performance. *Journal of Contextual Behavioral Science*, 2(3): 79–84

**Choi, J.J.**, **Haisley, E.**, **Kurkoski, J.**, and **Massey, C.** (2016). Small cues change savings choices. *Mimeo, Yale University*

**Church, M.A.**, **Elliot, A.J.**, and **Gable, S.L.** (2001). Perceptions of classroom environment, achievement goals, and achievement outcomes. *Journal of Educational Psychology*, 93(1): 43–54

**Cohodes, S.R.** and **Goodman, J.S.** (2014). Merit aid, college quality, and college completion: Massachusetts' Adams scholarship as an in-kind subsidy. *American Economic Journal: Applied Economics*, 6(4): 251–285

**Corgnet, B.**, **Gómez-Miñambres, J.**, and **Hernán-Gonzalez, R.** (2015). Goal setting and monetary incentives: When large stakes are not enough. *Management Science*, 61(12): 2926–2944

**Cornwell, C.M.**, **Lee, K.H.**, and **Mustard, D.B.** (2005). Student responses to merit scholarship retention rules. *Journal of Human Resources*, 40(4): 895–917

**Darnon, C.**, **Butera, F.**, **Mugny, G.**, **Quiamzade, A.**, and **Hulleman, C.S.** (2009). Too complex for me! Why do performance-approach and performance-avoidance goals predict exam performance? *European Journal of Psychology of Education*, 24(4): 423–434

**De Paola, M.**, **Scoppa, V.**, and **Nisticò, R.** (2012). Monetary incentives and student achievement in a depressed labor market: Results from a randomized experiment. *Journal of Human Capital*, 6(1): 56–85

**DellaVigna, S.D.** and **Malmendier, U.** (2006). Paying not to go to the gym. *American Economic Review*, 96(3): 694–719

**Dhami, S.** (2016). *The Foundations of Behavioral Economic Analysis*. Oxford: Oxford University Press

**Diamond, P.** and **Kőszegi, B.** (2003). Quasi-hyperbolic discounting and retirement. *Journal of Public Economics*, 87(9): 1839–1872

**Dobkin, C.**, **Gil, R.**, and **Marion, J.** (2010). Skipping class in college and exam performance: Evidence from a regression discontinuity classroom experiment. *Economics of Education Review*, 29(4): 566–575

**Duckworth, A.L.**, **Quinn, P.D.**, and **Tsukayama, E.** (2012). What No Child Left Behind leaves behind: The roles of IQ and self-control in predicting standardized achievement test scores and report card grades. *Journal of Educational Psychology*, 104(2): 439–451

**Duckworth, A.L.** and **Seligman, M.E.** (2005). Self-discipline outdoes IQ in predicting academic performance of adolescents. *Psychological Science*, 16(12): 939–944

**Duckworth, A.L.**, **Shulman, E.P.**, **Mastronarde, A.J.**, **Patrick, S.D.**, **Zhang, J.**, and **Druckman, J.** (2015). Will not want: Self-control rather than motivation explains the female advantage in report card grades. *Learning and Individual Differences*, 39: 13–23

**Dynarski, S.** (2008). Building the stock of college-educated labor. *Journal of Human Resources*, 43(3): 576–610

**Elliot, A.J.** and **McGregor, H.A.** (2001). A 2× 2 achievement goal framework. *Journal of Personality and Social Psychology*, 80(3): 501–519

**Fang, H.** and **Silverman, D.** (2009). Time-inconsistency and welfare program participation: Evidence from the NLSY. *International Economic Review*, 50(4): 1043–1077

**Firpo, S.**, **Fortin, N.M.**, and **Lemieux, T.** (2009). Unconditional quantile regressions. *Econometrica*, 77(3): 953–973

**Fryer, R.G.** (2011). Financial incentives and student achievement: Evidence from randomized trials. *Quarterly Journal of Economics*, 126(4): 1755–1798

**Fryer, R.G.** (2013). Information and student achievement: Evidence from a cellular phone experiment. *Working Paper 19113, NBER*

**Genesove, D.** and **Mayer, C.** (2001). Loss aversion and seller behavior: Evidence from the housing market. *Quarterly Journal of Economics*, 116(4): 1233–1260

**Gill, D.** and **Prowse, V.** (2012). A structural analysis of disappointment aversion in a real effort competition. *American Economic Review*, 102(1): 469–503

**Gill, D.** and **Stone, R.** (2010). Fairness and desert in tournaments. *Games and Economic Behavior*, 69(2): 346–364

**Giné, X.**, **Goldberg, J.**, **Silverman, D.**, and **Yang, D.** (forthcoming). Revising commitments: Field evidence on the adjustment of prior choices. *Economic Journal*

**Gneezy, U.**, **Meier, S.**, and **Rey-Biel, P.** (2011). When and why incentives (don't) work to modify behavior. *Journal of Economic Perspectives*, 25(4): 191–209

**Goerg, S.J.** (2015). Goal setting and worker motivation. *IZA World of Labor*, 178: 1–10

**Goerg, S.J.** and **Kube, S.** (2012). Goals (th) at work–goals, monetary incentives, and workers'f performance. *Preprint 2012/19, Max Planck Institute for Research on Collective Goods*

**Gossner, O.** and **Steiner, J.** (2016). Optimal illusion of control and related perception biases. *Discussion Paper 11478, CEPR*

**Griffee, D.T.** and **Templin, S.A.** (1997). Goal setting affects task performance. In *Proceedings of the JALT 1997 International Conference on Language Teaching and Learning*, 21–26

**Gruber, J.** and **Kőszegi, B.** (2001). Is addiction rational? Tprdicheory and evidence. *Quarterly Journal of Economics*, 116(4): 1261–1303

**Harackiewicz, J.M.**, **Barron, K.E.**, **Carter, S.M.**, **Lehto, A.T.**, and **Elliot, A.J.** (1997). Predictors and consequences of achievement goals in the college classroom: Maintaining interest and making the grade. *Journal of Personality and Social Psychology*, 73(6): 1284–1295

**Harding, M.** and **Hsiaw, A.** (2014). Goal setting and energy conservation. *Journal of Economic Behavior & Organization*, 107: 209–227

**Harrison, G.W.**, **Lau, M.I.**, and **Rutström, E.E.** (2005). Dynamic consistency in Denmark: A longitudinal field experiment. *Economics Working Paper 05-02, University of Central Florida*

**Heath, C.**, **Larrick, R.P.**, and **Wu, G.** (1999). Goals as reference points. *Cognitive Psychology*, 38(1): 79–109

**Henry, G.T.**, **Rubenstein, R.**, and **Bugler, D.T.** (2004). Is HOPE enough? Impacts of receiving and losing merit-based financial aid. *Educational Policy*, 18(5): 686–709

**Hsiaw, A.** (2013). Goal-setting and self-control. *Journal of Economic Theory*, 148(2): 601–626

**Hsiaw, A.** (2016). Goal bracketing and self-control. *Mimeo, Brandeis University*

**Hsieh, P.**, **Sullivan, J.R.**, and **Guerra, N.S.** (2007). A closer look at college students: Self-efficacy and goal orientation. *Journal of Advanced Academics*, 18(3): 454–476

**Jain, S.** (2009). Self-control and optimal goals: A theoretical analysis. *Marketing Science*, 28(6): 1027–1045

**Johnson, D.D.** and **Fowler, J.H.** (2011). The evolution of overconfidence. *Nature*, 477(7364): 317–320

**Kahneman, D.**, **Knetsch, J.L.**, and **Thaler, R.H.** (1990). Experimental tests of the endowment effect and the Coase theorem. *Journal of Political Economy*, 98(6): 1325–1348

**Kahneman, D.** and **Tversky, A.** (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47(2): 263–291

**Kőszegi, B.** and **Rabin, M.** (2006). A model of reference-dependent preferences. *Quarterly Journal of Economics*, 121(4): 1133–1165

**Khwaja, A.**, **Silverman, D.**, and **Sloan, F.** (2007). Time preference, time discounting, and smoking decisions. *Journal of Health Economics*, 26(5): 927–949

**Koch, A.K.** and **Nafziger, J.** (2011). Self-regulation through goal setting. *Scandinavian Journal of Economics*, 113(1): 212–227

**Koch, A.K.** and **Nafziger, J.** (2016). Goals and bracketing under mental accounting. *Journal of Economic Theory*, 162: 305–351

**Laibson, D.** (1997). Golden eggs and hyperbolic discounting. *Quarterly Journal of Economics*, 112(2): 443–477

**LaPorte, R.E.** and **Nath, R.** (1976). Role of performance goals in prose learning. *Journal of Educational Psychology*, 68(3): 260–264

**Latham, G.P.** and **Brown, T.C.** (2006). The effect of learning vs. outcome goals on self-efficacy, satisfaction and performance in an MBA program. *Applied Psychology*, 55(4): 606–623

**Latham, G.P.** and **Pinder, C.C.** (2005). Work motivation theory and research at the dawn of the twenty-first century. *Annual Review of Psychology*, 56(1): 485–516

**Lavecchia, A.M.**, **Liu, H.**, and **Oreopoulos, P.** (2016). Behavioral economics of education: Progress and possibilities. In E.A. Hanushek, S. Machin, and L. Woessman, editors, *Handbook of the Economics of Education, Vol. 5*, 1–74. North Holland

**Leuven, E.**, **Oosterbeek, H.**, and **Klaauw, B.** (2010). The effect of financial rewards on students' achievement: Evidence from a randomized experiment. *Journal of the European Economic Association*, 8(6): 1243–1265

**Linnenbrink-Garcia, L.**, **Tyson, D.F.**, and **Patall, E.A.** (2008). When are achievement goal orientations beneficial for academic achievement? A closer look at main effects and moderating factors. *Revue Internationale de Psychologie Sociale*, 21(1): 19–70

**Locke, E.A.** (1968). Toward a theory of task motivation and incentives. *Organizational Behavior and Human Performance*, 3(2): 157–189

**Locke, E.A.** and **Latham, G.P.** (2002). Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. *American Psychologist*, 57(9): 705–717

**Locke, E.A.**, **Shaw, K.N.**, **Saari, L.M.**, and **Latham, G.P.** (1981). Goal setting and task performance: 1969–1980. *Psychological Bulletin*, 90(1): 125–152

**McLeish, K.N.** and **Oxoby, R.J.** (2007). Gender, affect and intertemporal consistency: An experimental approach. *Discussion Paper 2663, IZA*

**Meier, S.** and **Sprenger, C.** (2010). Present-biased preferences and credit card borrowing. *American Economic Journal: Applied Economics*, 2(1): 193–210

**Mento, A.J.**, **Steel, R.P.**, and **Karren, R.J.** (1987). A meta-analytic study of the effects of goal setting on task performance: 1966–1984. *Organizational Behavior and Human Decision Processes*, 39(1): 52–83

**Miller, C.**, **Binder, M.**, **Harris, V.**, and **Krause, K.** (2011). Staying on track: Early findings from a performance-based scholarship program at the university of New Mexico. *Technical Report, MDRC*

**Morgan, M.** (1987). Self-monitoring and goal setting in private study. *Contemporary Educational Psychology*, 12(1): 1–6

**Morisano, D.**, **Hirsh, J.B.**, **Peterson, J.B.**, **Pihl, R.O.**, and **Shore, B.M.** (2010). Setting, elaborating, and reflecting on personal goals improves academic performance. *Journal of Applied Psychology*, 95(2): 255–264

**Park, Y.J.** and **Santos-Pinto, L.** (2010). Overconfidence in tournaments: Evidence from the field. *Theory and Decision*, 69(1): 143–166

**Patel, R.** and **Rudd, T.** (2012). Can scholarships alone help students succeed? Lessons from two New York City community colleges. *Technical Report, MDRC*

**Patterson, R.W.** (2016). Can behavioral tools improve online student outcomes? Experimental evidence from a massive open online course. *Mimeo, United States Military Academy at West Point*

**Pollak, R.A.** (1968). Consistent planning. *Review of Economic Studies*, 35(2): 201–208

**Prince, J.T.** and **Shawhan, D.L.** (2011). Is time inconsistency primarily a male problem? *Applied Economics Letters*, 18(6): 501–504

**Rabin, M.** (2000). Risk aversion and expected-utility theory: A calibration theorem. *Econometrica*, 68(5): 1281–1292

**Romer, D.** (1993). Do students go to class? Should they? *Journal of Economic Perspectives*, 7(3): 167–174

**Schunk, D.H.** (1983). Developing children's self-efficacy and skills: The roles of social comparative information and goal setting. *Contemporary Educational Psychology*, 8(1): 76–86

**Schunk, D.H.** (1984). Enhancing self-efficacy and achievement through rewards and goals: Motivational and informational effects. *Journal of Educational Research*, 78(1): 29–34

**Schunk, D.H.** (1996). Goal and self-evaluative influences during children's cognitive skill learning. *American Educational Research Journal*, 33(2): 359–382

**Schunk, D.H.** and **Ertmer, P.A.** (1999). Self-regulatory processes during computer skill acquisition: Goal and self-evaluative influences. *Journal of Educational Psychology*, 91(2): 251–260

**Schunk, D.H.** and **Rice, J.M.** (1991). Learning goals and progress feedback during reading comprehension instruction. *Journal of Literacy Research*, 23(3): 351–364

**Schunk, D.H.** and **Swartz, C.W.** (1993). Goals and progress feedback: Effects on self-efficacy and writing achievement. *Contemporary Educational Psychology*, 18(3): 337–354

**Scott-Clayton, J.** (2011). On money and motivation: A quasi-experimental analysis of financial incentives for college achievement. *Journal of Human Resources*, 46(3): 614–646

**Scrivener, S.**, **Weiss, M.J.**, **Ratledge, A.**, **Rudd, T.**, **Sommo, C.**, and **Fresques, H.** (2015). Doubling graduation rates: Three-year effects of CUNY's Accelerated Study in Associate Programs (ASAP) for developmental education students. *Technical Report, MDRC*

**Shih, S.S.** and **Alexander, J.M.** (2000). Interacting effects of goal setting and self- or other-referenced feedback on children's development of self-efficacy and cognitive skill within the Taiwanese classroom. *Journal of Educational Psychology*, 92(3): 536–543

**Smithers, S.** (2015). Goals, motivation and gender. *Economics Letters*, 131: 75–77

**Strotz, R.H.** (1956). Myopia and inconsistency in dynamic utility maximization. *Review of Economic Studies*, 23(3): 165–180

**Suvorov, A.** and **Van de Ven, J.** (2008). Goal setting as a self-regulation mechanism. *Working Paper 122, CEFIR NES*

**Tanaka, T.**, **Camerer, C.F.**, and **Nguyen, Q.** (2010). Risk and time preferences: Linking experimental and household survey data from Vietnam. *American Economic Review*, 100(1): 557–571

**Thaler, R.H.** and **Benartzi, S.** (2004). Save more tomorrow$^{TM}$: Using behavioral economics to increase employee saving. *Journal of Political Economy*, 112(S1): S164–S187

**Weinstein, N.D.** (1980). Unrealistic optimism about future life events. *Journal of Personality and Social Psychology*, 39(5): 806–820

**Wertenbroch, K.** (1998). Consumption self-control by rationing purchase quantities of virtue and vice. *Marketing Science*, 17(4): 317–337

**Wu, G.**, **Heath, C.**, and **Larrick, R.** (2008). A prospect theory model of goal behavior. *Mimeo, University of Chicago*

**Zimmerman, B.J.** and **Bandura, A.** (1994). Impact of self-regulatory influences on writing course attainment. *American Educational Research Journal*, 31(4): 845–862

# Supplementary Web Appendix

(Intended for Online Publication)

# Supplementary Web Appendix I Tables

| | Mean value | | Treatment-Control difference | | |
|---|---|---|---|---|---|
| | Treatment group | Control group | Difference | S.E. | $p$-value |
| Age | 0.005 | -0.005 | 0.010 | 0.032 | 0.764 |
| Male | 0.477 | 0.455 | 0.022 | 0.016 | 0.171 |
| Black | 0.064 | 0.051 | 0.012 | 0.007 | 0.091 |
| Non-Hispanic white | 0.604 | 0.619 | -0.015 | 0.015 | 0.328 |
| Hispanic | 0.193 | 0.192 | 0.000 | 0.013 | 0.984 |
| Asian | 0.102 | 0.092 | 0.009 | 0.009 | 0.328 |
| SAT score | 0.001 | -0.001 | 0.002 | 0.032 | 0.945 |
| High school GPA | -0.016 | 0.016 | -0.032 | 0.032 | 0.320 |
| Advanced placement credit | 0.759 | 0.756 | 0.003 | 0.014 | 0.800 |
| Fall semester | 0.620 | 0.607 | 0.012 | 0.015 | 0.435 |
| First login time | -0.004 | 0.004 | -0.007 | 0.032 | 0.820 |

Notes: The Treatment and Control groups contain 1,979 and 1,992 students respectively. Information about age, gender, race, SAT scores, high school GPA and advanced placement credit was obtained from the university's Registrar data. Age is measured on the first of the month in which the semester began and is rounded down to the nearest whole month. The variable SAT score is the sum of the student's scores on the verbal, analytic and numerical components of the primary aptitude test in the Registrar data (these are SAT scores for the majority of students). Advanced placement credit is an indicator for the student having entered the university with advanced placement credit. Fall semester is an indicator for the student having participated in the course in the Fall semester. First login time is the elapsed time between when the first email invitation to take the syllabus quiz was sent and when the student first logged into the course webpage. Each of the non-binary characteristics (age, SAT score, high School GPA and first login time) has been standardized to have a mean of zero and a variance of one within the Fall 2013 and Spring 2014 semesters combined (the performance-based goals experiment) and within the Fall 2014 and Spring 2015 semesters combined (the task-based goals experiment). The standardization of SAT score is stratified to ensure that this variable has the same mean and the same variance among students taking each type of aptitude test. S.E. is the standard error of the difference between the characteristic mean in the Treatment group and the characteristic mean in the Control group and is obtained assuming independent samples with equal variances. $p$-value is the two-sided $p$-value for the null hypothesis that the magnitude of the difference between the characteristic mean in the Treatment group and the characteristic mean in the Control group is zero. The joint significance of the characteristics is tested using a $\chi$-squared test based on the results of a probit regression of an indicator for treatment on an intercept and the eleven characteristics listed in this table: the $p$-value for the joint null hypothesis that none of the eleven characteristics predicts treatment is 0.636.

Table SWA.1: Characteristics of students across all semesters

| | Mean value | | Treatment-Control difference | | |
|---|---|---|---|---|---|
| | Treatment group | Control group | Difference | S.E. | $p$-value |
| Age | 0.007 | -0.007 | 0.014 | 0.045 | 0.761 |
| Male | 0.491 | 0.457 | 0.035 | 0.023 | 0.124 |
| Black | 0.069 | 0.047 | 0.022 | 0.011 | 0.037 |
| Non-Hispanic white | 0.628 | 0.644 | -0.016 | 0.022 | 0.464 |
| Hispanic | 0.175 | 0.175 | 0.000 | 0.017 | 0.999 |
| Asian | 0.094 | 0.085 | 0.009 | 0.013 | 0.482 |
| SAT score | -0.048 | 0.050 | -0.098 | 0.045 | 0.030 |
| High school GPA | -0.044 | 0.045 | -0.089 | 0.045 | 0.049 |
| Advanced placement credit | 0.762 | 0.770 | -0.008 | 0.019 | 0.686 |
| Fall semester | 0.575 | 0.591 | -0.016 | 0.022 | 0.482 |
| First login time | -0.003 | 0.004 | -0.007 | 0.045 | 0.876 |

Notes: The Treatment and Control groups contain 995 and 972 students respectively. The $p$-value for the joint null hypothesis that none of the eleven characteristics predicts treatment is 0.153. Also see the notes to Table SWA.1.

Table SWA.2: Characteristics of students in Fall 2013 & Spring 2014 semesters (performance-based goals experiment)

| | Mean value | | Treatment-Control difference | | |
|---|---|---|---|---|---|
| | Treatment group | Control group | Difference | S.E. | $p$-value |
| Age | 0.003 | -0.003 | 0.005 | 0.045 | 0.903 |
| Male | 0.462 | 0.454 | 0.008 | 0.022 | 0.704 |
| Black | 0.058 | 0.055 | 0.003 | 0.010 | 0.769 |
| Non-Hispanic white | 0.579 | 0.595 | -0.016 | 0.022 | 0.472 |
| Hispanic | 0.210 | 0.209 | 0.002 | 0.018 | 0.932 |
| Asian | 0.109 | 0.099 | 0.010 | 0.014 | 0.476 |
| SAT score | 0.051 | -0.049 | 0.101 | 0.045 | 0.024 |
| High school GPA | 0.013 | -0.012 | 0.025 | 0.045 | 0.579 |
| Advanced placement credit | 0.756 | 0.742 | 0.014 | 0.019 | 0.472 |
| Fall semester | 0.665 | 0.624 | 0.041 | 0.021 | 0.055 |
| First login time | -0.004 | 0.004 | -0.007 | 0.045 | 0.868 |

Notes: The Treatment and Control groups contain 984 and 1,020 students respectively. The $p$-value for the joint null hypothesis that none of the eleven characteristics predicts treatment is 0.471. Also see the notes to Table SWA.1.

Table SWA.3: Characteristics of students in Fall 2014 & Spring 2015 semesters (task-based goals experiment)

| Panel I: All students in the performance-based goals experiment | | | | |
|---|---|---|---|---|
| | Total points score | | Pr(Grade ≥ A–) | Pr(Grade ≥ B+) |
| | OLS | Median | OLS | OLS |
| Effect of asking students to set performance-based goals | -0.237 | -0.360 | -0.020 | -0.022 |
| | (0.458) | (0.494) | (0.022) | (0.023) |
| | [0.605] | [0.466] | [0.360] | [0.339] |
| Effect / (SD in Control group) | -0.022 | -0.034 | -0.041 | -0.043 |
| Mean of dependent variable in Control group | 83.220 | 83.220 | 0.389 | 0.498 |
| Observations | 1,967 | 1,967 | 1,967 | 1,967 |

| Panel II: Male students in the performance-based goals experiment | | | | |
|---|---|---|---|---|
| | Total points score | | Pr(Grade ≥ A–) | Pr(Grade ≥ B+) |
| | OLS | Median | OLS | OLS |
| Effect of asking students to set performance-based goals | -0.223 | 0.041 | -0.015 | 0.002 |
| | (0.672) | (0.665) | (0.032) | (0.033) |
| | [0.740] | [0.951] | [0.649] | [0.951] |
| Effect / (SD in Control group) | -0.021 | 0.004 | -0.030 | 0.004 |
| Mean of dependent variable in Control group | 83.644 | 83.644 | 0.403 | 0.511 |
| Observations | 933 | 933 | 933 | 933 |

| Panel III: Female students in the performance-based goals experiment | | | | |
|---|---|---|---|---|
| | Total points score | | Pr(Grade ≥ A–) | Pr(Grade ≥ B+) |
| | OLS | Median | OLS | OLS |
| Effect of asking students to set performance-based goals | -0.304 | -0.810 | -0.027 | -0.046 |
| | (0.625) | (0.689) | (0.030) | (0.031) |
| | [0.626] | [0.240] | [0.365] | [0.138] |
| Effect / (SD in Control group) | -0.029 | -0.076 | -0.056 | -0.092 |
| Mean of dependent variable in Control group | 82.864 | 82.864 | 0.377 | 0.487 |
| Observations | 1,034 | 1,034 | 1,034 | 1,034 |

Notes: The regressions are the same as those reported in Table 3, except that we no longer include controls for student characteristics. Heteroskedasticity-consistent standard errors are shown in round brackets and two-sided $p$-values are shown in square brackets. $^{*}$, $^{**}$ and $^{***}$ denote, respectively, significance at the 10%, 5% and 1% levels (two-sided tests).

Table SWA.4: Effects of performance-based goals on student performance without controls for student characteristics

| Panel I: All students in the task-based goals experiment | | | | |
|---|---|---|---|---|
| | Total points score | | Pr(Grade ≥ A–) | Pr(Grade ≥ B+) |
| | OLS | Median | OLS | OLS |
| Effect of asking students to set task-based goals | 0.743 | 0.924* | 0.042* | 0.043* |
| | (0.474) | (0.475) | (0.022) | (0.022) |
| | [0.117] | [0.052] | [0.057] | [0.052] |
| Effect / (SD in Control group) | 0.068 | 0.085 | 0.086 | 0.087 |
| Mean of dependent variable in Control group | 83.111 | 83.111 | 0.393 | 0.493 |
| Observations | 2,004 | 2,004 | 2,004 | 2,004 |

| Panel II: Male students in the task-based goals experiment | | | | |
|---|---|---|---|---|
| | Total points score | | Pr(Grade ≥ A–) | Pr(Grade ≥ B+) |
| | OLS | Median | OLS | OLS |
| Effect of asking students to set task-based goals | 1.581** | 1.700** | 0.093*** | 0.058* |
| | (0.706) | (0.674) | (0.033) | (0.033) |
| | [0.025] | [0.012] | [0.005] | [0.078] |
| Effect / (SD in Control group) | 0.141 | 0.151 | 0.189 | 0.115 |
| Mean of dependent variable in Control group | 83.285 | 83.285 | 0.417 | 0.529 |
| Observations | 918 | 918 | 918 | 918 |

| Panel III: Female students in the task-based goals experiment | | | | |
|---|---|---|---|---|
| | Total points score | | Pr(Grade ≥ A–) | Pr(Grade ≥ B+) |
| | OLS | Median | OLS | OLS |
| Effect of asking students to set task-based goals | 0.017 | 0.471 | -0.003 | 0.030 |
| | (0.637) | (0.652) | (0.029) | (0.030) |
| | [0.979] | [0.470] | [0.921] | [0.320] |
| Effect / (SD in Control group) | 0.002 | 0.045 | -0.006 | 0.060 |
| Mean of dependent variable in Control group | 82.966 | 82.966 | 0.373 | 0.463 |
| Observations | 1,086 | 1,086 | 1,086 | 1,086 |

Notes: The regressions are the same as those reported in Table 6, except that we no longer include controls for student characteristics. Heteroskedasticity-consistent standard errors are shown in round brackets and two-sided $p$-values are shown in square brackets. *, ** and *** denote, respectively, significance at the 10%, 5% and 1% levels (two-sided tests).

Table SWA.5: Effects of task-based goals on student performance without controls for student characteristics

## Supplementary Web Appendix II   Figures

| Component | Points available | Points scored | Answer key |
|---|---|---|---|
| Syllabus Quiz | 2 | 2 | N/A |
| Start-Of-Course Survey | 2 | 2 | N/A |
| Quiz 1 | 3 | 2 | Answer Key |
| Quiz 2 | 3 | 3 | Answer Key |
| Quiz 3 | 3 | 2 | Answer Key |
| Quiz 4 | 3 | 2 | Answer Key |
| Quiz 5 | 3 | | |
| Quiz 6 | 3 | | |
| Quiz 7 | 3 | | |
| Quiz 8 | 3 | | |
| Quiz 9 | 3 | | |
| Quiz 10 | 3 | | |
| | | | |
| Best Midterm | 30 | | |
| Midterm 1 | | | |
| Midterm 2 | | | |
| | | | |
| Final Exam | 34 | | |
| | | | |
| End-Of-Course-Survey | 2 | | |
| | | | |
| **Total Points** | **100** | **13** | |

**Grade Key**

| Total Points Scored (out of 100) | Letter Grade |
|---|---|
| 91 and above | A |
| 90 to 88 | A- |
| 87 to 86 | B+ |
| 85 to 81 | B |
| 80 to 78 | B- |
| 77 to 76 | C+ |
| 75 to 70 | C |
| 69 to 66 | D |
| 65 and below | E |

Figure SWA.1: Example gradecard for a student in the Control group (Fall 2013 semester)

**Consent Form for Cornell University Research Team Study on Course Performance**

Before you start the survey, I want to tell you about a "Cornell University Research Team" that is conducting research to evaluate which factors contribute to good performance on this course.

Research Method

The team will use:
- Survey responses.
- Grades from this course.
- Information held by the [University name] registrar (e.g., admissions data, demographic information).

Confidentiality

- All the information will be made anonymous.
- This means that your name will never be seen by the Cornell University Research Team and will not be associated with the findings.

What you will be asked to do in this study

Nothing.

Risks

There are no risks to you.

Right to withdraw from the study

You have the right to withdraw from the study at any time during the semester. If you withdraw there will be no consequences for you; your academic standing, record, or relationship with the university will not be affected. Details of how to withdraw are available from the course webpage.

Who to contact if you have questions about the study:

Cornell Research Team: [curt@cornell.edu]
Full contact details are available from the course webpage.

Who to contact about your rights as a participant in this study:

Cornell Institutional Review Board, Ithaca NY. Email: irbhp@cornell.edu, phone: 607-255-5138; website: www.irb.cornell.edu. Concerns/complaints can also be anonymously reported through Ethicspoint (web: www.hotline.cornell.edu, phone (toll-free): 1-866-293-3077). Full contact details are available from the course webpage.

**The Cornell University Research Team would be very grateful if you'd be willing to consent to your data being used in this study.** Remember that your name will never be seen by the Research Team and there is nothing you need to do. (If you choose not to consent, you will still receive [1%][2%] towards your score for this course from completing the survey).

Yes, I consent | No, I don't consent

Figure SWA.2: Consent form

Please set a goal for your grade in this course.

Think carefully before setting your goal.

The professor and the TA will not see your goal. However, each time you get your quiz, midterm and final scores back, your gradecard will remind you of your goal.

**My goal for this course is:**

- ⊙ A
- ⊙ A−
- ⊙ B+
- ⊙ B
- ⊙ B−
- ⊙ C+
- ⊙ C
- ⊙ D
- ⊙ E
- ⊙ Prefer not to say

Figure SWA.3: Fall 2013 semester goal-setting question in start-of-course survey

Please set a goal for your score in the [Midterm 1][Midterm 2][Final] Exam.

Think carefully before setting your goal.

The professor and the TA will not see your goal. However, each time you get your quiz, midterm and final exam scores back, your gradecard will remind you of your goal.

My goal for my score in the [Midterm 1][Midterm 2][Final] Exam is:

[ ] out of [30][30][34]

⊙ Prefer not to say

Figure SWA.4: Spring 2014 semester goal-setting question in mid-course surveys

**The goal that you set for this course is:** $\boxed{\text{X}}$

(You set your goal in the start-of-course survey)

| Component | Points available | Points scored | Answer key |
|---|---|---|---|
| Syllabus Quiz | 2 | 2 | N/A |
| Start-Of-Course Survey | 2 | 2 | N/A |
| Quiz 1 | 3 | 2 | Answer Key |
| Quiz 2 | 3 | 3 | Answer Key |
| Quiz 3 | 3 | 2 | Answer Key |
| ... | ... | ... | ... |

Figure SWA.5: Fall 2013 semester goal reminder on gradecard

| Component | Points available | Points scored | Answer key |
|---|---|---|---|
| ...<br>...<br>... | ...<br>...<br>... | ...<br>...<br>... | ...<br>...<br>... |
| Best Midterm | 30 | 24 | |
| Midterm 1 | | 22 | **Your goal(*): X** |
| Midterm 2 | | 24 | **Your goal(*): Y** |
| | | | |
| Final Exam | 34 | | **Your goal(*): Z** |
| | | | |
| End-Of-Course-Survey | 1 | | |
| | | | |
| **Total Points** | **100** | **41** | |

* You set this goal as part of a Mid-Course Survey

**Grade Key**

| Total Points Scored (out of 100) | Letter Grade |
|---|---|
| 91 and above | A |
| ... | ... |

Figure SWA.6: Spring 2014 semester goal reminder on gradecard

{TREATED AND CONTROL STUDENTS}

Practice Exams

There will be 5 practice exams for the [Midterm 1][Midterm 2][Final] Exam. Each practice exam will contain the same number of questions as the [Midterm 1][Midterm 2][Final] Exam.

The practice exams for the [Midterm 1][Midterm 2][Final] Exam will become active when Mid-Course Survey [1][2][3] closes. You will receive a reminder email at that time.

{TREATED STUDENTS ONLY}

Question 6

Please set a goal for the number of practice exams that you will complete out of the 5 practice exams for the [Midterm 1][Midterm 2][Final] Exam.

Think carefully before setting your goal.

The professor and the TA will not see your goal. However, when you take the practice exams you will be reminded of your goal.

My goal is to complete

☐ out of the 5 practice exams for the [Midterm 1][Midterm 2][Final] Exam

⊙ Prefer not to say

Figure SWA.7: Fall 2014 & Spring 2015 semesters practice exams information and goal-setting question in mid-course surveys

Dear Econ2023 Students,

The 5 practice exams for the [Midterm 1][Midterm 2][Final] Exam are now active.

{TREATED STUDENTS ONLY} Your goal is to complete X out of the 5 practice exams (you set this goal as part of Mid-Course Survey [1][2][3]).

To go to the practice exams, please go to the course webpage and follow the link.

Note that you will not receive any further reminders about the practice exams for the [Midterm 1][Midterm 2][Final] Exam and the practice exams will close when the [Midterm 1][Midterm 2][Final] Exam begins.

This is an automated email from the ECO 2023 system.

Figure SWA.8: Fall 2014 & Spring 2015 semesters practice exams reminder email

Practice Exams for the [Midterm 1][Midterm 2][Final] Exam

You have completed X out of the 5 practice exams for the [Midterm 1][Midterm 2][Final] Exam

{TREATED STUDENTS ONLY} **Your goal is to complete Z out of the 5 practice exams** (you set this goal as part of Mid-course Survey [1][2][3]).

Instructions:

- To take one of the practice exams, click on the link below.
- You can only take each practice exam once.
- There is no time limit.
- After answering each question, you will be given the correct answer.
- **This will be your only opportunity to see the correct answer.**
- You will not be able to go back to previous questions.

Practice Exam X+1

Figure SWA.9: Fall 2014 & Spring 2015 semesters practice exams introductory screen

Practice Exam X for the [Midterm 1][Midterm 2][Final] Exam

Your score was **Y** out of [30][30][34]

You have now completed X out of the 5 practice exams for the
[Midterm 1][Midterm 2][Final] Exam

{TREATED STUDENTS ONLY} **Your goal is to complete Z out of the 5 practice exams**
(you set this goal as part of Mid-course Survey [1][2][3]).

Return To Practice Exams Screen

Figure SWA.10: Fall 2014 & Spring 2015 semesters practice exams feedback screen

# Supplementary Web Appendix III  Formal results and proofs

## Supplementary Web Appendix III.1  Proofs for Section 4.2.1

**Proof of Remark 1.**

In the absence of a goal, the student-actor's utility and the student-planner's utility are given by, respectively:

$$\begin{aligned} u_{act}(e) &= \beta\delta f(e) - C(e) & (10)\\ &= \beta\delta e - \frac{ce^2}{2}; & (11)\\ u_{plan}(e) &= \beta\delta^2 f(e) - \beta\delta C(e) & (12)\\ &= \beta\delta^2 e - \beta\delta\frac{ce^2}{2}. & (13) \end{aligned}$$

Both utilities are strictly concave since $c > 0$. Straigthforward maximization then gives the result. ■

**Proof of Proposition 1.**

Using (2), on the range $e \in [0, g]$:

$$\begin{aligned} \frac{\partial u_{act}}{\partial e} &= \beta\delta(1 + l) - ce; & (14)\\ \frac{\partial^2 u_{act}}{\partial e^2} &= -c < 0; \quad \text{and so} & (15)\\ e^* &= \min\{\bar{e}, g\}. & (16) \end{aligned}$$

Using (2), on the range $e \in [g, \infty)$:

$$\begin{aligned} \frac{\partial u_{act}}{\partial e} &= \beta\delta - ce; & (17)\\ \frac{\partial^2 u_{act}}{\partial e^2} &= -c < 0; \quad \text{and so} & (18)\\ e^* &= \max\{\underline{e}, g\}. & (19) \end{aligned}$$

(i) When $g \leq \underline{e}$, on the range $e \in [0, g]$, $e^* = g$, and on the range $e \in [g, \infty)$, $e^* = \underline{e}$. Thus, on the range $e \in [0, \infty)$, $e^* = \underline{e}$.

(ii) When $g \in [\underline{e}, \bar{e}]$, on the range $e \in [0, g]$, $e^* = g$, and on the range $e \in [g, \infty)$, $e^* = g$. Thus, on the range $e \in [0, \infty)$, $e^* = g$.

(iii) When $g \geq \bar{e}$, on the range $e \in [0, g]$, $e^* = \bar{e}$, and on the range $e \in [g, \infty)$, $e^* = g$. Thus, on the range $e \in [0, \infty)$, $e^* = \bar{e}$. ■

**Proof of Proposition 2.**

On the range $g \in [0, \underline{e}]$, $e^*(g) = \underline{e}$ from Proposition 1, and so $\partial e^*/\partial g = 0$ and $\max\{g - e^*(g), 0\} = 0$. Using (4), $du_{plan}/dg = 0$ and so any $g \in [0, \underline{e}]$ is optimal (including $\underline{e}$).

On the range $g \in [\underline{e}, \bar{e}]$, $e^*(g) = g$ from Proposition 1, and so $\partial e^*/\partial g = 1$ and

$\max\{g - e^*(g), 0\} = 0$. Using (4), and noting that $\hat{e} > \underline{e}$ and $\overline{e} > \underline{e}$:

$$\frac{du_{plan}}{dg} = \beta\delta^2 - \beta\delta c g; \tag{20}$$

$$\frac{d^2 u_{plan}}{dg^2} = -\beta\delta c < 0; \quad \text{and so} \tag{21}$$

$$g^* = \min\{\hat{e}, \overline{e}\} > \underline{e}. \tag{22}$$

On the range $g \in [\overline{e}, \infty)$, $e^*(g) = \overline{e}$ from Proposition 1, and so $\partial e^*/\partial g = 0$ and $\max\{g - e^*(g), 0\} = g - \overline{e}$. Using (4), $du_{plan}/dg = -\beta\delta^2 l < 0$ and so $g^* = \overline{e}$.

Stitching the ranges together gives $g^* = \min\{\hat{e}, \overline{e}\} > \underline{e}$. Parts (ii) and (iii) follow, given that $\overline{e} < \hat{e} \Leftrightarrow \beta(1 + l) < 1$. Finally, (iv) follows immediately from Proposition 1. ■

## Supplementary Web Appendix III.2 Results and proofs for Section 4.2.2

### Remark SWA.1

*In the absence of a goal the student exhibits time inconsistency:*
*(i) The student-actor chooses effort* $\underline{a} = \beta\delta\theta/\kappa$.
*(ii) The student-planner would like the student-actor to exert effort* $\hat{a} = \delta\theta/\kappa > \underline{a}$.

### Proof of Remark SWA.1.

In the absence of a goal, the student-actor's utility and the student-planner's utility are given by, respectively:

$$\begin{aligned} u_{act}(a) &= \beta\delta f(a) - C(a) && (23)\\ &= \beta\delta\theta a - \frac{\kappa a^2}{2}; && (24)\\ u_{plan}(a) &= \beta\delta^2 f(a) - \beta\delta C(a) && (25)\\ &= \beta\delta^2\theta a - \beta\delta\frac{\kappa a^2}{2}. && (26) \end{aligned}$$

Both utilities are strictly concave since $\kappa > 0$. Straigthforward maximization then gives the result. ■

### Proposition SWA.1

*Let* $\overline{a} = (\beta\delta\theta + \lambda)/\kappa$ *and recall from Remark SWA.1 that* $\underline{a} = \beta\delta\theta/\kappa < \overline{a}$ *denotes the student-actor's effort in the absence of a goal.*
*(i) When* $g \le \underline{a}$, *the student-actor exerts effort* $a^* = \underline{a}$.
*(ii) When* $g \in [\underline{a}, \overline{a}]$, *the student-actor exerts effort* $a^* = g$.
*(iii) When* $g \ge \overline{a}$, *the student-actor exerts effort* $a^* = \overline{a}$.

### Proof of Proposition SWA.1.

Using (6), on the range $a \in [0, g]$:

$$\begin{aligned} \frac{\partial u_{act}}{\partial a} &= \beta\delta\theta + \lambda - \kappa a; && (27)\\ \frac{\partial^2 u_{act}}{\partial a^2} &= -\kappa < 0; \quad \text{and so} && (28)\\ a^* &= \min\{\overline{a}, g\}. && (29) \end{aligned}$$

Using (6), on the range $a \in [g, \infty)$:

$$\begin{aligned} \frac{\partial u_{act}}{\partial a} &= \beta\delta\theta - \kappa a; && (30)\\ \frac{\partial^2 u_{act}}{\partial a^2} &= -\kappa < 0; \quad \text{and so} && (31)\\ a^* &= \max\{\underline{a}, g\}. && (32) \end{aligned}$$

(i) When $g \le \underline{a}$, on the range $a \in [0, g]$, $a^* = g$, and on the range $a \in [g, \infty)$, $a^* = \underline{a}$. Thus, on the range $a \in [0, \infty)$, $a^* = \underline{a}$.

(ii) When $g \in [\underline{a}, \overline{a}]$, on the range $a \in [0, g]$, $a^* = g$, and on the range $a \in [g, \infty)$, $a^* = g$. Thus, on the range $a \in [0, \infty)$, $a^* = g$.

(iii) When $g \geq \overline{a}$, on the range $a \in [0, g]$, $a^* = \overline{a}$, and on the range $a \in [g, \infty)$, $a^* = g$. Thus, on the range $a \in [0, \infty)$, $a^* = \overline{a}$. ■

**Proposition SWA.2**

*Recall from Remark SWA.1 that $\underline{a} = \beta\delta\theta/\kappa$ and $\hat{a} = \delta\theta/\kappa$ denote, respectively, student-actor effort and student-planner desired effort in the absence of a goal.*

*Recall from Proposition SWA.1 that $\overline{a} = (\beta\delta\theta + \lambda)/\kappa$ denotes maximal student-actor effort in the presence of a goal.*

*(i) The optimal choice of goal for the student-planner is given by $g^* = \min\{\hat{a}, \overline{a}\}$.*

*(ii) When $\beta\delta\theta + \lambda < \delta\theta$, $g^* = \overline{a}$.*

*(iii) When $\beta\delta\theta + \lambda \geq \delta\theta$, $g^* = \hat{a}$.*

*(iv) Effort of the student-actor $a^* = g^* > \underline{a}$, and so the student-actor works harder than in the absence of goal.*

**Proof of Proposition SWA.2.**

On the range $g \in [0, \underline{a}]$, $a^*(g) = \underline{a}$ from Proposition SWA.1, and so $\partial a^*/\partial g = 0$ and $\max\{g - a^*(g), 0\} = 0$. Using (8), $du_{plan}/dg = 0$ and so any $g \in [0, \underline{a}]$ is optimal (including $\underline{a}$).

On the range $g \in [\underline{a}, \overline{a}]$, $a^*(g) = g$ from Proposition SWA.1, and so $\partial a^*/\partial g = 1$ and $\max\{g - a^*(g), 0\} = 0$. Using (8), and noting that $\hat{a} > \underline{a}$ and $\overline{a} > \underline{a}$:

$$\frac{du_{plan}}{dg} = \beta\delta^2\theta - \beta\delta\kappa g; \tag{33}$$

$$\frac{d^2u_{plan}}{dg^2} = -\beta\delta\kappa < 0; \quad \text{and so} \tag{34}$$

$$g^* = \min\{\hat{a}, \overline{a}\} > \underline{a}. \tag{35}$$

On the range $g \in [\overline{a}, \infty)$, $a^*(g) = \overline{a}$ from Proposition SWA.1, and so $\partial a^*/\partial g = 0$ and $\max\{g - a^*(g), 0\} = g - \overline{a}$. Using (8), $du_{plan}/dg = -\beta\delta\lambda < 0$ and so $g^* = \overline{a}$.

Stitching the ranges together gives $g^* = \min\{\hat{a}, \overline{a}\} > \underline{a}$. Parts (ii) and (iii) follow, given that $\overline{a} < \hat{a} \Leftrightarrow \beta\delta\theta + \lambda < \delta\theta$. Finally, (iv) follows immediately from Proposition SWA.1 ■

## Supplementary Web Appendix III.3 Results and proofs for Section 4.3.2

### Supplementary Web Appendix III.3, Part A: Task-based goals

For task-based goals, when we add uncertainty as described in Section 4.3.2 the student-actor's utility (given by (5) and (6) with no uncertainty) and the student-planner's utility (given by (7) and (8) with no uncertainty) become, respectively:

$$Eu_{act}(a|g) = \beta\delta[\pi f(a) + (1-\pi)(0)] - [\lambda \max\{g - z(a), 0\} + C(a)] \tag{36}$$

$$= \beta\delta\pi\theta a - \left[\lambda \max\{g - a, 0\} + \frac{\kappa a^2}{2}\right]; \tag{37}$$

$$Eu_{plan}(g|a^*(g)) = \beta\delta^2[\pi f(a^*(g)) + (1-\pi)(0)] - \beta\delta[\lambda \max\{g - z(a^*(g)), 0\} + C(a^*(g))] \tag{38}$$

$$= \beta\delta^2\pi\theta a^*(g) - \beta\delta\left[\lambda \max\{g - a^*(g), 0\} + \frac{\kappa[a^*(g)]^2}{2}\right]. \tag{39}$$

Comparing (37) and (39) to (6) and (8) without uncertainty, the only difference is that every $\theta$ in the case without uncertainty has been replaced by $\pi\theta$. Since $\theta \in (0,1)$ and $\pi\theta \in (0,1)$, the results for task-based goals without uncertainty described in Supplementary Web Appendix III.2 continue to hold with uncertainty, replacing every $\theta$ with $\pi\theta$.

### Supplementary Web Appendix III.3, Part B: Performance-based goals

For performance-based goals, when we add uncertainty as described in Section 4.3.2 the student-actor's utility (given by (1) and (2) with no uncertainty) and the student-planner's utility (given by (3) and (4) with no uncertainty) become, respectively:

$$Eu_{act}(e|g) = \beta\delta\{\pi[f(e) - l\max\{g - f(e), 0\}] + (1-\pi)[0 - l\max\{g - 0, 0\}]\} - C(e) \tag{40}$$

$$= \beta\delta\{\pi[e - l\max\{g - e, 0\}] - (1-\pi)lg\} - \frac{ce^2}{2}; \tag{41}$$

$$Eu_{plan}(g|e^*(g)) =$$

$$\beta\delta^2\{\pi[f(e^*(g)) - l\max\{g - f(e^*(g)), 0\}] + (1-\pi)[0 - l\max\{g - 0, 0\}]\} - \beta\delta C(e^*(g)) \tag{42}$$

$$= \beta\delta^2\{\pi[e^*(g) - l\max\{g - e^*(g), 0\}] - (1-\pi)lg\} - \beta\delta\frac{c[e^*(g)]^2}{2}. \tag{43}$$

**Remark SWA.2**

*In the absence of a goal the student exhibits time inconsistency:*
*(i) The student-actor chooses effort* $\underline{e} = \beta\delta\pi/c$.
*(ii) The student-planner would like the student-actor to exert effort* $\hat{e} = \delta\pi/c > \underline{e}$.

**Proof of Remark SWA.2.**

In the absence of a goal, the student-actor's utility and the student-planner's utility are given by, respectively:

$$
\begin{aligned}
Eu_{act}(e) &= \beta\delta[\pi f(e) + (1-\pi)(0)] - C(e) && (44)\\
&= \beta\delta\pi e - \frac{ce^2}{2}; && (45)\\
Eu_{plan}(e) &= \beta\delta^2[\pi f(e) + (1-\pi)(0)] - \beta\delta C(e) && (46)\\
&= \beta\delta^2\pi e - \beta\delta\frac{ce^2}{2}. && (47)
\end{aligned}
$$

Both utilities are strictly concave since $c > 0$. Straigthforward maximization then gives the result. ■

**Proposition SWA.3**

*Let $\overline{e} = \beta\delta\pi(1+l)/c$ and recall from Remark SWA.2 that $\underline{e} = \beta\delta\pi/c < \overline{e}$ denotes the student-actor's effort in the absence of a goal.*

*(i) When $g \leq \underline{e}$, the student-actor exerts effort $e^* = \underline{e}$.*

*(ii) When $g \in [\underline{e}, \overline{e}]$, the student-actor exerts effort $e^* = g$.*

*(iii) When $g \geq \overline{e}$, the student-actor exerts effort $e^* = \overline{e}$.*

**Proof of Proposition SWA.3.**

Using (41), on the range $e \in [0, g]$:

$$
\begin{aligned}
\frac{\partial Eu_{act}}{\partial e} &= \beta\delta\pi(1+l) - ce; && (48)\\
\frac{\partial^2 Eu_{act}}{\partial e^2} &= -c < 0; \quad \text{and so} && (49)\\
e^* &= \min\{\overline{e}, g\}. && (50)
\end{aligned}
$$

Using (41), on the range $e \in [g, \infty)$:

$$
\begin{aligned}
\frac{\partial Eu_{act}}{\partial e} &= \beta\delta\pi - ce; && (51)\\
\frac{\partial^2 Eu_{act}}{\partial e^2} &= -c < 0; \quad \text{and so} && (52)\\
e^* &= \max\{\underline{e}, g\}. && (53)
\end{aligned}
$$

(i) When $g \leq \underline{e}$, on the range $e \in [0, g]$, $e^* = g$, and on the range $e \in [g, \infty)$, $e^* = \underline{e}$. Thus, on the range $e \in [0, \infty)$, $e^* = \underline{e}$.

(ii) When $g \in [\underline{e}, \overline{e}]$, on the range $e \in [0, g]$, $e^* = g$, and on the range $e \in [g, \infty)$, $e^* = g$. Thus, on the range $e \in [0, \infty)$, $e^* = g$.

(iii) When $g \geq \overline{e}$, on the range $e \in [0, g]$, $e^* = \overline{e}$, and on the range $e \in [g, \infty)$, $e^* = g$. Thus, on the range $e \in [0, \infty)$, $e^* = \overline{e}$. ■

**Proposition SWA.4**

*Recall from Remark SWA.2 that $\underline{e} = \beta\delta\pi/c$ denotes student-actor effort in the absence of a goal. Recall from Proposition SWA.3 that $\overline{e} = \beta\delta\pi(1+l)/c$ denotes maximal student-actor effort in the presence of a goal.*
*Let $\tilde{e} = [\delta\pi - \delta(1-\pi)l]/c$ and recall from Remark SWA.2 that $\hat{e} = \delta\pi/c > \tilde{e}$ denotes the student-planner's desired effort in the absence of a goal.*
*There exists a $\overline{\pi} \in (0,1)$ such that for all $\pi \in [\overline{\pi}, 1)$:*
*(i) The optimal choice of goal for the student-planner is given by $g^* = \min\{\tilde{e}, \overline{e}\}$.*
*(ii) When $\beta(1+l) + l(1-\pi)/\pi < 1$, $g^* = \overline{e}$.*
*(iii) When $\beta(1+l) + l(1-\pi)/\pi \geq 1$, $g^* = \tilde{e}$.*
*(iv) Effort of the student-actor $e^* = g^* > \underline{e}$, and so the student-actor works harder than in the absence of goal.*

**Proof of Proposition SWA.4.**

On the range $g \in [0, \underline{e}]$, $e^*(g) = \underline{e}$ from Proposition SWA.3, and so $\partial e^*/\partial g = 0$ and $\max\{g - e^*(g), 0\} = 0$. Using (43), $dEu_{plan}/dg = -\beta\delta^2(1-\pi)l < 0$ and so $g^* = 0$. Note also that $\lim_{\pi\to 1}(dEu_{plan}/dg) = 0$, and so:

$$\lim_{\pi\to 1} [Eu_{plan}(g = \underline{e}) - Eu_{plan}(g = 0)] = 0. \tag{54}$$

On the range $g \in [\underline{e}, \overline{e}]$, $e^*(g) = g$ from Proposition SWA.3, and so $\partial e^*/\partial g = 1$ and $\max\{g - e^*(g), 0\} = 0$. Using (43), and noting that $\overline{e} > \underline{e}$:

$$\frac{dEu_{plan}}{dg} = \beta\delta^2[\pi - (1-\pi)l] - \beta\delta c g; \tag{55}$$

$$\frac{d^2Eu_{plan}}{dg^2} = -\beta\delta c < 0; \quad \text{and so} \tag{56}$$

$$g^* = \min\{\max\{\tilde{e}, \underline{e}\}, \overline{e}\}. \tag{57}$$

Note also that $\lim_{\pi\to 1}(\tilde{e} - \underline{e}) > 0$ and $\lim_{\pi\to 1}(\overline{e} - \underline{e}) > 0$. Thus, on the range $g \in [\underline{e}, \overline{e}]$, $g^* = \min\{\tilde{e}, \overline{e}\} > \underline{e}$ for $\pi$ sufficiently close to 1.

When $\pi = 1$, from the proof of Proposition 2, $g^* = \min\{\hat{e}, \overline{e}\}$ gives the student-planner strictly more utility than $g = \underline{e}$. Furthermore, $\lim_{\pi\to 1}(55) = (20)$, $\lim_{\pi\to 1} \tilde{e} = \hat{e}_{|\pi=1}$, $\lim_{\pi\to 1} \overline{e} = \overline{e}_{|\pi=1}$ and $\lim_{\pi\to 1} \underline{e} = \underline{e}_{|\pi=1}$. Thus:

$$\lim_{\pi\to 1} [Eu_{plan}(g = \min\{\tilde{e}, \overline{e}\}) - Eu_{plan}(g = \underline{e})] > 0. \tag{58}$$

On the range $g \in [\overline{e}, \infty)$, $e^*(g) = \overline{e}$ from Proposition SWA.3, and so $\partial e^*/\partial g = 0$ and $\max\{g - e^*(g), 0\} = g - \overline{e}$. Using (43), $dEu_{plan}/dg = -\beta\delta^2 l < 0$ and so $g^* = \overline{e}$.

Stitching the ranges together, and using (54) and (58), there exists a $\overline{\pi} \in (0,1)$ such that $g^* = \min\{\tilde{e}, \overline{e}\} > \underline{e}$ for all $\pi \in [\overline{\pi}, 1)$. Parts (ii) and (iii) follow, given that $\overline{e} < \tilde{e} \Leftrightarrow \beta(1+l) + l(1-\pi)/\pi < 1$. Finally, (iv) follows immediately from Proposition SWA.3. ∎