How Much Deadline Flexibility on Formative Assessments Should We Be Giving to Our Students?

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Abstract

Recent studies have proposed new ways of providing learning experiences and measuring students' achievement of learning goals, grounded on the principles of growth mindset, mastery learning, and specifications grading. In one initiative called "A's for All (as time and interest allow)", students are given the support to achieve the proficiency they want (not necessarily an A) as long as they are willing to put in the time and effort, thus providing students more control over their learning. One mechanism to support proficiency at different paces is to soften some of the assignment deadlines. In this study we investigated two particular flexible deadline policies, in which the summative assessment (exam) dates were kept fixed but the formative assessments deadlines were more flexible. Students were still expected to complete homework and pre-lectures within one week from the starting date for full credit. To add flexibility, in one semester (the *Lenient* schedule) students could submit homework until the end of the semester for 96% credit, and in the other semester (the *Strict* schedule) the 96% credit deadline was moved to the exam date corresponding to the formative assessments. We found that both flexible schedules resulted in fewer students completing the formative assessments. More students completed the homeworks before the exam date in the Strict semester, motivated by the partial credit deadline. Completion of formative assessments before the exams correlated with better performance, even when controlling for student GPA.

1 Introduction

The blended teaching format has been rapidly popularized over the past years, especially during the COVID pandemic time. This form of combining online and in-class instructions provides students with an opportunity to learn how to distribute their time independently [1, 2]. It is important for instructors to understand how online engagement on assignments outside the classroom affects students' overall course performance, so that they can better design course content and establish policies.

Research studies in computer science courses have shown that students who spread their work over more time (instead of cramming before a deadline) [3] or complete their work early [4] achieve better course performance. Nevertheless, academic procrastination (the intentional deferring or delaying of work that needs to be completed [5]) is a significant problem in higher education. Some findings report that 80–95% of college students procrastinate, and that 50% of students procrastinate consistently [6, 7, 8]. Procrastination can be caused by many reasons, such

as a lack of time management skills, too much work in some classes, or simply not having the right incentive to work.

One way to encourage students to stay on track with course content is to provide frequent and strict deadlines for homework or other type of formative assessments, which are often completed asynchronously outside of class time. Check-in dates help students break complex processes into manageable chunks as they plan and progress through course goals, and final deadlines can help them organize and prioritize work and avoid the anxiety of missed work piling up at the end of the term. Moreover, Felker at al. [9] suggest that giving extra credit for completing assignments early can be effective at encouraging students to have better work distribution. However, it is known that strict deadline policies may add to students' stress [10, 11], promote the submission of poor work, and encourage cheating [12, 13].

In contrast with strict deadline policies, self-paced Personalized System of Instruction (PSI) courses allow students to learn the material and take tests at their own pace, but students still need to master each unit of instruction before moving to the next one. This flexibility has logistical challenges (for example, the typical requirement of assigning a grade at the end of the semester) and has been more commonly adopted in distance learning courses [14, 15].

Finding a balance between giving flexible deadlines and decreasing academic procrastination, while promoting good study habits and better learning outcomes, is essential in promoting diversity and equity among students [16]. For example, some student populations may experience fewer barriers to keeping on track with the frequent and strict deadlines than others, such as working college students. Fulton's randomized experiment [17] in an online course for adult learners revealed that students with a more strict and frequent deadline spaced their study episodes to a greater extent when compared to students in a more flexible deadline schedule (end-of-semester submissions), which were positively and significantly related to performance on tests.

In an initiative called "A's for All (as time and interest allow)" [18, 19] instructors are encouraged to provide more flexibility in courses, allowing students to achieve the competency they want, if they are given enough time. Flexible policies can be presented in various forms, but in general, they allow all students in a course some degree of freedom over when they submit assignments, without negative impact on their learning or grades. Consequently, these policies move some of decision-making authority away from the instructor and into the hands of the student.

"Unit synchronization" is an example of a policy framework to promote "A's for All", in which instructors allow students to work at their natural pace within a unit or module (set of topics from a course). For example, students may have soft assignment deadlines within the unit to help with self-regulation, but they have to synchronize at the end of the unit by means of a stricter deadline. This policy empowers students while maintaining enough structure to support their learning and ensuring they do not fall behind too much.

In Miller et all [20], students in a macro-economy class were split into two groups, where the first one required students to complete assignments weekly (rigid deadlines), while the other allowed students to complete the assignments up until the end of the day before each of the three unit exams (flexible deadlines). They observed a higher completion rate for students in the flexible deadline group, and found that assignment completion had a positive effect on exam scores.

Another study in an engineering course compared a group of students with a rigid deadline with another group of students with a semi-self-paced schedule, where students could submit homework assignments at any point without penalty up to an exam date, and they did not find any difference in learning outcomes [21].

The primary goal of this study is to investigate how students' performance in fixed summative assessments is impacted by given deadline flexibility in formative assessments. We want to find out how much control can be given to students without compromising learning outcomes when summative assessments are fixed. Towards this end, we designed a quasi-experimental study over two semesters of the same course, each one with a different deadline schedule for the formative assessments. In the *Lenient* semester, students were able to submit homeworks until the end of the semester. In the *Strict* semester, students were allowed to submit their homeworks until the date of the summative assessment on the same topics. In both semesters the summative assessments (exams) occurred on a fixed schedule. Note that the naming Lenient and Strict is used throughout the paper to distinguish between two types of flexible schedule, where the former is more flexible than the latter. We conducted our studies to explore four research questions:

1. How does students' behavior change with the adoption of a flexible schedule for formative assessments?
2. Do students who significantly postpone the completion of formative assessments perform worse in the summative assessments?
3. Overall, do students perform better in the Lenient semester or the Strict semester?
4. Do students have a preference between Strict and Lenient schedules?

2   Methods

The study was performed on an upper-division required undergraduate computer science course offered at a large public research university. The course followed a flipped format, where students had to complete pre-lecture (PL) assignments (a combination of videos, text, and short checkpoint questions) and corresponding homework (HW) sets every week (the formative assessments). During class time, students worked in teams to complete collaborative learning activities related to the topics they learned asynchronously on the previous week. All course assessments were delivered through an open-source software platform that enables question randomization, unlimited attempts, automated grading process, and instant feedback [22].

One aspect of this online learning platform that facilitates the adoption of flexible deadlines is that it provides an unconstrained question-authoring interface allowing for sophisticated auto-grading of randomized questions. While completing pre-lectures and homework, students are able to get their submissions automatically graded and receive immediate feedback before trying another attempt. The removal of the manual grading task allows course staff to be more lenient with deadlines, since there is no need to coordinate when the grading process starts or finishes. In theory, deadlines could be completely removed when using auto-graded assessments. However, this would eliminate a mechanism for instructors to keep track of students' progress and for students to self-regulate.

In our quasi-experimental design, we adopted a mixture of fixed and flexible deadlines. In both studies, students were expected to:

- complete the in-class group activities during class time, or at most by the end of the day.
- submit homework and pre-lectures within one week of starting date for full credit.
- take six 50-min exams (summative assessments) covering topics from 2–4 pre-lecture and homework sets.

2.1 Summative assessments

To measure mastery of course content in both semesters, students took six exams during the semester (summative assessments), covering topics from 2–4 pre-lecture and homework sets. Combined, these six exams counted towards 35% of the students' grades. Table 1 shows the assessment sets included in each exam (for example, exam 2 covered content from pre-lecture and homework sets 3, 4, 5 and 6)

Exam number	1	2	3	4	5	6
PL + HW sets	1–2	3–6	7–9	10–12	13–15	16–19

Table 1: List of pre-lecture and homework sets that are included in each exam

Each exam was generated from a pool of randomized questions using the same online system adopted for the formative assessments. Students could re-submit answers for partial credit since all questions were auto-graded with immediate feedback.

2.2 Lenient semester

In the Lenient semester students were able to submit the homeworks for 96% credit until the end of the semester, and pre-lectures for 90% credit until the exam date of the same topic. For example, students were able to submit pre-lectures 3,4,5 and 6 for partial credit by the exam 2 date, as shown in Table 1. The higher credit reduction and shorter late period for the pre-lectures was set to encourage students to be prepared for the synchronous group activities during lectures.

All the homeworks combined were worth 25% of a student's grade. Thus a student who submitted all the homeworks by the end of the semester would only have a 1% credit reduction on their final score. Similarly, since pre-lectures counted towards 4% of the student's grade, late submissions by the exam date would have a credit reduction of up to 0.4% on their final score. This Lenient deadline offers an alternative between completely fixed deadlines, and completely flexible ones, where students have the option to take all assessments, including summative, at a time of their choice.

2.3 Strict semester

In the Strict semester, students were able to submit both formative assessments by the exam date corresponding to the same topic, earning 96% credit for late submission of homeworks and 80% for late submission of pre-lectures. A summary of the deadlines for both semesters appears in Table 2. The grade distribution between assessments was the same adopted in the Lenient semester.

	Type	Full credit deadline	Partial credit deadline
Lenient	Pre-lecture	one-week (100%)	exam date (90%)
	Homework	one-week (100%)	end of semester (96%)
Strict	Pre-lecture	one-week (100%)	exam date (80%)
	Homework	one-week (100%)	exam date (96%)

Table 2: Summary of deadline schedules for formative assessments for the Lenient and Strict semesters.

Figure 1 illustrates the schedule choice for both Lenient and Strict semesters. Homework and pre-lecture sets were released twice a week, and each set had full credit deadlines within one week of release date. Students had to take exams every two weeks, corresponding to a set of homeworks and pre-lectures. These exam dates were fixed in both semesters. The partial credit deadline was determined by the exam date in the Strict semester, and by the end of the semester in the Lenient semester.
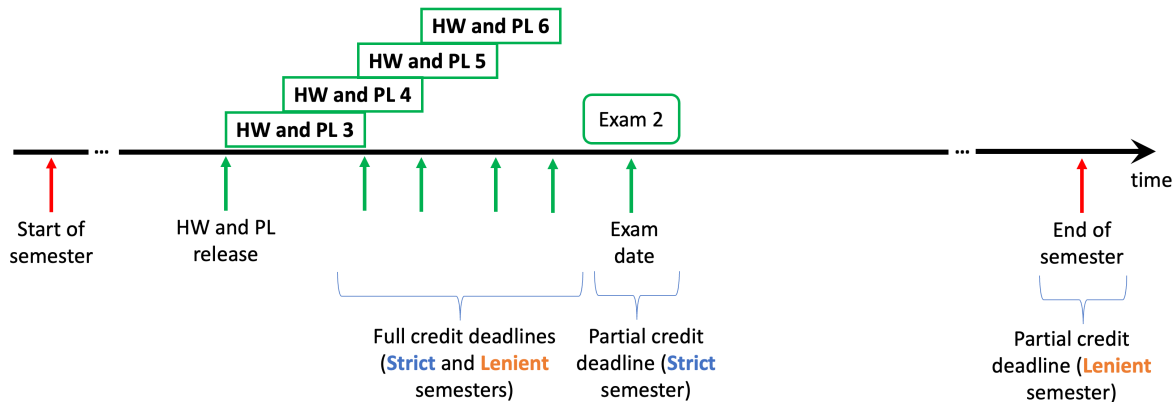

Figure 1: Illustration of the schedule (release dates and deadlines) for the Lenient and Strict semesters, showing homeworks (HW) and pre-lectures (PL) 3–6 and exam 2. The key difference between the semesters was the 96% partial credit deadline for homeworks, which was set to either the exam date (Strict semester) or the end of semester (Lenient semester).

2.4 Exam delivery format

Due to COVID requirements, the two semesters used different proctoring formats: in the Lenient semester, the class was split into two groups that alternated between taking the exams unproctored-online or proctored-online via Zoom; in the Strict semester students took the exams online with in-person proctoring. In one of our recent studies (not yet published), we found that proctored-online and proctored-in-person are similar in security and that unproctored-online are less secure. We will account for this difference in unproctored environments when performing one of the regression analysis below. Moreover, we observed that the mean absolute deviation in average exam scores between the two semesters was 0.64 percentage points (about 0.022 standard deviations) so we do not expect this to make a noticeable difference to any of the results.

3   Results

In this section, we first compare students' behavior regarding completion of formative assessments under the two different deadline schedules. Next, we quantify the impact of postponing completion of formative assessments on summative assessments. Then we conclude by comparing student performance in both semesters.

In the Lenient semester, we included 340 students (22% female) in the study, after filtering to keep only the students that took at least 4 exams and from whom we had access to their incoming GPA. The Strict semester included 422 students (27% female). The average incoming GPAs of students in the Lenient semester (3.7100) and the Strict semester (3.7103) were nearly identical, but we will nonetheless control for per-student GPA in our regressions.

Students were asked to participate in a voluntary research study under IRB approval by submitting an online consent form allowing the use of their anonymized data for research.

3.1   How do flexible deadlines impact students' behavior?

We say that a student completed a formative assessment if they achieved a score of 80% or higher. Since students have unlimited attempts to get 100% in formative assessments, the 80% threshold can be achieved by all students that put enough effort towards completing the assessment. Figure 2 shows the histograms of homework completion rates for students in both semesters. Each bar represents the number of students that completed a given number of homeworks. There were a total of 19 homeworks in each semester, thus the 20 bars represent students completing from 0 to 19 of them. Taking into account that the two lowest homework scores were dropped from the overall grade calculation, we say that a student *completed all homeworks* when a student completed 17 or more.

By the full credit deadline, the number of homeworks completed by the students was similar in both Strict and Lenient semesters (Fig. 2a). Only 22% of the students completed all assignments by the full credit deadline in the Lenient semester, and 25% in the Strict semester. We summarize the percentage of students who completed the homeworks by the different deadlines in Table 3.

	Fraction of students completing all homeworks by:		
	full credit deadline	exam date	end of semester
Lenient semester	22%	49%	67%
Strict semester	25%	71%	71%

Table 3: Fraction of students who completed all homeworks by the full credit deadline, the exam date (96% partial credit deadline for the Strict semester) and end of the semester (96% partial credit deadline for the Lenient semester).

Figure 2b shows that a larger set of students completed most of the homewoks by the exam date in the Strict semester, compared to the Lenient semester. In fact, 49% of the students completed all assignments by the exam date in the Lenient schedule, in contrast with 71% of the students in the Strict schedule. This difference in students' behavior was motivated by the 96% deadline
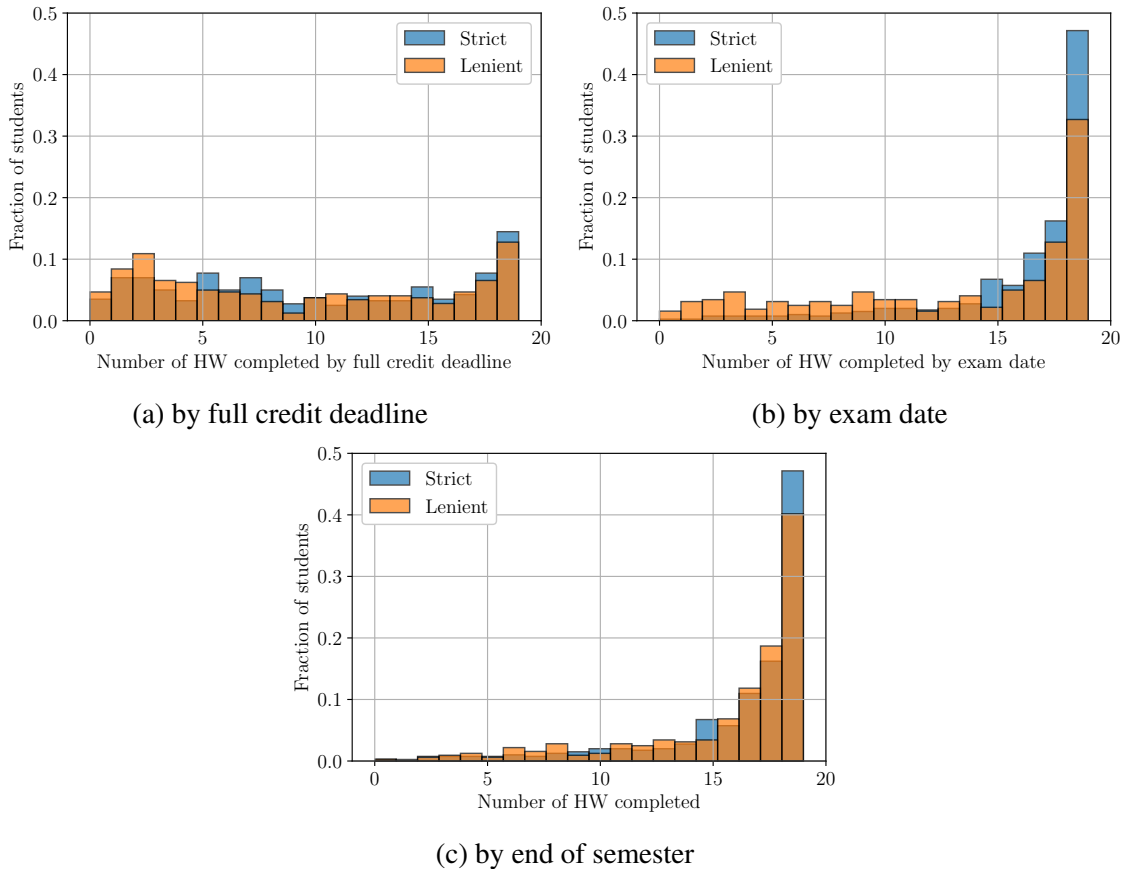
Figure 2: Homework completion rate for Lenient and Strict semesters by the different due dates. The 96% partial credit late deadline is the exam date in the Strict semester, and the end of the semester in the Lenient semester.

shift, which was moved from the end of the semester (Lenient) to the exam date (Strict). Overall, we found that the full credit deadline was not sufficient to motivate the majority of the students to complete the assignments in a timely manner. However, the existence of frequent summative assessments served as self-regulators to students who utilized the homework assignments as learning material to prepare for the exams. Note that this self-regulation existed even in the absence of an explicit deadline in the Lenient semester, but was greatly enhanced in the Strict semester by the additional deadline.

Completion rates by the end of the semester were similar, as illustrated in Fig. 2c, with 67% of students completing all homeworks by the end of the Lenient semester versus 71% in the Strict semester. Note that the histograms for the Strict semester in Figs. 2b and 2c are almost identical, since students cannot increase their scores after the exam date deadline. In the Lenient semester, 18% of students still completed their homeworks past their corresponding exams, to earn more points towards the final grade.

Similar behavior was observed for pre-lecture completion: a small percent of the students completed the pre-lectures before the full credit deadline, and that percent was increased by the exam date, in this case also motivated by the explicit reduced credit deadline in both

semesters.

3.2 Does postponing formative assessments impact summative assessment scores?

Our first finding indicates that, given the flexibility, most students will work on the formative assessments at their own pace and only 50% of them will complete the assessments by the exam date corresponding to each unit. In this section, we propose a model to quantify the impact of this procrastination on students' grades in summative assessments. We only use data from the Lenient semester for this analysis because it had substantially more procrastination behavior.

Figure 3 illustrates a positive correlation between the number of completed formative assessments and the exam average. Figures 3a and 3b shows the correlation between exam average and number of completed homeworks by the full credit deadline and exam date, respectively, indicating that completion by the exam date is a stronger predictor of higher exam scores. Figures 3c and 3d shows the correlation between exam average and number of completed pre-lectures by the full credit deadline and exam date, respectively. Note that in this case, the exam date is also the partial credit deadline for pre-lectures, which results in a much larger fraction of the students completing the assignment by this deadline (82% compared to 42% by the full credit deadline). Similarly, we observe that completion by the exam date is a stronger predictor of higher exam scores.

We propose a model to determine the score advantage on exam performance based on completion of formative assessments by the two different deadlines. For each exam, we fitted an ordinary least squares (OLS) model of the form

$$s_{ij} = \mu_j + \beta_1 H_i + \beta_2 \bar{H}_{ij} + \beta_3 \bar{\bar{H}}_i + \gamma_1 L_i + \gamma_2 \bar{L}_{ij} + \gamma_3 \bar{\bar{L}}_i + \beta \, \mathrm{GPA_i}, \tag{1}$$

where s_{ij} is the score that student i received in exam j, ranging from 0 to 100; $\mathrm{GPA_i}$ is the GPA for student i, taking values between 0 to 4; H_i or L_i is 1 if the student i completed all the homeworks or pre-lectures, respectively, before the full credit deadline and 0 otherwise; $\bar{H}_{ij}$ or $\bar{L}_{ij}$ is 1 if the student i completed all the homework sets or pre-lectures corresponding to exam j before the exam date and 0 otherwise; $\bar{\bar{H}}_i$ or $\bar{\bar{L}}_i$ is 1 if the student i completed all the homework sets or pre-lectures before the end of the semester and 0 otherwise. Note that if a student completed all the homeworks by the full credit deadline ($H_i = 1$), they necessarily also completed all the homeworks by the exam date and the end of the semester ($\bar{H}_{ij} = \bar{\bar{H}}_i = 1$ for all j); similarly if they completed all the homeworks by the exam date, they necessarily also completed all the homeworks by the end of the semester. We want to estimate the parameters μ_j, β, β_1, β_2, β_3, γ_1, γ_2 and γ_3 which can be interpreted as:

- μ_j: the difficulty of exam j
- β_1: the score advantage corresponding to completion of all homeworks by the full credit deadline
- β_2: the score advantage corresponding to completion of all homeworks by the exam
- β_3: the score advantage corresponding to completion of all homeworks by the end of the semester
- γ_1: the score advantage corresponding to completion of all pre-lectures by the full credit deadline
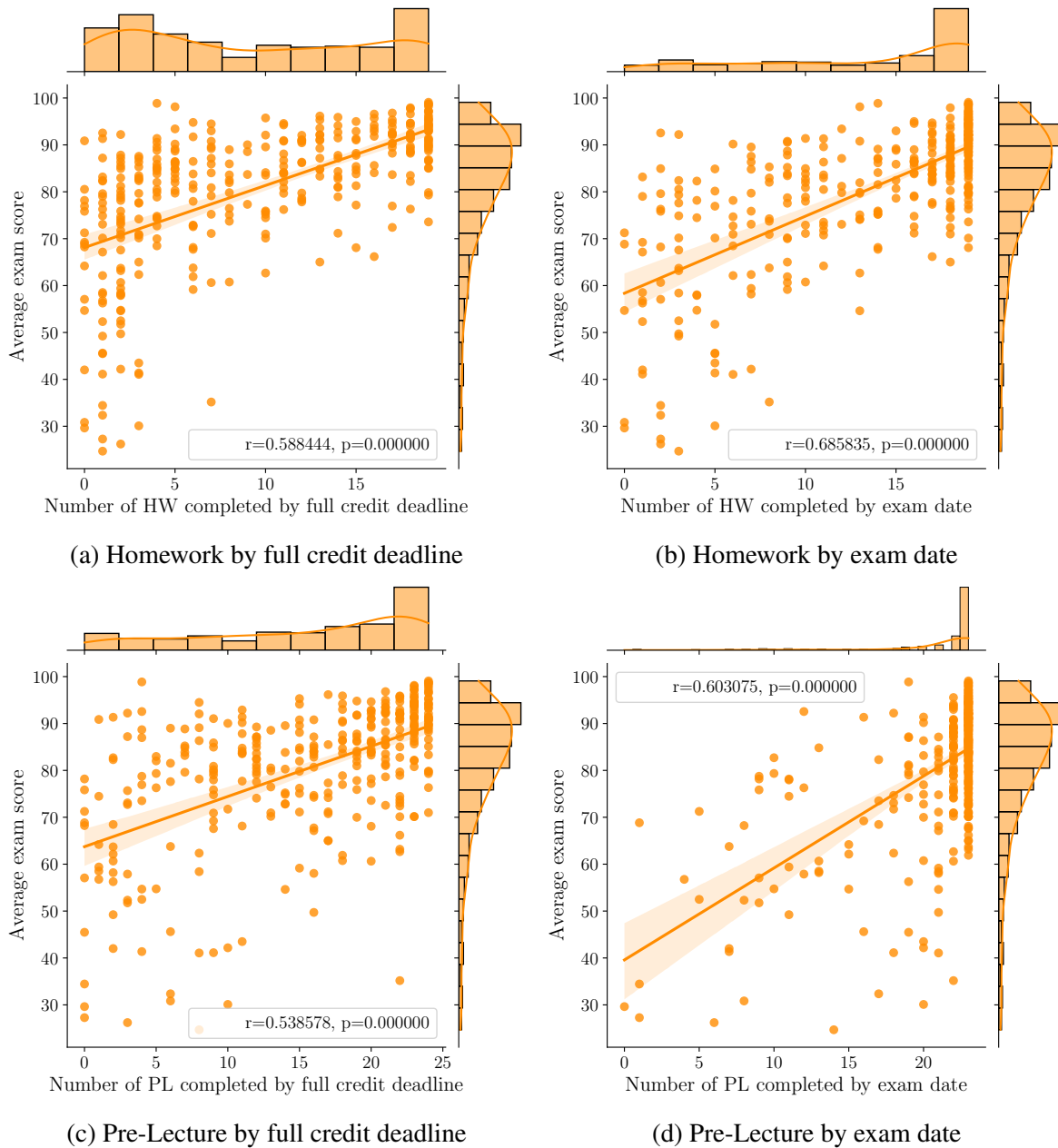
Figure 3: Lenient semester data: number of formative assessments (homework and pre-lecture) completed by each student at two different deadlines (full credit and exam date) versus average exam score. Each data point represents one student.

- γ_2: the score advantage corresponding to completion of all pre-lectures by the exam
- γ_3: the score advantage corresponding to completion of all pre-lectures by the end of the semester
- β: the ability of student i

Table 4 summarizes the results from the regression analysis using Equation 1. The effect sizes were computed by repeating the same regression analysis from Equation 1 using standardized

z-scores for the quiz grades and GPA.

Coefficient	Description (score advantage for ...)	Value	p	95% CI	Effect size
β_1	homework by full credit deadline	3.6	0.001	[1.55, 5.64]	0.1888
β_2	homework by exam date	6.04	<0.001	[4.09, 8]	0.2864
β_3	homework by end of semester	6.76	<0.001	[4.79, 8.73]	0.3543
γ_1	pre-lecture by full credit deadline	-0.99	0.3	[-2.85, 0.87]	-0.0457
γ_2	pre-lecture by exam date	7.57	<0.001	[5.16, 9.97]	0.3729
γ_3	pre-lecture by end of semester	7.22	<0.001	[4.58, 9.86]	0.3966
β	student ability	10.09	<0.001	[8.28, 11.89]	0.2197

Table 4: Coefficients from Equation 1

The baseline students for the model in Eq. 1 are the ones who did not complete all the homeworks and pre-lectures by the end of the semester. Students who completed the homeworks before the end of the semester received on average a 6.76 percentage point advantage in their exam scores after controlling for GPA, when compared to the baseline students. Students who completed the homeworks by the exam date received on average an *additional* 6.04 percentage point advantage in their exam score. An average 3.6 percentage point advantage was *further* added when the homeworks were completed by the full credit deadline, for a total of 16.2 percentage point advantage in the exam score, the equivalent of 5.5 percentage points on the overall course grade (over half a letter grade).

Similarly, completing the pre-lectures by the end of the semester gave students on average a 7.22 percentage point advantage in their exam scores when compared to the baseline students. An average 7.57 percentage point advantage was *further* added when the pre-lectures were completed by the exam date (in this case an explicit deadline). There was no significant advantage from completing pre-lectures by the full credit deadline. Thus overall, students who completed the pre-lectures before the exam date had on average a 15 percentage point advantage in their exams when compared to the baseline students, equivalent to almost a half letter grade for the entire course.

Students who complete formative assessments ...	average score advantage on exams (percentage points)
do not complete	0 (baseline)
by the end of the semester	14
by exam date	27.6
within one week	31.2

Table 5: Average score advantage for completing formative assessments by different times during the semester.

Table 5 shows the average percentage point advantage for completing formative assessments before the end of semester, exam date, and within one week. For students who complete the formative assessments by the exam date, the average of a 27.6 percentage point advantage corresponds to a full letter grade benefit in the overall course grade when compared to the

baseline students. Moreover, we note only a very small additional advantage is gained when completing the formative assessments within one week. These results suggest that completing formative assessments before the exams can strongly boost exam performance, and that requiring students to complete all assessments within a short deadline may be unnecessary.

3.3 Do students perform better overall in the Lenient or Strict semesters?

The regression model in Section 3.2 shows that, within the Lenient semester, students who complete more assignments before the exams get higher exam scores on average. The analysis in Section 3.1 indicates that a higher percent of the students in the Strict semester complete the formative assessments by the exam date. But these are largely correlational findings. The more important question is whether students perform better overall in the Strict semester when compared to the Lenient semester?

We propose another model to compare exam performances between the Lenient and the Strict semesters. Instead of using the full exam score for each student, we only used the exam questions that appeared in both semesters (155 total questions over the 6 exams). Not every student received all the questions, since the exams were randomly created out of a pool of questions. Thus the regression model becomes:

$$q_{ij} = \mu_j + \alpha_1 S_i + \alpha_2 U_{ij} + \beta \, \text{GPA}_i \tag{2}$$

where q_{ij} is the score that student i received in question j, ranging from 0 to 100; GPA_i is the GPA for student i, taking values between 0 to 4; S_i is 1 if the student i was in the Strict semester and 0 otherwise; $\bar{U}_{ij}$ is 1 if the student i received question j during an unproctored exam and 0 if the question appeared in a proctored environment. We want to estimate the parameters μ_j, β, α_1, α_2 which can be interpreted as:

- μ_j: the coefficient corresponding to the difficulty of question j
- α_1: the score advantage from taking the course with the Strict schedule
- α_2: the score advantage from taking the exam unproctored
- β: the coefficient corresponding to the ability of student i

The regression results are depicted in Table 6. Students in the Strict semester had on average a 1.1 percentage point advantage when compared to students in the Lenient semester, after controlling for the the impact of the unproctored environment and students' incoming GPA.

Coefficient	Description (score advantage for ...)	Value	p	95% CI	Effect size
α_1	being in the Strict semester	1.083	0.01	[0.26, 1.91]	0.026
α_2	taking exam unproctored	1.42	0.007	[0.38, 2.47]	0.034
β	student ability	21.06	<0.001	[20, 22]	0.17

Table 6: Coefficients from equation 2

We also investigated the impact of the deadline schedule on overall performance, by fitting the following regression model:

$$F_i = \alpha_1 S_i + \beta \, \text{GPA}_i + \xi, \tag{3}$$

where F_i is the course final weighted score for student i, ranging from 0 to 100; GPA_i is the GPA for student i, taking values between 0 to 4; S_i is 1 if the student i was in the Strict semester and 0 otherwise and ξ is the intercept. Note that in this case, F_i includes exams, homeworks, pre-lectures, in-class activities and final exam scores, thus a combination of scores that are not directly impacted by the deadline schedule or exam proctoring format. The linear regression results indicate that students following the Strict schedule had on average a 1.7 percentage point advantage (p = 0.018 and 95% CI [0.296,3.085]) on their final course grade (effect size of 0.1358), when compared to students following the Lenient schedule.

3.4 Do students prefer Strict or Lenient schedules?

In an anonymous survey at the end of the Strict semester, students were asked to provide feedback regarding the flexible deadline, by selecting their preferred policy:

A) 96% credit available until the end of the semester (policy adopted in the Lenient semester)
B) 96% credit available until the exam date, and 50% until the end of the semester (policy adopted in the Strict semester)
C) 80% credit available for one additional week past the one-week deadline
D) no built-in late deadline, but students can request extensions for valid reasons (sickness, family emergency, etc)

The response rate for the survey was 84%. Of those students responding, 58% preferred the Strict schedule policy (option A) compared to 27% of the students who preferred the Lenient schedule policy (option B). Only 8% would like a stricter schedule with one-fixed additional week to complete the assignments (option C), while the remaining 7% preferred no built-in flexibility (option D).

4 Limitations

The data from this study was collected in one Computer Science course at a highly-selective research university in the United States. It will be important to investigate the extent to which the results generalize to other settings. For example, project-based courses with specific milestones at pre-determined times would be an interesting comparison.

The adoption of flexible deadlines for this study was enabled largely by the online learning platform that allows questions to be autograded with immediate feedback. Unfortunately, some courses are still not able to completely eliminate manual grading with the current available technologies (for example, questions where students are expected to provide explanation of concepts or derive mathematical proofs). However, recent research work [23] that proposes language models to auto-grade text questions may enable a wider number of instructors to adopt flexible deadlines in their courses.

Another limitation is that our analysis compares data from two different semesters, and thus randomization was not used when setting up the two study groups. To account for the difference in the student populations, we included students' GPA in all regression analyses. Moreover, our two semesters had somewhat different exam proctoring settings, which may have impacted the results despite our efforts to control for this in the regression.

Finally, this study only investigated the impact of lenient schedules for formative assessments. It would be interesting to also consider the impact of relaxing the schedule for summative assessments.

5 Conclusions

In this paper, we performed a quasi-experimental study to measure the impact of two different flexible deadline schedules on exam performances. We kept the dates of the 6 bi-weekly exams fixed, following the framework of Unit synchronization, but allowed students to submit formative assessments later with a small credit reduction. We compared two formative assessment schedules: a Strict schedule where homeworks must be completed by the corresponding exam date to receive most of the credit, and a Lenient schedule where homeworks could be completed any time until the end of semester for most of the credit. Our results helped us answer three research questions:

RQ1. How does students' behavior change with the adoption of a flexible schedule for formative assessments? Our study indicated that students' study behavior in completing homeworks and pre-lectures in a flipped course is highly impacted by the schedule flexibility, with more students completing homeworks by the exam date in the Strict semester (71% versus 49%). We further observed that the small 4% credit reduction between the full and partial credit deadlines did not prevent the majority of the students (over 70% of the class) from missing the full credit deadline in both Lenient and Strict semesters.

This likely resulted from a combination of students' still-developing executive function skills and the courses's procrastination-friendly environment. Students could easily be distracted or attracted to things they thought have a higher priority, leading to them not finishing the assignments they were supposed to [24]. However, half of the students completed the formative assessments by the exam dates even without the presence of an explicit deadline (50% in the Lenient semester), showing that frequent testing can function as a mechanism for self-regulation.

RQ2. Do students who significantly postpone the completion of formative assessments perform worse in the summative assessments? Using data from the Lenient semester, when there was no explicit deadline by the exam dates, the regression model showed that students who finished formative assignments before the exam date did significantly better (by 32 percentage points) on the exams than students who did not. This result supports the framework of "Unit synchronization" as a viable policy towards achieving "A's for All", empowering students to attain their learning goals in semi-self-paced mode, while maintaining enough structure to allow instructors to submit grades by the end of the semester.

RQ3. Overall, do students perform better in the Lenient semester or the Strict semester? Regression models comparing both semesters showed a small but statistically significant advantage for students in the Strict semester, in both exam scores (1.1 percentage points) and final course grades (1.7 percentage points).

RQ4. Do students have a preference between Strict and Lenient schedules? Our survey results indicated that most students strongly preferred the Strict schedule over the Lenient schedule (58% versus 27%).

In summary, our study shows that students perform substantially better when they complete formative assessments before the corresponding summative assessments and that deadline policies that reward this behavior both result in better student outcomes and are preferred by students. We also found that students who completed formative assessments even more promptly (within one week, well before the corresponding exam date) received a much smaller, although statistically significant, advantage in exam scores. Based on the results from this study and earlier literature, we believe that the complete removal of deadlines can be detrimental to a large group of students, who need additional help with time management skills. However, it is possible to add flexible deadlines to formative assessments if other deadlines are imposed to make sure students keep up with the pace of the course, especially when instructors are not able to move the dates of summative assessments. This provides students with more control over their time and priorities, while still making sure they do not fall too far behind. When adopting the *Strict* deadlines, we found that students think the policies are "encouraging and motivating for learning", despite the fact they do not receive full credit when submitting an assignment late.

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