AC 2012-3724: EFFECTS OF AN EARLY HOMEWORK COMPLETION BONUS

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Effects of an Early Homework Completion Bonus

Introduction

The freshman engineering program at the University of Tennessee consists of two 4 hour courses, Physics for Engineers I and II.   The content of these courses is an introduction to engineering physics (approximately the first 20-25 chapters of an introductory engineering physics textbook), and an introduction to elements of successful engineering practice (teamwork, engineering design, and communication). The courses use a customized web-based homework system (Schleter and Bennett, 2006). This system provides individualized homework (Goulet, 2010); each student has the same problem but different parameters. Some of the features of the online homework are that each homework has a direct link to a discussion board, students can save notes for the staff to see when assisting the student through the discussion board, and students can upload images through scans, picture texts, or a sketching utility (Schleter and Bennett, 2011). All homeworks have multiple parts, and answers for each part can be submitted separately. Each part has a 2% penalty for each incorrect answer submitted. In addition, students can earn partial credit for late homework: homework completed after the due date but before the end of the module would earn 75% credit; homework completed after the module but before the end of the semester would earn 50% credit. The basis for this policy is that just because a student did not complete the homework on time does not mean the material is not important, and if they are able to eventually master the material, some credit will awarded.

Schilling (2010) suggested that a bonus be given for early homework completion. The analogy was made to a construction project, where there are late penalties, but also bonuses for early completion. Following this suggestion, a 10% bonus for homework completed more than 24 hours before the due date was implemented halfway through the 2010 fall semester, and has been used since then. The late policy was also changed so that there was not a step-function at the due date, but rather the penalty decreased linearly from 0% to 25% over the first 48 hours after the homework was due. The penalty remained at 25% through the module, and then dropped to 50% after the module. Homework credit vs. time is shown graphically in Figure 1.

Our basis for implementing the early homework completion bonus was an examination of when students worked on their homework. We have a lecture on a topic, a recitation the next day, and previously had the homework due two days after the recitation. The thinking was that students could work on their homework after the lecture and recitation, and if they had questions there was still another recitation where they could ask questions before the homework was due. In reality, almost all students waited less than 12 hours before the homework was due to complete it. Therefore, several years ago the due date was moved up to midnight of the day of the recitation on the subject. This was also when we added in the partial credit for late homework, so students still had the opportunity to get many of the points if they were indeed stuck on one of the homework questions.
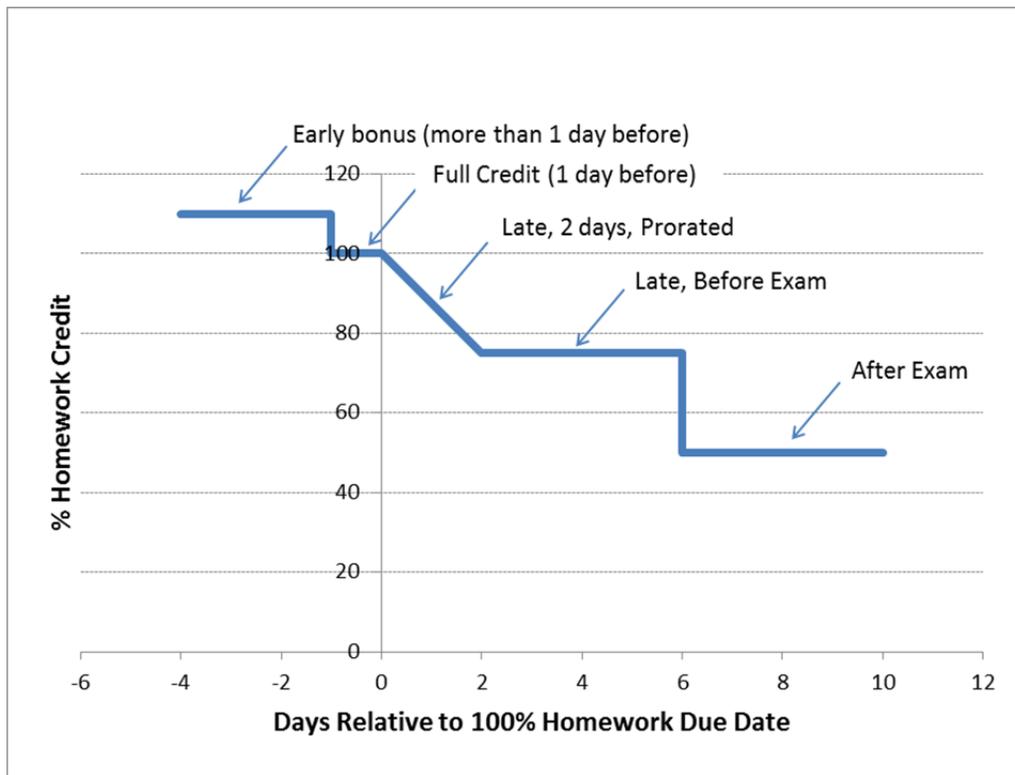
FIGURE 1. Homework Credit vs. Time (per problem)

Even with an earlier due date, most of the homework was still being completed in the 6-8 hours before the midnight due date. We wanted students to at least look at the homework before recitation, and be aware of what was being asked. We felt this would increase their engagement in the recitation if they knew the problems they were going to have to work. Therefore, the bonus was implemented primarily as an encouragement to at least look at the homework before recitation. The paper examines the effect the early homework bonus has had on the class.

Effects of Early Homework Bonus

Homework Completion

The effect of the early homework bonus on homework completion was examined in several different ways for the Fall 2011 semester. Figure 2 examines the correct answers and when they were obtained. The data labels are 110 for the bonus time, 100 for after the bonus but still full credit time, p75 for the 2 days after the homework is due and the credit is prorated to 75, 75 for more than 2 days after the full credit time but before the end of the module, and 50 for after the module but before the end of the semester. Most of the homework that is being completed is being completed during the bonus time. It is also interesting that almost 10% of the homework is being done late, and students are still working on the homework even after the module has been completed.
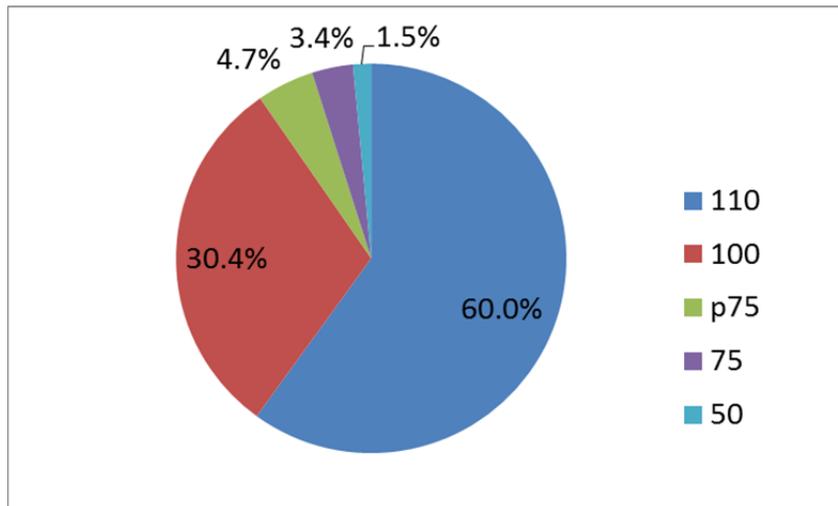
FIGURE 2. Homework Completion

Table 1 further breaks down the data on homework completion. It groups students based on the percent of total homework completed for the class, and the quintile of their exam average. The numbers given are the overall percent of correct homework. The numbers in parentheses are the percent of correct homework in the various times. Overall, the class completed 87% of the homework. As suspected, the percentage of homework dropped as the exam average went down. The percent completed in the bonus time also decreased as the exam average went down. It is interesting that in the lowest quintile of exam average, students completed 19% of their correct homework after the due date, with 4% being worked after the module was completed. Although it is gratifying that these students are continuing to work on their homework after the due date, it is disturbing that over 10% of their correct answers are being submitted more than 2 days late. This suggests that the issue with these students is not just a lack of understanding of the problems, but time management issues. They are capable of doing more of the homework, but are procrastinating. The implication is that at least some interventions with these students should focus on time management issues.

Table 2 examines the efficiency of students in completing the homework. The efficiency is obtained as the number of correct answers divided by the total number of tries. The efficiency during the bonus time is slightly greater than the overall efficiency. This suggests that students are not just making a few tries during the bonus time and then giving up and waiting for the recitation or help sessions, but are figuring things out for themselves. It is also interesting that the efficiency of the lowest quintile during the late 75 time and late 50 time is greater than the efficiency for the third and fourth quartile. This again suggests that the issue with lowest quintile is at least partially a time management issue. They are capable of working at least some of the problems, but are procrastinating.

TABLE 1. Homework Completion

Category	Percent Homework Completed					
	Total	110	100	p75	75	50
80th-perecentile and above exam average	97.8	76.1 (77.8)	18.3 (18.7)	2.2 (2.3)	1.0 (1.0)	0.2 (0.2)
60-79th percentile exam average	94.9	62.7 (66.1)	25.4 (26.8)	3.4 (3.6)	2.5 (2.6)	0.8 (0.8)
40-59th percentile exam average	91.8	51.5 (56.1)	30.9 (33.7)	5.1 (5.5)	3.1 (3.4)	1.2 (1.3)
20-39th percentile exam average	87.9	44.8 (51.0)	32.7 (37.2)	5.1 (5.8)	3.4 (3.9)	1.8 (2.1)
0-19th percentile exam average	64.1	26.6 (41.4)	25.3 (39.5)	4.8 (7.5)	4.8 (7.6)	2.5 (3.9)
Overall Class	87.3	52.3 (60.0)	26.5 (30.4)	4.1 (4.7)	3.0 (3.4)	1.3 (1.5)

TABLE 2. Homework Efficiency

Category	Percent Correct					
	Total	110	100	p75	75	50
80th-perecentile and above exam average	62.0	63.3	58.7	56.5	51.5	45.1
60-79th percentile exam average	56.8	58.8	54.8	51.6	55.6	45.9
40-59th percentile exam average	54.0	56.0	53.4	49.8	39.8	33.3
20-39th percentile exam average	52.4	55.1	51.5	48.9	45.2	41.5
0-19th percentile exam average	54.2	57.1	53.0	45.0	49.8	46.2
Overall Class	55.9	58.1	54.2	49.8	47.8	42.2

Comparison of with and without the Homework Bonus

In Fall 2010, the homework bonus was instituted halfway through the semester. Figure 3 shows typical graphs of the homework completed vs. time for before the implementation of the bonus and after the implementation of the bonus for that class. The graphs in Figure 3 represent a summation of all students' homework grades, or a total class grade. Each time increment is 12 hours. It is clear that students work on homework right before it is due. However, the amount of homework completed more than 24 hours before the due date jumped from approximately 15% to approximately 60% with the implementation of the early homework bonus.
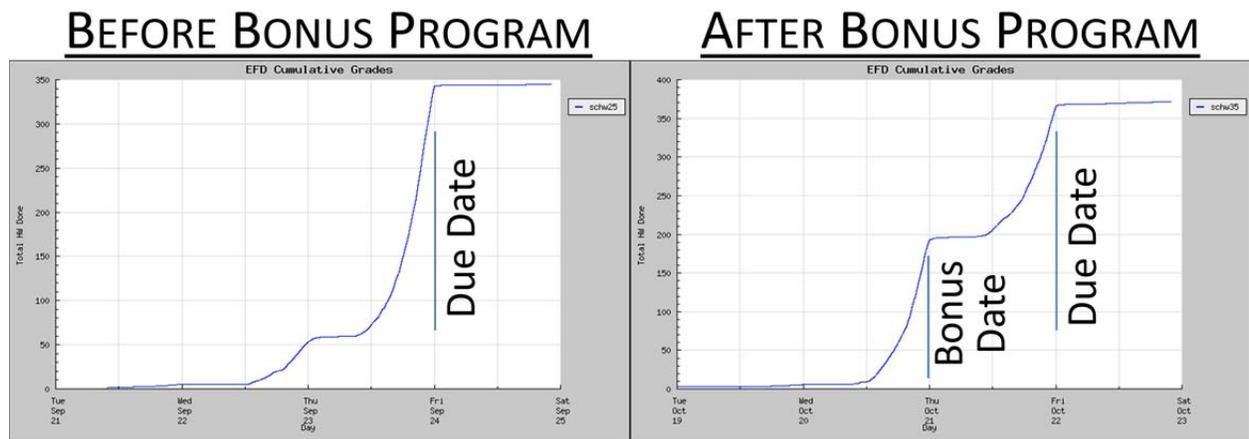
FIGURE 3. Effect of Bonus on Homework Completion Times

We further examined the effect of the early homework bonus by comparing homework averages from Fall 2009 (no early homework bonus program) to Fall 2011 (with early homework bonus program). Table 3 shows class homework averages by quintiles of exam average for the semester. The greatest increase occurred in the lowest quintile. It should be noted that with the implementation of the early homework bonus, there was also a change in the late penalty policy, with the immediate drop-off to 75% being replaced with a gradual drop-off over the 48 hours after the homework is due. Part of the increase, particularly at the lower end, could be due to this. However, it is encouraging to see the positive effect on the students with the lower exam average, and that this is not just a program whereby the A students are getting even more points.

TABLE 3. Effects of Early Homework Bonus on Homework Averages

Category	Fall 09 HW Avg	Fall 11 HW Avg	Increase	Percent Increase
80th-perecentile and above exam average	94.6	102.2	7.6	8.0
60-79th percentile exam average	93.5	97.3	3.8	4.1
40-59th percentile exam average	88.4	88.4	4.0	4.6
20-39th percentile exam average	81.3	81.3	6.4	7.8
0-19th percentile exam average	49.5	60.4	10.9	22.0
Overall Class	81.5	88.0	6.5	8.0

Use of the Discussion Board

As an efficient means to provide help to these large classes, we utilize an on-line discussion board. The discussion board is monitored by a graduate student teaching assistant for several hours (usually 8-10 p.m.) the night the homework is due. Students can post at other times and answer each other's questions. Faculty also monitor the discussion board and provide answers at other times. For example, faculty check the discussion during the weekends, and provide answers to unanswered questions.

As a result of the homework bonus, the discussion board went from being almost exclusively used the night the homework was due while it was being monitored and the students expecting the GTA to answer their questions, to being heavily used before the bonus deadline and students answering each others' questions. Figure 4 shows the posts by 6-hour period for two homework problems in Fall 2010. The first graphs show the discussion board posts before the early homework was implemented, and the second was after the early homework was implemented.
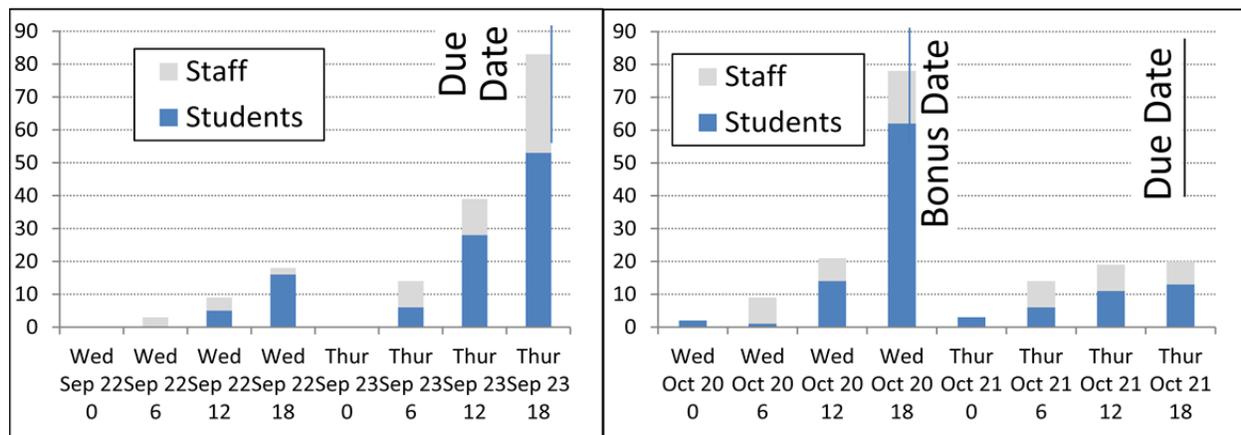

FIGURE 4: Comparison of the Number and Timing of Discussion Board Posts Before and After Implementing the Early Homework Bonus

Anecdotally, the effect of the early homework bonus has been that students are working more together. For example, when a faculty member posted in response to a question on the discussion board during the bonus time that a similar problem would be worked the next day in recitation, there was an almost immediate post from a student saying to the other students to keep working together as they thought they could get it. They did continue to post, and did figure out the problem on their own.

Student Feedback

A mid-semester survey was conducted in Fall 2011, with students being asked "Do you feel having a bonus for early homework completion has affected your learning, and if so how?" The response rate on the survey was 343 out of 403 students, or 85%. 283 of the 343 respondents (82.5%) stated or implied yes, that the early homework bonus had positively affected their learning. Of those 283 students, 51.9% identified specific learning contributions including better preparation for lectures, improved practice at self-guided learning, and reinforcement of understanding from lectures and recitations. Among the students who stated or implied a learning benefit but did not explicitly address learning per se, motivation to not procrastinate and to work and study in a timely manner were the most commonly identified benefits. Motivation was a common theme among all respondents stating or implying yes, with the word occurring in 21.2% of those responses; another 15.9% of "yes" respondents used the word" incentives." Only 9.9% of "yes" respondents used the word "points" in responses, and only a few of those seemed to imply that the potential grade boost was a primary motivating factor. A larger number of those citing "points" indicated that the bonus actually reduced stress about grades and the pressure to "get the right answer" on the first attempt.

Half of the 60 students (17.5% of the total) who stated that the early homework bonus did not contribute to their learning did not elaborate. 15% of the "no" respondents explicitly identified the potential grade improvement as a benefit, while 21.7% identified motivation not to procrastinate as a benefit. Only five respondents (1.5% of the total) stated that the early homework bonus did not contribute to their learning because they required additional clarification of concept from lecture and recitation subsequent to the early bonus deadline. While this number is gratifyingly low, it may represent a subset of those students most vulnerable to failure in the course, and suggests consideration of designing mechanisms to identify those students who require remediation and tutoring. Of the remaining "no" respondents, three stated they did not have time for early homework completion, and one student took umbrage with the program as beneath the dignity and standards of a major research institution.

Overall, including "no" respondents who nonetheless identified motivation not to procrastinate, 86.3% of the students identified benefits from the early homework bonus offering. These findings are especially instructive in comparison to results of a question on the same survey asking students "What prevents you from doing homework?" In response to that question 50% of students identified time management difficulties – procrastination, obligations of other classes, etc. as impediments. This suggests a consequence of the "incentives" for early homework completion is that a substantial number of students benefited through increased "motivation" to hone their time management skills. Only 1.5% of students identified themselves as unable to complete homework early due to lack of understanding of the concepts. This compares to 8.1% of students who identified lack of understanding as an impediment to homework completion. The early homework bonus may have led some students to discover abilities they thought they lacked. Nine students explicitly identified discovering their ability to learn and solve problems on their own as a benefit of the early homework bonus.

Conclusions

The initial goals of implementing the early homework bonus program were rather modest. We were hoping that students would at least look at the homework before recitation and have some familiarity with the problems, even if they could not work them. However, the early homework bonus has had a much larger effect on the class. Over half of the homework is being completed in the bonus time. The positive effects are that the bonus system encourages students to figure things out for themselves, and it discourages procrastination. Improved preparation for lecture and recitation, and reinforcement of learning are also benefits identified by some students in the mid-semester survey. The data also indicate that part of the issues with low-performing students is not just capability, but time management issues. Although the bonus system has had some positive impact on these students, it appears additional intervention measures related to time management are necessary.

Acknowledgement

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