Effects of Homework Policy on Student Performance

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Abstract

Homework and exam assignments are essential instructional tools used in multiple disciplines and for all course levels. With the development and adoption of online learning environments for problem creation and assignment, some issues associated with paper submission of homework assignments have been alleviated. Online, web-based homework has become necessary for the facilitation of learning in large classes, particularly those that require frequent feedback to students. The use of online homework allows a greater number and variety of problem types to be assigned. Student confidence is also built through access to immediate assignment feedback from the learning system. Timely completion of homework assignments is necessary for development of skills needed to perform well on in-class exams that are used to assess abilities to apply those skills. This paper describes and compares online homework assignment policies and their effects on student performance in thermodynamics and heat transfer courses.

Introduction

For courses with large student enrollments, grading assignments is time-consuming work that requires considerable resources for instructors and teaching assistants to complete. Online homework assignments are increasingly being used[1], allowing students to practice and receive timely feedback as they develop their problem-solving skillsets[2], [3]. Typical fall and spring semester enrollments in the considered sections of the heat transfer and thermodynamics courses are 80 to 130 students. To facilitate greater student flexibility for completion of assignments, during a recent semester, homework assignments were assigned with common due dates. Multiple assignments were posted with a common due date that was two days before the scheduled exam. The scheduled exams evaluated the concepts and principles covered in the homework assignments. Comparisons of student homework and exam grades are presented for the thermodynamics and heat transfer courses.

With increasing class sizes and the continued development of commercially available online assessment tools and software, the assignment of online homework is increasing. In addition to reducing the labor-intensive task of grading, online homework offers some advantages including immediate feedback to students and abilities for students to resubmit assignments for automatic regrading. Additionally, some online assessment software offers customization of assignments based on correct or incorrect student answers. The availability of algorithmically randomized numerical problems also provides an effective obstacle to the copying of answers[2].

In this study, the results of student performance in two courses, thermodynamics and heat transfer are presented. Two semesters of grades are compared for each course. One semester in which students were assigned homework with serial due dates, and another semester in which students were assigned homework with common due dates. Homework with serial due dates are those which are regularly assigned during the semester, with a deadline for submission that is 7 to 10 days after the date on which the assignment was posted. The assignments are typically

made after the previous has been assigned and already submitted. Homework with common due dates are those which are assigned with a common deadline for submission that is two days before the associated exam.

Courses

This study was conducted for two courses taught at the University of South Florida, EGN 3343 Thermodynamics I, and EML 4123 Heat Transfer. Thermodynamics I is a required course for undergraduate mechanical engineering, civil engineering, chemical engineering, and industrial and systems engineering students. Heat transfer is a required course for undergraduate mechanical engineering students. Depending on his or her discipline, students in Thermodynamics I are junior or senior students. Students in Heat Transfer are all senior students. Each of the courses met in a single section during the semester for which class performance is presented.

In 2012, the McGraw-Hill Connect online homework system was adopted for Thermodynamics I. Prior to adoption of McGraw-Hill Connect, written homework was collected for grading. After adoption of McGraw-Hill Connect, all homework and reading assignments were completed online. In-class written exams continued to be administered to assess student performance. Students were required to purchase either a physical or electronic copy of the textbook, and required to subscribe to the online homework system. Online homework assignment problems were chosen from question banks that mirror the textbook content. Only those problems for which algorithmic options existed were assigned. Algorithmic problems allow for variation of the numerical values associated with a given problem statement.

In 2018, the McGraw-Hill Connect online homework system was adopted for Heat Transfer. Prior to adoption of McGraw-Hill Connect, the WileyPLUS online homework system was used. All homework and reading assignments continued to be made and completed online. In-class written exams continued to be administered to assess student performance. Students were required to purchase the subscription to the online homework system that included the electronic copy of the textbook. Homework assignment problems were chosen from question banks that mirror the textbook content. Only those problems for which algorithmic options existed were assigned.

Traditionally, homework in both courses was assigned with serial due dates as corresponding material was presented during class lecture. In an effort of continuous course improvement, a decision to assign homework with common due dates was made to give students more flexibility in the timing for completion and give them opportunities to work ahead. Assignments with common due dates covered all the material that would be tested on the following exam. The common due dates for those assignments was two days before the scheduled exam. The expected result of homework with common due dates was that assignment grades and student understanding would increase. It was further expected that increased understanding would result in higher exam grades.

Thermodynamics I

In Spring 2017, assignment of homework with serial due dates was the policy. The deadline for homework submission was 7 to 10 days after the assignment was posted. For that semester, the class average homework grade was 86.0%, and the class average exam grade was 69.0%. In Spring 2018, assignment of homework with common due dates was the policy. The deadline for homework submission was 2 days before the scheduled corresponding exam. For that semester, the class average homework grade was 91.6%, and the class average exam grade was 74.5%. During both semesters, homework assignments consisted of problems taken from the same banks of online problems.

In Spring 2017, three exams were administered. Three homework assignments were due before the administration of the first exam. Three and two homework assignments were due before administration of the second and third exams, respectively. Averages for the first, second, and third exams were 71.4, 76.8, and 67.5%, respectively. In Spring 2018, three exams were also administered. Three homework assignments were due before the administration of the first exam. Two and three homework assignments were due before administration of the second and third exams, respectively. Averages for the first, second, and third exams were 81.1, 71.1, and 74.2%, respectively. In Table 1, are grades for students with exam averages of 80% or higher, 70 to 79%, and less than 70%. The distribution of exam grades is presented in Figure 1(a-f).

Exam Performance	Exam Average, %	Homework Average, %	Number of Students	% of Students
Spring 2017, Serial Due Dates				
80% or Higher	85.6	89.4	33	28.7
70 to 79%	74.4	91.2	30	26.1
Less than 70%	58.4	84.4	52	45.2
All Students	69.0	86.0	115	100.0
Spring 2018, Common Due Dates				
80% or Higher	86.6	96.3	52	38.8
70 to 79%	74.7	89.3	38	28.4
Less than 70%	60.2	87.9	44	32.8
All Students	74.5	91.6	134	100.0

Table 1 Thermodynamics I Student Performance

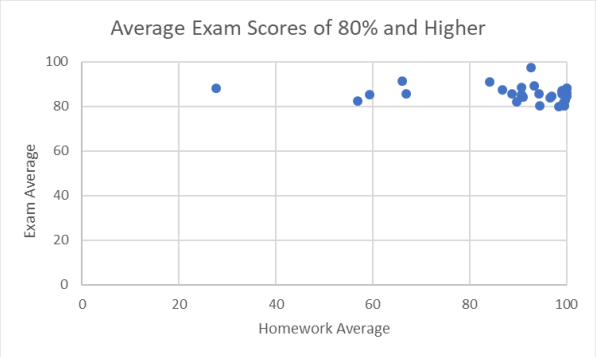

Figure 1a Thermodynamics I Spring 2017, 80% and Higher

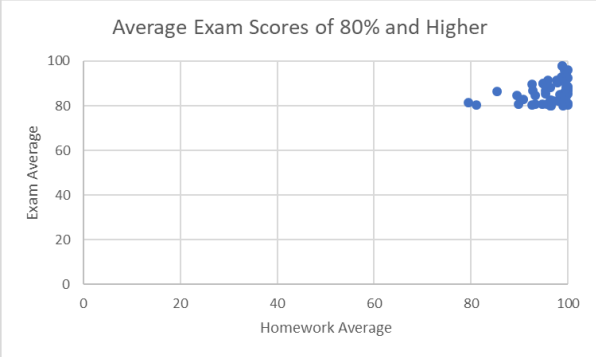

Figure 1d Thermodynamics I Spring 2018, 80% and Higher

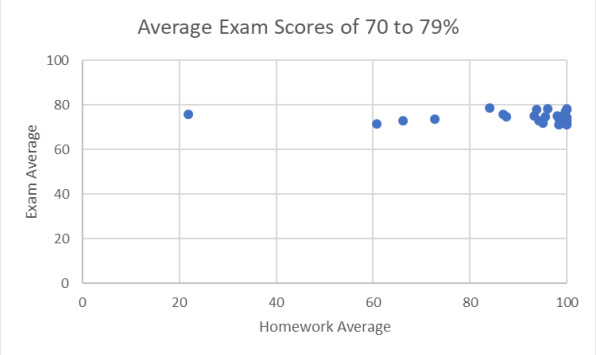

Figure 1b Thermodynamics I Spring 2017, 70 to 79%

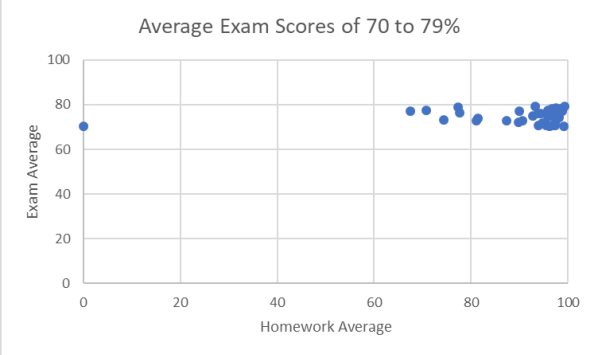

Figure 1e Thermodynamics I Spring 2018, 70 to 79%

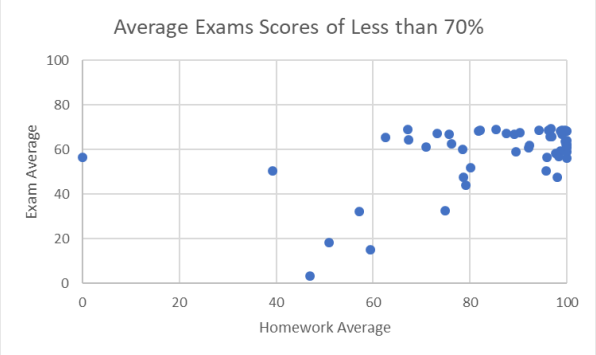

Figure 1c Thermodynamics I Spring 2017, Less than 70%

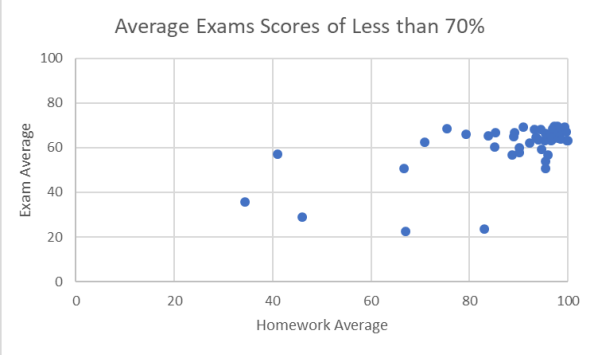

Figure 1f Thermodynamics I Spring 2018, Less than 70%

Heat Transfer

In Summer 2018, assignment of homework with common due dates was the policy. The deadline for homework submission was 2 days before the scheduled corresponding exam. For that semester, the class average homework grade was 90.3%, and the class average exam grade was 75.5%. In Fall 2018, assignment of homework with serial due dates was the policy. The deadline for homework submission was 7 to 10 days after the assignment was posted. For that semester, the class average homework grade was 92.3%, and the class average exam grade was 77.2%.

During both semesters, homework assignments consisted of problems taken from the same banks of online problems.

In Summer 2018, three exams were administered. Three homework assignments were due before the administration of the first exam. Four homework assignments were due before administration of the second exam, and four before the third exam. Averages for the first, second, and third exams were 75.3, 73.0, and 80.0%, respectively. In Fall 2018, three exams were also administered. Three homework assignments were due before the administration of the first exam. Four homework assignments were due before administration of the second exam, and four before the third exam. Averages for the first, second, and third exams were 74.3, 78.2, and 80.7%, respectively. In Table 2, are grades for students with exam averages of 80% or higher, 70 to 79%, and less than 70%. The distribution of exam grades is presented in Figure 2(a-f).

Exam Performance	Exam Average, %	Homework Average, %	Number of Students	% of Students
Summer 2018, Common Due Dates				
80% or Higher	84.9	95.7	14	31.8
70 to 79%	73.0	88.2	23	52.2
Less than 70%	65.1	86.5	7	16.0
All Students	75.5	90.3	44	100.0
Fall 2018, Serial Due Dates				
80% or Higher	85.0	94.5	34	37.8
70 to 79%	75.5	90.9	40	44.4
Less than 70%	64.4	90.5	16	17.8
All Students	77.2	92.3	90	100.0

Table 2 Heat Transfer Student Performance

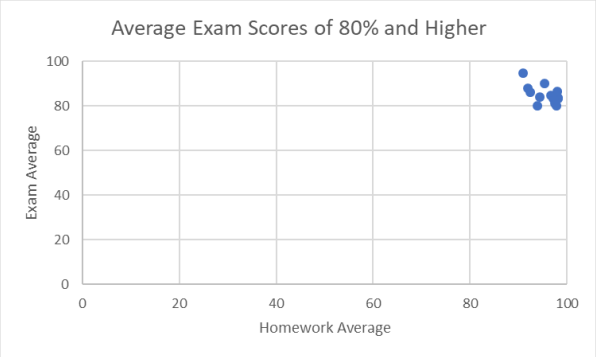

Figure 2a Heat Transfer Summer 2018, 80% and Higher

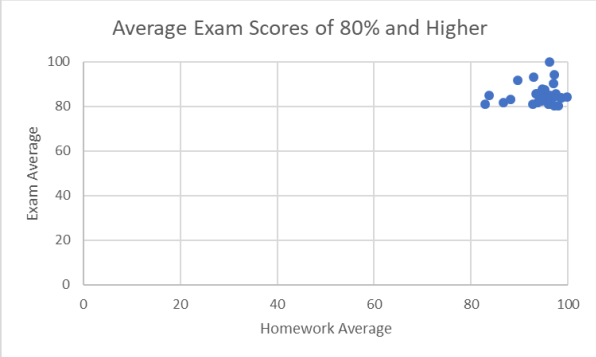

Figure 2d Heat Transfer Fall 2018, 80% and Higher

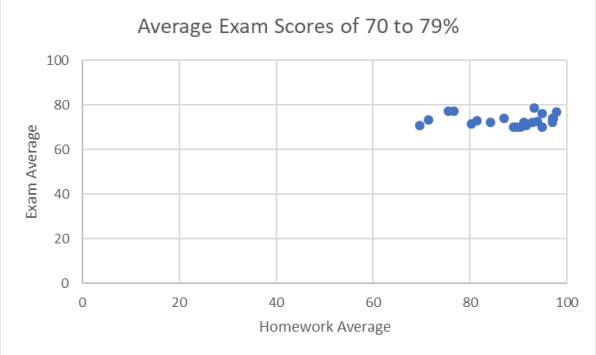

Figure 2b Heat Transfer Summer 2018, 70 to 79%

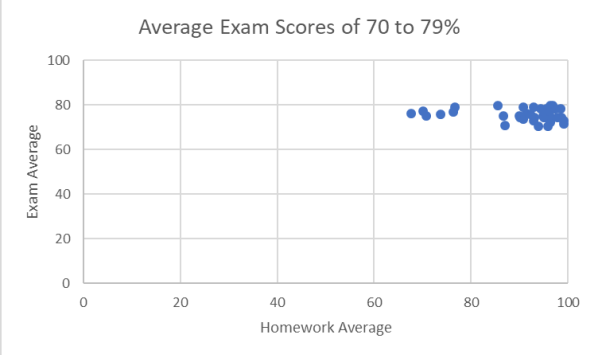

Figure 2e Heat Transfer Fall 2018, 70 to 79%

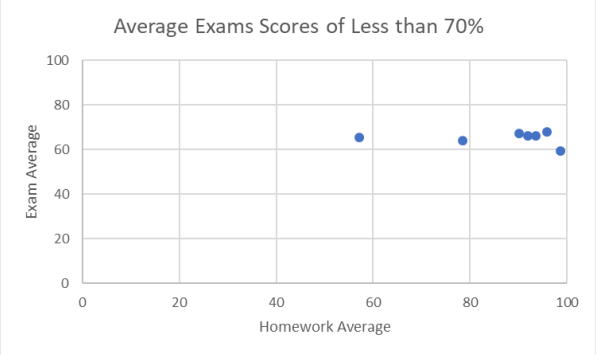

Figure 2c Heat Transfer Summer 2018, Less than 70%

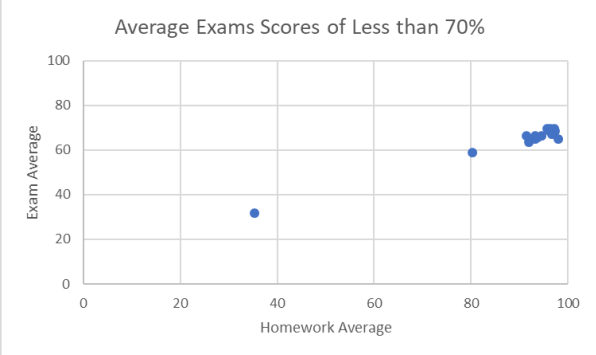

Figure 2f Heat Transfer Fall 2018, Less than 70%

Discussion

When the decision was made to adopt a common due date homework policy, the expectation was that student performance would increase. The decision was part of continuous evaluation and modification efforts to improve both courses. Common due dates gave students more flexibility in the timing of homework completion and opportunities to work ahead.

Analysis of Thermodynamics I student performance shows that for common due dates, higher average homework and exam grades for the class resulted. For students who scored 80% or higher on exams, homework averages were notably higher with the common due date policy. Also, a smaller percentage of students earned average exam grades less than 70%. The desired effect was achieved, but according to data in Figure 1(a-f), there is no correlation between average homework and exam grades. To determine any meaningful statistical differences between the effects of the homework policies, more semesters of course homework and exam grades must be collected and analyzed.

For Heat Transfer, analysis of student performance indicates that with the common due date policy, only the students with exam averages of 80% or higher had higher homework grades. Average exam grades in both semesters were not significantly different. The desired effect was not achieved, and according to data in Figure 2(a-f), there is no correlation between average homework and exam grades.

Differences between student performance in the Thermodynamics I and Heat Transfer courses is most likely attributable to the different student populations and their motivations. With regard to engineering discipline, a much greater diversity of students enroll in Thermodynamics I, compared to Heat Transfer. Heat Transfer is a senior-level course in the mechanical engineering department, in which only mechanical engineering students enroll. Typically, they are within one year of graduation. Thermodynamics I is a junior-level course in the college of engineering, in which junior- and senior-level students in mechanical, civil, chemical, and industrial and systems engineering enroll.

Most of the enrolled juniors are mechanical, civil, and chemical engineering students, while almost all the seniors are industrial and systems engineering students. Thermodynamics I is a required course for all the disciplines, but not a prerequisite for other courses in industrial and systems engineering. Thermodynamics I is a prerequisite for other required courses in mechanical, civil, and chemical engineering. Differences in the motivation of students enrolled in the course influence student performance, and thus average class performance. Depending on the distribution of disciplines of the enrolled students, class averages are affected.

In consideration that the changes were made for course improvement, it is encouraging to see that adoption of a common due date policy did not negatively impact student performance. To determine whether statistically significant differences in student performance exist, more semesters of grades must be an analyzed for each homework policy.

References

[1] V. Jungic, D. Kent, and P. Menz, “On Online Assignments in a Calculus Class,” p. 15.
[2] S. Bonham, R. Beichner, and D. Deardorff, “Online homework: Does it make a difference?,” *Phys. Teach.*, vol. 39, no. 5, pp. 293–296, May 2001.
[3] L. L. Parker and G. M. Loudon, “Case Study Using Online Homework in Undergraduate Organic Chemistry: Results and Student Attitudes,” *J. Chem. Educ.*, vol. 90, no. 1, pp. 37–44, Jan. 2013.