Observations from First Use of an Online Homework and Learning Management System

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Abstract

Currently, university students have easy access to textbook solution manuals. An internet search reveals the ease of finding such material. Copying or following the manual's solutions is widespread amongst undergraduate engineering students. Student learning and problem solving skills suffer when homework is copied. An online homework and learning management system was implemented in a sophomore engineering course in an attempt to individualize homework and encourage students to complete homework problems on their own. A secondary objective is the reduction of faculty time associated with grading homework.

This paper highlights an instructor's experience implementing such a system in a sophomore Statics/Mechanics of Materials course for the first time. Student performance is compared to the same course taught in the previous offering using traditional pencil and paper homework. The online homework and learning management system was supplied through the publisher of the course textbook. The system utilized was *Mastering Engineering*®, which features include online homework, tutorials, and assessment. It is noted that all other aspects of student work in the course (quizzes, exams) were done with tradition pencil and paper.

Benefits for students comprised more and immediate feedback, hints to retry and successfully complete problems. Benefits to an instructor using an online homework and learning management system included allowing easier assessment of learning, tailoring of instruction and assigned problems to address deficiencies, as well as automatic grading.

Anecdotal evidence, test and homework data comparisons, and student feedback relating to the online homework and learning management system are presented. Data indicated that using an online homework/learning system seems to have had little measurable effect on the exam and course grades for the students in the Statics/Mechanics of Materials course discussed. Use of the online homework system appears to mitigate copying of homework solutions, and is as effective as requiring and manually grading paper homework.

Keywords

Statics, online homework management

Introduction and Background

Homework is an important part of the engineering foundation courses such as Statics/Mechanics of Materials. Numerous studies have documented that students learn and perform better on examinations with additional time on learning tasks[1,2,8]. Performing homework builds skills and good work habits. When homework is not graded, the student homework completion rate is

typically lower than when homework was graded. Even when homework is collected for grading, a significant number of students may copy or "follow" a solution manual. While some benefit is still gained by this approach, students do not develop a good approach to problem solving, and may perform poorly when tested. Meaningful grading of homework is a tedious task and can take significant faculty time. Despite receiving graded homework, a significant number of students may still not successfully use or review the feedback information given in a graded homework to improve their understanding or change work habits.

An approach to administering homework that attempts to address many of these shortcomings and enhance student learning is an on-line homework/learning management system. Several learning management systems are presently available. Some are run by publishing companies to accompany textbooks. One such system is *Mastering Engineering*® . This is the Online Homework /Learning Management System tool implemented in the course discussed in this manuscript.

A comparative assessment of student performance on exams when using online homework tools in an undergraduate engineering mechanics course has been reported by M. Head[6]. In this paper it was concluded that, overall results of students in an engineering mechanics course showed the use of online homework aided in improving student grades, thereby suggesting an enhancement of student learning.

Another study using non-graded on-line homework enforced completion by using a random problem from the homework as a quiz[7]. In this study frequent quizzes (manual) were used instead of grading homework. The assessed students' performance (via frequent quizzes) had a greater correlation with exam performance than grading homework assignments. However, the results indicated the frequent quizzes did not improve students' performance on tests.

Features of the On-line Homework /Learning Management System and Implementation

The features of the *Mastering Engineering*® system span many aspects of teaching. Homework, quizzes, tests, tutorials, and additional outside content maybe assigned. Control of the assignments and extent of use is totally up to the instructor. Homework/quiz/test features include reveal date/time, due date/time, number of attempts, deduction per try, penalty for late, points per problem, bonus points, extra credit problems. The problem-based structure allows video-based instruction/questions, numerical solutions, multiple choice answers, category answers (drag and drop), and some limited graphical responses. Many problems are set up to have unique answers for each student, thereby preventing direct copying of answers between students. Hints are provided to encourage students to retry and complete problems. The structure can serve as an entire course's student graded interaction.

The primary features of the *Mastering Engineering*® system utilized in the course discussed here were providing and grading homework problems and giving tutorials to help students learn key knowledge of the subject. Most of the problems were chosen to be very similar to supplemental problems in the text. These supplemental problems were recommended to the students strictly as supplemental materials to the online homework, and thus were not graded.

Observations and Comments

Many students had initial resistance to an online homework/tutorial system. One issue was the additional cost of the software access for students who did not buy the text with the access card from the bookstore. However, the students quickly adapted. There are some program quirks with regard to drawing figures, such as force vectors (Arrows must be drawn away from the point of application vs. drawn towards the point of application for force vectors.) Other features were found to be very positive. These popular features included, immediate feedback, hints, multiple tries, extra credit options for additional work, and individual time extensions by student.

Benefits for the instructor included having homework graded automatically, data on student performance, student time spent on homework, and easily changing the due time. Note: it was important for the instructor to allow a tradition question and answer on the homework during class time. Student questions from the online homework were similar to those from traditional pencil-and-paper homework.

Data Analysis and Comparison to a Previous Semester

Data from the Online Homework Management System are for the current semester in-progress. Figure 1 provides the average homework score for all students. Comparison data from the previous year, showing average manual cumulative homework scores is shown in Figure 2. Note: The manual homework scores were only graded on a scale from 1-5, and provided minimal feedback to students. In many instances only 1 problem in a set was graded. However, the curves are very similar. The average homework score was 71% for online homework and 78% for manual homework. With more original work being completed via the on-line approach, the average homework grade has decreased slightly compared to the previous year's manual homework. Figure 3 shows the variation of the average homework score by assignment for online homework. There is significant variation depending upon the assignment difficulty.

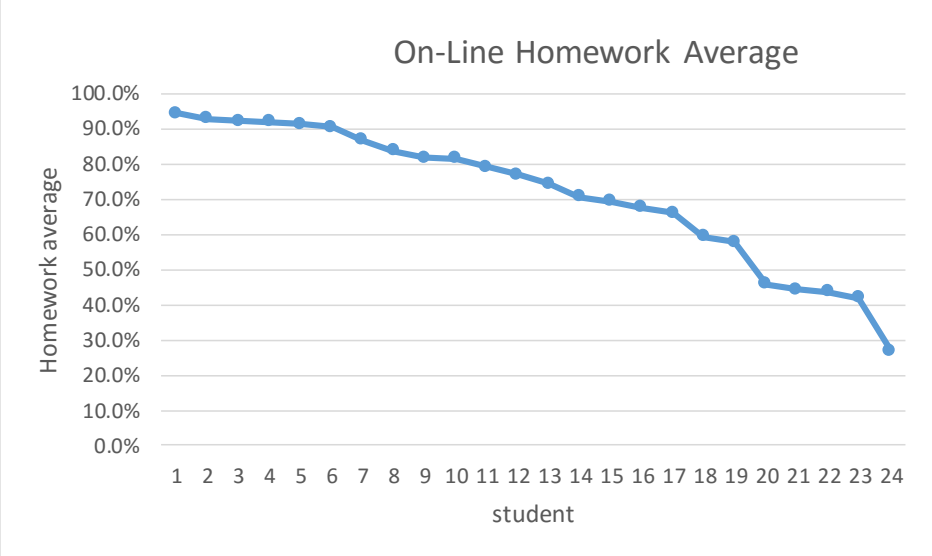

Figure 1. Distribution of Online Homework Average Scores by Student

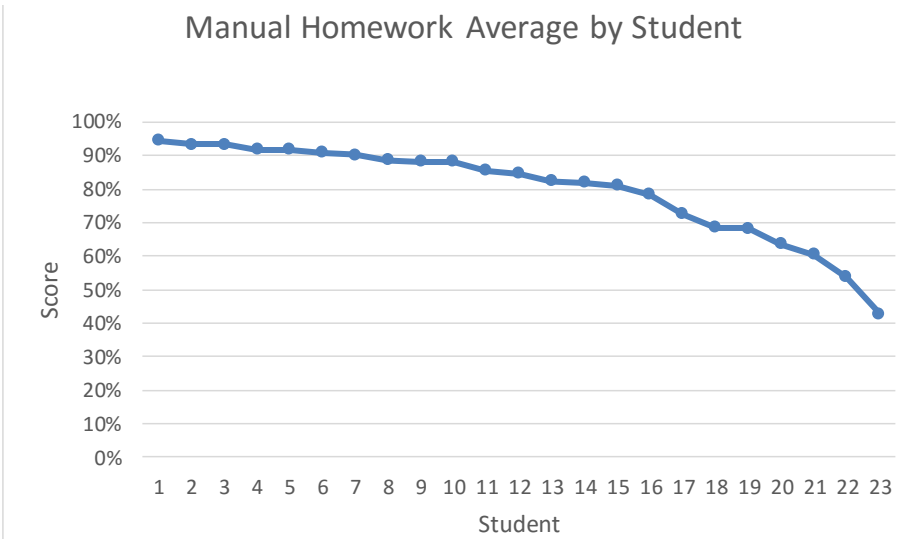

Figure 2. Distribution of Manual Homework Average Scores by Student

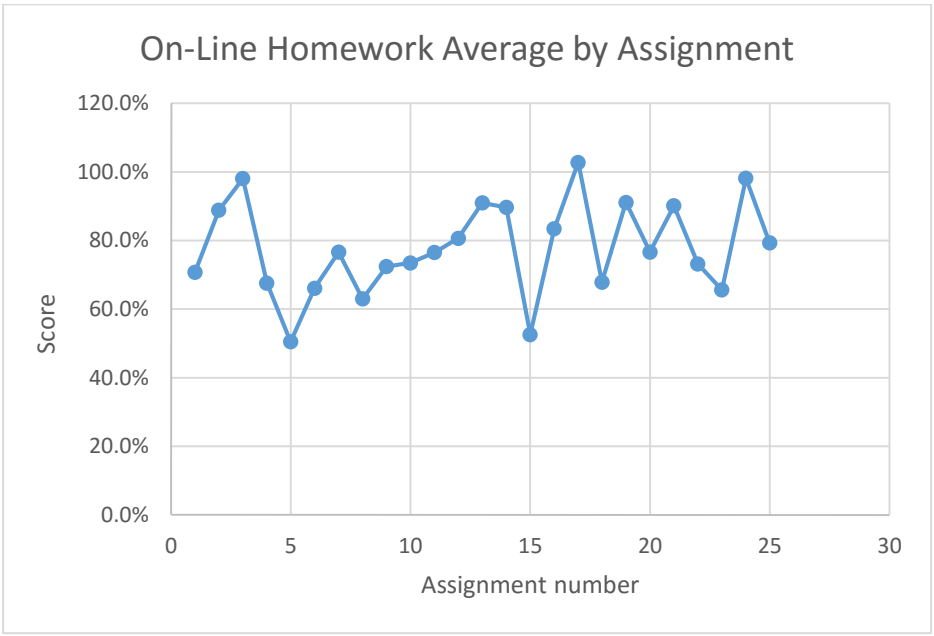

Figure 3. Distribution of Online Homework Average by Assignment

Exam scores are more interesting, as they are used as an indicator of learning. While the exams for the two courses are different, the content and difficulty are fairly similar. Figures 4 and 5 show the exam scores by student for the first two exams for the online and manual (paper) homework courses, respectively. Again, the similarity between the two courses can be readily seen. The average exam scores for the online homework course were 86% and 76% for exams 1 and 2, while the average scores for the manual homework course were 86% and 79% for exams 1 and 2. Clearly, the averages are very close for each exam.

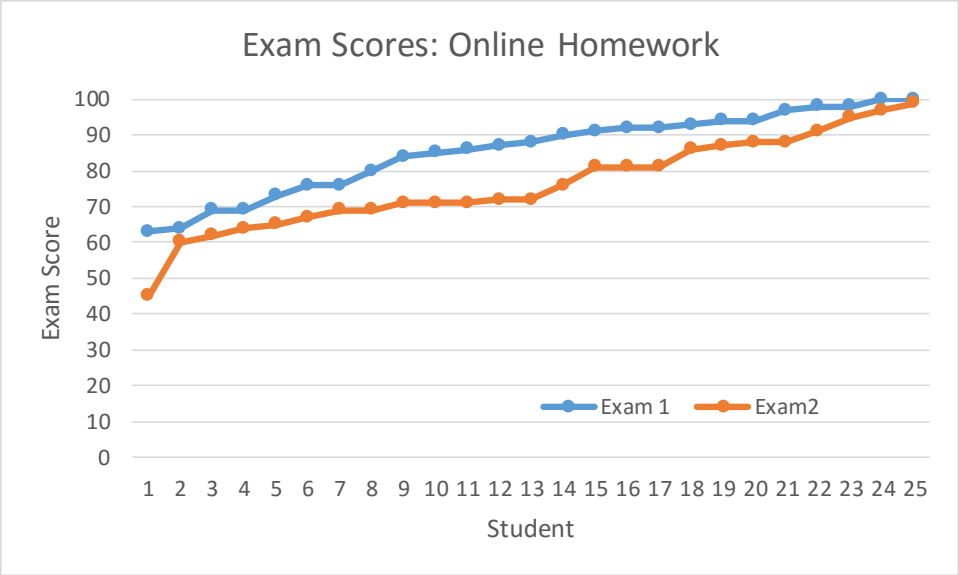

Figure 4. Exam Scores with On-line Homework

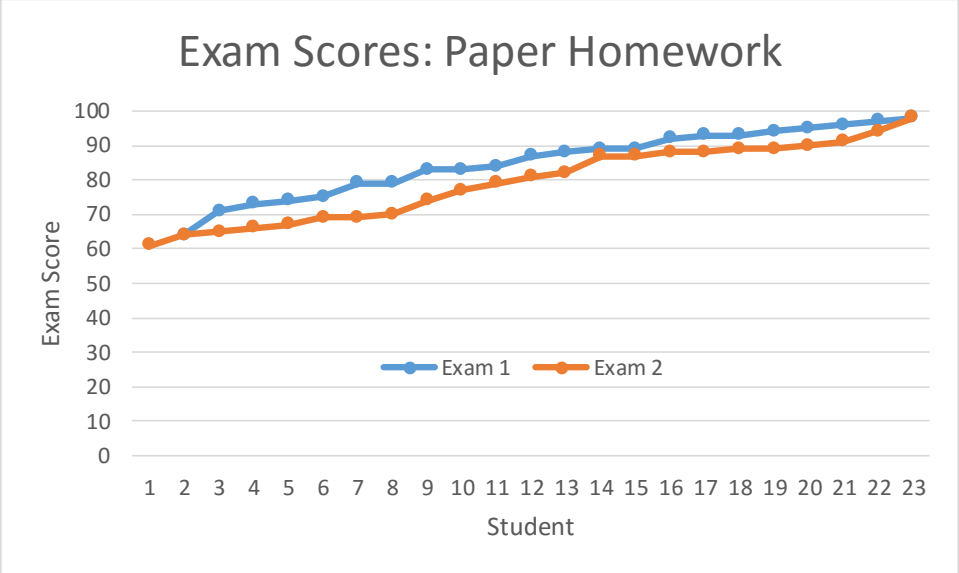

Figure 5. Exam Scores with Manual Homework

The online homework system captures the time of each student performing the homework. Cumulative time of each student is plotted vs. the student's current course grade. A correlation, as expected can be observed in Figure 6.

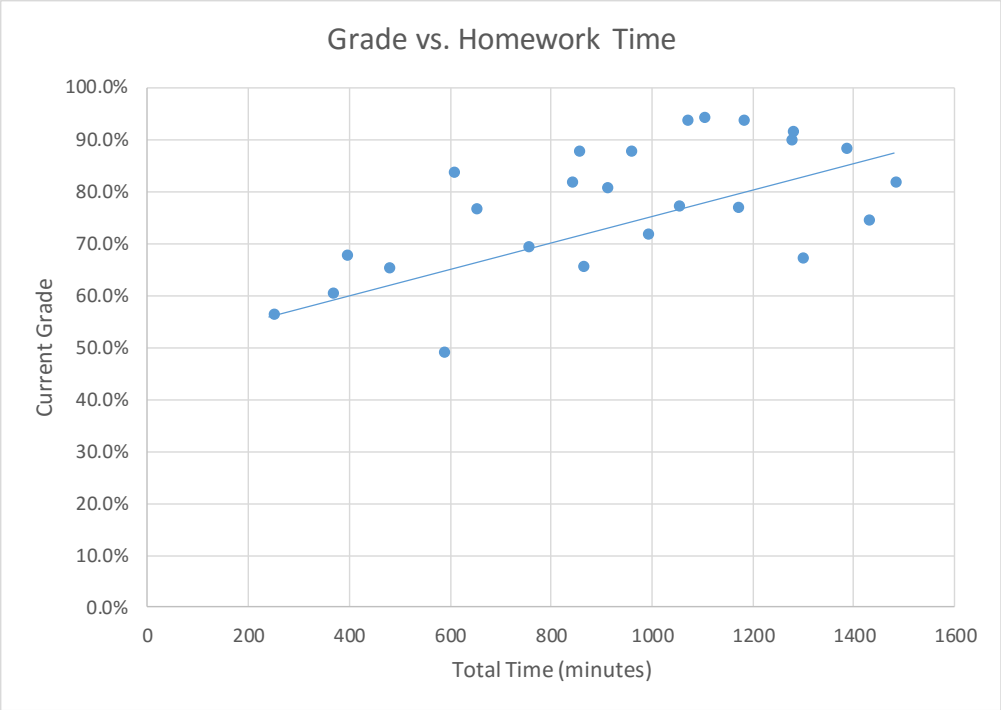

Figure 6. Grade vs. Total Time Working Online Homework

Conclusions and Recommendations

The data presented here are somewhat more qualitative and anecdotal as compared to a statistically designed experiment with a control group. However, the results do provide some meaningful insight into the use of online homework systems for benefit to students and faculty.

First, the test data between the two student groups (online vs. manual homework) are very similar, and most likely not statistically different. Both had 86% for the first exam average, while the second exam scores had 76% and 79% averages for the two groups. Figures 4 and 5 indicate that the second test was most likely more difficult for the online homework group as a whole.

The average homework scores were 71% for online homework students and 78% for manual homework students. This small difference is mostly likely attributable to the variations and differences in scoring schemes. What is more interesting is the fraction of students scoring below 60% on homework averages. The fraction below 60% was 6/24 for the online homework group and 2/23 for the manual homework course. It is unclear if poorly prepared students were copying more solutions manually, or if the students really did better on their manual homework. Since the exam scores and distributions are very similar, the difference is most probably due to poorly prepared students copying solutions for manual (paper) homework.

Figure 6 demonstrates the correlation with the time spent doing online homework and the course grade. This measure of the homework time, in relative terms between students, might be useful to spot students not performing well, early in the semester.

Use of the online homework/learning system seems to have made little measurable difference in the exam and course grades for the students in the Statics/Mechanics of Materials course discussed. Use of the online homework system did mitigate direct copying of homework solutions. The online homework/learning system appeared as effective as requiring and grading manual/paper homework. However, the limited number of students studied and the variations of tests in the groups confound the data.

Based on this limited comparison, it is difficult to say if there is a quantifiable learning improvement for students using the online homework/learning system vs. manual homework. Some researchers have noted improvements.[6,9] Still others[4], concluded no measures difference. Anecdotally, students benefited by hints, multiple tries and immediate feedback of the online approach. However, the faculty time in homework preparation and grading while not measured, was obviously much less with the online homework/learning system. Certainly, the reduction of faculty time used in grading, with no loss of student contact time or decrease in learning outcomes, is sufficient reason to continue using the online homework/learning system.

Recommendations

Going forward the online homework/learning system will continue to be used for the remainder of the course, and subsequent courses. Further data will be compiled at the end of the semester, and upon subsequent utilization.

Additional features of online quizzes and exams will also be trialed in future offerings. If successful, the system would most certainly ease the implementation of a complete online version of this course.

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