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A Self-Assessment Based Homework Model

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Abstract

Homework is considered as a substantial process of learning especially for engineering education. However, due to the fast development of network technology, students now can easily find solution manuals on the internet. While some students use solution manuals to study, there are quite a few students who just copy homework solutions and lose opportunities to learn. This paper proposes a self-assessment based homework model. In addition to finishing homework students need to correct their homework by using solutions and assess their performance using autopsies designed by the instructor. To test the efficiency of this model, an experimental study was carried out in "Control of Mechanical System" class with an enrollment of 39 students at California State University, Los Angeles. The results suggest that the proposed homework assignment model is effective.

Introduction

Homework, in addition to attending the lectures, is considered as a substantial part of learning, especially for engineering education[1-3]. By doing homework, students practice what they have learnt in the class and further improve their learning outcome[4]. It has been found that students' grades can be improved by 10% if homework is just collected, or by 30% if homework is graded and its feedback is provided to the students[5].

Due to the fast development of network technology, students now can easily find solution manuals on the internet before the solution were officially provided by instructors. It is reported that about 70% of students use solution manuals regularly to help with their homework assignments, especially when these homework assignments are graded[6]. While some students use solution manuals to study, there are quite a few students who just copy the homework solutions. They lose opportunities to practice and ultimately fail to learn. The fairness of students' performance evaluation is also affected. While those who use the solution could get full credit for almost all the homework assignments, it is unfair for the students who put more effort into doing homework themselves to receive lower credit because of the flaws in their solutions. An even worse consequence is that it becomes harder for the teachers to judge students' understanding of course concepts, which is an important source of feedback to adjust their teaching strategies.

The impact brought by easy access to homework solutions has attracted a lot of attention and many scholars have recognized it as one of the major concerns in engineering education[3,7]. Hence, exploring better strategies to assign homework or alternatives that can replace homework has become a hot research topic. Some strategies that can be used when students have access to solution manuals include[8-11]: 1) creating customized homework/quiz; 2) lowering the weight of homework in the overall grade; and 3) using online software that is able to randomly change the numerical numbers in the questions and grade homework automatically. But all these strategies have their own drawbacks. For example, creating customized homework is very effective but requires a significant amount of time, and thus, it is hard for faculty to implement given their research and/or other teaching responsibilities. In addition, unless new assignments are

continually created, the chance for students finding the solutions will grow over time if the solutions are distributed to the students or solved in class by instructors. Lowering the weight of homework might discourage students' effort. Many online software is costly and is currently only available for a very limited number of courses.

In this paper, a homework assignment model based on self-assessment is proposed. Different from the traditional methods, where students finish and submit homework before the deadline and teachers grade homework and provide feedback, the proposed model requires students to correct and assess their own homework and submit it with a homework autopsy before the deadline. The autopsy questions are designed by instructors to understand if students meet the learning objectives, as well as gaining a better understanding of the obstacles students are encountering. The advantages of this method are: 1) Instead of checking and grading homework in detail, the instructor can quickly scan students' corrections to gauge students' learning performance. It significantly reduces the instructors' time spent in grading; 2) By checking the homework autopsy, instructors can learn why students make mistakes from the students' perspective; 3) By correcting homework themselves and doing the autopsy, the students tend to achieve deeper learning through actively seeking clues from the solutions; and 4) Although homework autopsies are learning objective oriented and different from one homework to another, they can be repeatedly used in different semesters. It could potentially save instructors' time in designing homework assignments in the long run if they continue teaching the same course. To test whether proposed model can enhance the students' learning efficiency, an experiment has been conducted in "Control of Mechanical System" class at California State University, Los Angeles (Cal State LA).

Self-Assessment based Homework Model

In a typical traditional homework assigning model, students will be given a certain amount of time to do the homework and submit it before the deadline. In the proposed self-assessment based homework assigning method, to successfully finish the homework assignment, the students need to 1) finish the homework themselves 2-3 days before the deadline; 2) check the homework and correct all the mistakes based on the solutions provided by the instructor, using a different colored pen to correct mistakes; and 3) finish the homework autopsy designed by the instructor.

The homework autopsy is inspired by exam autopsy, which is a method to help students identify the reason mistakes were made in the exam in order to avoid those in the future and to deepen their understanding of the material. While it is inspired by exam autopsies, homework autopsies have a significant difference in both purpose and design. Homework autopsies are designed to understand students' "real" learning outcomes and obstacles to meet learning objectives. They provide very valuable resources/feedback for instructors to adjust their teaching strategies from students' perspective. Another fundamental difference between homework and exam autopsy is that homework autopsy is learning objective orientated and thus each homework and even each question will have its uniquely designed autopsy. A sample of homework autopsy has been provided in Figure 1. It can be seen that these two autopsy questions are very different because the two homework problems test different learning objectives. Another factor that affects the

choices listed under an autopsy question is the instructors' cumulative experience on why students made mistakes when teaching the same course multiple times.

A good homework autopsy will be able to help students identify specific obstacles that prevent them from solving homework problems and help instructors identify places to adjust in teaching. While this can also be true for exam autopsies, homework autopsies are more granular, providing more refined and immediate feedback.

(3) If you made a mistake in Question 1, it is because

(a) Exchange the locations of summation point and pick-off point;

(b) Don't know how to apply current law and voltage law;

(c) Don't know how to find transfer function based on differential equation;

(d) Making a mistake when solving equation sets;

(e) Others, specify _____

(4) If you made a mistake in Question 2, it is because

(a) I did not find correct EOM;

(b) I did not find correct TF;

(c) I don't know the input should be modeled as an impulse signal;

(d) I don't know how to apply partial-fraction expansion method;

(e) Others, specify _____

Figure 1. Sample questions from the autopsy of a homework

Analyzing the Effectiveness of the Self-Assessment Homework Model

1. Background of Class

The study was carried out in "Control of Mechanical System" class (ME4110) with an enrollment of 39 students. ME4110 is an upper division, elective mechanical engineering course. The students who chose this course are mostly junior, senior, or graduate students from mechanical engineering program.

The final grade of a student is calculated from a weighted average of his/her grades on homework, pop quizzes, project (group), mid-term exam, and final exam. Five homework were assigned throughout the semester, and each assignment typically consisted of 5 to 7 questions that are mostly chosen from the textbook (about 70%) and the rest (about 30%) are designed by the instructor.

2. Treatment group and Control Group

The students were divided into two groups: the treatment group and control group. The treatment group were provided with solutions before the homework deadline. The students in this group were required to correct their homework themselves by using a pen of a different color and complete the homework autopsy prepared by the instructor. The control group did homework in the traditional way, where solutions were provided after submission, and the homework were graded based on students' performance.

It is worth mentioning that homework grading policies were different for the two groups. The students in the treatment group were given full score if he/she corrected all the homework and submitted a homework autopsy. The students in the control group were graded based on both their endeavor and performance – if the students tried all the homework questions, they received 70% of the homework grades and the other 30% were based on their performance in 2 to 3 questions that were randomly chosen by the instructor.

At the beginning of the semester, the detailed rules for both homework methods and grading policies were introduced, and the students were given the opportunity to choose the method they wanted. In this study, 28 students chose the new homework method (treatment group) and 11 students chose the traditional homework method (control group). It is worth mentioning that although students chose the homework method based on their willingness, there is no significant difference in students' GPAs of the two groups. The average GPA of treatment group is 2.91 and that of the control group is 2.82, a relatively minor 3.2% difference.

Results and Discussion

The average homework score of students' performance in the control group and treatment group were 88.6% and 90.7%, respectively. It worth mentioning that the average score of treatment group was not 100%, since not every student submit all the homework. Note that the grade of one student who did not attend the exam was dropped from the control group, and the grade of one student who did not submit any homework was removed from the treatment group in this experimental study. To study how the proposed homework model can help improve learning, the students' scores in mid-term and final exams were assessed in this paper.

Table 1 shows the average and median grades of students' midterm and final exams. It can be seen that the average and median scores of the treatment group are 6.8% and 11.8% higher than those of control group in the midterm exam, respectively. In the final exam, the average score of treatment group is 10.9% higher than that of control group, though the median is lower than that of control group by 4.3%.

Table 1. Comparison of Median and Average Scores

	Mid-term exam		Final exam	
	Control group	Treatment group	Control group	Treatment group
Average	74.83	79.93	56.94	63.10
Median	77.5	86.67	62.72	60.01

Comparison of students' midterm exam performance of the two groups are given in Figure 2 through Figure 4, where Figure 2 shows the normalized histogram distribution with approximated contour, Figure 3 compares the grade distributions, and Figure 4 is stacked bar graph of students' scores of the two groups. It can be seen that students' performance of the treatment group is significantly better than that of the control group in the midterm exam. More noticeably, the number of students who received "A"s in treatment group is twice of that in the control group.

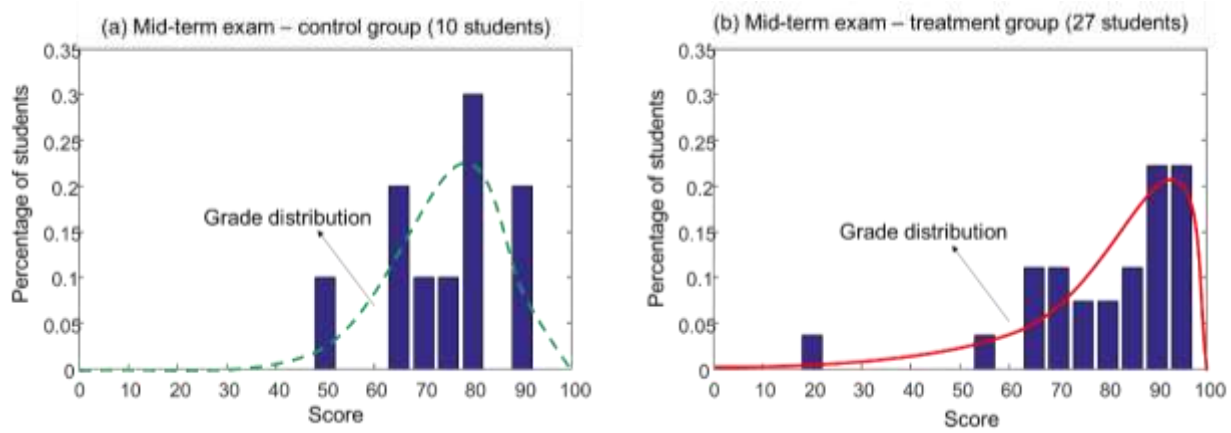

Figure 2. Students grade distribution in mid-term exam

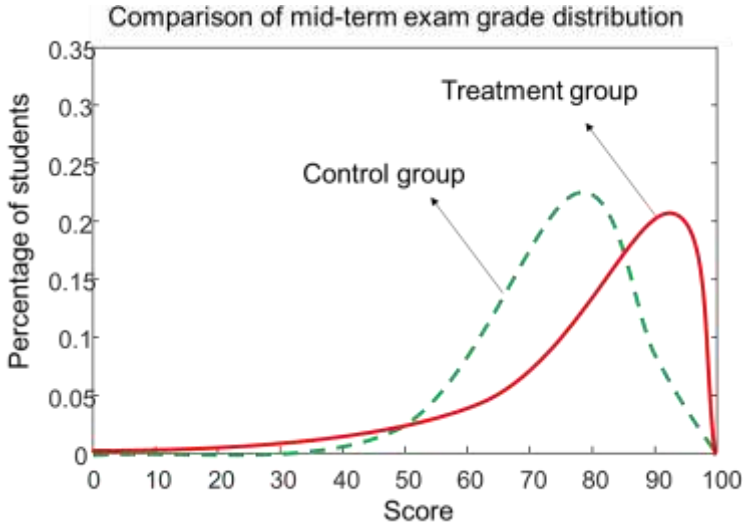

Figure 3. Comparison of midterm exam score distribution

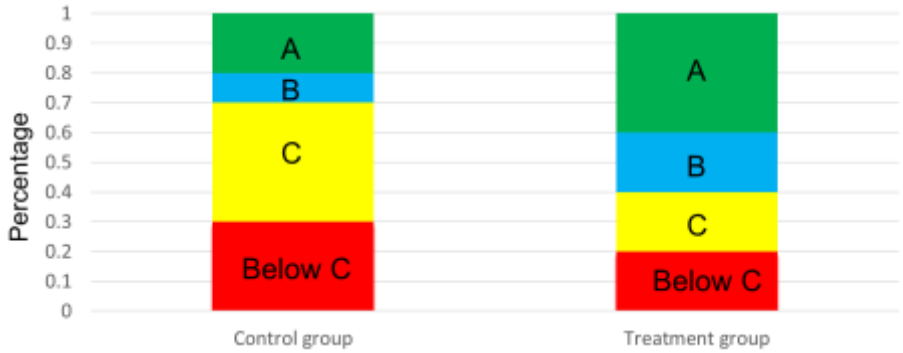

Figure 4. Stacked bar graph of mid-term exam score (A: 90~100; B: 80~89; C: 70~79; Below C: 69 or lower)

Similar to the study done for the midterm performance, the results and comparison of students' final exam scores of the two groups are shown in Figures 5 through 7, where Figure 5 shows the normalized histogram distribution with approximated contour, Figure 6 compares the grade distributions, and Figure 7 shows stacked bar graph of the two groups. Even though the difference of control group and treatment group is not obvious in the Figure 6. However, from Figure 7, it can be clearly seen that the students' performance in the treatment group is better. Almost 25% students from the treatment group received a B or better grades, while none of students from the control group got a grade better than "C".

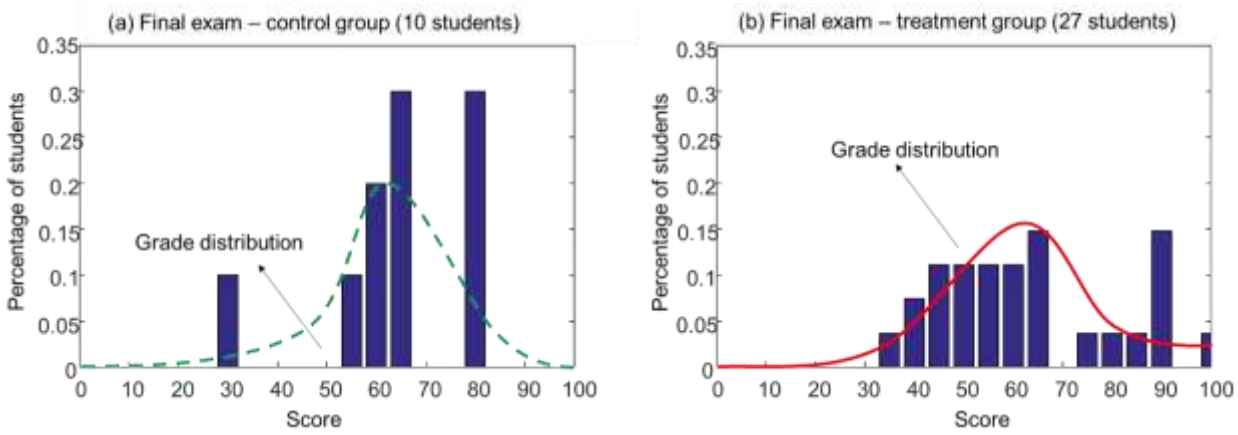

Figure 5. Students grade distribution in final exam (bar stack)

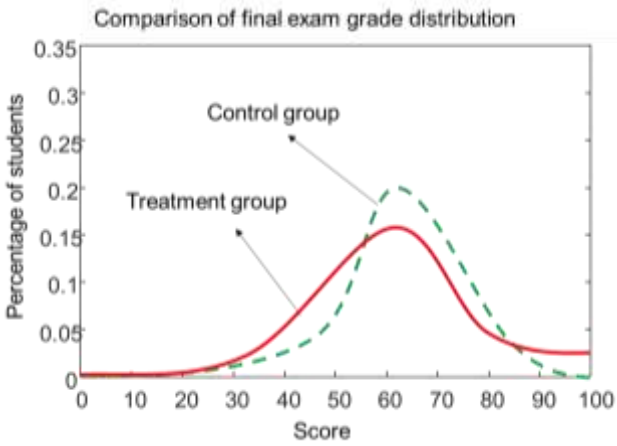

Figure 6. Comparison of final exam grade distribution

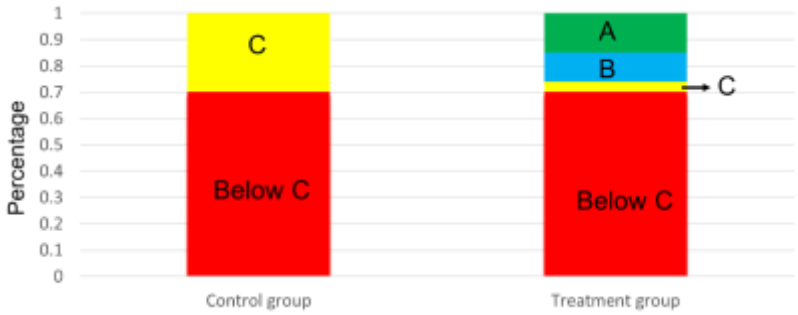

Figure 7. Stacked bar graph of final exam score (A: 90~100; B: 80~89; C: 70~79; Below C: 69 or lower)

Comparing Figure 7 with Figure 4, the ratio of students who got C or worse was increased in both groups in the final exam. Since the final exam contributes only 15% to students overall grade, it might be because students who received a higher grade in the midterm exam in both groups can get their expected score even if with a relatively low final exam grade. It can be reflected by the students average integrated score (i.e., this score is calculated based on the student's performance in homework, project, mid-term exam, and final exam) of the class. The average overall score of students in the treatment group is 83.09, while that in the control group is 77.73. In addition, the students at Cal State LA, in general, has less time to study each subject in the final exam, since all final exams are scheduled within one week and students have in average three to five final exams during finals week.

Conclusion

This paper presents a self-assessment homework assigning model. Under this model, in addition to finishing homework, students need to correct their homework by using solutions and assess their performance using autopsies designed by the instructor. This new homework assigning method shows many advantages over traditional method in helping students learn better and helping instructors collect valuable feedback for teaching adjustment. The effectiveness of this method in improving students learning efficiency is further verified by using an experiment

conducted in an upper division elective engineering course. The proposed homework assigning method has potential to overcome the new challenges brought by the easy access of homework solution manual.

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