Homework with Try-again Feedback

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Abstract

The concept of homework has an interesting history in the academic literature. The consensus of the value of homework has risen and fallen several times through the literature of the last century. The focus of the majority of this previous research was based on students up and through the secondary level, with a lesser focus at the post-secondary level. Instructors at the post-secondary level see homework as necessary for students in order to practice new concepts and obtain new skills and these instructors have expectations of how, when, and why students do homework. The hypothesis for this work is that students that dedicate time to solving homework assignments will perform better on the learning objectives of a course. This paper reviews homework submissions of post-secondary students based on their performance and actions in a statics course of a mechanical engineering technology program. This paper will discuss the different strategies seen in the students' homework submissions, assess how students perform in a class based on homework completion, and provide suggestions for future work in this area.

Introduction

The definition of homework, as defined by Cooper,[1] is "tasks assigned to students by school teachers that are meant to be carried out during non-school hours." The topic of homework has gained a significant interest from the majority of the nation's population because of the public school system and the time commitment by students to complete assignments during non-school hours. Many initial reviews and studies compared homework to no homework learning[2, 3] and many of these studies are inconclusive. In a review of homework literature, Knorr stated[4] that the research is inconclusive and that "we may be spending our energies on trying to answer one or two questions that are so broad and that encompass a set of factors so complex as to make the questions unanswerable." The first estimate of the effect size of the homework no homework debate was performed by Marshall in 1983[5] and showed a d-index of +0.3 SD for the homework group over the no homework group. Much of the literature has concluded that homework has little to no effect size at the elementary student level, but a higher effect size at secondary grade levels [1, 6]. The debate continues with recent articles and opinions about the importance of homework in the national spotlight.[7-9] Most of this homework or no homework debate surrounds the elementary through secondary school ages. The effect size grows at the higher grade levels and therefore you could assume that tertiary students will have a greater benefit from homework and especially students in engineering technology programs.

Most of the current work with tertiary students and homework revolves around the use of online homework tools.[10-15] This work follows closely with the work on learning management systems (LMS)[16] where much of the content of a course is available on the internet. Physics[10-13, 17] has done much of the work in this area with respect to online tools revolving around homework. Bonham[10, 13] showed how students that did online homework scored better on the homework and associated tests over students that had paper homework in physics courses. Mestre et al.[12] showed how physics students spent more time per week on online homework than on paper and pencil homework. The online homework tools have been tested at the elementary level as well and Mendicino et al.[18] showed that "students learned significantly more with Web-based

homework than with paper-and-pencil homework, and the effect size we reported of 0.61 is large compared to other possible interventions shown in an in-depth study of the effect sizes of more than 100 classroom innovations accumulated from thousands of studies."

The use of homework has been studied in the engineering fields as well. A specific example dealing with a statics course and the students perceptions[15] showed different results for different semesters, but concluded that students like multiple attempts, want to work at their own pace, receive immediate feedback, and receive detailed feedback about mistakes. Statics is an introductory mechanics course that teaches students the foundations of Newton's Laws of Motion. Some people see this course as a "weeder" course that eliminates poor students from good students.

The statics courses used for this study were flipped courses taught in the manner of reference.[19] The content was provided to the students through online audio and video with interactive pdf files. Each of the classes used for this study incorporates online homework submissions that are recorded by a LMS. The online homework assignments are made of multiple problems related to the material covered. Figure 1 shows an example of one of these assignments. A figure is shown and the question requests a value from the information provided in the figure. The LMS is used to record student actions, student responses, and provide feedback on homework submissions. This example problem is similar to an assignment that would be assigned from a textbook where a student submits the solution on paper for a grader to review and grade. Using the LMS eliminates the need for a grader for most problems and provides a mean for implementing try-again feedback.

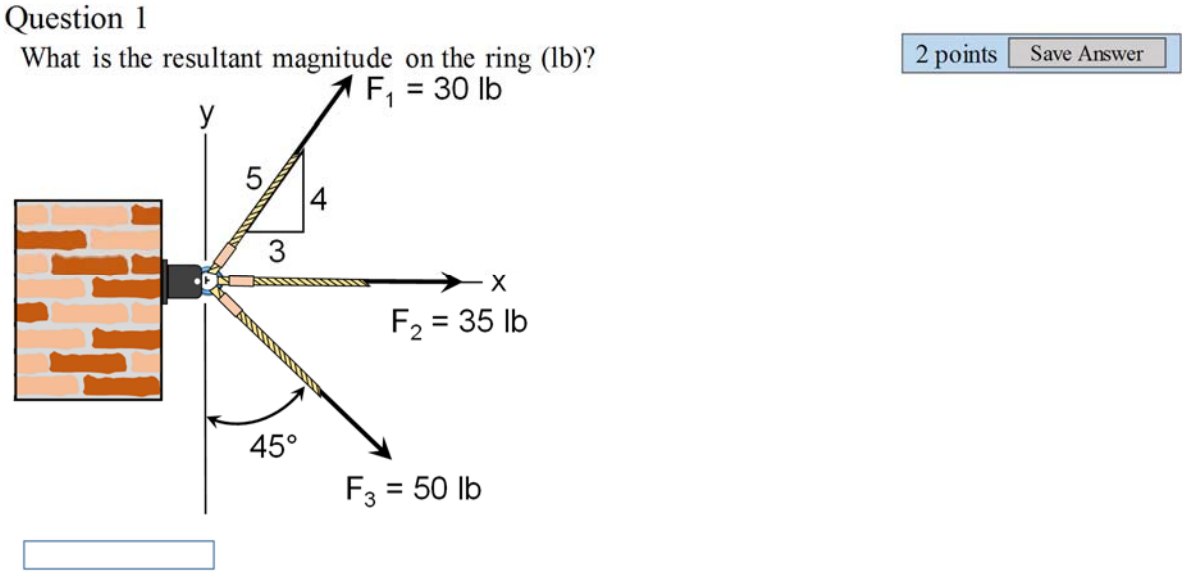

Figure 1. Example problem provided to the students using a LMS with a block provided for the students to supply a numerical answer.

The courses use try-again feedback[20] where the students are able to work on the assignments until the due date and only receive the answer key to the homework once the due date is past or once the student has obtained 80 percent of the answers correct. The 80 percent rule is

implemented by the instructor to assist students with learning as the instructor expects that some problems will be more difficult for a student to grasp without some assistance. The student must answer all of the questions for each submission because the LMS does not differentiate between the problems for separate submissions. This type of feedback allows the students to use different strategies and use different avenues to complete the assignments. Some students use the homework to learn the material. Other students see the homework as a task that needs to be completed for that portion of the grade and sometimes use other students or the solutions manual to finish the assignments. An Institutional Review Board (IRB) reviewed this study and allowed the data to be extracted from the LMS. This paper will discuss the different strategies seen in the students' homework submissions using try-again feedback for assessment and provide suggestions for future work in this area.

Results and Discussion

The data from this study was taken from two separate statics courses taught two different semesters in a mechanical engineering technology program. One class was taught in the spring semester of 2013 and had nine total students. The other class was taught in the spring semester of 2014 and had nine total students as well. Therefore this study contains 18 total students where the courses were taught in the exact same manner with the same homework problems and different examinations. Blackboard[21] was the LMS used for this study and this LMS saved each of the students homework submissions, each submission time stamp (when the student began the assignment and when the student submitted the assignment), and the overall grades.

Five data points were extracted for comparison purposes from the homework submissions and the test grades for this study. The data included the average test grades (grades are assumed to show understanding of the learning objectives), the average homework score, the total homework score percentage of problems answered correctly just before obtaining the 80 percent HW score (when solutions are released), the average number of times worked on a homework assignment, and the total average time spent on an assignment in the LMS. Each student had four test grades for the entire semester, including the final exam, and each student had 14 homework assignments. Table 1 shows all of the average data points for this work. The data for student number 9 was not recorded when the data was de-identified for the occurrence and time data as shown below in the table.

The effect size (Pearson r)[22] calculation was performed between all of the data recorded in order to view any correlational relationships. Student 9 data was extracted from the calculation when the occurrence and time data were analyzed. The largest relationship occurred between the average homework score and the number of times working on the homework and the time spent on the LMS homework assignment. The effect size between the average homework scores and the number of times spent on the homework was 0.46, but the effect size between the average homework scores and the time spent on the LMS system was -0.41. These values imply moderate correlation and that when students worked on their homework on numerous occurrences; they perform better on the homework. The effect size between the average homework score and the test grades was -0.1, the effect size between time spent on homework and test grades was -0.03, and the effect size between the number of times spent on each assignment and the test grades was -0.25. These values are weak to moderately weak and do not

indicate a relationship between the homework and how well the students did on the test and therefore the learning objectives of the course.

Table 1. Average test scores, average homework scores, average homework scores just before obtaining 80 percent, average number of times worked on the homework (occurrence), and average time spent in the LMS doing the homework assignment.

	Test	score	score < 80	occurrence	time (min)
student 1	86.8	78.3	58.6	1.8	22
student 2	78.3	60.4	55.0	1.9	74
student 3	92.3	65.0	66.0	2.2	49
student 4	67.5	74.2	28.3	1.3	14
student 5	80.5	80.0	77.5	2.5	48
student 6	71.3	97.1	59.2	2.4	32
student 7	63.5	99.2	63.8	4.3	32
student 8	79.8	55.8	42.0	1.0	37
student 9	35.8	46.7	63.3	N/A	N/A
student 10	64.3	76.7	57.9	2.0	12
student 11	85.8	94.5	60.5	2.0	14
student 12	75.8	91.7	55.4	2.4	53
student 13	66.5	94.2	52.0	2.6	43
student 14	83.3	100.0	72.5	1.0	14
student 15	89.5	100.0	75.0	1.3	110
student 16	60.8	71.8	69.3	1.5	60
student 17	83.5	91.7	70.0	2.3	35
student 18	76.0	100.0	34.2	1.9	58

The results presented here show that student performance on the homework has a very weak correlation with how well the students do on the exams and therefore the learning objectives. This result could be caused in this course by the students having time before taking a test to review the actual homework solutions, ask the teacher additional questions, and do additional example problems. There is a moderate correlation between the homework scores and the number of separate times spent on the homework. This correlation follows that students have time to ask for help and therefore return to the homework and repeat the assignment because of the try-again feedback used with these assignments. There is also a moderate correlation between the time spent on the homework and the average homework score. The more time spent on the homework indicates that the homework score will typically be lower. This correlation may be flawed because the recorded time only records the time that the students are actively in the LMS. Students may be working on the problems when the LMS is not recording. Future work should use a scenario where the students are forced to be actively on the LMS during the assignments in order to verify this correlation.

Each homework assignment was provided to the students over a week's duration. The occurrence numbers from table 1show that the average number of times students typically spend per week working on the assignments is 2 times per week. This low number may be because the students are only on the homework problem portion of the LMS that number of times per week, but they are reviewing the material or the problems from the text at other times during the week

as well. Future work will take into consideration the time spent on other activities (access to notes, etc.) in the LMS when analyzing this data to verify if students are spending just a couple times a week working on this content.

The effect size between the homework score less than 80 percent and the average homework score is 0.35. The effect size between the homework score less than 80 percent and the test scores is 0.26. These values are moderately weak, but there could be a small correlation between how the students learn the material using the try-again feedback that needs to be studied in greater depth. Every student had the same homework assignment and therefore students may have been working together and checking the answers on one student's LMS access with the try-again feedback. Therefore, the other student would have lower scores on the pre-80 percent that would affect these results. Future work could check the relationship by giving all students individual problem sets that requires all students to check their scores with the try-again feedback individually.

The next set of data that was analyzed was with respect to the try-again feedback and the students receiving the solutions once 80 percent of the answers were submitted correctly. The hypothesis here is that the students that want to learn the content will continue working on the assignments after obtaining the 80 percent score and not just insert the answers once they receive the homework solutions. Table 2 shows the data for the reactions of the students to the homework submission feedback. The single submission means that after the students obtain at least 80 percent and less than 100 percent, the students only submit the assignment one additional time to obtain 100 percent credit. The multiple submissions refer to students that submitted the assignment multiple additional times after obtaining at least 80 percent and less than 100 percent. The perfect submissions refer to students that submitted all correct answers before obtaining the 80 percent mark. The "< 80 %" refers to students that did not obtain the 80 percent mark for the assignment. This data shows that few students had a perfect submission for any of the assignments and that many of the students did not get the 80 percent mark.

Table 2. Homework credit for each assignment based on when students obtained full credit after getting 80 percent of the answers correct and obtaining access to the homework solutions.

HW assignment	1	2	3	4	5	6	7	8	9	10	11	12
single submission	15	9	9	6	7	6	7	6	9	5	7	14
multiple submissions	0	0	5	0	3	4	3	3	3	9	1	0
perfect submission	2	1	1	3	1	0	1	1	2	1	3	3
< 80 %	1	8	3	9	7	8	7	8	4	3	7	1

The results from Table 2 show several different conclusions. First, on assignment 4, 50 percent of the students did not obtain the 80 percent mark and therefore did not have access to the solutions before the due date. This value implies that at least 50 percent of the students were not receiving the answer keys from classmates that had previously finished the assignment. Second, 67 percent of the time, students obtain a perfect score right after obtaining the 80 percent mark. Typically students left the harder questions to complete last and therefore students would

typically stop working on the assignment after obtaining the 80 percent mark and submit the solutions from the answer key. This procedure was verified during conversations with the students when they consider "40 percent" being half way complete. Only 21 percent of the time would students have additional attempts after obtaining the 80 percent mark which is considered when the students are working on the homework to learn the concepts. Along with this assumption, 13 percent of the time, students obtain a perfect score on the initial attempt. Honesty issues could play a role in these results because the test scores do not typically indicate understanding of the learning objectives to get a perfect score on the homework. Therefore, many students appear to see the homework as something that has to be completed for the grade and not as something to help them learn the content.

Conclusion

The results show that there is no correlation between how students perform on homework and how well they do on exams in a freshman statics course in mechanical engineering technology. These results may be caused by the way the class is set up being a flipped course and using try-again feedback on the homework assigned. The data did show that students only spent an average of 2 times a week working on homework assignments. This low number of attempts for a foundation class may be problematic and needs to be addressed for future classes. Repetitive exposure to the topic will increase the students understanding of the material and needs to be implemented for this foundation course.

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