AC 2012-3375: WORK-IN-PROGRESS: INITIAL INVESTIGATION INTO THE EFFECT OF HOMEWORK SOLUTION MEDIA ON FUNDAMENTAL STATICS COMPREHENSION

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Work In Progress: Initial Investigation into the Effect of Homework Solution Media on Fundamental Statics Comprehension

Introduction

Solutions to homework assignments are provided in many engineering science classes as a method of helping students see a "correct" solution procedure for the assigned problems. This work-in-progress reports on an initial investigation into providing homework solutions in different media. Specifically, homework solutions are presented as static screenshots of a completed analysis (Treatment 1) and annotated videos of the analysis being developed (Treatment 2). Student performance on a pre/post Statics Concept Inventory is used as a measure of the effectiveness of the two different homework solution treatments. Treatment 1 has been administered once and Treatment 2 has not been administered at all, so this paper is presented as a work in progress.

Background/Justification

The pedagogical theories that underlie this study are the existing work on a Statics Concept Inventory[1,2] and highly-guided instruction[3]. The Statics Concept Inventory (SCI) is used as a measure of student learning of fundamental statics concepts. In this study, an electronic version of the SCI (located at http://dev.cihub.org, currently in beta) was used. The SCI was administered both at the beginning of the course and near the end of the course, measuring student performance gains.

The hypothesis underlying this study is that students will better learn the fundamentals of an analysis-type course if they can see solutions to typical problems being developed instead of just the completed analysis. If students watch the solution being developed, they can predict the next steps, think about what their analysis would look like, and check their solution step-by-step. If students have access to a completed analysis, they would be more likely to just check the "final answer" instead of checking the individual steps of their analysis. Additionally, watching an expert problem-solver (the instructor who prepares the solution) approach a problem can help students develop their own problem-solving strategies[3]. This instruction by example could be particularly effective if the rationale behind particular analysis steps, assumptions, and equations being used is given to the students (through written comments in the margins or audio commentary).

Method/Details

The participants in this study were undergraduate students enrolled in a first year required course "Statics and Mechanics of Materials". Students were given access to the homework solutions (using the standard course management software, Angel) after the respective assignment was due. The homework solution provided was varied between a static homework

solution (a simple PDF of a completed problem analysis from the instructor's tablet PC, Treatment 1) and an annotated video of the homework solution (a screencast of the instructor's tablet PC showing the problem analysis *as it develops*, Treatment 2). See Figure 1 for an example of a static homework solution. The annotated video of this homework solution consists of the lines of the solution appearing one by one, with a few seconds delay between each step. Therefore, the information presented is identical between the two treatments.

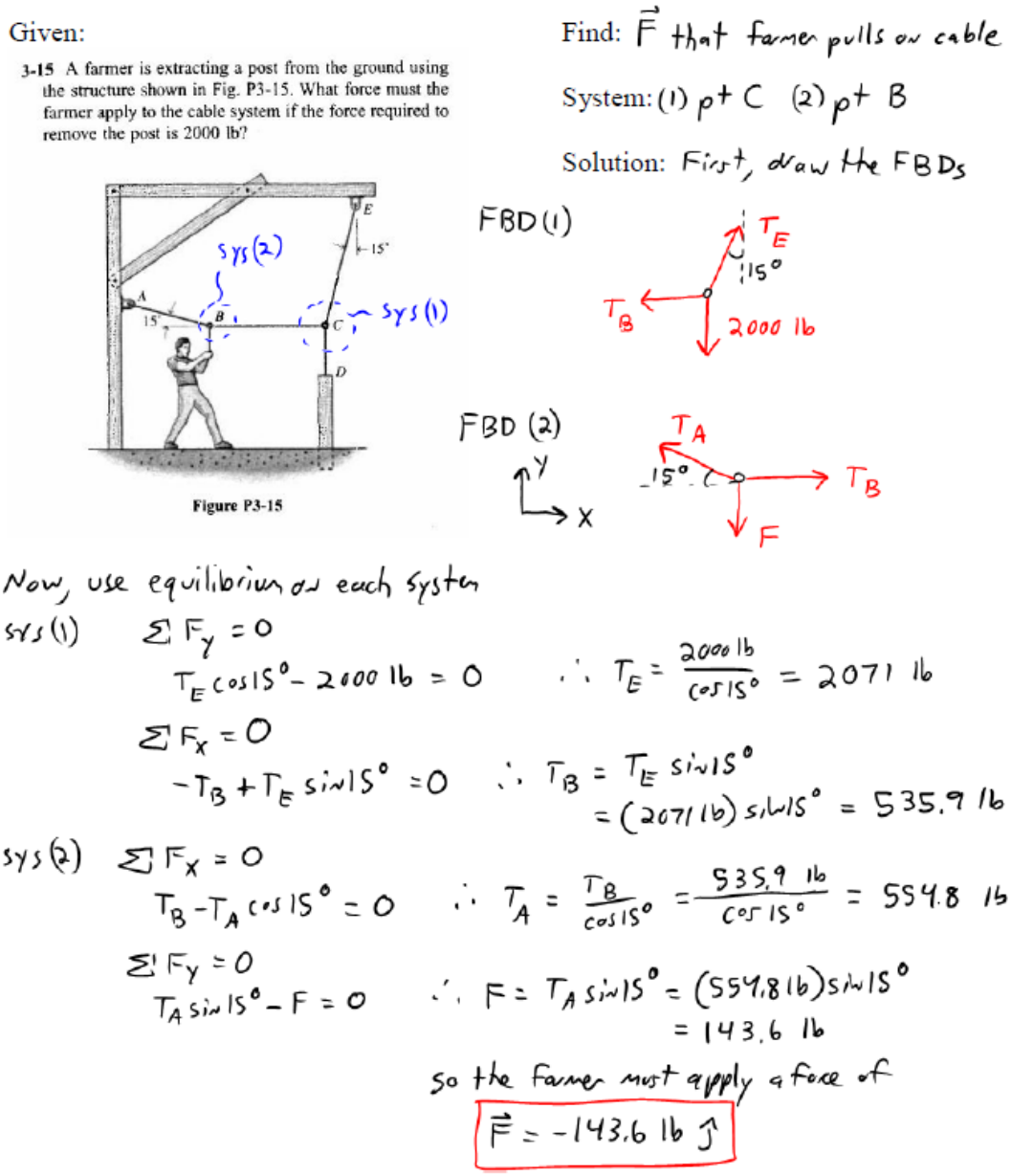

Figure 1. Example static homework solution (Treatment 1)

The static homework solution and the annotated video were both posted on the online course management site where students log in to access the solutions. The annotated video was encoded into a standard format that allowed embedded viewing in the student's browser. The change in homework solution format occurred between two different class offerings (no class received both treatments).

Assessment of the impact of these homework solutions was performed by administering a Statics Concept Inventory near the beginning and end of the quarter. The intent is to compare improvement in scores of students, specifically those who did and did not access the different homework solution formats. However, the small sample size made comparisons difficult. Additionally, the small sample size made using demographic information difficult because of confidentiality concerns. Future studies involving more students may be able to uncover demographic differences in the student response to the homework solution media. In addition to the Concept Inventory scores, the results of a self-reported student survey asking about student's attitudes towards the homework solutions are presented.

Students were not required to view the homework solutions. This may introduce a self-selection effect where the strongest students access the solutions the most and experience the largest gain on the post-course SCI. However, the main comparison being made in this study is between the two different solution formats. The highly-motivated student will likely use the resources available, regardless of format. Comparison between the results of the two treatments will still be possible even if some students do not access the solutions at all.

Due to a change in expected course assignments, the author will not be able to administer Treatment 2 until after the conference presentation. However, other instructors of Statics and Mechanics of Materials have agreed to administer both treatments in their courses this Spring (one treatment to each of their two sections). This expansion of the study should result in around 220 students participating in both treatments for the 2011-2012 academic year. In addition to a larger sample size, involving other instructors will help generalize the results to variations in teaching style and classroom interactions. It is expected that an initial analysis of around 200 students will be completed in time for the conference. This analysis should include initial results of the pre/post SCI differences between the two treatments.

Results

Treatment 1: Static Solution

Treatment 1 was administered to a section of 28 students during the previous Fall quarter. The students who consented to be included in this study and who answered the surveys totaled 18 students. Students having access to static homework solutions took a statics concept inventory at the beginning and the end of the course. There was a statistically significant increase in student scores between the two (pre- and post-) test administrations. The average score on the pre-SCI was 28.88% while the average score on the post-SCI was 44.69%. While this result does

not reveal anything particular about Treatment 1, it does show that the material on the SCI overlaps with the material covered in the Statics and Mechanics of Materials course, although not completely.

Student records of log in to each homework solution posted in the course management software were compiled and correlated with their reported access on the course survey. Students accessed the homework solutions an average of 4.4 times over the course of the term. There were approximately thirty assignment solutions posted, so on average the students accessed the solutions much less than once per assignment. Interestingly, their actual access (as recorded by the course management software) was not significantly correlated to their reported access, but does appear to follow the pattern of reported usage presented in Table 1. Students appear to view the solutions as a method of preparing for exams (28%) while only a few students review most assignments (6%). The lack of correlation between the student's reported access and their actual access suggests student recollection of the frequency with which they accessed the solutions is inaccurate.

Table 1
Frequency of Homework Solution Access
Fall 2010 (N=18)

Approximately, how often do you review the homework solutions posted on the class Angel page?	
A few times per quarter	39%
Once every other week	6%
Once or twice a week	11%
For most assignments	6%
Only before exams	28%
Never	11%
Why do you review the homework solutions on Angel?	
To review for an exam	83%
To check your homework	73%
To review for the concept inventory	0%
Other	6%

Near the end of the term, students were asked to complete a survey regarding the static homework solutions. The survey included both quantitative and qualitative questions. The student responses to quantitative questions regarding the homework solutions are given in Table 2. There were no significant correlations between frequency of solution access and quantitative survey responses. Only 2 students (11%) reported never accessing the homework solutions. Therefore survey responses could not be compared based on students who did and did not access the solutions.

Table 2
Frequency of Response
Fall 2010 (N=18)

	Mean	Strongly Agree	Agree	Neither Agree No Disagree	Disagree	Strongly Disagree
The homework solutions are easy to follow.	4.11	22%	67%	11%	0%	0%
The homework solutions help me to understand the proper solution method.	4.22	33%	57%	11%	0%	0%
The homework solutions help me understand the course material.	4.00	22%	56%	22%	0%	0%
I know where to access the homework solutions.	4.50	56%	39%	6%	0%	0%
The homework solutions are easy to access.	4.33	44%	44%	11%	0%	0%
A video explanation of the homework solution being developed would be more useful than the pdf.	3.72	22%	50%	17%	6%	0%
I have greater understanding of the basic fundamental concepts because of the homework solutions.	3.39	6%	28%	67%	0%	0%
I have greater understanding of the basic fundamental concepts because of the examples worked in class.	4.33	50%	33%	17%	0%	0%
I have greater understanding of the basic fundamental concepts because of doing the homework.	4.11	28%	61%	6%	6%	0%
I have greater understanding of the basic fundamental concepts because of another aspect of class not previously mentioned.	3.28	0%	33%	61%	6%	0%

The responses overall paint a picture of students appreciating the static solutions to the homework. When grouping "strongly agree" and "agree" together, students found the solutions easy to follow (89%), helpful for understanding the course material (78%), and easy to access (88%). A majority of students (72%) felt that a video explanation of the solution would be more useful than the static solution, providing support for the usefulness of implementing Treatment 2. When asked about which aspects of the course helped their understanding of basic fundamental concepts, 89% of students identified "doing the homework" as useful, 83% identified "examples worked in class" as useful, and one-third of the students reported the homework solutions and "another aspect of the class not previously mentioned" as useful. This "other aspect" included in-class demonstrations, concept questions, small group work, lectures, and tutors.

The survey also included qualitative questions regarding the static homework solutions. When asked what students liked most about the posted homework solutions, common responses included the immediacy of the feedback (that the solution was made available before the submitted homework was graded), emphasis on the solution process steps, showing the correct solution format, and that they were great tools to study for the exam. The least liked aspect of the posted homework solutions was that occasionally the reason behind a solution step was not clear or the process was hard to follow.

Finally, students were given a chance to give general comments on the homework solutions. Students expressed a general appreciation for the resource, although a few responses indicated that some students never used the solutions.

Unfortunately, there was not enough variability in the amount of access to the solutions to determine if there was a correlation between viewing the solutions and pre-/post-SCI score

improvement. Even though the statistical significance of the static homework solutions cannot be determined, the qualitative comments paint a picture of students appreciating and using the resource. A larger sample size should make statistical analysis possible. However, the fundamental usefulness of written-out homework solutions has been demonstrated, at least qualitatively. It will be interesting to see if the video homework solution gathers a similarly strong, or possibly stronger, qualitative response from the students.

Treatment 2: Annotated Video Solution

This procedure and assessment will be repeated in a future term where students will be given access to annotated videos of the homework solution as it develops. Their access of these video solutions will compared to their pre- and post- test SCI administrations. The same survey will be given to determine if students have different attitudes towards video solutions as compared to written solutions.

Time Commitment of Video Solutions

One common concern of faculty about video solutions is the time commitment required to develop them. After some initial efforts getting used to the tablet interface and the operation of the screen-capture software, developing video solutions can take up to twice as long as developing the written solution, at least for this author. Of course, this additional time depends on how many steps are involved in the solution as well as how much time is spent "pausing" between steps. The largest factor in the additional time of developing the video solution is the number of steps. A problem involving finding the moment about a point due to a single force at a known distance will take much fewer steps to complete than a problem involving force analysis, moment analysis, and complicated geometry. Thus, making a screen capture of the simpler problem will be faster. As one might expect, adding audio commentary to the screen capture adds more time to the solution development.

Conclusion/Future Work

This investigation into homework solution format will continue. Specifically, the annotated video solution treatment will be given in the future. The author will study if frequency of access to the video solution is correlated to improvement in SCI score. Future investigations are planned to determine if the audio commentary (as compared to written parenthetical comments) adds significantly to the student benefit. Finally, detailed studies of the extra time required to develop annotated video solutions are planned to help understand the cost/benefit ratio of developing this resource for students.

References

[1] Steif, P. S., and Dantzler, J. A. (2005). "A Statics Concept Inventory: Development and Psychometric Analysis." Journal of Engineering Education 94 (4): 363-71.

[2] Steif, P. S., and Hansen, M. (2006). "Comparisons Between Performances in a Statics Concept Inventory and Course Examinations." International Journal of Engineering Education 22: 1070-76.

[3] Kirschner, P. A., Sweller, J., and Clark, R. E. (2006) "Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching." Educational Psychologist, 41 (2): 75-86.