

Using the Mastering Engineering Homework Online Tool in the Circuits Course: Advantages and Shortcomings

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Abstract

In an era where countless debates are taking place about new ways the digital-native generation of students learn and grow, techniques such as online homework tools are being offered by several editors, and have been improved throughout the last few years to best serve problem solving skills and improve students learning outcomes. In this study, we used the Pearson *Mastering Engineering* homework online tool in the electrical circuits' class as a trial in the homework that covers the RL/RC natural, step response, and sequential switching, which is one of the most challenging parts of the circuits' course. Students' performance in the homework was monitored and a survey was administered to get students' feedback on using the *Mastering Engineering* tool. The final exam included one problem on RC switching, and performance was correlated to the results of the homework.

Background/Introduction

Homework is a critical part of college education. It is the primary tool to enforce the learning taken in class. Instructors spend a big portion of their time creating new homework and writing their solutions. For effectiveness, homework assignments usually have to be updated every semester to avoid having students use old posted solutions. Nevertheless, many students find ways to cheat using solutions provided by sites such as *CourseHero*, or *Cramster* [1]. The good grades in homework give them the false impression that they are performing well in the class, until the exams come, and many are deceived. Instructors have long struggled to find ways to make students learn in a more efficient way, and homework remains a big dilemma suggesting that its practices should change. New teaching styles have been blossoming during the last few years, such as the flipped classroom where homework is no longer a work done at home [2]. There are however arguments about potential disadvantages of such pedagogy [3]. With the spread of the internet came homework online tools, such as WebAssign a tool created by Dr. Risley of the University of North Carolina in 1997 [4] and WeBWorK an open source online homework system [5]. While not very common in Engineering, online homework tools have now been used by instructors for over a decade, especially in math, physics, and chemistry classes [6,

7]. There are several reasons why these online tools are attractive: First, they save grading time, a hard-to-resist quality especially for large classes. Second, they provide immediate feedback to students, unlike in the case of paper homework where they have to wait at least a week before they get a chance to know what they did wrong; which in most cases comes at a time students are already dealing with new concepts in class. Online tools can also allow students to end up getting a high homework grade if they are given several chances to enter their results online. Third, the problems' variables being changed for each individual, allow less chances for them to copy from their peers. In this study, we test "Mastering Engineering" (ME), the Pearson online homework tool in an electrical Circuits class for homework dealing with the sequential switching in RL, and RC circuits, a part of the course that is historically known to be troublesome to most students. Grades were recorded and compared later with the scores on an RC switching problem in the final exam.

Experiment

After covering the chapter dealing with step response of RL and RC circuits and solving related circuits with sequential switching (2 or 3 switches open at specific times which changes the circuit response at each of the switching, and the question usually asks to find the expression of current or voltage as a function of time) The *Mastering Engineering* tool settings can be adjusted by the instructor. For instance the number of times allowed for responses. There is also a deduction of points if the student asks for hints to answer the question. Each student gets different numbers, and even problems are not in the same order, which leaves very little space for copying from peers. In order to eliminate any effects of instructor or peer pressure (or impression of pressure) on students, the responses were made completely anonymous. We used surveymonkey.com to collect the data.

The following are the questions students had to answer:

- 1- How prepared did you feel when starting your homework using the Mastering Engineering tool?
- 2- How easy was it to use mastering engineering to solve circuit problems (compared to paper homework)?
- 3- How clearly did Mastering Engineering present the problems/questions?
- 4- How much did the Mastering Engineering tool help you develop critical thinking skills?
- 5- How helpful were the hints provided in Mastering Engineering (if you used them)?
- 6- How effective was Mastering Engineering in teaching you more about RC/RL switching (in other words did you feel you improved your understanding of the material?)
- 7- Based on your experience using it, what are in your view the greatest strengths (if any) of Mastering Engineering?

- 8- Please describe the greatest weaknesses (if any) of Mastering Engineering.
- 9- If you were given the choice, would you have chosen Mastering engineering as your homework tool in this class?

For question 1 thru 6, students were supposed to choose a rating of 1, 2, 3, 4, or 5. While for questions 7 and 8 students were asked to narrate their opinion in a few lines. Finally question 9 had 4 options for answers: “Definitely yes”, “Maybe”, Neutral, “I would prefer to avoid”, and “No! please no!”. A total of 32 students participated in the study.

Results and Discussion

Figure 1 shows students previous familiarity with the Mastering Engineering tool. 27 out of 32 students felt at least somehow familiar with the tool. The reason being because the physics class that is the prerequisite for circuits uses a similar tool called “Mastering Physics”. Figure 2 shows students’ rating on how easy it was to use the Mastering Engineering tool. Contrary to the familiarity with the tool (~84%), the easiness of use was not evident. About 50% of students rated it at 2 or less.

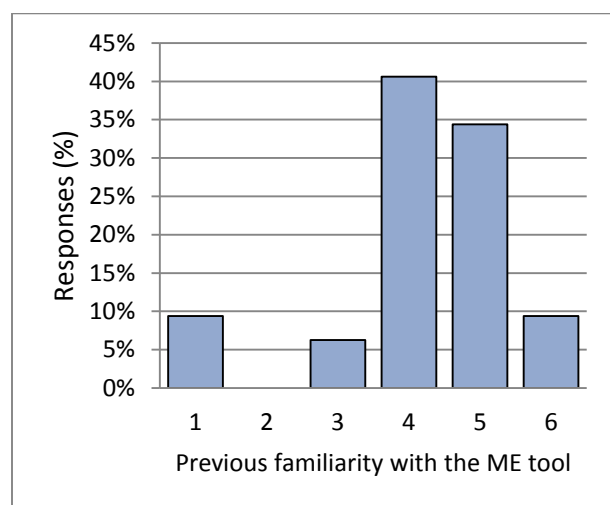


Fig. 1. Previous familiarity with the online homework tool used.

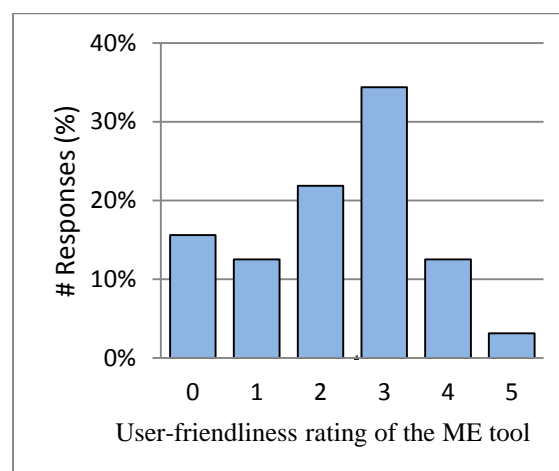


Fig. 2. Easiness of using Mastering Engineering.

Figure 3 shows students’ rating of the clarity of questions presented in the homework. As expected, this graph slightly matches the graph depicting the easiness of the tool (the clarity of questions affects students perception of easiness of using the tool). When asked about the major advantages in using Mastering Engineering, the top answer (~28%) indicated the “instant feedback” feature of the tool (Table 1). That is no surprise since students are usually frustrated when they can’t see their copies (and the homework solution) soon after the homework. They like to know what went wrong right away; specifically when exams get close. The ME tool also offers students hints to answer questions if they ask for help. About

22% of them rated the hints to be a major advantage, while 19% liked the step-by-step guidance in answering questions. Only 9.4% thought the tool was good because it prevented students from cheating. Figure 4 shows students' rating of critical thinking. Over 68% believe that the ME tool pushed them to think critically. While we have not compared this rating with ratings they would have given about a regular pencil and paper homework, we can assume that the student, being alone in front of a screen is better isolated to think critically, as opposed to traditional ways where students often stop to ask a peer about a problem, instead of trying to solve it all alone. Hints were appreciated by most students, but about 20% of them thought that hints were useless or had very little value (rating of 0 or 1 in Fig. 5), probably due to a lack of clarity.

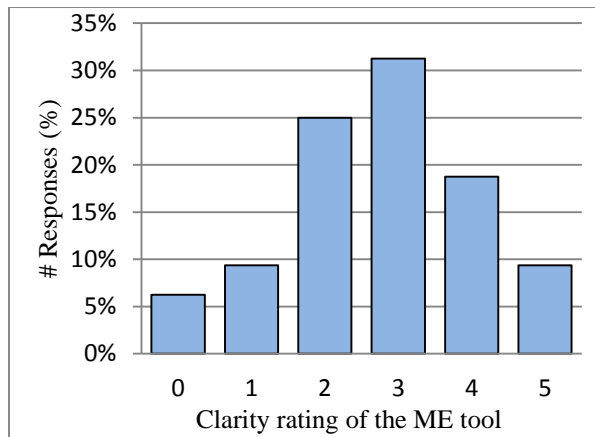


Fig. 3. Clarity of question in ME.

| Advantages of using ME | % Responses |
|------------------------|-------------|
| Instant feedback | 28.13% |
| Hints | 21.88% |
| step by step guidance | 18.75% |
| None | 12.50% |
| No cheating | 9.38% |
| other | 9.38% |

Table 1: Advantages of using the ME tool.

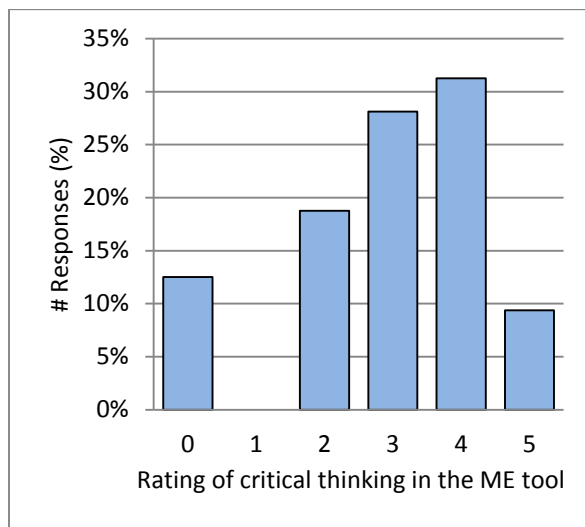


Fig. 4. Students' assessment of critical thinking in the ME tool

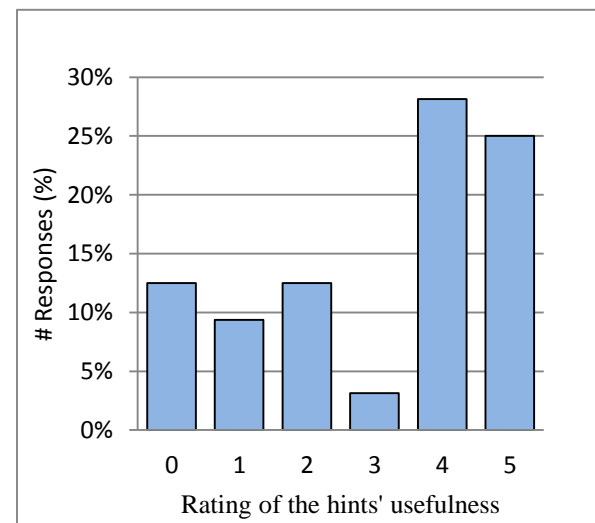


Fig. 5. Ratings of the "hints" feature help.

Table 2 shows the major weakness of the ME tool listed by students. The total percentage is greater than a 100% because few participants provided two or more weaknesses. The major issue listed by 40% of students is related to inputting the answers. Sometimes the answer is right, but the user may use an additional decimal or enter the wrong symbol for a unit. The ME tool only accepts the answer as programmed by the homework designers. This is in our view a big issue, and the origin of all frustration observed among students when they came to seek help during office hours. Finally, when asked if they would be interested in using the ME homework tool in the future, over 59% did not reject the idea versus the 41% who would rather not deal with it.

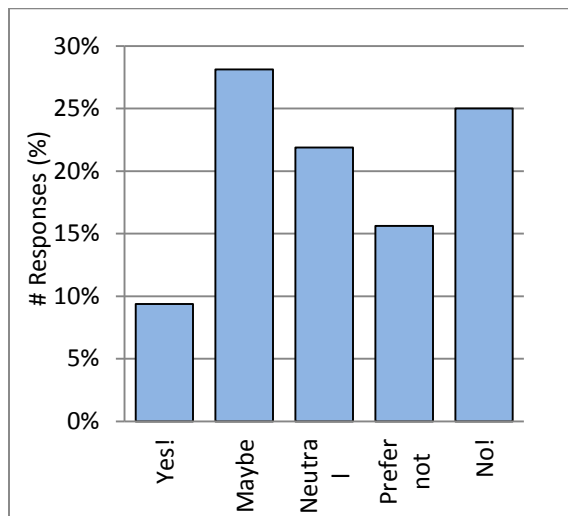
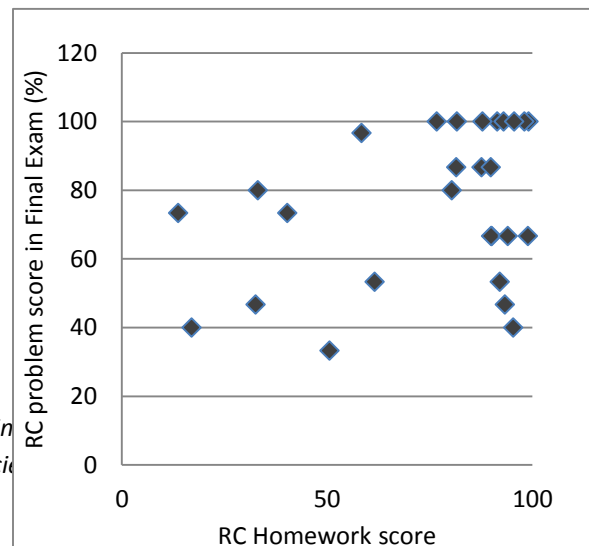


Fig. 6. Students opinion on using the ME homework tool in the future.

| Weakness | Responses |
|---|-----------|
| Issues with inputting the answers | 40.63% |
| Time consuming | 18.75% |
| Unclear in general | 12.50% |
| No partial credit | 9.38% |
| Points deduction for trying | 9.38% |
| Not user friendly | 6.25% |
| None | 6.25% |
| No advice received (what did I do wrong?) | 6.25% |
| Everything | 6.25% |

Table 2: Major weaknesses of the ME tool.

We wanted to look for any correlation of the homework results to the results obtained in the final exam. Figure 7 shows the scores obtained in the final exam versus the average score of all homework assignments (paper and pencil type), while Figure 8 shows the score of the problem in the final exam specifically covering RC circuits, versus the homework # 6 scores (the one done online). In both figures we see little correlation between homework and exam. However, there is a small number of students (7) who scored high (above 85%) in the homework and below 65% in the corresponding problem in the final, which usually happens when using regular homework.



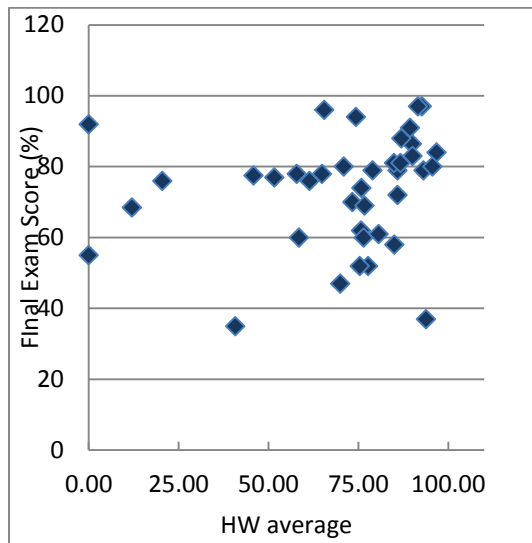


Fig. 7. Final exam scores vs. total homework average

Fig. 8. Scores of the RC problem in the final exam versus homework 6 scores. HW 6 (RC) was done using the Mastering Engineering tool.

Conclusion

We tried *Mastering Engineering*, an online homework tool, for the first time in our circuits' course by targeting the RL/RC natural, step response, and sequential switching. Students' feedback was collected and analyzed and their performance tracked in the final exam. The tool has several advantages such as the instant feedback, the hints and the individualized character that prevents cheating. While some of the disadvantages included the difficulty in using the tool, specifically inputting results, or typing complex formulas. The correlation to results in the final exam was not much different than the case of paper and pencil homework. There was a slight irritation of most students with using this tool, but majority of them didn't reject the idea of using it in future classes. A longer term use of this tool, with a larger data might lead to further findings.

References

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