



## **Assessment and Analysis of Learning via a new Approach! Teaching Electrical Circuits course by Mastering Engineering**

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# Assessment and Analysis of a New Learning Approach Teaching Electrical Circuit Courses via Mastering Engineering

## Abstract

Teaching electrical engineering circuits to undergraduate non-electrical engineering majors such as Mechanical Engineering students is a challenging and motivating adventure. The basic circuit concepts are long-standing; Ohm's laws are centuries old but still students struggle to solve problems involving the application of Ohm's laws when incorporating it with other ideas. For example, in the node voltage analysis, estimating the currents entering and leaving a node using Ohm's law is sometime problematic to students. Exploring new techniques for teaching electrical circuits is a continual journey. For our part, we have introduced Mastering Engineering online problem solving and answering approach for electrical circuits with the intent to improve students' learning skills and mastering circuit concepts.

This online assignments have video based coaching problems, tutorials with hints to guide students to learn the electrical circuit concepts and regular text book end of chapter homework problems. As part of the course requirement, students are assigned to do the conceptual problems to self-learn and to do more advanced problems to master the concepts. This mandatory requisite makes them learn the chapter-materials in more in-depth. The aim of this study was to determine whether this tool will indeed help students to learn the course materials to their own as well as to their instructors' satisfaction.

This report will present information about the Mastering Engineering approach used in our sections and the weekly workload assigned to students. The study will present the average time spent by students for each assignment, individual problems, and the total time spent by students to do the assignments. In addition to this work, at the end of the semester, a survey was done to see how much mastering Engineering helped our students to master the course materials. About hundred students, from two different sections participated in the survey. The data was analyzed using a spreadsheet and the outcome will be reported in this paper. This particular study was done for electrical circuit course taught to non-electrical engineering students. The electrical circuit course for non-electrical engineering students is a challenging task. The course covers mainly circuit analysis using various laws and theorems, and applications of electrical engineering, such as AC circuits and electric power, magnetic circuits, transformers, and rotating machines.

## Introduction

Incorporating online based techniques with traditional teaching is an interesting idea and is in practice at several institutions<sup>1-4</sup>. How these activities impact learning varies<sup>5-9</sup>. Like other colleges, at our institution most of the mechanical engineering students take electrical engineering circuit courses. As part of the electrical engineering circuit course requirement, weekly homework assignments were given. Grading homework assignments submitted by a large student body by Teaching Assistants is not practical. To deal with this issue and provide immediate feedback on homework, the online tool called Mastering Teaching Online<sup>10</sup> (Mastering Engineering<sup>11</sup>) was used. An online platform was developed by the Pearson

publishing company. In order to get access to a particular course site to do assignments and other activities, student and/or faculty need to have course IDs assigned by Pearson for that particular course. This is a reasonably new approach to deal with same old circuit problems. The Mastering engineering has three interesting features, coaching problems, tutorials, and chapter problems. Mastering Engineering is offered by Pearson publishing. Studies to determine the effectiveness of this system recommend that additional information is needed<sup>10</sup> to evaluate it. Since this is an important study to determine the effectiveness of mastering Engineering, publishing this work will help and guide its future users.

In coaching problems, video based demonstrations were used to introduce the concepts and students were asked questions based on that. Even though more chapter problems were given each week compared to the coaching/tutorial problems, the effect of the latter was important and motivated students to explore the next level of problems with the help of the hints provided by the Mastering Engineering.

The assignments help students to master several important concepts related to electrical circuits and circuit elements: current, voltage, power, resistors, capacitors, and inductors and circuit analysis using Kirchhoff's laws. Selected topics introduce a variety of applications of electrical engineering, such as AC circuits and electric power, transfer function analysis, Magnetic Circuits and transformers, and DC machines.

### **Teaching Approach**

The course was structured as follows; each week consisted of three sixty-five minute lectures, and a lab, which was taught as a separate course. Syllabus for the course was provided at the beginning of the semester. Students were expected to read the concepts of the chapters before it was discussed in class. Video demonstrations and tutorials were used to help achieve this objective. The problems were slightly less complex than those assigned in the class defined as end of chapter problems. The number of problems varied from assignment to assignment and was based on the content of the chapters.

During the problem discussion time, the faculty helped students to clear their concerns and understand the problems well. Twenty five-minute weekly quizzes were given based on the chapter concepts. Better understanding of the homework problem aided the students to do well in the quizzes.

### **Data Analysis**

The survey was done at the end of the semester, so the students had a clear opinion and were able to answer questions on mastering engineering. Seven survey questions were asked (see appendix A). Over one hundred students took part in the survey from two different sections. The data obtained for each question was analyzed using a basic excel spread sheet. The following survey questions (Q) were analyzed for this report.

**Q1.** Have you taken Engineering Physics 2 or an equivalent course (electricity and magnetism) in the past? (Circle one) [Yes] [No].

**Q2.** Have you taken any other electrical circuit related or equivalent course in the past? (Circle one) [Yes] [No].

**Q3.** Rate in 5 (high) to 1 (low) scale, how much your previous physics background helps you to understand the electrical circuit concepts of this course.

**Q4.** Rate in 5 (high) to 1 (low) scale, how much the Mastering Engineering Tutorials/Demos help you to learn the circuit concepts.

**Q5.** Rate in 5 (high) to 1 (low) scale, how much the Mastering Engineering Homework Assignments help you to learn the electrical circuit concepts.

**Q6.** Do you think Mastering Engineering helps you to master the electrical circuit concepts? [Yes] [No].

**Q7.** Write brief comments on what will make Mastering Engineering more effective.

Points given by students for each question were added and the average was obtained by dividing it by the number of students participating in answering that particular question (except for questions 6 and 7; question 6 is simply a yes or no, and question 7 requests student comments about mastering engineering). Responses to questions 1 to 6 were graphed using excel. The responses to questions 1 and 2 are shown in Figure 1, to questions 3, 4 and 5 are shown in Figure 2, and to question 6 is shown in Figure 3.

Figure 1, Q1 shows that almost all the students had taken Physics2, mainly electricity and magnetism, before taking this electrical circuit course. As expected, Figure 1, Q2 shows that our students did not have any advanced circuit course background before taking the electrical circuit course, which is what we were interested in evaluating with this study. Response to questions 1 and 2 indicate that all our students had similar levels of background on electrical circuit concepts prior to this course.

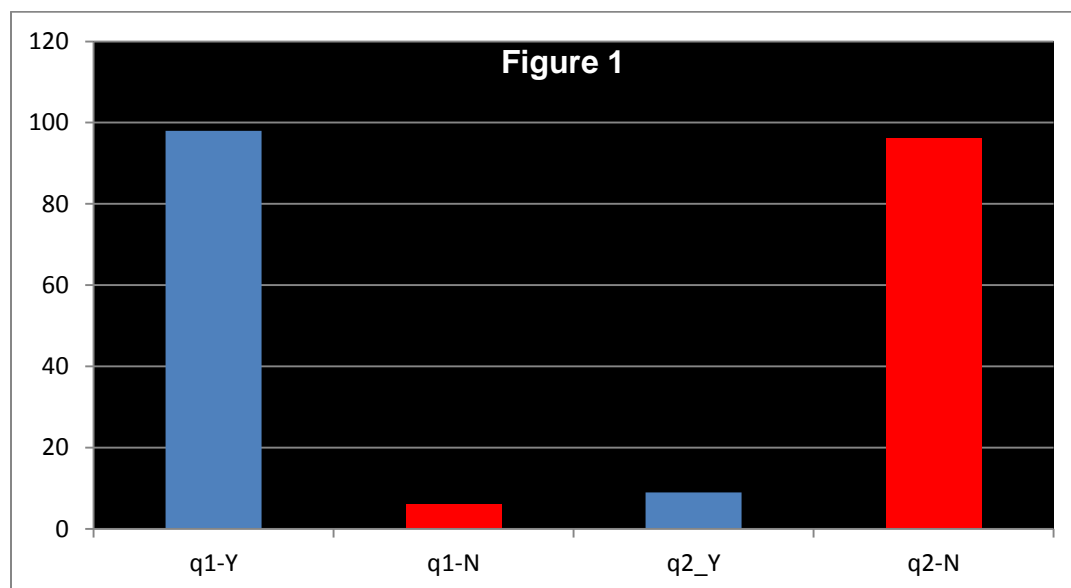


Figure 2, Q3 shows how much the Physics 2 based circuit can help to learn engineering circuit concepts. Students ratings were about 3.0 out of 5 (shown in the y-axis).

In Figure 2, results of Q4 are shown. Students rated it at 2.75 out of 5. This was lower than the value we had hoped for suggesting that the students were not content to do conceptual problems before learning the chapter materials in class. These results show that students who participated in the survey did not benefit from the help rendered by the video based coaching problems and tutorials.

Figure 2, Q5 received 3.6 out of 5 demonstrating that a good portion of our students benefited by using Mastering Engineering online tool homework assignments and instant feedback.

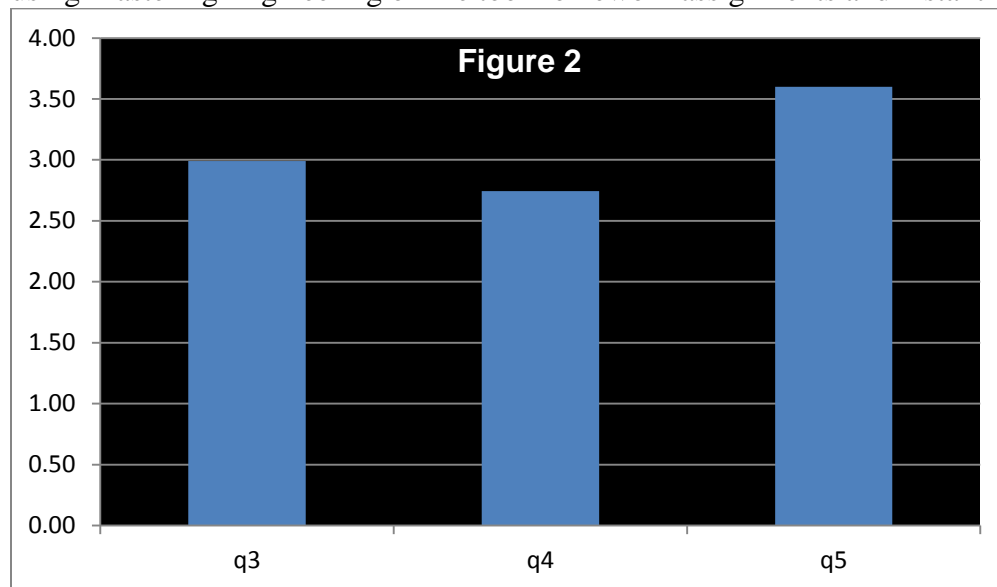
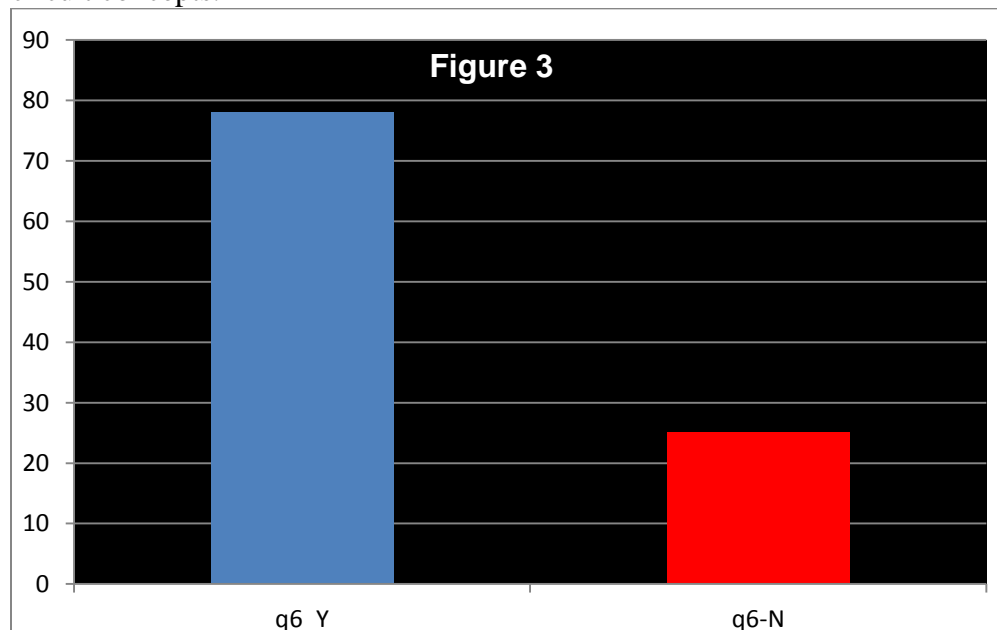
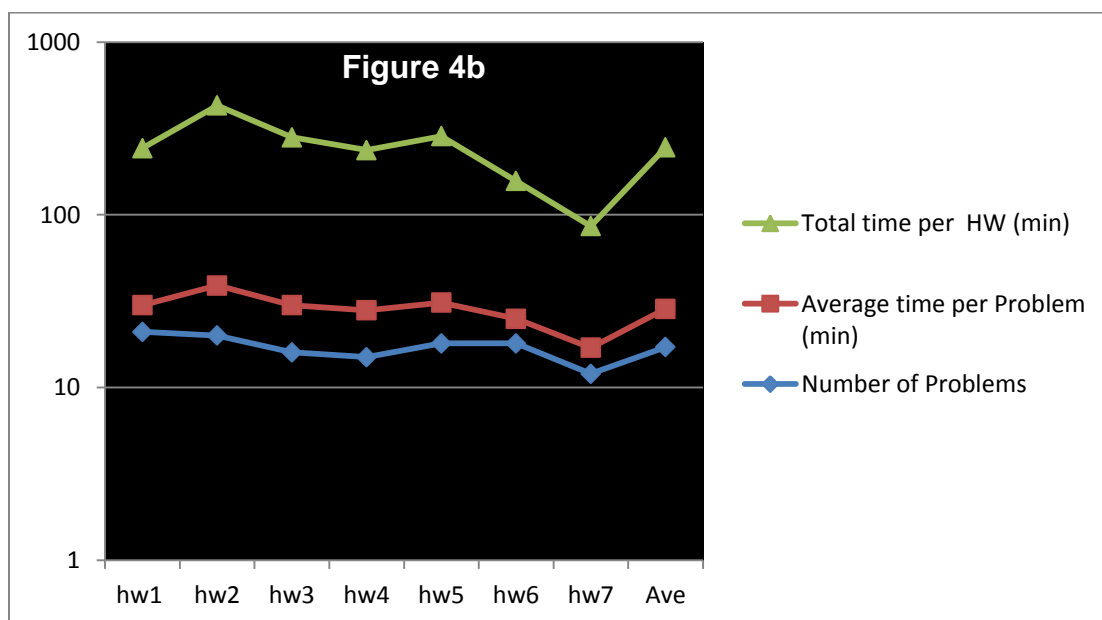
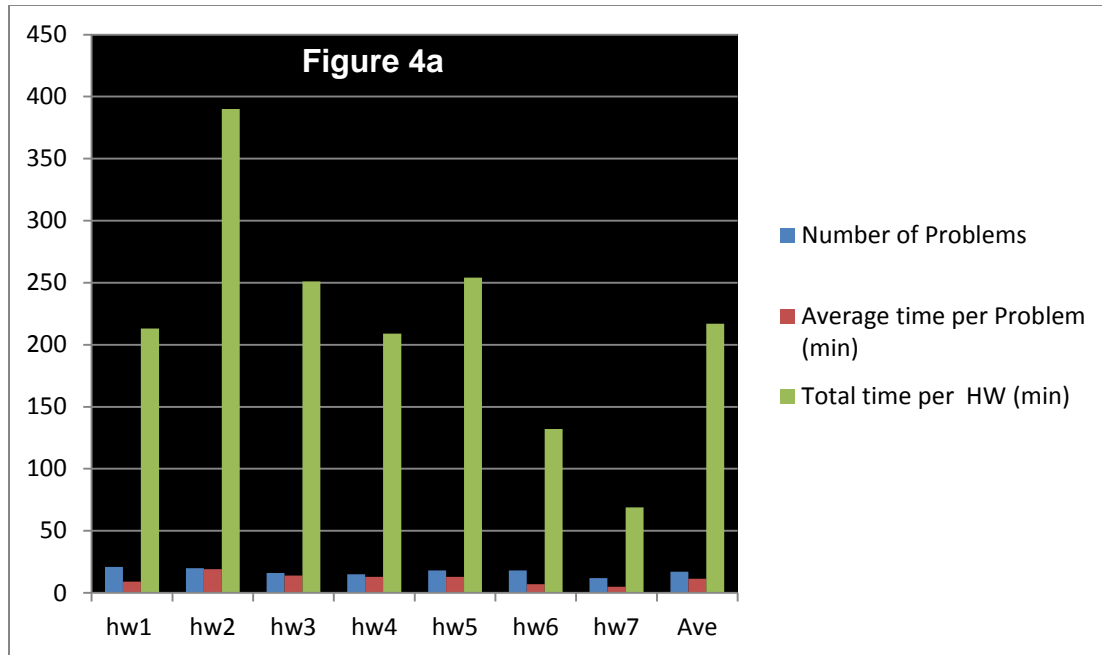


Figure 3, Q6 reflects the students' view regarding the important question of this study and survey whether "the mastering engineering helps you to master the electrical circuit concepts". The majority of the students, about 78%, felt that mastering engineering helps them to learn electrical circuit concepts.



Some sample results to question Q7, the students comments regarding the use of the online tool, mastering engineering, is given in appendix B.

Figure 4a and 4b are based on the data showed in the appendix B. Three main elements were graphed for each homework assignment: the number of homework problems, average time spent for a problem, and the total time spent for assignment. Figure 4a, is the bar graph representing the above mention details of the homework assignments using mastering engineering. Figure 4b is the scatter plot representation of Figure 4a basics, but the y axis is in the log scale to show the variation in detail.



## Conclusion

Mastering Engineering helps students to learn the Electrical circuit concepts. The study was done with two different sections. Students spent considerable amount of time, on average over 3 hours per assignment, and over 25 hours per semester to solve homework problems via mastering engineering. This is in addition to other reading assignments and exercises. The impact of video based coaching problems and tutorials with hints did not have any considerable impact, but it was very helpful for students to get exposed to the concepts before they learn them in class. Based on this study, mastering Engineering is helpful to students to master the key concepts of the course. Over seventy five percent of the survey participants indicated that it was. The students' responses were very consistent regarding the impact of mastering engineering, despite the fact that different sections were taught by different Instructors. Student's comments (see appendix B) were positive, and mainly reflects their own expectation rather than a deficit in the mastering engineering online tool.

Since this is pioneering work of this type of teaching, no prior data is available to compare the improvement in students' homework and exam scores before and after the introduction of Mastering Engineering; this aspect needs to be assessed in the future. This concern was partially answered in question 6, in students' view, the tool certainly helped them to understand the material better and aided improved performance.

The online problem assignments and answering tool such as Mastering Engineering is a useful tool to master the concepts of Engineering when it is incorporated with traditional approaches. Specially, in this modern era, when several courses are offered online by colleges, using an online tool is helpful to students. This study is only a sample; additional studies are needed to reach firmer conclusions regarding the impact of mastering engineering in teaching engineering courses.

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## APPENDIX A: Survey Questioner

EECE2210  
College of Engineering  
Northeastern University  
Survey: Mastering Engineering

1. Have you taken Engineering Physics 2 or an equivalent course (electricity and magnetism) in the past? (Circle one)

Yes	No
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2. Have you taken any other electrical circuit related or equivalent course in the past? (Circle one)

Yes	No
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3. Rate in 5 (high) to 1 (low) scale, how much your previous physics background helps you to understand the electrical circuit concepts of this course.

4. Rate in 5 (high) to 1 (low) scale, how much the Mastering Engineering Tutorials/Demos help you to learn the circuit concepts.

5. Rate in 5 (high) to 1 (low) scale, how much the Mastering Engineering Homework Assignments help you to learn the electrical circuit concepts.

6. Do you think Mastering Engineering helps you to master the electrical circuit concepts?

Yes	No
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7. Write brief comments on what will make Mastering Engineering more effective.

## APPENDIX B: Students Comments

7. Write brief comments that will make Mastering Engineering more effective.

Excellent tool, detailed solutions after assignment would help

7. Write brief comments that will make Mastering Engineering more effective.

leave as is. It is an effective tool.

7. Write brief comments that will make Mastering Engineering more effective.

The questions that allowed for hints really help take me step-by-step through how to solve those problems which helped me understand better.

I wish you wouldn't get penalized for looking at hints, Also it would be awesome to have access to some worked out solutions

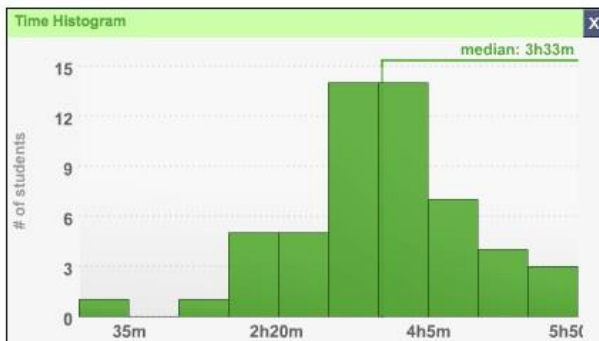
Otherwise, love it

if there were tutorials on every problem it would be more helpful

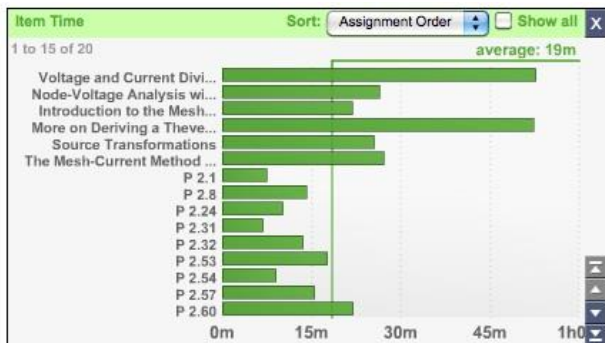
APPENDIX C: Time Chart

Left side chart: Time required for Individual problem of the homework assignment on the Right side chart: The time Histogram of students assignments completion time

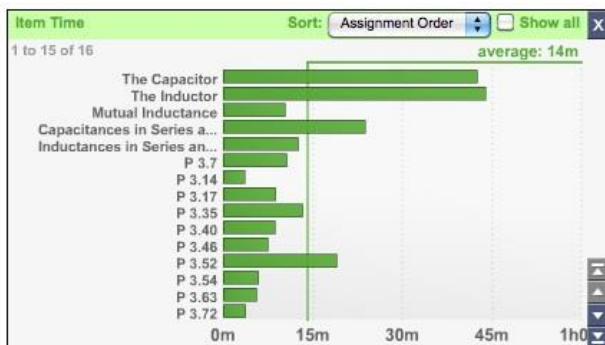
Homework 1:



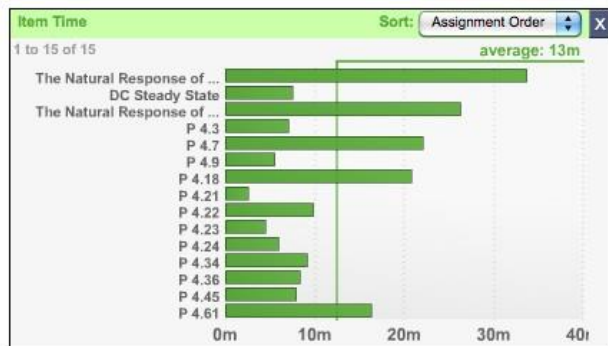
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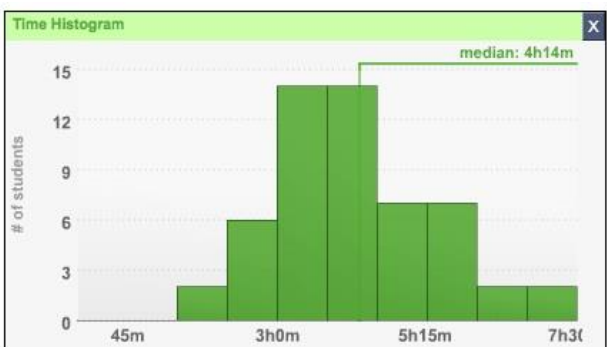
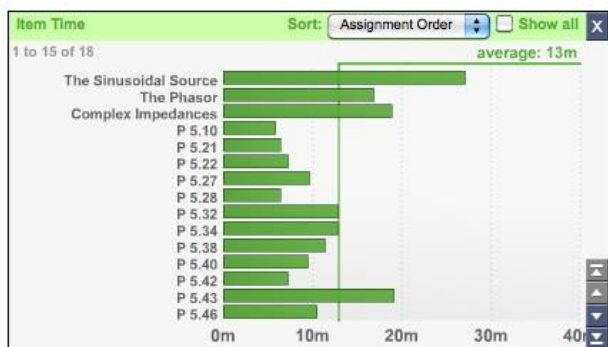
Homework 3:



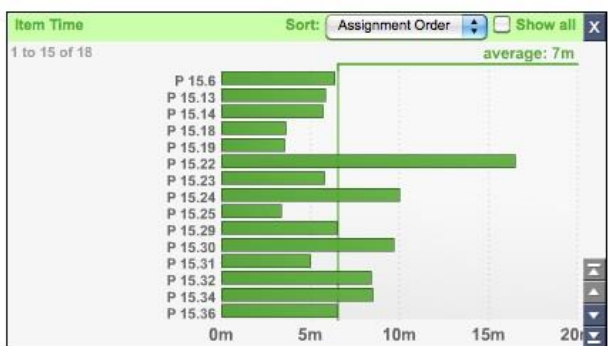
Homework 4:



Homework 5:



Homework 6:



Homework 7:

