



## **A New Teaching Approach for Ancient Engineering Physics: Master Physics via Mastering Physics! A Study and Survey**

**Dr. Bala Maheswaran, Northeastern University**

367 Snell Engineering Center College of Engineering 360 Huntington Ave. Boston, MA 02115 ma-  
hes@coe.neu.edu

# **A New Teaching Approach for Ancient Engineering Physics: Master Physics via Mastering Physics! A Study and Survey**

## **Abstract**

Teaching Engineering Physics at the undergraduate level is always a challenging and interesting adventure. The Physics concepts are long-standing, for example, Newton's laws are centuries old but still students struggle solve problems involving the application of Newton's laws. Exploring new techniques for teaching engineering physics is a never-ending quest. For our part, we have introduced Mastering Physics online problem solving and answering approach for engineering physics with the intent to improve students' learning skills and mastering physics concepts. These online assignments have video based coaching of problems and tutorials with hints to guide students to learn the physics concepts. As part of the course requirement, students are assigned to do the conceptual problems before the chapters in lectures are introduced and do more advanced problems after the chapters are covered in class. This mandatory requisite made them to learn the chapters in advance. The aim of this study was to determine whether learning concepts ahead of the lecture helps students' learning in the class.

This report will present information about the Mastering Physics approach used in our sections and the weekly workload assigned to students. At the end of the semester, a survey was done to see how much mastering physics helped our students to master the course materials. Over hundred students, from three different sessions participated in the survey. The data was analyzed using a spreadsheet and the outcome will be reported in this paper. Comparison of different session's opinion regarding the mastering physics will also be analyzed in the paper. This particular study was done for Engineering Physics 2, which covers mainly electricity and magnetism.

## **Introduction**

Incorporating online based techniques with traditional teaching is an interesting idea and is in practice at several institutions<sup>1-2</sup>. How these activities impact learning varies<sup>3-5</sup>. Like other colleges, at our institution most of the engineering students take Engineering Physics 1 and 2. As part of Engineering Physics 2 course requirement<sup>6-7</sup>, 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, an online tool called Mastering Physics was used. This is a reasonably new approach to deal with old physics concepts. The Mastering Physics<sup>8</sup> had three interesting features, coaching problems, tutorials, and chapter problems. Mastering physics is offered by Pearson publishing and no studies to our knowledge has been done to determine its effectiveness. Since this is a pioneering study to determine the effectiveness of mastering physics, 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. For tutorials based questions, 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 Physics.

The assignments help students to master several important concepts, such as Ohms law to deal with current, resistor, capacitors, inductors, magnetic flux via Faraday's and Lenz's laws, the Lorentz force, the torque on the coil, and the right hand rule to determine the direction of rotation.

### **Teaching Approach**

The course was structured as follows; each week two sixty-five minute lectures and one Integrative Learning Session for one hundred and forty minutes were administered, a lab associated with it 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. In order to evaluate and encourage students to read the materials ahead of class, pre-Chapter homework was assigned based on conceptual questions, video demo and tutorials that were slightly less complex than the problems assigned in the class defined as 'Post-Chapter' assignments. The number of problems varied for Pre-Chapter and Post-Chapter assignments and also slightly varied from chapter to chapter.

During the Interactive Learning Session, students assembled in a group of four or five and worked on the Post-Chapter problems which were due after the Interactive Learning Sessions. On average about thirty students made up an Interactive Learning Session, and several of these sessions were conducted for one lecture class. A faculty and a teaching assistant supervised each session. The last twenty minutes of the Interactive Learning Sessions were used for weekly quizzes.

### **Data Analysis**

This survey was done at the end of the semester, so that students were able to make a clear opinion and answer about mastering physics, and six survey questions were asked. Over one hundred students took part in the survey from three different Interactive Learning Session Groups, labeled as group 1, group 2 and group 3. These Interactive Learning Session Groups were supervised by different instructors. 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: Rate how much the Pre-Chapter questions/tutorials help to learn the engineering physics concepts in advance, before the lecture (5-high to 1-low)?

Q2: Rate how much the hints given in the Pre-Chapter questions/tutorials were useful to understand and solve the engineering physics problems (5-high to 1-low)?

Q3: Rate the number of Pre-Chapter questions/tutorials (five tutorials per chapter) from sufficient (5) to not enough (1).

Q4: Rate the mastering physics weekly homework assignments from very challenging (5) to not challenging (1).

Q5: Rate the mastering physics weekly homework questions (ten problems per week) from sufficient (5) to not enough (1).

Q6: Do you think that mastering physics helps you to master engineering physics concepts (circle one) [Yes] [No].

Points for each question were added for each group separately and the average was obtained by dividing it by the number of students participating in that particular question, except for question 6, which is simply a yes or no. Each question was graphed using excel, and the groups represented different Interactive Learning Sessions.

Figure 1 displays how much the Pre-Chapter questions/tutorials help to learn engineering physics concepts in advance. Students rated between 2.5 to 3.0 out of 5, shown in the y-axis. This is lower than the value we had hoped for. Our students' were not content to do conceptual problems before learning the chapter materials in class. There is no considerable variation between groups.

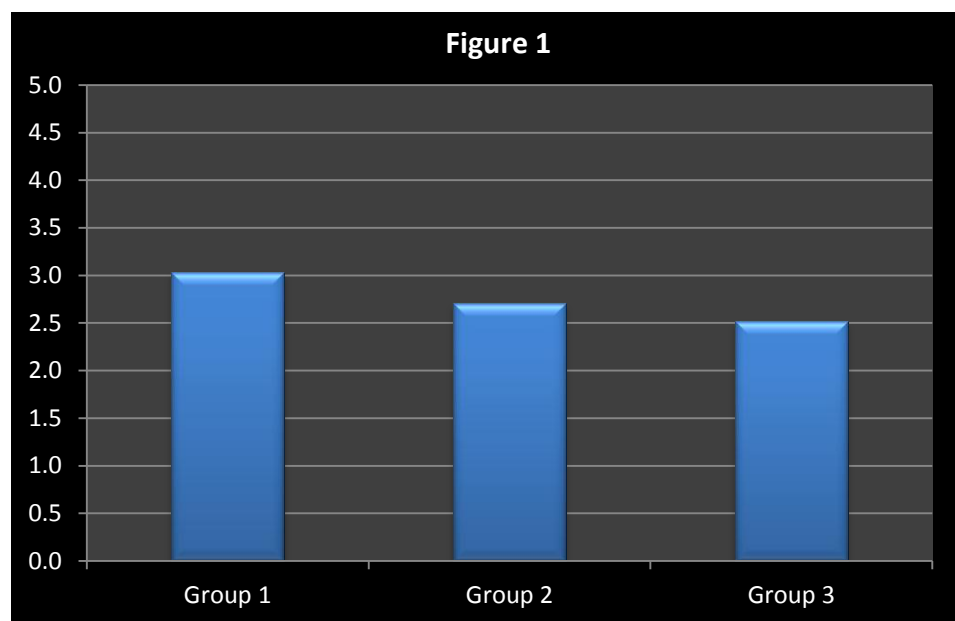


Figure 2 demonstrates how much the hints in tutorials help students to do the Pre-chapter problems. Again this figure shows that the range varies between 2.6 to 3.3 out of 5 between three groups shown in the y-axis. These results show that students who participated in the survey did not benefit from the help rendered by the tutorials, and their interest in preparing for the chapter in advance.

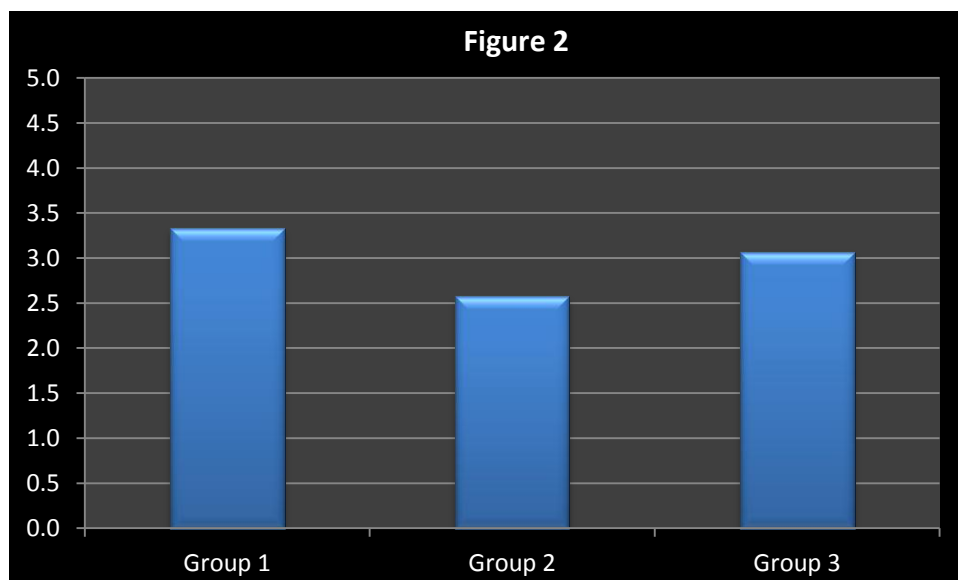


Figure 3 illustrates that most of the students who took the course and survey were satisfied with the number of Pre-Chapter questions. There is no significant variation within the different groups. This may represent the general trend of the students, in that they generally prefer less workload.

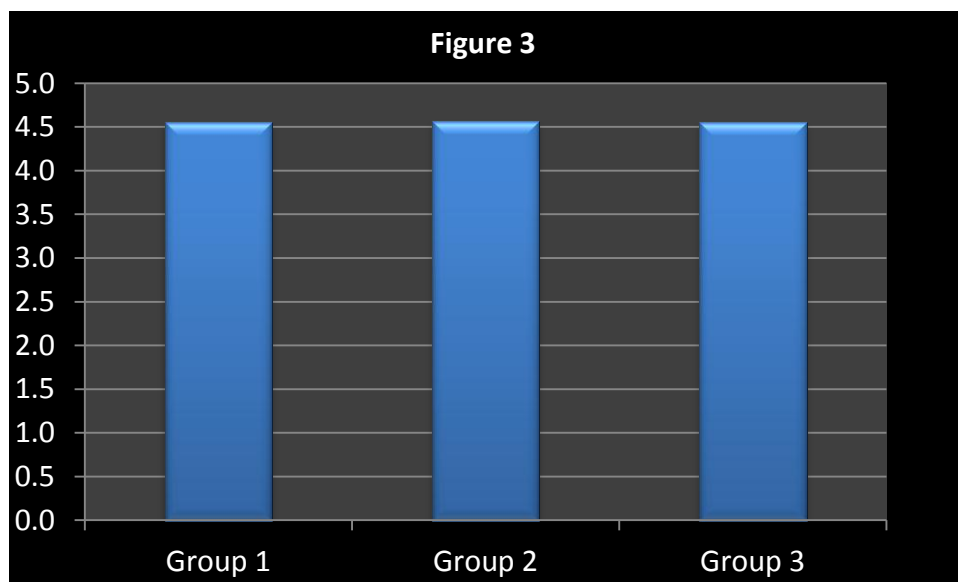


Figure 4 indicates the responses to the question, “Rate the mastering physics weekly homework assignments from very challenging to not challenging”. Average for each group is above 4.0. In general problems were more or less the same standard as the previous year regardless of new mastering physics technique. This response was as we had expected from class.

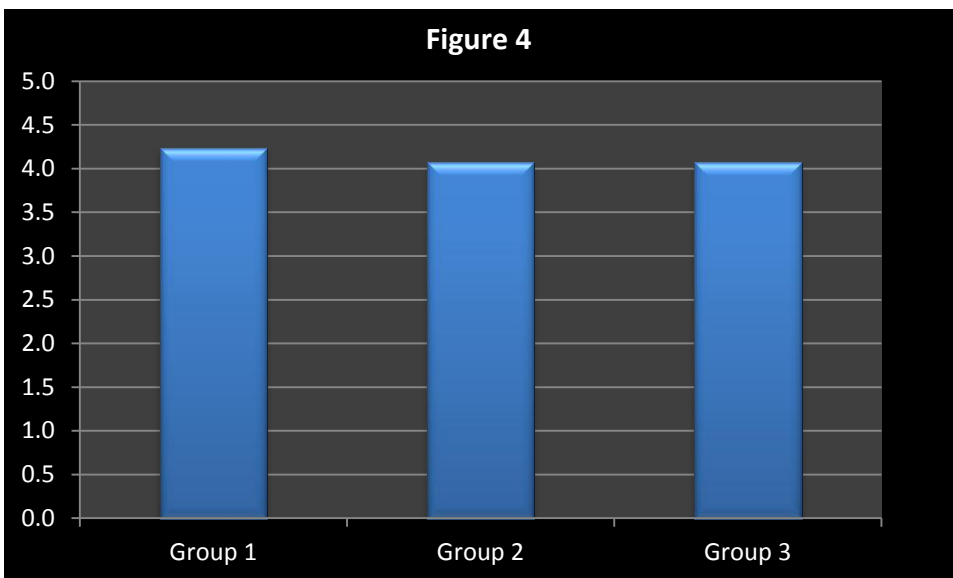


Figure 5 shows that the students who took the course were fully satisfied with the number of Post-Chapter questions. The response were very strong (above 4.0) from all three groups. This may represent the general trend of students that they prefer less workload or less number of problems per assignments. It is justifiable that most of the students take several courses per semester to fulfill their graduation requirements.

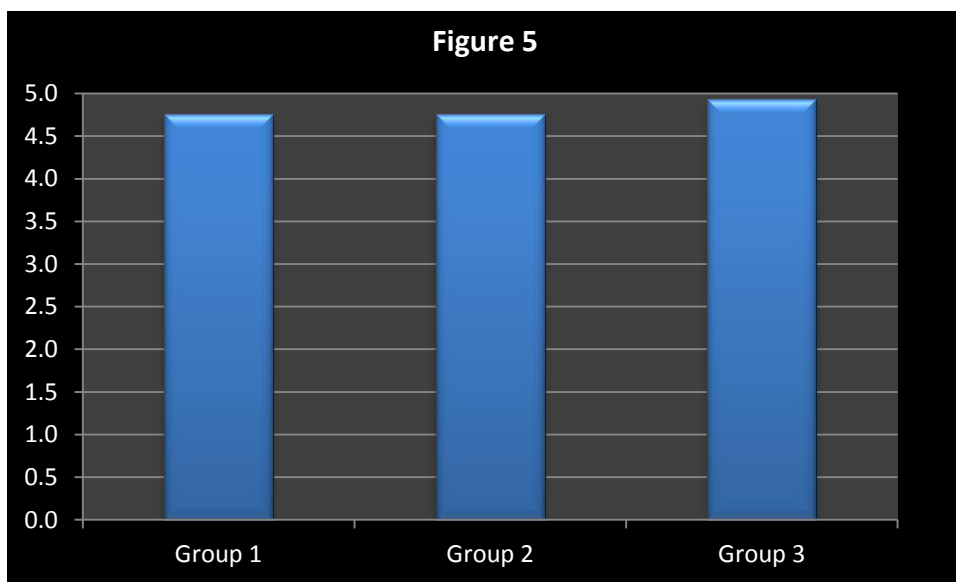
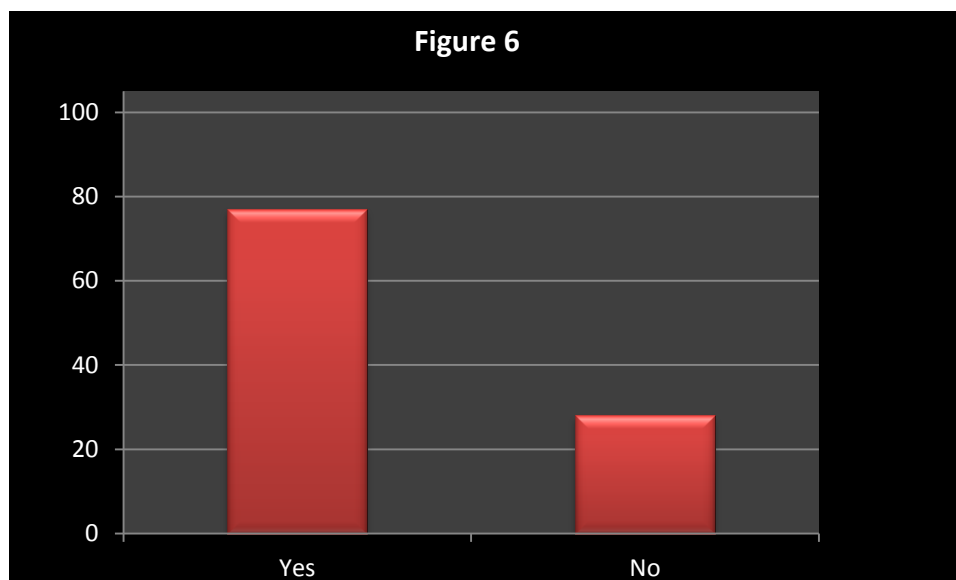


Figure 6 reflects the students' view regarding the important question of this study and survey whether "the mastering physics helps you to master the engineering physics concepts the course". The majority of the students, about 75% felt that mastering physics helps them to learn engineering physics 2 concepts.



### Conclusion

Mastering Physics helps students to learn the physics concepts. The study was done for three Interactive Learning Sessions. Students were very satisfied with the number of problems per assignment. The impact of Pre-Chapter questions did not have any considerable impact from students' point of view, but it was very helpful for students to get exposed the concepts before they learn them in the lectures. Based on this particular study and figure 6, the answer to the title concern, "Master the Physics via Mastering Physics!" is clearly answered: it is helpful for students to master the key concepts of the course. About seventy five percent of the survey participants answered "Yes". Based on Figures 1 to 5, the students' responses were very consistent, despite the fact that Interactive Learning Sessions were taught by different Instructors and teaching Assistants.

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

**Acknowledgements:** The author would like to acknowledge Dr. Henry Smith and Dr. Vasilka Sopova of Northeastern University for helping with the survey.

### References

1. Connections Physics Review (CPR) Program, Amanda Funai, Allie Interrante, Rachelle Reisberg, Sara Wadia-Fascetti, Bala Maheswaran, ASEE Conference Proceeding, 2006 - 1764.

2. Summer Bridge: a step into the engineering gap, Richard Harris and Bala Maheswaran, ASEE Conference Proceeding, AC 2009-570.
3. Supplemental freshman physics/chemistry programs to support women in engineering. Rachelle Reisberg, Amanda Funai and Bala Maheswaran, ASEE Conference Proceeding, AC 2009-1851.
4. A Study of Physics-Based Problem Solving Approaches in the Freshmen Engineering Course, Bala Maheswaran, ASEE Conference Proceeding, AC 2011–292.
5. Summer Bridge: An Engineering Diversity College Industry Partnership initiative between NUPRIME and Raytheon-IDS, Richard Harris, BalaMaheswaran, Rachelle Reisberg and Chester Boncek, ASEE Conference Proceedings AC 2012-4713.
6. How much Physics the First Year Engineering Students really need: A Study and Survey, Bala Maheswaran, ASEE Conference Proceeding, AC 2012-3390.
7. Impact of a Design Project on Engineering Physics: Does motor design project motivate students? Bala Maheswaran, ASEE Conference Proceeding, AC 2013.
8. <http://www.masteringphysics.com/>