

---

# APPLIED PHYSICS

---

## Memo

**To:** Applied Physics Faculty  
**CC:**  
**From:** Daniel Ludwigsen  
**Date:** 5 April 2004  
**Subject:** Mastering Physics Trial Semester

During winter term, my section of Physics 224 employed a trial subscription to Mastering Physics, the online homework/tutorial system from Pearson. (Addison Wesley and Prentice Hall are publishers within the Pearson organization, responsible for the Knight and Fishbane texts.)

As we consider online support in conjunction with selecting a textbook for our introductory courses, I thought it would be appropriate to share notes from the trial semester with Mastering Physics. I welcome any questions on these comments, and will try to respond as best I can based on my perspective and experience.

### Main Points

Mastering Physics allowed me to enforce homework participation in Physics 224 with a minimum of preparation time or effort. The tutorial capability posed a greater challenge to students than simply looking at instructor's solutions. I believe those who invested time in the work were rewarded, and I was better able to respond to their questions and gauge their understanding. While this trial was not scientific (no control group, participation was mostly up to students), I am left with a positive impression. The way the system is implemented in a course is quite flexible, and variations will influence perception and results.

### General Comments

Mastering Physics is a system with widespread deployment (national or perhaps even international), so there is a good deal of information available on student performance and preferences. National statistics (difficulty ratings and average time spent on problems) helped me as I assembled the sets. In addition, it has been found that there is a period of time while the student is learning the format and style of the system. These issues can distract attention from physics and frustrate students, which certainly happened to my group. However, knowing it would happen encouraged me to simply support students' effort and perseverance.

My section was at a disadvantage when compared to national or system-wide average students in

E&M, who begin using the system during the first term of an introductory sequence – usually two *semesters*. Finally, this section consists of off-track students who are not taking PHYS-224 in the usual first term of their sophomore year.

Grading policy is flexible in the system. The instructor can allow or disable solution requests, limit the number of attempts, set penalties for wrong answers in attempts, and give bonus points for not opening hints.

#### Deployment Comments

I required my section to use Mastering Physics to earn 5% of the overall term grade. The weight was intentionally small, but it was thought that those who were willing to put in the time would receive a bit of a boost in their grade. Some chose not to do any assignments, and most put in some effort but did not complete all the assignments.

I was able to construct assignments from prepackaged tutorial and traditional (end-of-chapter) questions. These were designed to accompany the text by Young and Freedman, 11e. Most assignments were easily coordinated with the Benson text, with a bit of flexibility in nomenclature (most memorably, the unit vectors were  $\mathbf{x}$ ,  $\mathbf{y}$ , and  $\mathbf{z}$  instead of  $\mathbf{i}$ ,  $\mathbf{j}$ , and  $\mathbf{k}$ ). In classroom work, I used both Benson- and Mastering Physics-style symbols and made a point of identifying differences.

Classroom examples and test questions were designed to work with Mastering Physics, so that there was a mix of repetition and extension. I did rely on Mastering Physics to introduce or review some technical points, applications, and topics that could not be covered in class. An example might be a tutorial that thoroughly covers the analogy between gravitational potential and electric potential. A significant review of the derivation of potential energy from Newtonian Mechanics could be provided *outside* of class time.

Most assignments were structured around problems that offered tutorial help, rather than EOC (end-of-chapter) problems that only responded with correct/incorrect and occasional feedback such as, “The correct answer does not depend on  $r$ .” The intention behind this component of the course was to improve student understanding, and provide formative rather than summative evaluation. This was made clear to students, and as a result, many may not have undertaken the significant effort required to use the system and work the problems thoroughly.

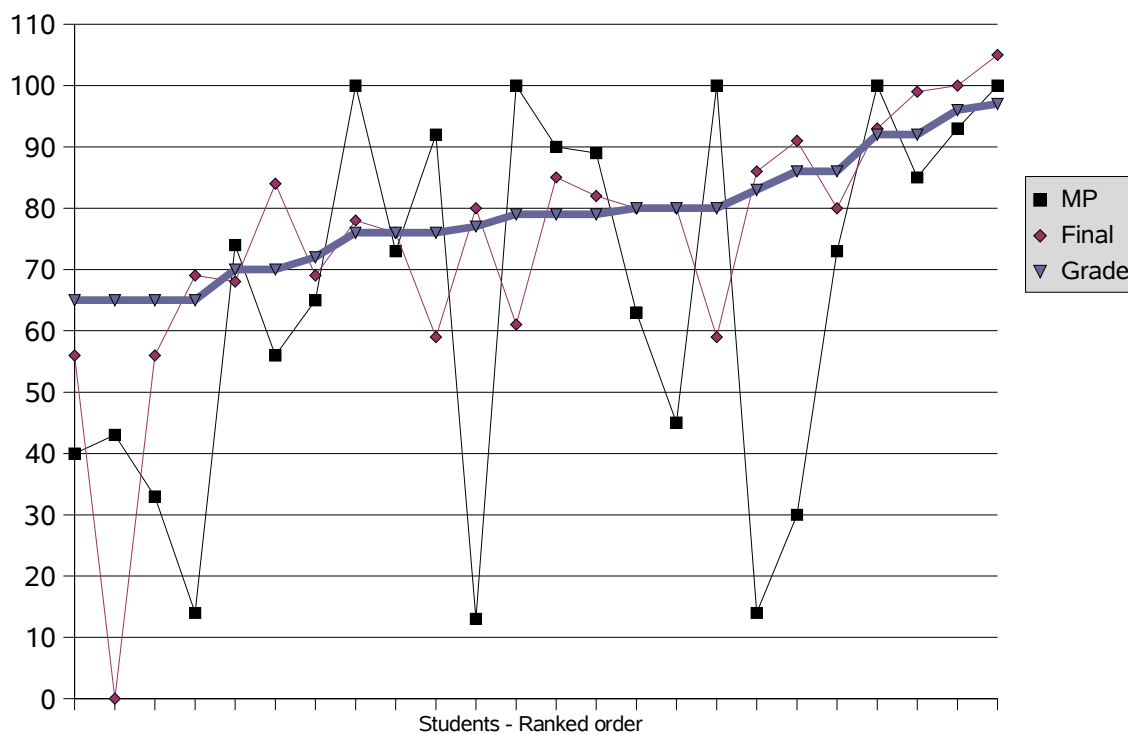
Assignments (19 over the 10 week term) ranged in length from a few questions to sets designed to cover an entire week of work. Smaller and more frequent assignments were found to be preferable, both to keep students on track with the course, and to better focus on concepts and topics.

### Comments on Results

National average times for most problems were typically lower than my students spent on the problems. Quick scans of assignment summaries also indicate that my students had fewer correct answers (and more wrong answers) than the national averages. On a scale of 1-5 (with 5 as most difficult), my students often rated questions at least one point higher/more difficult than the national average.

The plot below shows some quantitative results. The score for the final exam, the term grade, and the Mastering Physics score is plotted vs. students in ascending order, ranked on term grade.

## Physics 224 Winter '04 sec.02



The Mastering Physics score reflects both “participation” and “performance” - 40% for fully completing every problem, and 60% based on the score for each assignment. In addition, extra credit opportunities were available to improve both areas.

There are a few cases that bear discussion here. The students who scored near 14/100 on Mastering Physics clearly chose not to participate. The successful student who only scored 30/100 on Mastering Physics worked traditional problems from Benson, employing solutions in the library and came to me with questions. The students who scored 100/100 MP points did not necessarily perform perfectly throughout the term, but raised their grade with extra credit and generally consistent work. The lowest of these was the most frequent visitor to my office!

The large-scale variation of the MP scores on this plot indicates that offering Mastering Physics is not well correlated to success on the final or a good term grade. In fact, it might appear that those who did well in MP often did poorly on the final, and vice versa. (Note the many cases where the term grade appears between the final and MP scores.) However, this may be misleading for several reasons. The implementation of Mastering Physics was gentle and intended to help those students willing to put in the effort to use it. The MP score was built in to boost the scores in such a way that deliberate, diligent students could partially make up for poor test performance in stress situations. Also, since the MP score only represents a small weight in the total average, the five tests throughout the term are what really raised the scores in these cases.

From the point of view of the teacher, Mastering Physics provided me with a constant read on the participation and status of the class. This was perhaps the most important benefit from my perspective. I could go into a student's assignment and see all answers, hints used, and track performance on as small a scale as I'd like – very helpful when offering help via email or discussion board. Even in my office hours, students would bring up their work in the system so that we could discuss it. I could *almost* get in touch with exactly what the student was thinking. Only their work with pencil and paper lay outside my view. The breakdown of problems into parts, however, let me know at which step students started to falter.

Compared with the present system of setting students loose to work problems and check library solutions, I find two benefits: First, I'm better connected to student work if I want to be. Second, the students are held accountable, and, I believe, more homework was attempted. For this reason alone, I recommend we adopt an online homework/tutorial system for our introductory sequence.