
Throughout the 2015-16 Academic Year, the Department of Physics had numerous meetings to

Studies have shown that in a traditional, well-taught lecture class, the BEMA gain is measured to be around 20% while in a class employing a wide range of active engagement and peer-to-peer instruction techniques, the gain can be above 30%.

For the overall post-test BEMA score, the generally acknowledged threshold for understanding the material is an average of about 60%.

Of significant concern is that our students are not meeting these thresholds. As part of our new curriculum, we have converted our 1 quarter electromagnetism course (PHYS 1003) into a 1 semester course (PHYS 136), covering the same material but with an extended time to include more active learning, peer-to-peer activities, and review and assessment throughout the course.

The BEMA was also used to assess upper division students' knowledge of electromagnetism in Physics 4001-4003. The exam was administered at the beginning of PHYS 4001 and again at the conclusion of PHYS 4003 with the results listed below:

	4001-4003 (3 rd /4 th yr)	1003 (1 st yr)
Gain between post- and pre-test:	15	22
Overall post-test score:	45	42

Of significant concern, we did not observe significant gains between the lower and upper division performance. The Department has discussed this at length and continues to debate the best path forward. The introduction of the new PHYS 230 (Physical Reasoning) is intended to offer further review and reinforcement of basic concepts in electromagnetism and other subjects in Physics.

The Physics Graduate Record Exam (GRE) test consists of approximately 100 five-choice questions, some of which are grouped in sets and based on such materials as diagrams, graphs, experimental data and descriptions of physical situations. The aim of the test is to determine the extent of the examinees' grasp of fundamental principles and their ability to apply these principles in the solution of problems. Most test questions can be answered on the basis of a mastery of the first three years of undergraduate physics.

In Physics 2004, we use a subset of questions from the GRE test centered around topics that students should have familiarity with through the General Physics sequence (including Modern Physics, PHYS 2004).

Subject area breakdown:

Subject	2014 results	2013 results	National Average
Classical mechanics:	29	25	52
Electromagnetism:	11	18	48
Optics:	30	25	40

Subject	Physics 2004 (avg)	Physics 4950 (avg)
Classical mechanics:	27	22
Electromagnetism:	15	24
Optics:	28	18
Thermodynamics:	19	18
Quantum:	22	18
Special relativity:	23	5
Laboratory methods:	22	36
Special topics:	24	20

Of concern, here too we did not observe significant gains between the lower and upper division performance.

A Department goal is for our students to achieve at least the national average on all nationally normed exams. (This goal, in the case of the GRE exam, may be aspirational as we are comparing all our students to a subset of students who applied to graduate school in Physics.)

There are certainly some bright spots as we have achieved or have come close to achieving that goal for the Physics 1000 series, indicating that our General Physics instruction is successful and our teaching strategies are working.

However, the performance of our upper division students falls short of our goals, and in fact the performance of the 3rd and 4th-year students shows little improvement compared to the 1st and 2nd-year students. On the other hand, one should be careful about reading too much into the results as relatively few students (< 10) have taken the exams each year.

The Department held many meetings of the tenure-track faculty throughout the year to “close the loop” and strategize on what improvements might be made to curriculum and teaching methods.

It was the continued opinion of the faculty that based on these results, physics majors overall were suffering from a lack of a fund of knowledge about physics and had significant weaknesses in conceptual understanding and problem solving skills that needed to be addressed.

The following strategies were suggested:

(1) Basic physics knowledge taught in the General Physics sequence (PHYS 1001-1003, PHYS 2004) would continue to be emphasized throughout the upper-division curriculum by additional “basic” problems added on to homework assignments to give students extra practice at the basic concepts. This will be done, to as great a degree as possible, without sacrificing the advanced instruction that is part of the present curriculum.

