

MasteringPhysics

School Name Georgia Southern University, Statesboro, GA

Course Name Introduction to Physics

Course Format Lecture and lab

Key Results Over a four-year period of study, students who attempted all of the MasteringPhysics homework assignments earned significantly higher final exam averages than students who skipped assignments.

Submitted by

Delena Bell Gatch, Associate Professor

Course materials

College Physics, Young

About the Course

Georgia Southern University is the fifth largest university in the University System of Georgia, with an enrollment exceeding 20,000 students a year. The school's first-year retention rate of first-time, full-time, degree-seeking freshmen who entered in fall 2012 (and returned in fall 2013) was 80 percent.¹

Introduction to Physics is primarily taken by construction management and exercise science majors. Certain course material, including vectors, kinematics, Newton's laws of motion, and conservation laws, requires mathematical skills at a trigonometry level. Upon completion of the course, successful students can demonstrate a conceptual understanding of physics, advanced problem-solving skills, and basic laboratory skills.

Challenges and Goals

According to Associate Professor Delena Bell Gatch, the students who take her course tend to work well in groups, have competent technology and lab skills, and exercise strong writing skills. "However, they often are not mathematically prepared for the course," she says. "Some struggle with conceptual understandings, are unable to see the connections between the concepts and problems, and spend too much time equation hunting and trying to memorize procedures to solve specific problems."

Gatch implemented MasteringPhysics to help promote regular student engagement with course content and to provide her

students with immediate feedback and grading so they know where they need remediation. In addition, she consults the program's diagnostics before each class to better understand student misconceptions and needs.

Implementation

From fall 2010 to fall 2013 Gatch's students met both in a large lecture and in smaller-group labs twice a week. In each of the reported semesters she assigned a weekly MasteringPhysics homework assignment comprising a mix of question types, including tutorial, activity, and end-of-chapter questions.

For fall 2010, spring 2011, and fall 2011, she also assigned the Introduction to Mastering assignment as the first required assignment. For subsequent semesters, she added content to the introductory assignments. The Introduction to Mastering assignment was implemented as follows:

- Prior to spring 2012—Seven Introduction to Mastering questions.
- Spring 2012—The same seven Introduction to Mastering questions + 10 items from the math review questions of Mastering Chapter 0.
- Fall 2013—Eight Introduction to Mastering questions + 16 math review items, several of which address vectors.

Assessments

55 percent	Exams (three exams and a comprehensive final)
15 percent	MasteringPhysics homework
15 percent	Lab exercises
10 percent	In-class activities
5 percent	Service learning project

¹2013/14 Fact Book, p. 8, <http://em.georgiasouthern.edu/osra/wp-content/uploads/sites/5/fb1314.pdf>

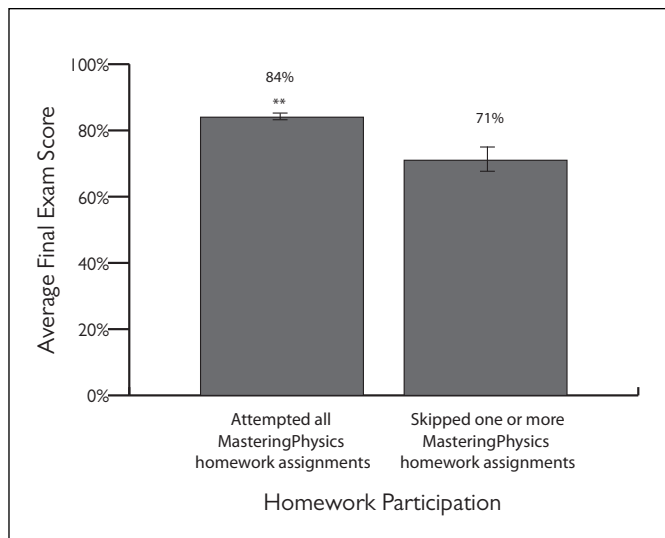


Figure 1. Average Final Exam Scores per MasteringPhysics Homework Participation, Spring 2013 (Attempted all, $n = 116$; Skipped one or more, $n = 31$) Err Bars = Standard Error, Significance $**p < 0.01$

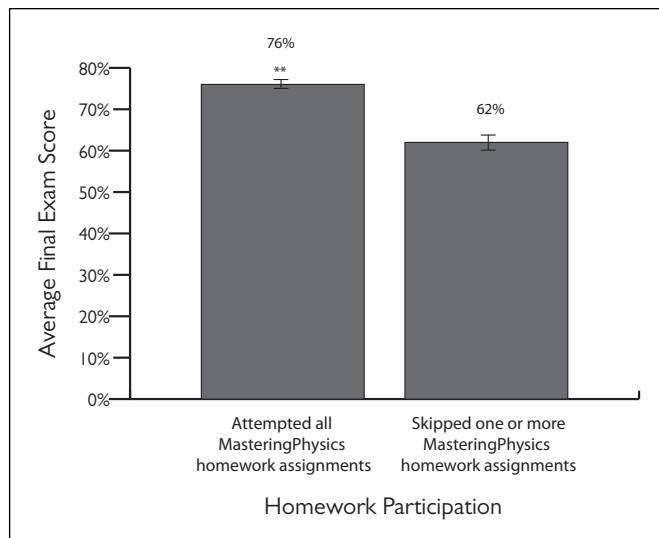


Figure 2. Average Final Exam Scores per MasteringPhysics Homework Participation, Fall 2013 (Attempted all, $n = 98$; Skipped one or more, $n = 28$) Err Bars = Standard Error, Significance $**p < 0.01$

Results and Data

Gatch evaluated student performance based upon participation in MasteringPhysics homework during the spring and fall 2013 semesters. She found that students who attempted all of the MasteringPhysics homework assignments scored significantly higher on the comprehensive final exam with $p = 0.007$ for spring 2013 and $p = 0.001$ for fall 2013 (figures 1 and 2). For purposes of this study, a skipped homework was considered one with a score of 0; and the analysis does not include any students who did not take the final exam. Results also showed the following:

- Spring 2013, 21 percent of students skipped one or more MasteringPhysics homework assignments. The average number of assignments skipped was 2.5 of 13 assignments.
- Fall 2013, 22 percent of students skipped one or more MasteringPhysics homework assignment. The average number of skipped assignments was 3.7 of 15 assignments.
- In each semester, 26 percent of students who skipped MasteringPhysics homework assignments skipped four or more assignments.

In addition to analyzing performance on the MasteringPhysics homework assignments, Gatch evaluated spring 2012–fall 2013 student performance on the Introduction to Mastering assignment. She posited that the assignment’s tutorial math problems help students review the math skills they’ll need for the course. Data indicated that students who scored 80 percent or higher

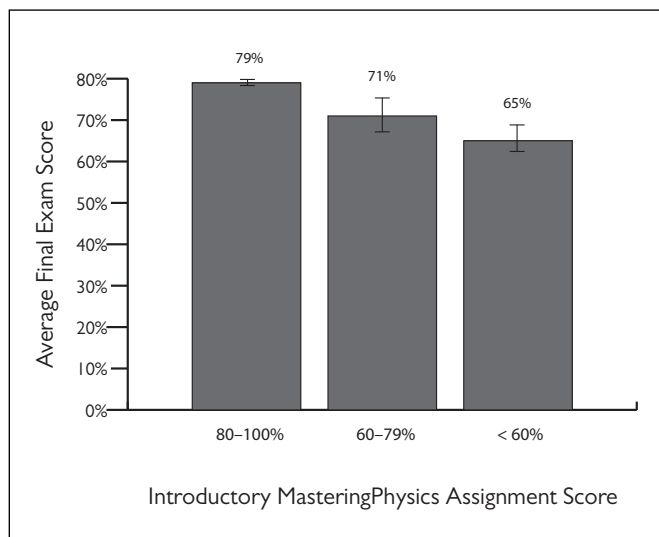


Figure 3. Average Final Exam Scores by Performance on Introductory MasteringPhysics Homework, Spring 2012–Spring 2013 (80% or higher, $n = 500$; 60–79%, $n = 29$; less than 60%, $n = 42$) Err Bars = Standard Error

on the Introduction to Mastering assignment earned significantly higher final exam scores than students who scored lower on this assignment (Figure 3).

The scores from the Introduction to Mastering assignment with the math review questions could serve as a leading indicator identifying students who may be at risk in the course.

“With MasteringPhysics, I can monitor student performance and get a sense of student motivation based on participation in homework assignments. This kind of consistent monitoring and assessment of student results also enables me to target at-risk students earlier in the course and to focus my teaching specifically on those concepts students need help on.”

Finally, Gatch examined participation data alone (without taking performance into consideration) for the Introduction to Mastering assignment during this same period and for three prior semesters when the assignment included only the Introduction to Mastering questions. Similarly, the data showed that students who attempted the introductory assignment did significantly better on the final exam than did students who skipped it. She notes, “While this assignment does not contain specific physics concepts being taught in the course, the decision to skip the assignment could be an indicator of student motivation, which impacts student performance in the course.”

The Student Experience

In spring 2013, Gatch asked her students what strategies for success they would share with incoming fall 2013 students. Student feedback included:

- “I would stress doing the homework early and not looking up the solutions online, to do all the work.”
- “Try very hard to understand the material, not just memorize it.”
- “Take practice quizzes online to reduce the risk of making simple mistakes and ensure that you know material.”

Gatch has a strong interest in physics education research and is currently investigating students’ motivation in various programs across the university, as well as the experiences of new faculty in developing student-centered instruction. Results from this study will be published in the future.

Conclusion

Because MasteringPhysics homework offers Gatch’s students the opportunity to practice outside of class, they are more prepared for both class and lab and perform better on assessments. Data indicate that students who attempted all of the MasteringPhysics homework tended to earn higher final exam scores and that student motivation can be a key variable that can impact performance.

MasteringPhysics also helps Gatch target her teaching. “With MasteringPhysics, I can monitor student performance and get a sense of student motivation based on participation in homework assignments,” she says. “This kind of consistent monitoring and assessment of student results also enables me to target at-risk students earlier in the course and to focus my teaching specifically on those concepts students need help on.”