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Learning to Teach and Teaching to Learn

Maria Babiuc-Hamilton
Marshall University, babiuc@marshall.edu

LEARNING TO TEACH AND TEACHING TO LEARN

M. C. Babiuc-Hamilton

Marshall University, Huntington, WV

babiuc@marshall.edu

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Introduction

•New studies show that students do better in science classes that are taught interactively..
•We compare two different pedagogical approaches in teaching introductory physics:
1. the lecture-based method,
2. the active learning laboratories

•We present the data on student performance on exams, homework, lab activities and tests, from 126 students taking the 200-level introductory physics courses at Marshall University, in Huntington, WV.
•We discuss the efficiency of each method in fostering the success of students in the introductory physics courses.
•We find that subtle differentiations can be implicitly detected in students' exam grades, homework, participation, and choice of major.

Description of Teaching Methods

The Lecture-based Method

• The text includes medical and biological examples suitable for our pre-med students.
•The course covers Mechanics, Thermodynamics, & Waves.
• The lectures were based on the Power-Point presentations modified to include more solved problems, examples, movies, and summaries.
•The interactive problem-solving used the online PhysicsNow tutorials. Students were encouraged to work in small groups and to reach consensus at each step of the problems.
•The final grade was based on homework, attendance, two partial and one comprehensive final exam.
• All the tests contained 10 multiple choice problems, prepared with the ExamView .
•For the PHY201 algebra-based course, we choose *Enhanced College Physics* by Serway et al. with
1. integrated multimedia resources,
2. *ExamView* test preparation software
3. *PhysicsNow* online homework and tutorial

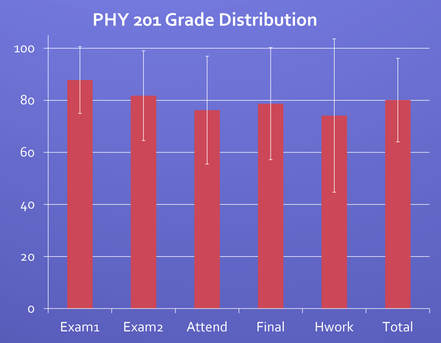
The Active-learning Method

•For the PHY202 lab course we choose the active learning laboratories based on the *RealTime Physics*, part of *Activity-Based Physics*
•The course included 14 lab activities and homework from Mechanics, Thermodynamics, & Waves.
• Each experiment was designed to be completed in 2 hours of intense work and to provide students with a coherent observational basis to help construct models of physical phenomena
•The in-lab activities, reports and homework problems gave us a realistic feedback on the learning process, more accurate than the lecture.
• As result, we were able to return to concepts that appeared difficult to grasp by students, like projectile motion, circular motion, the simple harmonic oscillator, the difference between velocity and acceleration, etc…
•The final grade was based on lab activity, homework, and 2 exams containing 10 problems similar to the homework.

Distribution of Numerical Grades

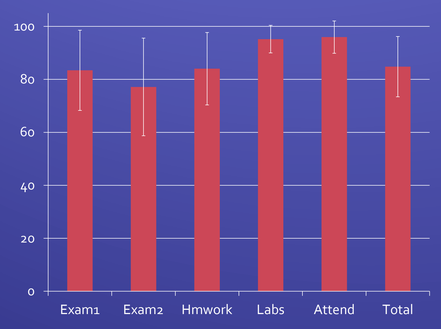
Lecture-Based Course

•The class average was 80, though the breakdown shown here demonstrates that performance varied strongly by assignment.
•Homework grades were the lowest, because of the students were not used to PhysicsNow online homework
•But note the different results for men and women in this regard, described on the right.



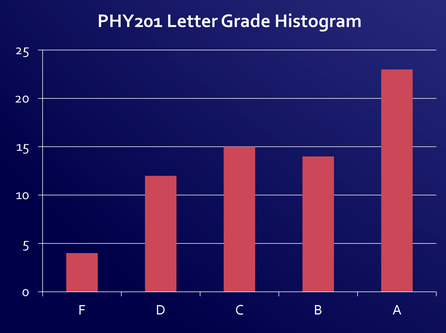
Activity-Based Course

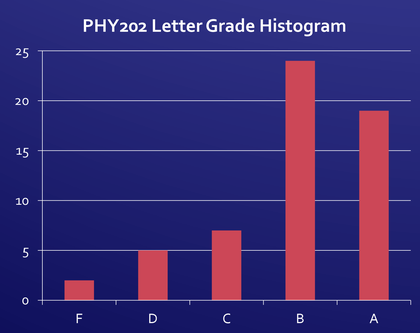
•The class average was 85, higher than the lecture-based course.
•The in-lab activities grades and the attendance are the highest. Those grades reflect physics knowledge only indirectly, through students' perseverance and effort.



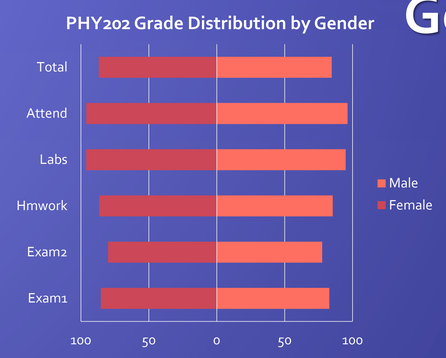
Distribution of Letter Grades

Note the skewing away from the expected Gaussian curve. This is due to the presence of several pre-med majors, who have proven to be more driven to succeed than the other students.



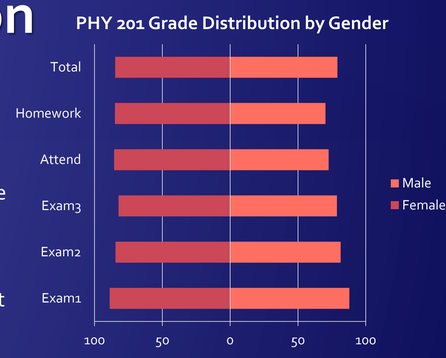


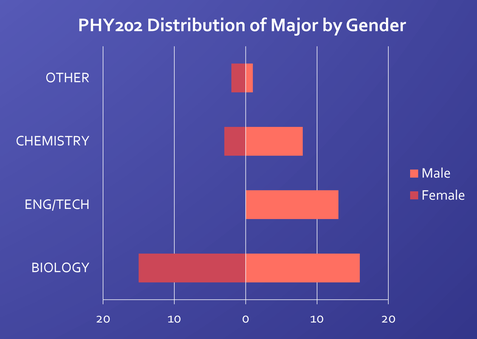
Gender Comparison



Distribution of Grades

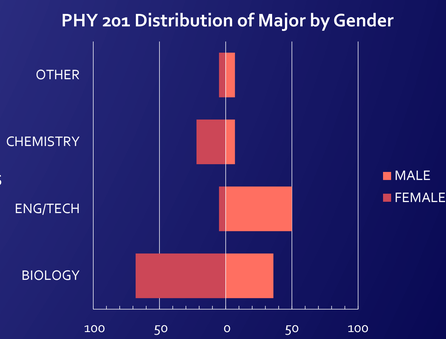
•The histograms show that women scored slightly better than men in both courses For the activity-based PHY202 course the grades distribution per gender is very close
•The difference is more visible in the lecture-based PHY201 course. Women's advantage over men is most in seen in attendance and homework, in which result is tied more closely with effort, unlike in-class tests .





Distribution of Majors

The statistics clearly indicate for both courses that women tend to steer away from engineering/technology and are more attracted towards biology and chemistry. Those choices show how males and females can be motivated in learning physics: technical applications of physics seem to interest males, while females are attracted to physics in the context of life sciences.



Conclusions

•Enhancing the success of students in taking introductory undergraduate physics courses is a difficult endeavor .
•Students describe traditional introductory courses as boring and repetitive and suggest that faculty should consider more innovative subjects and interactive pedagogy in the introductory course
•Students speak highly of open-ended, project-based labs that emphasize concept development, even if they are more time-consuming than traditional labs.
•Faculty should consider more innovative subjects and interactive pedagogy and should foster a cooperative (non-competitive) spirit, developing a less formal relationship with students.
•Women can do better than men in the algebra-based courses, regardless of teaching method.

Acknowledgments & References

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