RE-THINKING THE TEACHING OF INTERMEDIATE ELECTRODYNAMICS

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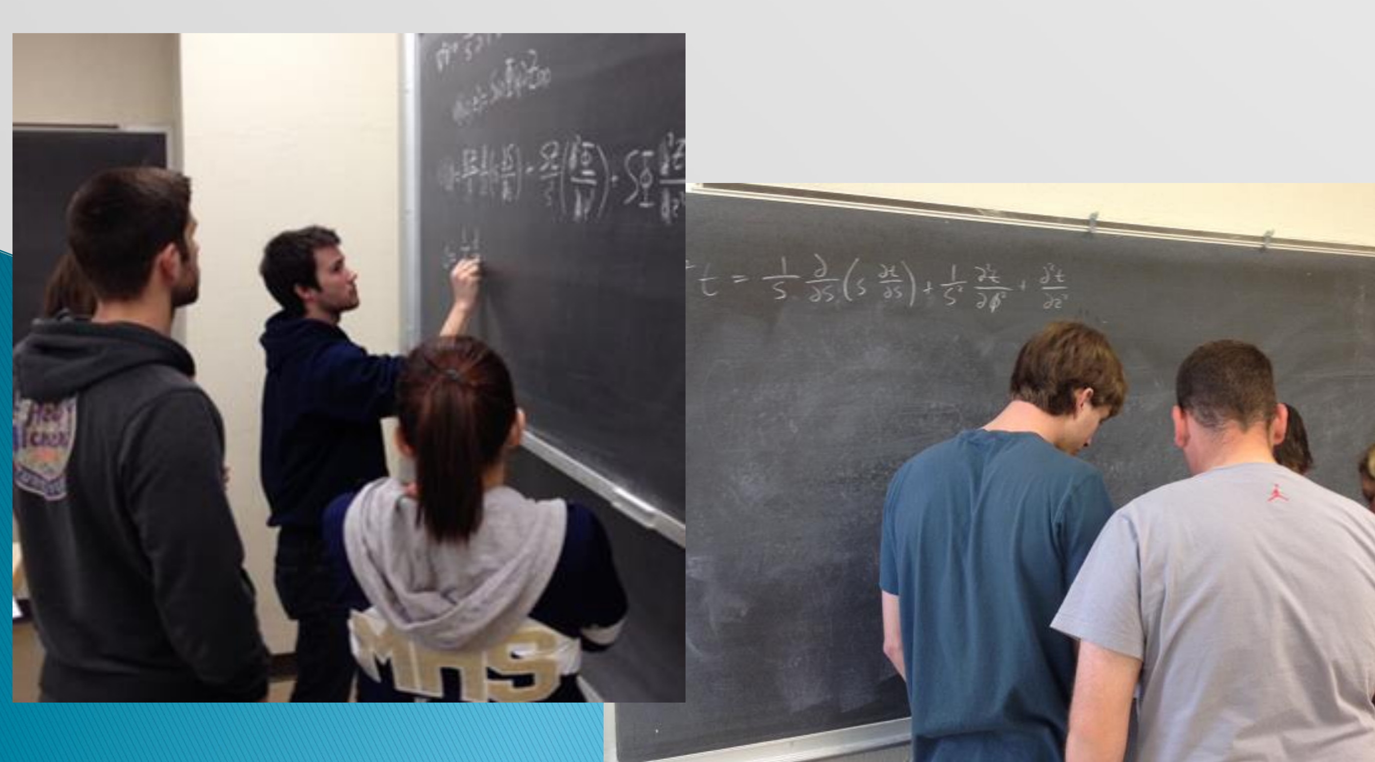
Abstract

The "flipped" classroom teaching model makes lecture-like information available outside the classroom, and then builds on this instruction through learning activities like group problem solving, discussion, and short projects. This differs from the traditional lecture/homework model by requiring students to enter the classroom prepared to learn. I have adopted a more modest version of the flipped classroom. Reading the text is used in a way similar to lecture videos, and students are rewarded for and challenged to complete reading and short assignments in preparation for group problem-solving sessions during each class period. This no-lecture classroom, emphasizing a more dynamic form of communicating conceptual and detailed understanding through written and oral assignments, was eagerly adopted by my students. In addition, preliminary comparisons with the results from more traditional versions of this course show a slight improvement in average test scores. More significantly, this method has given opportunities for the less confident student to demonstrate their understanding in multiple formats.

Introduction

Active learning in the physics classroom has been demonstrated to be an effective and important component of physics pedagogy (Thornton & Sokoloff 1998, Dori & Belcher 2005, Deslauriers, Schelew, & Wieman 2011). More recently the flipped classroom has become an important addition to physics education. However, much of the emphasis has been directed toward the introductory physics courses, and has required a substantial time commitment to create and distribute the video content.

Many flipped-classrooms models are centered on student access to video content. I chose to emphasize another mode of outside-the-classroom learning – reading. Through guided reading assignments from *Introduction to Electrodynamics: 4th Edition* by D. J. Griffiths, I nearly eliminated the need for lectures and created a very active learning environment where students applied concepts, argued methods, and presented and worked in teams to solve problems.



Curricula Comparison

PHYSICS 330: Intermediate Electrodynamics

Covers basic content through Maxwell's Equations.

Traditional Course Curriculum	**Reading-Oriented Curriculum**
Lecture concepts, examples	**Group Work** concepts, problems
	Individual Work presentations notebooks, quizzes

Homework
5-6 problems per week

Exams
Four Unit Exams

FINAL ORAL EXAM

Results Comparison

Student Results	Traditional (N = 14)	Reading-Oriented (N = 17)
Exam 1	74.2 ± 8.9	80.2 ± 14.0
Exam 2	64.8 ± 9.4	72.7 ± 13.7
Exam 3	70.9 ± 12.3	78.9 ± 12.0
Exam 4	74.7 ± 7.7	78.0 ± 9.3
Final Exam	85.5 ± 4.4	88.1 ± 8.6

Course Details

- **Students completed about 1/3 more problems in the reading-oriented model.**
- **A reading outline was provided to focus student reading.**
- **Additional reading from the American Journal of Physics was required.**
- **Students presented to their groups and to the class.**

Student Comments

- **"Working problems on the board was a really helpful way to nail down the concepts."**
- **"The flipped classroom is pretty much excellent. It has done nothing but help with the ability to do problems and communicate what I am thinking to other people."**
- **"Working problems on the board during class was a huge help. Really forced you to justify your steps and made us discuss the problems which further helped us to understand the content."**
- **"The course is like a party where we go to talk about physics."**

Acknowledgements

- **Deslauriers L, Schewlew E, Wieman C. *Improved Learning in a Large-Enrollment Physics Class*. Science, 332 (May 13 2011).**
- **Dori Y J, Belcher J. *How does technology-enable active learning affect undergraduate students' understanding of electromagnetism concepts?* The Journal of the Learning Sciences, 14(2) (Oct. 8 2009).**
- **Griffiths D J. *Introduction to Electrodynamics: 4th Ed*, Pearson , 2013.**
- **Thornton R K, Sokoloff, D R. *Assessing student learning of Newton's laws: The Force and Motion Conceptual Evaluation and the Evaluation of Active Learning Laboratory and Lecture Curricula*. Am. J. Phys. 66, 338 (1998).**