

A Busy Professor's Guide to Sanely Flipping Your Classroom

Cynthia Furse
Electrical and Computer Engineering
University of Utah
Salt Lake City, UT 84112, USA
Cynthia.furse@utah.edu

Abstract—This paper describes the use of the flipped classroom approach for an Introduction to Electromagnetics course. Video lectures were created on a tablet PC, and uploaded to YouTube. Students watched the videos before coming to class. Class time was used for problem solving strategy (using homework as the problems) and engineering applications of the concepts. Student satisfaction scores (course evaluations) rose significantly, and preliminary data show test scores have also risen.

I. INTRODUCTION

This paper will describe my 4 year experiment with the flipped electromagnetics classroom [1] and strategies to sanely flip your classroom for the first time. In a flipped class, students watch video lectures prior to coming to class, so that class time can be spent on problem solving strategy (for the homework) and applications of the concepts of the day.

Concerns of a busy professor (which will be discussed in this paper) include:

- How to create the video lectures, and how to find time to do it.
- How to get students to watch the videos, and what to do for those who don't
- How to use class time to best advantage now that students have already seen the lecture, should you require students to come to class
- How will this affect your students' satisfaction and learning outcomes?

Each of these concerns will be discussed in this presentation.

I have used the flipped classroom to teach ECE3300: Introduction to Electromagnetics [2], a required junior-level 1 semester EM course, and ECE 5340/6340: Numerical Electromagnetics, [3] an elective senior or graduate level course. ECE3300 typically has 65-100

students, and ECE5340/6340 has around 30 students. Videos for both courses are available publically on YouTube [3] or (better organized, along with written materials and applications) on the course websites linked above. In addition, I often refer to math tutorials from the Khan Academy [5] and others as reference material for students who might have forgotten the calculus needed in this course.

II. VIDEO LECTURES

Video lectures replace traditional lectures in the flipped classroom. I recorded classes on a white board or a tablet PC [2][3]. Typical 50 minute lectures end up being about 20 minute of material without the classroom 'start up' time, questions, and other stopping points. Students say they like several short, discrete segments (3-5 minutes long), rather than full length videos. They also prefer the tablet PC videos, where they see the writing/derivations and hear my voice. Interestingly, they express that they actually feel more connected to me when they do not see my 'talking head'. One student expressed that it 'felt like you were right here at my elbow showing me how to do this stuff' when watching the videos on his ipad.

There are a number of video capture options available for both Mac and PC. I now use Ink2Go, which provides a very simple user interface and easily creates *.wmv files directly. [6] Another good software, which also allows video editing is Camtasia. [7] The video capture software lets you write on anything that shows up on your computer such as Power Point, One Note, Word, or even a virtual white board provided by Ink2Go. I use a PowerPoint template that lets me include pictures, figures, tables, imbedded video, etc. and write over the top of these things as needed.

As a busy professor, I do not feel that I have time to edit my videos. By keeping the length of each video short (3-5 min), if I make a serious mistake or don't like how I am explaining something, I can stop the recording and start over again from that point. I also give my students a few extra credit points for finding and commenting (on the discussion board or YouTube video) for other students to see. This takes care of simple mistakes.

There are several places you could upload your videos. I use YouTube, because it is well indexed, highly searchable, and public. My videos are available and freely accessible for students and professors around the world, and are used extensively as a result. Some lectures have been watched over 87,000 times by students and professional engineers around the world, providing significant educational impact (positive impact, I hope) for our electromagnetics community.

Students are expected to watch the videos prior to coming to class. I do not provide any specific incentives for video watching for juniors, seniors, graduate students, however this might be needed for freshman and perhaps sophomores as well. The only incentive is learning. I do not lecture in class, so a student who did not watch the lecture in advance is likely to feel behind during the in class time. I simply ask that student to go back and watch the video, and do not hold the rest of the class up on their behalf. About 80-85% of the students have typically watched the lecture before class.

III. IN CLASS

How the face-to-face (F2F) class time is used seems to be critical to the success and student satisfaction with this method. The majority of students watch the video the night before (a few the weekend before). They are not required to come to class, but since we begin the homework in class most students choose to come. A few say they try the homework first, and if they can do it all, they might not come to class. If they find it is difficult, and they have questions, they will come to class for sure.

I begin class with a short (5min) student-driven review of the video lecture and then begin the first homework problem. Students work with their nearest neighbors (stadium seating) and begin to set up /try the first homework problem. I wander up and down the aisles, looking at student work as they begin. Students typically answer each other's easy questions, but after a few minutes (2-4min), the more

difficult questions become apparent. Then a few students begin to ask me as I walk by. When I have 'collected' the hard question(s), typically at about minute 5-6, I stop the class, and we discuss the problem solving strategy for that question on the board. Then we either move on with that problem or move on to another. We step through the problems in this way, leaving each problem set up but not calculated, until about the last 10 minutes of class, when we discuss an engineering application using the concept of the day's lecture.

IV. RESULTS

By all measures, the vast majority of students like the flipped classroom. They appreciate being able to go back and review the lecture videos, and the opportunity to discuss homework problems with the professor in a 'just in time' setting. My student teaching evaluations immediately jumped when I switched to this teaching method. Student comments are consistently complimentary of the method.

Students also appear to be learning more and doing better with this teaching approach. The biggest change I noticed as an instructor is that the students asked far more questions, and many of these were higher level questions than I previously received. The first two years I did not find significant changes on exam scores, but the past two years I have seen a significant rise. Additional data is needed before fully supporting this conclusion.

My own satisfaction teaching the course has risen, and (after the videos were created) prep time is reduced. The flipped classroom has been a very successful experiment, and I plan to use this method in all future courses I teach.

REFERENCES

- [1]C. Furse, 'Lecture-Free Engineering Education,' *IEEE Antennas and Propagation Magazine*, Vol. 53, No. 5, pp. 176-179, 2011
- [2]www.ece.utah.edu/~cfurse (scroll down to the YouTube icon)
- [3]<http://www.ece.utah.edu/~cfurse/ece6340/>
- [4]www.youtube.com
- [5]www.khanacademy.org
- [6] Ink2go.com
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