

Flipping the Design Class Using Off-the-shelf Content: Can it work?

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Flipping the Design Class using “Off-the-shelf” Content: Can it work?

ABSTRACT

The benefits and challenges of flipping classrooms have been demonstrated in many recent papers, including several presented in the Mechanical Engineering Division at American Society for Engineering Education (ASEE) Annual Conference and Exposition. This, combined with very negative student reviews of the current textbook, convinced the author at Ohio Northern University (ONU) to experiment with a partially-flipped classroom in the fall semester of 2013. In preparation for this, the author found a tremendous amount of already-developed video and text resources available online for no cost, and often very high quality. This led to the idea for this paper – can a flipped classroom be taught using only these types of resources?

This has been done twice now at ONU in a senior-level design course. The online content includes popular videos (such as TED talks), how-to guides (either video or text), and reference materials or case studies.

Initial student responses have been very positive, with some students noting they are actually enjoying an engineering class for the first time. Surveys regarding this approach, as well as student performance on common final exam questions, are included. Preliminary findings indicate that in general this approach can work, but that there are certain content areas in which the available resources are very weak. A summary of resources used and student ratings of each will also be provided.

BACKGROUND

This paper describes work completed at Ohio Northern University (ONU), a small, private, comprehensive university focused on undergraduate education. At ONU, engineering students are heavily involved in design projects throughout the curriculum. A course in the senior year called “Process of Design” is required for all mechanical engineering students. This course provides content to accompany the capstone projects, a model that is not unique¹.

Previously, this course was taught in a traditional lecture environment, though regular active-learning activities were completed during class time. “Engineering Design” by Dieter and Schmidt² was typically used as the textbook, though other textbooks, such as “Engineering Design” by Eggert³, were tried.

Several authors have recently discussed the advantages of a flipped classroom at American Society for Engineering Education (ASEE) Conference and Exhibition, for example Mason⁴ and Kecskemety⁵. Typically, flipped classrooms are based on recorded lectures from the faculty member. The focus of this paper is to consider another option in design courses, in which many resources already exist which can provide a broader view of the design world than one faculty member could create.

OVERVIEW

Videos have been selected to cover various aspects of the design process. This material is usually NOT the same as the textbook would have covered, rather it is a different perspective. The goal was to find videos that are likely to give students background on a part of the design process and initiate classroom discussion. This section will give a short overview of each section of videos, with a very short description of why the video was selected.

Introduction to Design and Problem Definition

- Video 1: An introduction to David Kelley and [*IDEO, an Innovative Design Company*](#). This video provides a bit of introduction to design thinking, to IDEO, and to some of the first projects IDEO worked on. Of particular interest for discussion is David Kelley's discussion of their project of creating the mouse for Apple. They spent significant time trying to ensure that moving the mouse one inch would move the cursor one inch – and after much work they realized that this didn't matter at all – the user's brain could take care of that without any problems. Similarly, student designers often add constraints that aren't truly constraints, and spent a lot of time solving problems that aren't critical to the goal.
- Video 2: Timothy Prester TED talk [*Design for People, not Awards*](#). In a discussion about designing medical equipment for the developing world, he does a wonderful job of discussing user-centered design, and giving multiple examples of the kinds of user issues that designers often overlook.
- Video 3: Regina Dugan TED talk [*From mach-20 glider to hummingbird drone*](#). She gives an overview of some of the projects going on at DARPA when she headed that organization. She focuses on what engineers and designers can accomplish when they do not have to fear failure. This ability is important in the divergent-thinking part of design, and serves as a good starting point for discussion.
- Video 4: Joi Ito TED talk [*Become a Now-ist*](#). He provides a challenge to traditional design education, discussing the fact that people can now prototype almost in real time, changing the traditional new product development structure. This serves as a good tool for discussion of the different types of product development, and how different markets require differing timelines for the design process.
- Video 5: A “typical” flipped classroom lecture on video for a specific tool, Quality Function Deployment (QFD or House of Quality). [This video](#) is used as a reference to introduce the concept of QFD.
- Video 6: Tony Fadell TED talk [*The first secret of design is noticing*](#). His talk describes how easy it is to take the way the world is for granted, rather than constantly noticing ways that the world can be improved. This is a great talk to start a “bug list” exercise.

Creativity

- Video 1: David Kelley TED talk [How to build your Creative Confidence](#). This talk discusses myths about creativity, and makes clear that creativity can be improved with practice. This is a very good video to start the section on creativity.
- Video 2: Tim Brown TED talk [Tales of Creativity and Play](#). Similarly to the previous video, this talk begins with a discussion of how most people do not think of themselves as creative. The talk discusses how playfulness and environment can work to foster creativity.
- Video 3: Janine Benyus TED talk [Biomimicry in Action](#). She gives multiple examples of cases where looking to nature has produced better designs. She suggests a good exercise of asking designers to look at how nature has solved problems as part of the design process.
- Article on Brainwriting: This is a simple article [on the BrainWriting](#) method (sometimes referred to as 6-3-5), a team-based creativity method.
- Video 4: Ken Robinson TED talk [Do Schools Kill Creativity?](#) He discusses how the current education system is very focused on getting right answers, and how this discourages creativity and the arts. This serves as a good discussion point on how engineering design is different than engineering science.

Decision making

- Video 1: Dan Ariely TED talk [Are we in control of our decisions?](#) This talk focuses on the fact that the way questions are asked can influence our decisions. This is helpful in talking with students about how they frame design questions and how many alternatives they consider.
- Video 2: Kathryn Schulz TED talk [On Being Wrong](#). She makes the point that no one likes to be wrong, and that most people always assume they are right. The acknowledgement that we might be wrong can lead to better decisions.
- Video 3: Dan Gilbert TED talk [Why we make Bad Decisions](#). He gives numerous examples about how people regularly make very poor decisions, especially when money is involved.
- Article on Pugh's Method. All of the videos in this section are meant to provide background about why we need formal decision-making tools. Humans on their own make poor decisions, but still assume they are right. [This reading](#) introduces the first of several decision-making tools that are used.

Other design-related issues

- Video 1: [Microsoft Project™ tutorial](#) as part of the project management section.
- [Article on liability issues](#) in design. This article is used to start the discussion of legal issues in design.
- Video 2: [FMEA tutorial](#)
- Video 3: Amy Cuddy TED talk [Your body language shapes who you are](#). Communication is clearly a critical part of design. But students rarely think about the importance of body language, which this video discusses both in terms of brain chemistry and in terms of the perceptions of others.

- Video 4: Steve Howard TED talk [*Let's go all-in on selling sustainability*](#). This talk is presented from the view of an IKEA executive, who talks about the moral and financial reasons for pursuing more sustainable products and supply chains.
- Video 5: Craig Martin talk at U. of Kansas on Engineering Ethics, [*2013 J.A Tiberti Lecture on Ethics in Engineering*](#). This talk provides a good, broad introduction to professional ethics from an industry point of view, and begins the course discussion of ethics.
- Video 6: Kelly McGonigal TED talk [*How to make stress your friend*](#). Design decisions, and design team dynamics, can be very stressful situations. This talk shows that the way we react to those stressors, more than the stress itself, is what is most important.
- Video 7: Dan Ariely TED talk [*Our buggy moral code*](#). This talk is also related to ethics, and focuses on the fact that we think we make good ethical decisions, but that those decisions are strongly affected by our environment and our peers. This talk is again related to professional ethics.
- Video 8: Dan Ariely TED talk [*What makes us feel good about our work?*](#) This talk is really focused on what people need to feel that their work is rewarding, and leads into a discussion of design careers, the relative importance of money as students make career decisions, etc.

RESULTS:

Impact of these changes will be measured and discussed in terms of three measurements – teaching evaluations, final exam averages, and student surveys. The authors acknowledge that none of these tools are perfect assessment tools, but all can provide some insight. The data used will be from the two years prior to this change, and the two years since the change.

The same instructor has taught the course for the four years being considered. In the 2 years before the change, the average teaching evaluations (instructor overall) was a 3.5 on a 5 point scale, based on about 90% of students responding. Most comments were negative, especially about the textbook. In the two years after the change, the average rating on the same question was 4.1, again with about 90% of students reporting. Comments were split about evenly between negative and positive.

The final exam has not stayed completely identical over the past 4 years, but changes have been minor. The final exam average for the two years before the change was 82%, and has been 81% for the two years after the change. This change is not statistically significant, indicating that the change has not hurt student performance relative to the course outcomes.

Since the change, students have been asked to answer a survey, and some of those questions deal specifically with the “flipped” nature of the course. This year, 27/45 respondents (there were 50 total in the course) agreed or strongly agreed that “I’m going to watch some more TED talks after this class even though it won’t be required.” The

average value on this response for all students was 3.83/5. Last year, 16/33 agreed or strongly agreed with the same statement, with an average score of 3.45/5 (36 total students in the course). These results indicate that about half of students believe they will continue to watch videos such as the ones used in the course, a very clear indication of life-long learning aspirations.

It is also worth noting that students indicated on open-response questions that the ethics video and the tutorials were among the least-favorite activities in the course. The author believes this is due to the highly entertaining nature of TED talks – after “getting used” to those, other videos can seem difficult to watch.

LESSONS LEARNED

The goal of this “experiment” in a design course was to see if we could gather some of the benefits of a “flipped” classroom using already-created, publicly available content. Several lessons have been learned that may be helpful to other educators considering this approach.

First, it does not appear, based on final exam scores, to have significantly improved student learning. So from that perspective, a traditional flipped classroom with professor-created videos may be better because they can be created in a more focused manner that more directly relates to the material on the final exam.

Second, students greatly prefer this to a traditional textbook. This is reflected both in the quantitative and qualitative responses on course evaluations, and anecdotally in discussions with students. This is despite the fact that the new approach meant that most days there was a quiz to begin the class, to hold them accountable for having watched the video or read the article before class. It should also be noted that in a class of 50 students, moving from a traditional textbook to this approach has saved the students approximately \$10,000.

Third, about half of the students say they agree or strongly agree that they will continue to watch TED talks – a clear indicator of curiosity and ongoing learning.

From the instructor’s point of view, there is significant room for improvement. First, you will note that there are about half as many activities listed as there are days in a typical semester. Students were not typically asked to watch videos outside of class on days when there were other things due, but the author believes it would be better to add about 10 more activities. For a few specific design-related topics, there are very few high-quality videos available online. In such cases the author intends to create videos and make them available to other instructors.

It is worth noting that although it did not show up in any of these measures, this approach has led to much better, and much broader, discussions in the classroom. Very few of the videos were presented by typical engineering professors – this provided a breadth of perspective that the author, or most engineering faculty, cannot provide alone. It also allowed students to see the relevance of the things they were learning.

Finally, it can take a tremendous amount of time and effort to find good resources. Some videos may start well, or include language or other references that seemed inappropriate for students. So often it required looking through twenty videos to find one that was appropriate, relevant, and helpful for the students. This has led the author to believe that while this approach will continue to be used, it should not be pursued as an “easier” way to flip a classroom.

REFERENCES

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