Five Years of Flipped Classrooms: lessons learned

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Introduction

In recent years, flipped classrooms have gained in popularity at many universities.[1] However, they remain uncommon in design education. This paper presents the author's experiences creating and teaching flipped classrooms for required computing and communications courses over the past five years. In each of the two case studies, the introduction of flipped classrooms produced improvements in student learning outcomes, student engagement, and more efficient uses of school resources (e.g. contact hours, classroom space, TA's, etc.) compared to non-flipped versions of the courses. The author presents the details of the course structures, assessment methodology, and outcomes for the studies. The intent of presenting these studies is to share ideas about creating effective flipped classroom experiences and to help beginning design educators determine whether flipped classrooms are appropriate for their needs.

Flipped Classrooms

The use of online media – streaming videos, collaborative discussions, readings, etc. – is changing education. Students are teaching themselves through YouTube tutorials, independent courses such as Kahn Academy, and open-source efforts like edX. Online courses like these are often discussed as a lower-cost, more accessible alternative to traditional education.[2] But can this same media be used to improve the learning experience for students when they meet together in school? This is the main idea behind flipped classrooms, which first developed as a learner-centered, technology-supported model in high schools in the late 2000's.[3] More recently, one of the drivers of the flipped classroom movement in higher education is the need for universities to accommodate increasing enrollments with limited resources. Two-thirds of universities are using already using lecture-capture software -- in many cases, to support flipped classroom efforts.[4]

Briefly stated, a flipped classroom involves taking content which would normally be delivered in a classroom, such as lectures and tutorials, and assigning it to students outside of the classroom, often via online videos.[5] Assignments that would typically be given as homework are addressed in class instead, thus "flipping" the classroom. An advantage of flipped classrooms is that they can provide more time for interaction between students and instructors, often in the context of inquiry-driven group work and discussions. Additionally, students have the opportunity to ask more questions about the lesson materials and receive immediate support for their assignments as they complete them in class. In this manner, the traditionally passive classroom experience is transformed into more productive active learning.

Despite encouragement from universities, the growing popularity of flipped classrooms has not yet reached most beginning design programs. The following are two case studies of required computing and communications courses that experimented with flipped classrooms.

Fig. 1 Students in a flipped classroom

Case study #1 – Computational Methods

In 2011, the author began teaching a required course in computational design at the University of North Carolina at Charlotte (UNCC). Computational design is often considered an advanced subject, but at UNCC it is taught within the foundation sequence to third year undergraduates. Because it was an

experimental course, the author began collecting data during the first year and continued to do so for each new version of Computational Methods. In addition to required department evaluations and recorded grades, students completed pre- and post-class online surveys of their attitudes and opinions about the course content and teaching methods. An average of 75% percent of students participated in the surveys.

The first version of the course used traditional labs of 20-25 students (4 sections). The labs met twice weekly, followed by an all-class lecture at the end of the week. This format was not only challenging to teach – requiring the delivery of the same lab tutorials by the instructor four times a day – it was also not well-received by students. In their course evaluations, many students complained about the difficulty of the subject and the perception that it was not relevant to their future careers. Only 65% of students reported they were satisfied with their experience.

The lecture / lab teaching method, used in the earliest iteration of Computational Methods, is the traditional course format for many courses that teach computing skills. However, it is not necessarily the most effective or equitable means of student learning for this subject. Following tutorials in the classroom can be difficult for some students, particularly those with less computing experience, such as the economically disadvantaged. Women, also, can feel intimidated by the male culture of computing and inherited biases about technology use.[6] At the same time, it can be difficult for instructors to manage the lesson when the tutorial has to stop because a student needs help. This creates a situation where the class is not able to learn at the same pace. Furthermore, students tend to learn rote technique in the labs. The application of these methods is arguably where they begin to have the most significant impact upon learning, but also where students need more individualized instruction.

In response to feedback from the 2011 class, a flipped classroom format was used the following year. Online tutorial videos were recorded on YouTube and assigned to students prior to the class, while the lab activity shifted from tutorials to a project-based class. The new lab assignments were designed to teach students problem-solving skills and design thinking while applying the lessons from the videos. Students collaborated with self-selected partners on the in-lab projects. The instructor and TA's worked directly with students in the labs to discuss assignments, troubleshoot problems, and provide encouragement. The Friday lecture remained, but with additional time allocated for discussing common problems from the labs.

The switch to flipped classrooms dramatically impacted the students' learning experience. Over the next two years, student pass-rates (C or better) improved from 86% to 97%. Student satisfaction rose to 94% and then 98% the following year. There are several potential explanations for this. First, students could watch the videos to learn at their own pace: replaying steps if they were lost and playing videos at a faster speed if they were confident. This seemed to improve the overall level of computing skill among students before attempting the lab and allowed for later remediation and review. Second, female students and international students could work together to solve problems; they did not have to be concerned about being embarrassed for interrupting a tutorial to ask questions. (In computer science, all-female groups have been shown to improve learning.[7]) Third, students received much more one-on-one time with the instructor during the project-based labs. This helped to guide the lessons toward students' abilities and interests and produced a more positive teacher-student rapport. Last, the additional time spent on projects instead of tutorials helped the class to appreciate the importance of computation within design. When asked whether computational methods were relevant to their future education, 92% of students from the flipped classroom responded affirmatively. Compared to earlier surveys, nearly twice as many students said they would take an advanced version of the course (32% vs. 60%).

Fig. 2 Students in the UNCC active learning space

In 2014, the launch of a specially-designed active learning classroom on campus brought a third iteration of Computational Methods. This new space featured group tables with microphones and HD monitors as well as a wireless

microphone for the instructor. In place of the Friday lecture, the students participated in small group activities meant to summarize and respond to questions about the week's lessons, followed by shorter lectures on concepts, precedents, and theory. The student outcomes of this version improved slightly, from 97% passing to 100%. Most importantly, this version of the flipped course reported the highest satisfaction compared to previous iterations. 93% of students remarked that they preferred the new active learning format rather than a traditional lecture.

The unique technology in the classroom helped to inspire the active learning lecture, but it was not a requirement. The group tables and whiteboards were the most necessary equipment. Small group activities and shorter lectures kept the room engaged better than a traditional lecture. This final change helped to further flip the classroom from passive to active experiences..

Case study #2 – ARCH 230

At Iowa State University, ARCH 230 is a required visual communications course taught in the second-year undergraduate program. As the first and only required communications course in the curriculum, the content covers a wide set of topics: architectural drawing conventions, computer drafting, three-dimensional modeling, photo collage, desktop publishing, and basic computational design and digital fabrication.

Fig.3 Group discussion in ARCH 230

In 2015, the author experimented with making ARCH 230 a flipped classroom. Like Computational Methods, previous versions of the course utilized a lecture / lab format. The new version moved communications lessons out of the computer labs and into the second-year design studio, with over 90 students working in the space together, using their personal laptops at their own desks. Students watched online video tutorials before class (and sometimes at the start of class), then completed weekly assignments in pairs. The class met twice a week. The first day of class, students started their projects and were shown precedent examples of the communications methods with high-definition screens on movable carts. Later in the week, the second day of class was reserved for answering questions and for pin-ups of work in progress. Students submitted their projects for grading at the end of the week. The flipped classroom format was repeated a second time, in 2016, with new videos and some updates to assignments.

Fig.4 ARCH 230 students working together in their studio space

Flipping the classroom into the design studio presented its own unique challenges. Because students are working at their desks and on their own machines, it can be easy for them to lose focus and distract themselves with other tasks: watching television, working on studio projects, studying for tests in other courses, etc. One must be careful not to allow students the sense that the course is a study hall. In large classrooms, where students are spread out over the space, classroom management and lesson design are essential. It can be tempting to let the students work on their own and wait for them to ask questions, but staying actively engaged as an instructor helps everyone. Teaching assistants may have to be trained in strategies for approaching students, as they are not always naturally inclined to do this. In addition, structuring "break-out" sessions, where students leave their desks for discussions, pin-ups, and short lectures is another way to keep students on task and interested in the work.

Data from the lecture/lab version of ARCH 230 was not available but student outcomes and evaluations collected for 2015 and 2016 were well above average. The average grade was 86.5% and the overall evaluation was in the top 10% of courses within the department. The most important impact of the flipped

classroom version of ARCH 230 was its improved efficiency. This will be discussed in the next section.

Discussion

The following section is a summary discussion of lessons learned from the two case studies and the author's five years of flipped classroom experimentation.

Learning how to learn

One way flipped classrooms are said to improve learning is through the use of online videos, which is a form of media many students are comfortable with and often use to learn on their own. Furthermore, the use of active learning strategies, as opposed to passive learning, are supposed to improve student engagement.[8] However, this does not mean that students will always learn better from flipped classrooms. Indeed, in earlier iterations of both case study courses, some students were unprepared for labs and complained that they felt the flipped classroom model wasn't teaching them effectively.

Fig.5 Students benefit from training in how to learn effectively from flipped classrooms

Follow up interviews concluded that many students did not understand how to watch the videos actively: in their group pairs, discussing together, collecting notes and questions, and following along with tutorials. They were simply watching the videos, often in another computer window while doing other activities. Although many K-12 schools are also experimenting with flipped classrooms, the format remains new to many students, who often carry over bad habits from the ways they typically engage with media. To help students get the most out of flipped classrooms, they must be taught how to learn from them. Towards this end, it can be helpful to design the first lesson in the course so that active learning behavior is clearly modeled and encouraged. This way, students immediately learn the mindset and habits necessary to succeed. When the author introduced training in active learning methods to his courses and syllabi, complaints about the format decreased significantly.

Improving efficiency

Many colleges encourage the development of flipped classrooms as a means of cost-reduction while maintaining a high quality of education. Improving teaching efficiency may not possible for all types of courses, but with regards to the two case studies, the flipped classroom resulted in some savings, particularly in terms of space and teaching assistants. Teaching Computational Methods at UNCC required only one TA as support staff, to help with lab coaching and grading. Other courses of a similar size had two or three TA's. At Iowa State, teaching ARCH 230 in the architecture studios eliminated the need for a large 90-person classroom for lectures. This space could be removed from the department's teaching budget. In addition, because students used their own laptops for in-class work, this opened the use of the College labs for students and other courses. In terms of teaching assistants, the course was originally taught with five – one for each studio section. This was later reduced to three TA's, but, because of the format, the course was able to absorb this reduction without difficulty. Both case study courses were large – about 75 students on average – and so flipping them may have created more efficiencies than with a smaller class size.

Instructor effort

A common concern about flipped classrooms is how much work it requires.[9] Students tend to think instructors in flipped classroom do less work, because they are merely showing (and re-showing) videos. Instructors worry about the additional time it might take to produce videos. In the authors' experience over the last five years, it is not the case that flipped courses require substantially more or less effort, but rather that one's effort is distributed differently than in traditional teaching. For Computational Methods and ARCH 230, the online tutorial and lecture videos needed to be prepared, recorded, and edited. This required an upfront investment of time, which was returned when the videos were later reused for multiple semesters. The time saved teaching tutorials in lab was used to "coach" students which required at least as much effort as teaching the lab before. In terms of personal teaching style, engaging with the students in this manner was more comfortable and felt more rewarding than attempting to deliver specific content from a script (often multiple times a single day) and resolving technical issues with classroom equipment.

One teaching area where the author noticed a significant change was the time spent responding to students' requests for help via email. In the traditional class with the labs, the author might receive three or four emails per lab because an

instruction was unclear, a student missed a class, resolving technical issues, etc. After introducing the flipped version, the volume of this type of email was reduced to almost zero. This is likely because students could replay the videos, receive help from their partner, or because those issues could be resolved in labs. Something else to consider is that instructors who are not as familiar with recording software may also need training and additional time to be able to produce and upload their lecture videos. As discussed in the previous section, flipped classrooms can help teachers with limited resources, but saving time or effort may not be a strong reason to experiment with the format.

Video sharing and accessibility

Streaming videos are often a critical component of flipped classroom strategy. In addition to providing the best course content for one's videos, consideration should be given to how student will access them. When the first version of the flipped classroom was developed for Computational Methods, the author made the decision to upload all of the videos to YouTube. This decision was both pragmatic and altruistic. At the time, the YouTube user experience was superior to the University's own courseware, both for uploading and viewing. Camtasia software was used for screen capturing, which had many features that helped make computing tutorials clear, such as highlighted cursors and click feedback. Compared to other, similar tools, Camtasia uploads directly to YouTube at full HD resolutions, which can help students see the software interfaces better. YouTube works with a variety of devices, such as mobile phones. This turned out to be important because a surprising number of students watch their course videos on their phones and follow along separately on their laptop. Providing open access to the materials was also a priority. In the interest of sharing knowledge, the videos were uploaded as public and kept ad-free.

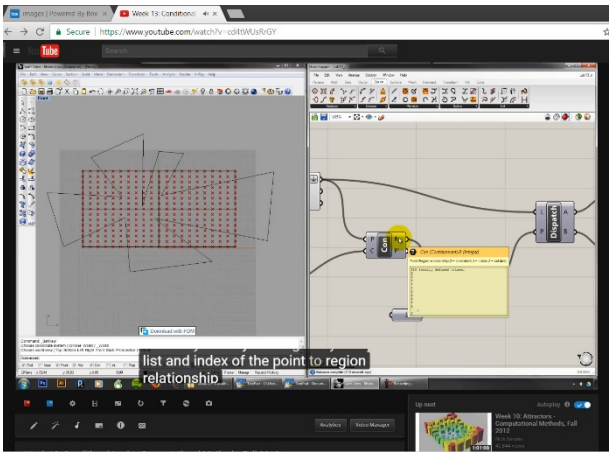

Fig.5 Automated captions on a YouTube video

An additional benefit of using YouTube for the flipped classroom has been the improvements in captioning over the past seven years.[10] Videos uploaded to YouTube now receive automated captions, which can help with comprehension. Many of the international students in ARCH 230 use the captions to follow along in English or their native language. The English captions, at least, appear to be very accurate. The author was surprised to find that the captions manage to translate computing terms and software commands well. As enrollment of international students in architecture schools continues to rise, providing accessibility is a consideration when selecting learning technologies.

Impact of online resources

Many schools have their own tools for flipped classrooms, such as Panopto, which has advanced features for adding video annotations and student interaction. In some ways, these tools may provide a better experience for student learning compared to sites like YouTube, but they often limit viewing to users within the campus computer network. With this in mind, another benefit of flipped classrooms is that open access online resources created for the course can generate impact beyond the institution. For example, the videos created for Computational Methods and ARCH 230 have been collectively viewed over one million times on YouTube[11] by users in dozens of countries. At last count, eleven architecture programs have used the author's videos in their courses. In 2016, the author's channel was cited by ArchDaily as one of the top channels for architects.[12]

Making the videos public, rather than restricting them to a University system, was one reason why so many others were able to make use of this media. Another helpful strategy was to consistently tag the videos and provide clear descriptions with timestamp "chapters." This had the effect of making the videos easy to search, so they would consistently appear in Google results. Being able to refer to the videos has been helpful for lessons in other studios and the school appreciates being associated with a useful resource. For tenure-track faculty, the popularity of learning materials among peer intuitions, professionals, and publications is a potential way to demonstrate the impact of one's work.

When flipping fails

Not all students learn best from flipped classrooms. In the author's classroom evaluations, about 4 percent (on average) of students reported strong dissatisfaction with the format. Lecture and tutorial videos can present problems similar to those of traditional classrooms; some students still do not learn well simply by watching a video. A few mentioned they would prefer to learn tutorials in the lab, with the instructor present, because they find it difficult to follow the videos. Others

reported that they would prefer to take the course online, as if there was nothing more to the course than the content itself. Occasionally, students have difficulty working together in groups and reject this part of the experience. One or two individuals have shared the opinion that the flipped classroom is "not teaching."

While the majority of student experiences appeared to be positive, these criticisms and concerns should not be overlooked. Learning is highly individualized and while flipped classrooms can be more flexible than more traditional courses, the possibility remains that students may struggle with these methods. Instructors need to be aware of this and watch for signs that students are not learning. In flipped course syllabi, it can be helpful to mention that alternatives can be arranged, such as one-on-one tutoring for students who have trouble learning from the videos and other lessons.

Conclusion

Although the effectiveness of flipped classrooms is still a matter of some debate[13], over the past five years, experimenting with flipped classrooms has been an overall positive experience for the author. In the first case study of Computational Methods, the transition to a flipped classroom helped to make a difficult subject more personally relevant and inclusive for students. The second case study, ARCH 230, demonstrated how a flipped classroom format can be used to introduce the teaching of visual communications and computing skills into a shared studio space. The benefit of this change has been a more efficient use of school spaces and personnel, while maintaining high student performance and satisfaction. Regardless of any changes in student outcomes, flipping classrooms provided the author with intellectual challenges, invigorated his teaching, and resulted in increased exposure for the author and his institutions.

Universities promote the use of technology in order to accommodate more students while preserving the quality of education. Many believe that online-only courses are a solution. In a field such as visual communications in beginning design, which depends so much upon skill, craft, and nuance, an online course does not make much sense. Flipped classrooms appear to be a happy medium where technology can be used to create efficiencies whenever possible so class time with students can be used more efficiently. Those who worry that recording tutorials and lectures might spell their own obsolescence can still argue that the role of the instructor is critical for engaging the class through coaching, encouragement, and spontaneity. More experimentation is needed to improve these methods, but for some types of courses, flipped classrooms are a productive addition to design education.

Notes

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