122nd ASEE Annual Conference & Exposition
June 14 - 17, 2015
Seattle, WA
Making Value for Society
Paper ID #12823

Resources for "flipping" classes

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Resources for Flipping Classes

Abstract

As flipped classes become more popular, opportunities for sharing resources and techniques arise. Instructors can learn from the experience of others, and they can also borrow materials and approaches that others have used. But the design space is very large, and simple web searches usually fail to retrieve the most relevant materials. This paper aims to serve as a guide to what is currently available in three areas: sites devoted to the pedagogy of "flipping," sources for reusable materials such as videos, and techniques other than lecturing that can be used during a class session.

Keywords: flipped class, inverted lecture, pedagogy of engagement, active learning

1. Introduction

"Flipped" classes have surged in popularity over the last three years, driven by the ease of recording and posting video content for students to watch, and the need during class time to compete with distractions from portable electronic devices. Evidence for the benefits of flipping is starting to mount. Studies have shown improved learning in architectural engineering and chemistry courses [1], economics [2], and biology [3], among other fields. Many other studies report student *perceptions* of improved learning [1, 4, 5] .

The instructor who desires to "flip" a class confronts two issues: how to locate or create content for use outside of class, and how to use time effectively during class. This paper presents resources for addressing both of those needs. To uncover a wide variety of resources, a web-based survey was sent to three listservs for college educators and educational researchers: the POD Mailing List, the ACM SIGCSE Members List, and the Engineering Technology[1] listserv in October 2014. These listservs have a total of about 3000 subscribers, but only 32 responses were received. This probably reflects the fact that few educators have yet "flipped" their classes, but since thousands of faculty and hundreds of faculty developers were surveyed, it's likely that they were able to name most of the prominent resources and techniques.

[1] pod@listserv.nd.edu, the listserv of the Professional and Organizational Development (POD) Network in Higher Education; sigcse-members@acm.org, the listserv of the ACM's Special Interest Group on Computer Science Education; and etd-l@listproc.tamu.edu, the listserv of ASEE's Engineering Technology Division.

2. Resources on the pedagogy of flipping

The most prominent site on flipping seems to be the Flipped Learning Network (http://flippedlearning.org). It collects articles, press reports, and research studies on the "flipped" model, and also has an "Online Community of Practice" with over 22,000 participants. It reports on a 2014 survey of over 2000 teachers, and the accompanying infographic shows that this form of instruction is becoming commonplace in K-12 education. A site with similar resources, but oriented toward higher education is "OLT: Flipped Classroom Project" from the University of Queensland. It has case studies in several disciplines, including Engineering Design. It has synopses of various ways to use class time, including case studies, peer learning, problem-based learning and project-based learning. It gives some advice on how to measure learning gains. Flip It! Consulting has a blog with posts on various aspects of flipping that will be useful to educators in many disciplines. A notable collection of links and references to other resources is provided by Robert Talbert at Grand Valley State University. His intention is to turn it into a wiki that will allow others to add resources to the list. For those in scientific disciplines, a useful book is *Lecture Free Teaching*, by Bonnie Wood, published by the National Science Teachers Association.

2. Finding videos and other resources

An instructor who wants to flip a class has three choices on how to provide pre-class activities: assign readings (e.g., from the textbook for the course), assign students to watch third-party videos on the material for each day's lesson, or produce his/her own videos. The first approach, of course, is the easiest, but it also seems to be the least common. According to multimedia learning theory [6], people have separate audio and video channels, which in effect gives a larger bandwidth to narrated videos than to textual material that is simply read. Stelzer et al. compared the exam performance of students who learned from either written or multimedia presentations in an introductory electricy and magnetism course. Though their sample size was small (45 students), they found that students who watched the multimedia presentations scored nearly one standard deviation higher than students who read the textbook [7]. Moreover, there is evidence that students are more likely to watch videos than read the textbook before class [8].

The second approach depends on finding suitable videos. Several sites offer videos that, in principle, can be used.

TedEd (ed.ted.com) claims to offer over 106,000 lessons. They are technically superb, but it's not easy to search the site for videos on a particular topic. A search for "statics," for example, yields five hits: the first is on the origin of words used to describe electricity, the second is on the Kansas-Nebraska Act of 1854, the third is on optical illusions, the fourth is on how to create animations, and the last one is a history of video games. A search for “data structures” returns five similarly irrelevant hits. A search for “digital logic” does not return anything. The videos are of reasonable length (a few minutes each), and playback can be sped up to 2x recording speed, or slowed down to 0.25.

Khan Academy (khanacademy.org) has videos and other resources on a wide variety of topics. Its videos are also professionally produced. They concentrate on explaining topics using stylized handwriting that happens right before the viewer’s eyes. It has several videos on statics, which are part of a physics course, but nothing on data structures. Its videos are hosted on YouTube, so all of the YouTube playback controls can be used.

Teachertube.com is K-12 oriented, but in the author’s experience, is more likely to return videos that can be used in higher education. A search for “statics” returns about 8 useful hits. There are useful videos on “data structures” too, though they must be ferreted out of a set of poorly focused results. The production quality is much less professional; many of the visuals are hand-written. And there doesn’t seem to be any way to control the playback speed.

Academic Earth (academicearth.org) bills itself as the site for “open courseware from the world’s best universities.” It offers thousands of complete courses, but the videos are mostly lecture capture, which makes them hard to “drop into” other courses. There are 11 Mechanical Engineering classes, but none on statics. There are two separate courses on data structures from the University of California, Berkeley, but both are lecture capture. The viewer can control playback speed.

If an instructor wants to offer an entire course that was produced elsewhere, there are many opportunities to do so using MOOC platforms such as EdX and Coursera. The production quality is usually much better than lecture capture. Early experiments at San Jose State in 2012-13 showed mixed results [9].

Many textbooks now include videos as ancillary resources, along with lecture slides. If so, they will usually be the best option for courses using that text. If not, the best place to start looking for videos is likely to be **YouTube**. It has hundreds of videos on statics, and hundreds on data structures. And, YouTube searches can locate Khan Academy videos. If the number of hits is too great for the instructor to watch, students could be assigned to look for videos on specific topics, and share their top choices with the class.

3. Producing one’s own videos

Many instructors record their own videos. This makes it a lot easier to provide continuity in coverage and insure that prerequisite topics have been covered in advance. Camtasia Studio is easily the most popular application for creating them. It has a “spotlight” call out to focus students’ attention on a particular part of a slide. It allows multiple-choice and fill-in-the-blank quizzes to be embedded in videos. (TedEd also allows this.) Results can either be uploaded to an LMS or e-mailed to the instructor once a day. It can also generate captions from PowerPoint notes panes; this facilitates developing accessible content. Most users consider Camtasia to be reasonably priced, especially with the educational discount. A free product from the same company (Techsmith) is Jing, which will record up to 5-minute videos with limited editing capability. A variety of other platforms are used: iMovie, Panopto, ScreenFlow, Snag It, Snapzpro, and Tegrity. Office Mix from Microsoft is a new platform that seems to have an impressive array of features.

4. How to use class time

There is a rich history of research on active learning [12] in general, and in engineering in particular [13]. "Flipped" classrooms can in principle use any of these techniques during class. Our survey asked educators three questions about how they used class time: what activity did they start with, what did they do for the bulk of class time, and how did they end a class period? In all three phases, a few techniques predominated.

4.1. How to start. Many instructors begin class time with a **quiz**. They may use clickers to administer the quiz, they may give it on paper, or they may host it in an LMS. In the latter situation, the quiz is often due just before class. This is a way to hold students responsible for doing the assigned reading or watching the videos. It is often a low-stakes quiz; the questions may be easy, or students may be allowed to take it a few times without penalty. It may even be ungraded, in which case it serves as a way for the instructor to determine which of the preparatory material needs to be reviewed during class time.

Other ways to deliver a quiz in real time are PollEverywhere (http://polleverywhere.com) and SMSPoll (http://smspoll.net). These are free for small classes, but moderate cost at worst. A free way to provide much of the same functionality is Google Moderator (http://www.google.com/moderator).

A second way is to ask and answer questions on the preparation (reading or video). This may consist of asking students to identify the "**muddiest point**" of the lesson. These can be written down on paper, or submitted via an online form, and then the instructor can discuss them. A variant is to give an ungraded quiz, as above, and then address items that the students seemed to be weak on. One instructor told us that ***he*** answered common questions in front of the class, and less common questions by e-mail. The instructor can ask students to turn to the student next to them and generate questions that could be asked to the class. The instructor may also go over highlights from the lesson, and ask questions verbally, to see how well the students have understood.

The highlights approach leads into the third approach, **summarizing** key ideas from the lesson. Student might be asked to write a summary in advance; the instructor could look them over to decide which points to address. Students could be asked to discuss what they'd like to see summarized. A variant on this is the "**3-2-1 approach**," where students are asked to tell a group …

- 3 things you have learned,
- 2 things you already knew, and
- 1 thing you are still confused about.

They can turn in notes from these confabs, and the instructor can use them as a starting point for discussion.

Another alternative is borne out of experience with active learning. Class begins with a **mini-lecture**, which goes over points not covered in the reading or video, to set the stage for a collaborative in-class activity. The instructor describes the background and explains what students are about to do together. One instructor said she counts this group work for 5% of the course grade.

4.2 Activities for the main class period. Flipped class time can be organized around activities that have traditionally been assigned as **homework**, such as problem sets or worksheets to complete. Students are allowed to ask the instructor or TA when they have questions. These activities are often done in groups. Students who finish early may be allowed to leave; those who don't finish may meet outside of class to complete the activity, or they may be allowed to finish on their own and submit individually. One instructor told us that she has students who finish early, work on a crossword puzzle over terms in the class material.

A variant on homework-replacement is to have students solve "**challenge questions**" that are similar to problems they will encounter on the exam. The difference between this and "homework" problems seems to be that challenge questions are shorter or easier to solve, because several of them have to be doable during a single exam.

In computer-science classes, students often spend the class period **programming**. They can work with partners; this means they are "pair-programming," which has been shown to have important benefits, especially for the reliability of their code [10, 11]. However, if students are to complete a programming exercise during one class period, it's necessary to set it up carefully. An instructor might do requirements analysis with class participation, in front of the class, or might write a skeleton of the code that students need to finish. Otherwise, even good students might have difficulty finishing during class time. One instructor says that, once several students have the program working, he will choose one and display it for the class to see. Or, if someone has an "interesting" compilation diagnostic or bug, he may show that to the whole class, to help them develop skills for interpreting compiler messages and debugging programs.

Another way to spend the class period that, admittedly, takes considerable preparation time, is to use **pedagogies of engagement** such as Team-Based Learning (TBL) [14], Process-Oriented Guided-Inquiry Learning (POGIL) [15], Problem-Based Learning (PBL) [16], or Peer Instruction [17]. The first three of these [18] are different approaches to having students work in groups on problems that lead them to understand principles, often scientific principles, behind the work that they are doing. With Peer Instruction, students are shown a question that targets the misunderstandings that students typically have. They vote individually (e.g., with clickers), then discuss the question in groups and vote again. Finally, the class as a whole discusses it, and answers any remaining questions the students have, before moving on to the next topic, where the process is repeated. The very activity of confronting their and others' misunderstandings of the concept helps students to think more deeply—metacognitively—about what they are studying.

These pedagogies constitute different approaches to **collaborative problem solving**. Problem-solving sessions may also be less structured … the students could be given arbitrary course-related problems to discuss in groups. If they encounter trouble, the instructor could give an impromptu mini-lecture on the difficulty. If not, students could proceed at their own pace to solve the problem.

We saw that a flipped class could begin with a mini-lecture that goes more into depth than the class-preparation material. Students then solve a problem together. This can be followed by another, pre-written **mini-lecture**, to allow students to apply the principles to a new, or harder problem.

4.3 How to finish. Our respondents also told us of a variety of ways to finish a class. The simplest was to just let the students **finish the problems**. If they finished early, they could leave early, or perhaps work a crossword puzzle (see above). A variety of **reflective activities** were also proposed. One of these is the old standby, the *minute paper*, in which students are asked to write for one minute about concepts covered in class. Another is the *muddiest point* reflection (see Section 4.1), in which students report what was the hardest concept to understand. This can then be addressed at the start of the next class. This can be combined with the "clear skies" technique [19, 20], where students give the most important point, or tell what they understood best.

One instructor gave these ideas for reflective topics:

- Something I learned from this week's lesson was …
- Something from this week's lesson that still is not clear to me is …
- An interesting question that remains for me is …
- Something about today's class that I would like to know more about was…
- Pair the three previous with "Something I can do to resolve this is …"

- Something I learned about myself through this week's lesson was …
- Something I learned about how I learn this week was …
- The part of the lesson I feel I benefited the most from was …
- The most surprising/unexpected idea from this week's lesson was …
- The most stimulating/interesting thing I found about this week's lesson was …

The whole class can be involved in a **reflective discussion**. The students discuss where the work done during class will be applicable to work to be done later in the course. The instructor can address difficulties that teams commonly encountered, and remind them to watch the video for the upcoming class. Or, the instructor might simply **summarize** what was done and learned that day.

Getting ready for upcoming classes is another common closing activity. One instructor said that he provided "pointers to videos/readings that build on today's experience and set things up for next time." Another instructor said he closed with a **clicker quiz** on the material covered that day.

5. Summary

"Flipped" courses are rapidly gaining popularity, but the strategies for class time are very similar to active-learning approaches that have been developed over the past 25 years. The main difference is that active learning now occupies most or all of the class period. Consequently, an understanding of active learning will help instructors use class time effectively. Several training organizations and web sites have been established to promulgate effective practices across disciplines. Prep work can involve reading or watching videos. In either case, it is helpful to give a low-stakes quiz to induce students to prepare for class. If the choice is videos, then YouTube is probably the best source for pre-existing videos. But, unless the video or videos are designed to be "dropped into" an existing class, it will probably be better for instructors to record their own videos. They application most frequently recommended for that is Camtasia.

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