Teaching in a flipped classroom.

Jillian Grose-Fifer
CUNY John Jay College

Chapter 11: Teaching in a Flipped Classroom

Jillian Grose-Fifer

John Jay College of Criminal Justice and The Graduate Center, CUNY

Abstract

In this chapter, I describe how I switched to using a flipped class model in an upper-level Sensation and Perception course, by reversing where different types of learning take place. In the flipped model, instead of introducing students to basic concepts in class, they answered guiding questions after watching videos or reading the textbook before attending class. They then spent class time working collaboratively in small groups on more challenging assignments, many of which had been homework assignments in prior (non-flipped) courses. In-class activities consisted of mini-experiments, and other student-centered hands-on learning experiences designed to foster higher-order critical thinking and scientific inquiry skills. Flipping the class provided students with greater support for these more challenging activities and made the course more manageable both for students and for me, the instructor.

What Is a Flipped Classroom Model?

In traditional teacher-centered classrooms, students spend most of the time in class listening to the instructor explain basic concepts, which students then apply in subsequent homework assignments designed to deepen and expand their knowledge. Flipped (or inverted) classes switch where and how these activities occur, with the idea that understanding basic concepts is something that students can learn on their own without too much difficulty, but that higher-order thinking (such as applying concepts) benefits from support from peers and the instructor (Bergmann & Sams, 2012; Crouch & Mazur, 2001; Lage, Platt, & Treglia, 2000; Mazur, 1997, 2009; Soicher, this volume; Talbert, 2017). Flipped learning classrooms are interactive, student-centered learning spaces that engage and motivate students, thus increasing the likelihood that transformative learning will occur.

Why I Decided to Flip My Biological Psychology Courses

Mazur, a Physics professor at Harvard University; Baker, a Media and Communications professor at Cedarville University; Lage, Platt and Treglia, three Economics professors at Miami University; and Bergmann and Sams, two high school Chemistry teachers in rural Colorado, are all considered to be pioneers of the flipped classroom model (Baker, 2000; Bergmann & Sams, 2012; Crouch & Mazur, 2001; Lage, et al., 2000; Mazur, 1997, 2009). It is noteworthy that they were all teaching courses that many students struggle to master because the subject matter often seems abstract. I teach Sensation and Perception, an upper-level course in the Psychology major at my college, which students often find challenging for similar reasons. Indeed, assessment data from my courses showed that 51.4% of 101 students surveyed agreed that the subject matter in Sensation and Perception was more difficult than other Psychology courses at the same level. In this chapter, I describe why and how I made the switch to teaching Sensation and Perception class in a flipped class format, along with some of the associated

Correspondence to: Jill Grose-Fifer, Department of Psychology, John Jay College of Criminal Justice, 524 West 59th Street, New York, New York 10019,
Email: jgrose-fifer@jjay.cuny.edu

challenges and benefits. Before flipping, I used an interactive lecture format whereby I spent class-time questioning students about major concepts and providing explanations as needed, with demonstrations interspersed for further clarification. For homework, students conducted mini-experiments from a CD-ROM that came with the textbook. I thought these homework assignments would help students connect practice to theory while gaining valuable experience with experimental design, data collection, and analysis. However, students really struggled with figuring out how to run the experiments and interpret the data. My goal was for students to attain mastery of the concepts, so I allowed them to redo their homework as many times as they wanted. This became a huge burden for both them and me, as it sometimes took them multiple attempts and I struggled to give feedback to a relatively large number of students in a timely manner. Also, although my classes were designed to be interactive, sometimes students were unable to answer the questions that I posed, most probably because they had not done the assigned reading, a commonly reported phenomenon among undergraduates (Berry & Chew, 2008; Clump, Bauer, & Breadley, 2004; Hobson, 2004; Landrum, Gurung, & Spann, 2012; Sikorski et al., 2002). I ended up spending too much of the class time talking. It was clear that I needed to switch things up!

Getting Started with Flipping!

Encouraged by a growing number of publications, largely from science/math-based (and some Psychology) courses, showing that flipping led to superior performance on exams, assignments, and course grades (Cummins-Sebree & White, 2014; Foldnes, 2016; Hew & Lo, 2018; Hussey, Fleck, & Richmond, 2014; Morton & Colbert-Getz, 2017; Peterson, 2016; Pierce & Fox, 2012; Talley & Scherer, 2013; Wilson, 2013; Wong, Ip, Lopes, & Rajagopalan, 2014), I decided to give it a try. In keeping with backward design (McTighe & Wiggins, 2012; Wiggins & McTighe, 2005), I first reviewed and honed my learning objectives for the course, decided on how I would assess whether students had achieved them, and then designed my learning activities. Flipped class instructors introduce students to the basic materials in their pre-class assignments in various ways, for example, Bergmann and Sams (2012) provide videos that students watch by themselves in their own time, but Mazur and colleagues assign readings that students collectively discuss and annotate online (Miller, Lukoff, King, & Mazur, 2018). In keeping with the principles of Universal Design for Learning (CAST, 2018), I wanted to support the diverse learners in my class by providing some variety in the pre-class assignments. Therefore, my students can choose between reading the textbook and watching a video, but everyone is asked to answer a list of related questions (not collected or graded) before class. I used the review guides that I had created for my previous courses to generate the guiding questions, and then set about learning how to create videos (for more details see Pre-Class Activities below).

I began cautiously, flipping just one or two class periods and surveying my students' perceptions about how it affected their learning before committing to a more widespread "flip". I decided to start teaching my course (which meets for 75 minutes twice a week, i.e., 2.5 hours weekly) using a "partial flip". My plan was to alternate each flipped class (watching a video/reading the textbook and answering study guide questions for homework followed by an in-class workshop) with the regular class format I described above. In order to increase transparency and increase student buy-in, I spent time during the first class of the semester explaining my rationale for the switch and asking students to reflect about what helped them to learn best. In my first two courses, I also promised that if, after trying the partial flip for one quarter of the semester, they wanted to make changes, I would heed their feedback. When surveyed, students from both courses (n = 70) were very enthusiastic about the hands-on active learning in the workshops, which is consistent with other research showing that college students generally view flipped classes positively (Bishop & Verleger, 2013; Cummins-Sebree & White, 2014; Hew & Lo, 2018; Pierce & Fox, 2012; Wilson, 2013). However, they felt that the pre-class assignments required a lot of work outside of class, which is another common finding in flipped classes (Talbert, 2017). The majority (81.4%) of students indicated that they wanted to continue with the current partial flip format, 11.4% reported that they would like a fully flipped course, and only 5.7% indicated they would have preferred that the course was not flipped at all. So, I have continued using the partial-flip format.

Pre-Class Activities

As mentioned above, flipped class instructors use a variety of pre-class assignments to introduce students to basic concepts; videos are very common, as are readings and pre-class quizzes (Akçayır & Akçayır, 2018). Having decided to give my students the option of watching a video as part of their pre-class assignments, I needed to learn how to make a video, without buying new software (though after a few complaints about sound quality, I did invest in a basic USB headset with a microphone, which cost about $30). I used Microsoft PowerPoint[1] on my desktop computer to add narration and animation to existing slides that I had used in my previous courses. I then exported these as MP4 videos and uploaded them to YouTube as unlisted files (these types of files are only available to people who have the link and so only my students had access to them). I then posted the links in my course management system (Blackboard). I created the videos using Mayer's principles of multimedia design (Mayer, 2014a, 2014b); thus, most slides consisted of graphics (with minimal text) to which I added verbal (and laser pointer) explanations. I also experimented with Screencast-O-Matic (https://screencast-o-matic.com/ — free software for recordings of 15 minutes or less) when I wanted to capture content on my computer screen that was outside the PowerPoint environment. I particularly liked using PowerPoint because I could record and save (or delete) the animation and narration, one slide at a time. This meant that if I made a mistake, or something interfered with the recording (like a fire alarm), I could easily re-record just that particular slide. In contrast, I could only pause the video in Screencast-O-Matic (useful if you know you are going to cough, for example) and so if I seriously messed up, I would have to start again. I have since learned how to use free editing software like Audacity (https://www.audacityteam.org/) and Shotcut (https://shotcut.org/), but I find these very time consuming and so I try to do the best job I can the first time around. I avoid using a script because not only are they time-consuming to create, but I like the more natural sounding videos that I produce if I am not reading. Admittedly if I did use a script I could probably shave some time off the videos, however, I often have to make the trade-off between spending a lot of time making a really high quality video and getting one ready in time for class (Bergmann & Sams, 2012). I have found the automatic closed caption feature on YouTube videos are relatively accurate and I need to make very few edits. Closed captions make the videos accessible to students with hearing impairments, and may also be useful for students for whom English is a second language. Students with visual impairments can answer the guiding questions from the readings, but they may also find listening to the videos helpful. My students have been very positive about my videos; 84% of 101 students surveyed agreed that watching the videos helped their learning, which is in line with the findings of a review by Kay and Kletskin (2012). Kay and Kletskin also concluded that students felt that viewing course content in videos increased their learning and gave them greater control over when and where they learned, and students found videos particularly helpful when reviewing for tests and exams. Because videos provide students with access to the materials 24/7, students can learn at

[1] Powerpoint 2013 (version 10) and above has all the needed features, but Screencast-O-Matic can also be used to record from other slideware.

their own pace, a feature that Bergmann and Sams (2012, 2014) describe as critical for flipped learning. Poorer performing students tend to re-watch videos more than high-performing students (Owston, Lupshenyuk, & Wideman, 2011). Others have shown that watching videos that cover course materials particularly benefit women, members of minoritized groups (Gross, Pietri, Anderson, Moyano-Camihort, & Graham, 2015), and international students (Evans, 2008). Furthermore, unlike traditional classes, if a student is absent from a flipped class they don't miss learning about the basic subject matter because they can watch the videos in their own time. For the same reasons, I also make videos that explain assignments or replicate demonstrations that I performed in class, e.g., how to use PsycINFO or a particular feature of the course management system to upload an assignment (Screencast-O-Matic works well for this purpose).

Occasionally, I ask my students to watch a video made by someone else, such as a TED Talk (https://www.ted.com). This strategy was also used by Wilson, whose students watched Khan Academy (http://khanacademy.com) videos as pre-class assignments in a statistics course (Wilson, 2013). Using existing videos can be very helpful for instructors who do not have much time to create their own (YouTube (https://www.youtube.com)and TEDEd (https://ed.ted.com) are also good places to look). However, over time you might want to gradually replace these with your own videos, because you may be able to create videos that better align with your learning objectives and also instructor-created videos have been shown to help establish rapport between students and instructors. Rose (2009) found that college students felt that instructor-created videos helped them get to know their instructor better. Similarly, K-12 students report preferring their own teachers' videos to those made by others, because they think they show that their teachers care about them (Bergmann & Sams, 2014). You can always survey your students about which they prefer (something I plan to do next semester).

My experience of flipping was not as seamless as I had first imagined, but others have also reported that initial teething problems are quite common and one size does not fit all (Bergmann & Sams, 2012, 2014). I found that my students are not always as prepared as I wanted them to be before coming to class. However, this is not uncommon; in their review of 71 studies of flipped learning (most in higher education), Akçayır and Akçayır (2018) found that lack of student preparedness was the most common issue. I quickly learned that my students were more likely to watch the videos when I assigned short (five question) multiple-choice online quizzes testing their understanding. Others have also found that quizzing incentivizes students to do their pre-class assignments (Bishop & Verleger, 2013; Fautch, 2015; Wilson, 2013). Bergmann and Sams (2012) stress the importance of teaching students how to watch videos and they ensure compliance by checking students' notes and asking them to bring questions to class. Other instructors prefer students to read a textbook in preparation for class because learning how to extract important information from a complex text is an important skill (Talbert, 2017). Although I agree with this in principle, I am well aware that reading non-compliance is very high (70 to 80%) among undergraduates around the country (Berry & Chew, 2008; Clump et al., 2004; Hobson, 2004; Landrum et al., 2012; Sikorski et al., 2002). Furthermore, surveys from students in my three flipped courses showed that they were more likely to watch the video than read the textbook. Only 21% said that they read the assigned textbook pages whereas 69% said that they watched the assigned videos before most or all of the classes. 41% wrote out the answers to the study guide questions before class. This may be because I assigned guided questions before all class periods and students were more likely to do their homework before a workshop than before a regular class period.

In part, some of my difficulties may be because my students have very heavy demands on their time. I teach in a large Minority/Hispanic-Serving public institution (MSI/HSI) and data from the 2018 National Survey of Student Engagement (NSSE) provided by my Office of Institutional Research show that the typical senior at my college spends significantly more time dealing with non-academic responsibilities than students at other North East public institutions or HSIs. Each week, the average senior at my college spends 9 hours caring for dependents, 9 hours commuting, and 19.2 hours working for pay (although surveys of students in my flipped courses (n = 101) showed that they worked even more—an average of 24.4 hours). According to NSSE data, seniors at my college only spend an average of 12.9 hours per week on academic work (other than attending classes); again, this is significantly less than students at other schools nationally (who tend to average about 14.6 hours per week on academic work). Thus, one of the biggest challenges that my students face is finding time to do their homework for all of their courses. This is not an insignificant challenge as one of the assumptions in a flipped class is that students will come armed with the requisite knowledge to engage in higher-order thinking during the in-class activities. Relatedly, Gross and colleagues showed that the more time students spent watching pre-assigned videos, the better their exam performance (Gross et al., 2015).

A time calculator posted in a blog by Elizabeth Barre (2016) from Rice University's Center for Teaching Excellence has become invaluable to me in terms of understanding how long it takes my students to complete various out-of-class assignments. For example, reading and understanding 20 pages of a textbook consisting of mostly new concepts is likely to take students two hours, but if they have to actively engage with the materials by answering questions it will take as much as five hours! My students just don't have that kind of time. Indeed, the most common reason that my students gave for not watching the videos was that they were too long; most lasted about an hour. Despite published recommendations to the contrary (Bergmann & Sams, 2012, 2014; Gilboy, Heinerichs, & Pazzaglia, 2015; Leicht, Zappe, Litzinger, & Messner, 2012; Wagner, Laforge, & Cripps, 2013; Zappe, Leicht, Messner, Litzinger, & Lee, 2009), I was reluctant to give up the format that I had used in my regular classes—I asked questions (which I then had to answer myself) and there was a lot of repetition. I also retained all the demonstrations and examples that I would use in class. If I had adopted Bergmann and Sam's (2012) rule of thumb of 1 to 1.5 minutes of video per school grade level, my videos should have been a maximum of 19.5 minutes (assuming that most of my students were in 13th grade!) However, a study analyzing video watching in Massive Open Online Courses (MOOCs) (where the majority of the course content is delivered via videos) suggests that even this is too long. They found that regardless of length of the video, most students disengaged after 9 minutes (Guo, Kim, & Rubin, 2014). Guo and colleagues also found that students were most engaged when the voice in the video was animated and enthusiastic and stressed that instructors should not slow down when they speak. Other studies surveying students in flipped classes about their preferred length of a video show that the majority favor 10-20 minutes—even if this means taking a slightly longer video and chunking it up into smaller ones (Leicht et al., 2012; Wagner, et al., 2013; Zappe et al., 2009). Feedback from my first two flipped courses encouraged me to segment my videos. Slightly more than half (54%) of the 71 students surveyed preferred the one-hour video to be segmented into two halves, whereas more than one third (36%) preferred either three x 20 minute videos, or four x 15 minute videos (with twice as many students preferring the former option). Accordingly, I am in the process of re-recording all my videos with the goal of having them last no more than 10 minutes. I constantly have to remind myself that watching a 10-minute video will take students much longer than this, because I (like many flipped class instructors) ask students to actively engage with the material by taking notes and answering questions. Unfortunately, the calculator I provided above does not make estimates for these kinds of activities, but Barre (2016, July 11) cautions that students are likely to take at least three times as long as an instructor would for any given assignment. I have also found this advice to be helpful for designing the class activities I describe below.

Activities in the Flipped Classroom

Bergmann and Sams (2012, 2014) suggest that instructors need to ask themselves "*What is the best use of my face-to-face time with students?*" before beginning with lesson planning. They also advise using frequent formative assessment to evaluate whether students find the activities helpful. With flipped learning, the classroom becomes a collaborative space in which students construct knowledge with their peers, under the guidance of the instructor. Thus, it creates an environment of collectivism and cooperative learning, which is particularly important for supporting students from minoritized groups, or those who are the first in their family to attend college (Cuellar, 2014; Espinosa, Turk, & Taylor, 2017; Núñez, 2009; Treisman, 1992). During workshops, students in my flipped Sensation and Perception courses work in informal groups of two and three, which change in composition from class to class. Students bring their own laptops to class or borrow one from our college loaner program (so that there is at least one computer per group). Frequently, students spend class time carrying out psychophysical experiments; they record their results in a worksheet by tabulating and/or graphing their data and interpret them using a series of guided questions. I have found great experiments from various websites including APA's Online Psychology Library (https://opl.apa.org), John Krantz's website at Hanover College (https://psych.hanover.edu/JavaTest/Media/ESP.html) and John Krantz and Bennett Schwartz's Interactive Sensation Laboratory Exercises site (https://isle.hanover.edu), Faculty for Undergraduate Neuroscience (www.funfaculty.org/drupal/node/2339), and PsyToolKit (https://psytoolkit.org) that use precise stimulus presentation timings and collect accurate reaction time data. Though I am now using PsyToolKit software to create my own experiments, too. Thus, my students can assess whether they can replicate phenomena, such as the face inversion effect, Muller-Lyer illusion, audibility curves etc. I also use no-tech activities where students work collaboratively to solve authentic problems, such as how to design signs for night roadwork (Kreiner, 2009; note Kreiner provides several suggestions suitable for problem-based learning in Sensation and Perception courses). In other workshops, students hone their writing skills by practicing paraphrasing or extracting information about specific kinds of experimental design from complex, primary source articles in neuroscience (for more information, see Grose-Fifer & Davis-Ferreira, 2018). Another one of my favorite (low-tech) activities consists of providing students with an electronic document with various advertisements that they analyze by identifying both the constituent "parts" and the "whole" and deciding which Gestalt Principles are at work. After doing this in their small groups, we discuss their answers as an entire class. I call on individual students to ensure total class participation (see also Grose-Fifer, Brooks, & O'Connor, 2019, for more suggestions on how to encourage this in your classes). Inevitably, some of my students come unprepared for these class activities, but they can still access the video and associated handout from Blackboard during class to look up information. This strategy also works for students who need help remembering particular concepts. I collect the worksheets at the end of the workshop, look them over for misconceptions, which I address in the next class, and grade them as complete/incomplete. I then use these scores to calculate course participation grades (10% of the final grade).

Many flipped class instructors begin their classes with a quiz or by asking students whether they found any particular concepts in the video confusing or difficult to understand (Bergmann & Sams, 2012, 2014; Talbert, 2017). When students post their questions in the course management system or email them prior to coming to class this allows the instructor to use the just-in-time teaching technique (Simkins & Maier, 2010), where they can quickly prepare materials to help students resolve specific difficulties. Activities in other studies of flipped learning also include using case-studies, role-plays, problem-based learning, and team-based learning (for more details about these techniques, see Grose-Fifer et al., 2019).

One of the most satisfying aspects about the flipped class is watching students in the workshops create zones of proximal development (Vygotsky, 1978), where they help each other deepen their knowledge of the concepts. Students are able to connect and explain to each other using terminology that feels comfortable and easy to grasp, thus lessening cognitive load and making it easier to learn. I can also spend more time with students who need more help than others, thus helping to level the playing field.

Assessment of My Flipped Courses

Flipping my courses was designed to target improvements in multiple learning outcomes that map onto four of the American Psychological Association's broad goals for the undergraduate major in psychology (American Psychological Association, 2013)—including Knowledge Base in Psychology, Critical Thinking and Scientific Inquiry, Communication, and Ethical and Social Responsibility in a Diverse World (as students learn to collaborate with their classmates). Somewhat disappointingly, analyses comparing my flipped (3 courses with 109 students) with the two previous un-flipped (2 courses with 71 students total) courses showed no significant differences in the percentage of students with DFW grades (16.9% pre-flip vs. 17.4% flipped), average exam scores (78.3% pre-flip vs. 78.9 % post-flip) or final course grades (82.2% pre-flip vs. 81.7% flipped). In contrast, other large-scale studies on the efficacy of flipped learning have yielded more positive results. One meta-analysis of 28 studies found that flipped classes using video lectures for homework improved summative assessment performance over traditional classes for students in the health professions (Hew & Lo, 2018). Another, more extensive meta-analysis of 46 studies across a multitude of disciplines and countries found that flipped classes led to better exam scores across all disciplines, and improved course grades in health, but not non-health-related courses (Chen et al., 2018).

I clearly have not been able to boost the performance of my students as strongly as has been reported in the meta-analyses cited above. However, it is important to note that I am not using the same baseline for comparison as in these studies. My pre-flipped courses did not follow a traditional lecture format; they included discussion and demonstrations where students were active participants, and students engaged in multiple in-class writing workshops. Although there was no statistical evidence for academic improvement, there were clearly no decrements in performance as a result of the partial flipping. I am further encouraged that slightly more students are passing the course with a satisfactory grade of C or better (70.4% pre-flip vs. 77.9% flipped), and my course evaluation scores have improved (4.62 out of 5 pre-flip, to 4.76 post-flip), although it should be noted that neither of these differences are statistically significant. Moreover, my grading load has become more manageable, and student feedback about flipping has been very positive. In general, my courses are often perceived by students to have a heavy workload, but partial flipping actually seems to have reduced that perception in my Sensation and Perception course. Even though the majority (66.3%) of students in my flipped courses perceived my course to have more homework than their other 300-level Psychology courses, comments from my formal online college course evaluations indicated that significantly fewer students in the flipped courses (2.7%) complained that the workload of the course was *too* heavy compared to those in the pre-flipped courses (16%), $p = .023$ (Fisher's Exact Test). Moreover, 95% of my students in the flipped courses said that the in-class workshops helped their learning; 94% said that the class had helped them to better understand the scientific method; 92% agreed the class improved their ability to interpret scientific information; and 53% agreed that the class had increased their ability/willingness to work with others.

Therefore, my students viewed the flipped courses rather more positively than students in a recent meta-analysis; among students in the health professions 30% still preferred traditional lecture-based classes over flipped classes (Hew & Lo, 2018), whereas I found only 5.7% students shared this preference. This may be because I made the rationale for flipping very transparent at the outset and only used a partial flip. Flipping makes students more accountable for their own learning; they cannot sit passively in class, which makes some students resistant to change (Felder & Brent, 1996). To this end, I have found that class time is well spent having students reflect about desirable difficulties, i.e., the notion that when learning is effortful, it is more effective for long-term retention (Bjork & Bjork, 2011). In summary, the majority of my students and I enjoy the flipped classroom format, and I will continue to use student feedback to make future adjustments.

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