Case Studies and the Flipped Classroom

By Clyde Freeman Herreid and Nancy A. Schiller

Case study teaching has been extolled for its ability to engage students and develop critical-thinking skills, among other benefits. But there is a price to be paid: greater preparation time, student resistance to novel teaching methods, and a concern on the part of many teachers about content coverage. The latter is especially worrisome to STEM (science, technology, engineering, and mathematics) instructors who equate coverage with learning. They rightfully point out that there are state and national standards that must be met, standardized exams that students must take, and prerequisites for advanced courses that must be satisfied. What to do? Must we abandon case studies and leave storytelling to books, films, TV, elementary school teachers, and preachers?

Wait! Help is on the way in the form of the "flipped classroom." The "flipped" approach to teaching has become particularly attractive because of the availability of internet resources including audio and video on virtually any subject, frequently narrated by some of the world's outstanding authorities. And the approach seems to have singular appeal to students in this electronic age where videos in particular have found a special place in the heart of the "Awesome Generation."

In the flipped classroom model, what is normally done in class and what is normally done as homework is switched or flipped. Instead of students listening to a lecture on, say, genetics in class and then going home to work on a set of assigned problems, they read material and view videos on genetics before coming to class and then engage in class in active learning using case studies, labs, games, simulations, or experiments. A guiding principle of the flipped classroom is that work typically done as homework (e.g., problem solving, essay writing) is better undertaken in class with the guidance of the instructor. Listening to lecture or watching videos is better accomplished at home. Hence the term *flipped* or *inverted classroom*.

The lure of the flipped classroom

Kathleen Fulton (2012) listed the following among the advantages of the flipped classroom: (1) students move at their own pace; (2) doing "homework" in class gives teachers better insight into student difficulties and learning styles; (3) teachers can more easily customize and update the curriculum and provide it to students 24/7; (4) classroom time can be used more effectively and creatively; (5) teachers using the method report seeing increased levels of student achievement, interest, and engagement; (6) learning theory supports the new approaches; and (7) the use of technology is flexible and appropriate for "21st century learning."

We recently surveyed the 15,000+ members of the National Center for Case Study Teaching in Science Listserv to see if the method was being used by STEM case study teachers. Two hundred case teachers reported that they teach in a flipped classroom and cited additional reasons for doing so, including the following: (8) there is more time to spend with students on authentic research; (9) students get more time working with scientific equipment that is only available in the classroom; (10) students who miss class for debate/sports/etc. can watch the lectures while on the road; (11) the method "promotes thinking inside and outside of the classroom"; (12) students are more actively involved in the learning process; and (13) they also really like it.

A common approach, described by a physics teacher who responded to our poll, is to assign an introductory video podcast the night before the class in which the case study will be run, which the teacher posts to YouTube for students to view. Students receive a set of guiding questions related to the podcast to answer before class. In class, students receive the first part of the case study to work on and apply what they learned in the previous night's podcast. After they complete the first part of the case study, a second podcast is often shown in class to spur discussion, after which students are given the second part of the case. Another podcast may be assigned that night covering information students will need to continue with the next part of the case in the next class period. These steps are repeated as needed until the case study is completed.

Studies published in the peer-reviewed literature on the impact of the flipped classroom on student learning in STEM classes appear to support the anecdotal evidence supplied by teachers in our survey. Strayer (2012) compared the learning environments of a flipped introductory statistics class with a traditional introductory statistics class at the same university using the College and University Classroom Environment Inventory, field notes, interviews, and focus groups. Students in the flipped classroom were less satisfied with how the classroom structure oriented them to the learning tasks in the course, but they became more open to cooperative learning and innovative teaching methods. Zappe, Leicht, Messner, Litzinger, and Lee (2009) flipped a large undergraduate architectural engineering course. Student evaluations of the course indicated that the classroom flip had a positive impact on student learning: Students perceived the method of teaching as more effective than lecturing and reported that they enjoyed the class and benefited from watching the lecture videos outside of class.

Ruddick (2012) described a course redesign project based on the flipped classroom concept for a college preparatory chemistry course. Students in the flipped section of the course watched video lectures at home and spent class time working on problem-solving activities. Final exam scores and "percent success" (the percentage of students who finished the course with a letter grade of C or higher) were compared between the "reverse-instruction" (RI; flipped) and regular-lecture sections. In addition, student feedback was gathered using a Student Assessment of their Learning Gains (SALG) survey and student course evaluations. Results showed that the RI students outperformed the standard lecture-based students, with higher final exam scores and overall success in the class. Comments on the SALG survey suggested that the RI (flipped) students became more interested in and felt less intimidated by chemistry and found the online video and PowerPoint materials useful.

Pitfalls of the flipped approach

There are difficulties with the approach. STEM case teachers who responded to our poll identified two major problems:

1. Students new to the method may be initially resistant because it requires that they do work at home rather than be first exposed to the subject matter in school. Consequently, they may come unprepared to class to participate in the active learning phase of the course. Faculty solve this problem by giving a short quiz either online or in class or by requiring homework that references information that can only be obtained from the outside reading or videos.

2. The homework (readings, videos) must be carefully tailored for the students in order to prepare them for the in-class activities. For most teachers (and students), videos are the method of choice for delivering the out-of-class portion of the instruction. However, in our survey, teachers said that finding good quality videos is difficult. Faculty are using videos produced by sources such as the Kahn Academy (http://www.khanacademy.org/) and BozemanScience (http://www.bozemanscience.com/science-videos/) or are creating their own using software programs like Camtasia, PaperShow, and ShowMe or apps on the iPad like Educreations and Explain Everything. They then post these to YouTube, iTunes U, and Podcasts (Vodcasting) or on course management systems like Blackboard or Moodle. The quality of the teacher-created videos is often marginal, however, and creating them requires a significant amount of time.

The flipped classroom is similar to other methods that depend heavily on students preparing outside of class. In team learning, developed by Larry Michaelsen, students are given reading assignments before class and then in class encounter individual quizzes, group quizzes, and finally case studies (Michaelsen, 1992; Michaelsen, Knight, & Fink, 2002); Herreid (2002) has described the successful use of Michaelsen's method in STEM courses. Just-in-Time Teaching requires significant student preparation too. Students are required to accomplish web-based assignments that are due shortly before class. The instructor reads the student submissions to adjust the classroom lesson to suit the students' needs. Class time is spent dealing with questions and introducing material on a need-to-know basis (Novak, Patterson, Gavrin, & Christian, 1999; Simkins, Maier, & Rhem, 2009). "Hybrid courses" and "blended courses" have students learning their subject matter via a combination of traditional classroom interactions and some form of internet-based learning. These and related methodologies share some of the same advantages as the flipped classroom as well as the two major challenges identified previously. Like the flipped classroom, all of these methods allow instructors to cover principles, facts, and terms as part of out-of-class student preparation and to use classroom time to deliver the application side where students grapple with real-world problems and see the material in context.

Instructional video

For many educators, the flipped classroom is synonymous with the use of internet technology in general and videos specifically (Overmyer, 2012). In keeping with this, the majority of teachers who responded to our poll prefer online videos over reading material to accomplish the goal of preparing students out of class for in-class active learning. Their students prefer video too.

Video podcasts are audio-visual files distributed in a digital format through the internet using personal computers or mobile devices (McGarr, 2009). They are used to support traditional real-time, in-class classroom activities. They are not the primary mode of instruction—as in the case of MOOCs (massive open online courses), for example, in which an entire course is delivered online—but supplemental to it.

There is extensive literature on the effect of instructional video podcasts, which have been shown to have a positive impact on *student attitudes* (Bolliger, Supanakorn, & Boggs, 2010; Fernandez, Simo, & Sallan, 2009; Hill & Nelson, 2011; Holbrook & Dupont, 2010; Lonn & Teasley, 2009); *student behavior* (Chester, Buntine, Hammond, & Atkinson, 2011; Foertsch, Moses, Strikwerda, & Litzkow, 2002; McCombs & Liu, 2007); and *student performance* (Alpay & Gulati, 2010; Crippen & Earl, 2004; Traphagan, Kusera, & Kishi, 2010; Vajoczki, Watt, Marquis, & Holshausen, 2010). All of this bodes well for their use in the flipped classroom

Studies on the use of video podcasts in the STEM flipped classroom support these findings. He, Swenson, and Lents (2012), for example, examined the use of video tutorials as a supplement to learning in an undergraduate analytical chemistry course. Concepts and problems that students found particularly difficult were identified by assessing students' homework assignments and exam responses. A tutorial video clip aimed at each specific "knowledge point" was designed by the instructor using Camtasia and uploaded to the course website. To assess the effectiveness of the video tutorials, students' oral and written feedback, pre- and post-video exam performance, and data from previous classes taught by the same instructor were examined. The researchers concluded that online video tutorials are a valuable, flexible, and cost-effective tool for "improving student mastery of chemistry problem solving."

Kay and Kletskin (2012) developed a series of 59 problem-based video podcasts covering five key areas in mathematics (operations with functions, solving equations, linear functions, exponential and logarithmic functions, and trigonometric functions) as self-study tools using Camtasia for a 1st-year undergraduate calculus course. The podcasts were posted to the course website and used over a 3-week period. A custom-designed tracking tool was used to track the total number of video podcast visits. The data showed that a majority of students used the video podcasts frequently (two-thirds of the students viewed over 4,500 video podcasts during a 21-day period). Information collected using a survey and open-ended response question indicated that students found the podcasts useful, easy to follow, and effective in helping them understand new material.

The future of the flipped classroom

The flipped classroom shows promise. Now what? We can wait for a few years while teachers plug along producing their own homemade videos and see if the flipped-teaching movement really has staying power, or we can buckle down and get serious about testing this idea. If the latter, we need to start developing cases that include preclass videos. An obvious place to launch this effort would be courses in general biology or anatomy and physiology in which there are a large number of faculty using cases. If we were to include videos along with the cases, more teachers would presumably be able to solve the problem of coverage and go on to use more real-world problems in the classroom.

These videos could be either content driven or scene setting. As an example, a content video would be one showing the structure of DNA. This would then act as a prelude to a forensic case in which DNA is used to solve a crime, such as in the case study, "The Case of the Druid Dracula" (Brickman, 2006). A scene-setting video might be one such as seen in the case study, "Why Is Patrick Paralyzed?" (Knabb, 2009), which profiles a young man who is dying of a metabolic disorder. Or it could be a short film clip of a prison in Russia beset by multiple drug-resistant TB, setting the scene for a case on antibiotic resistance. Of course, even though each case has particular requirements, many cases could use the same videos.

Right now, this effort needs some direction, some standardization, and the sharing of cases and videos. We at the National Center for Case Study Teaching in Science stand ready to assist in this process. We wish to encourage teachers not only to write cases so that we can publish them on our website, but also to include video material that can be used as preparatory material for the students before the case is presented. Not only do we welcome the creation of such video cases, we welcome existing video material from open-access/public-domain sources that can be used in conjunction with current cases on our site (http://sciencecases.lib.buffalo.edu).

Before the flipped classrooms, there were auto-tutorials, team learning, peer instruction, inquiry learning, Just-in-Time Teaching, blended classrooms, hybrid courses, and POGIL (process-oriented guided inquiry learning). Educators are forever experimenting and innovating. A central theme in all of this activity is the idea that active learning works best. Telling doesn't work very well. Doing is the secret. Active student engagement is necessary, and one of the best ways to get it is to use stories that catch students' interest and emotion. The best film directors, authors, preachers, comedians, lecturers, and motivational speakers know this. So do the best teachers. And they use a variety of methods to achieve it. The better a student is prepared, the more learning that can be achieved. The flipped classroom idea is not new. Teachers have forever struggled to get students to study on their own, either ahead of time or as homework; that is when the real learning happens, not when the teacher is lecturing, droning on and on. The flipped classroom, with its use of videos that engage and focus student learning, offers us a new model for case study teaching, combining active, student-centered learning with content mastery that can be applied to solving real-world problems.

It's a win-win. ■

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