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Giving students their first exposure to course content online allows instructors to use classroom time for active learning which promotes deeper disciplinary understanding

How Do You Foster Deeper Disciplinary Learning with the "Flipped" Classroom?

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In his book, *The One World School House*, Salman Khan (2012) describes how he created the Khan Academy, a series of free online tutorials, which began simply as attempts to help his niece learn algebra. Significantly, Khan had no teaching background and no allegiance to any specific educational theory. Instead, he worked inductively, first conducting his tutorials on the phone and then later posting short videos on YouTube where he was limited to ten-minute lessons. What he discovered is that students best absorb content when it is delivered in small sections (eighteen minutes is optimal, according to Middendorf and Kalish's 1996 study of college students' attention spans), that they learn better if the lesson can be self-paced (Tullis and Benjamin 2011), and that contact time is best spent on guided coaching (Knight 2007) rather than lecture. Initially, Khan's success was mostly anecdotal—and based on the increased numbers of students viewing his YouTube videos; however, when the Khan Academy partnered with middle schools in Los Altos, California, students' math scores improved (Gallagher 2012; Sinha 2011). These are not new ideas but their application to teaching and learning in college courses has only recently gained momentum, largely as a result of the growing availability of instructional technologies and the popularity and convenience of online and hybrid courses. When considering the benefits that are associated with online approaches to teaching and learning such as learning games, convenience, and ease of use (Flynn 2013), many have now raised questions about what the face-to-face classroom delivers that online learning cannot (Bowen 2012).

More faculty from across disciplines are turning to the "flipped" classroom as a pedagogical strategy that offers the best of both worlds. The flipped classroom allows for content coverage to take place outside of the classroom, thereby freeing face-to-face classroom time for the involvement of students in active learning strategies that allow them to engage in and

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master the essential moves of their discipline. The flipped classroom fosters deeper disciplinary learning in a way that strictly face-to-face or exclusively online courses cannot.

This chapter examines how the "flipped" classroom (in which the lecture occurs outside of class and what is traditionally the homework is done in class, allowing for more hands-on coaching of students) is used to foster deeper disciplinary learning in courses from two very different areas of the university: biology and literature. Note "flipped" classrooms are most frequently administered as "hybrid" courses, in that the learning environment is a hybrid of time spent online and in the face-to-face classroom. We review the current literature in our respective fields regarding best practices in the "flipped" classroom and describe how lower level courses in biology and literature can be taught using electronic discussions, guided reading questions, and lecture webcasts so that face-to-face class time can be used to allow students to practice the essential moves of the discipline (Shulman 2005). We come to this project from very different disciplinary backgrounds, teaching styles, and assumptions about teaching. One of the benefits of this cross-disciplinary discussion is that it forces us to make more transparent the implicit values and habits of our disciplines. And in the end, this is what the best hybrid classes achieve for our students.

As José Bowen (2012) and others (Kamenetz 2010; William Bowen 2013) have argued, the emergence of online learning—and Massive Open Online Courses (MOOCs)—forces us to redefine how we use the face-to-face classroom, despite uneven success rates (Westervelt 2013). Because content can be delivered via MOOCs, YouTube, and countless online sources, the relatively expensive time spent in class should be used thoughtfully—in what José Bowen (2013) dubs "massively better classrooms" (para. 4), where instructors teach application of content through interactive, active learning exercises. Bowen recommends that class time be spent in adapting the content material to the specific needs and interests of one's students. Instead of giving a generic lecture on Shakespeare in the humanities classroom, for example, one might create an exercise that allows students to connect the issues and language of a particular play to the concerns of the students and their regional, localized, and class-based lives. And in the science classroom, instead of lecturing on the basic physiology of a particular organ system, one might challenge students to predict the impact of disruption of that system or to design strategies for treating diseases that commonly affect that system. Thus, one of the best results of the growth in online learning is that it should force educators to reexamine their teaching techniques. If lectures can be uploaded and students can watch free lectures on YouTube, what can the classroom be used for that cannot be outsourced or conducted online? If classes can be freed from the burden of coverage, what should we use them for?

A partial answer to that question is that classroom time should be spent providing students with opportunities to practice the moves of the discipline through hands-on, active learning exercises. What does it mean to think and act like a literary critic or a biologist? And how can we create these situations in class? Teaching the "attitudes, values, and dispositions" of a discipline or profession (Shulman 2005, 55) is not something that can be accomplished through traditional "transfer of information" lectures alone. Numerous studies from multiple disciplines now indicate that deep disciplinary learning takes place when students are challenged with learning activities that actively engage them in the habits of mind that drive their discipline. For example, studies within the science classroom resoundingly demonstrate that the most effective strategies for teaching students to think and act like scientists (to generate hypotheses, to design sound experiments, to analyze and interpret data) involve their active engagement in collaborative, inquiry-based learning activities, rather than their passive engagement in traditional lectures, where the scientific method is merely discussed or modeled (Handelsman, Miller, and Pfund 2007). In literature courses, students need opportunities to examine literary passages, make claims based on textual evidence, and consider multiple viewpoints in interpreting literature. The opportunity for real-time, active engagement in such disciplinary habits is where the face-to-face classroom trumps the online learning environment: whereas online tools lend themselves well to the "transmission of information" (content coverage through lecture webcasts, for example), the face-to-face classroom arguably provides the best context for facilitating the active learning strategies that best foster the disciplinary habits of mind that we hope to instill in our students. Thus, increased implementation of active learning strategies in the face-to-face setting allows for Bowen's "massively better classrooms."

Both content coverage and acquisition of disciplinary habits of mind are crucial to students' intellectual development and professional preparedness. Yet covering both bases is a difficult task in either the strictly face-to-face classroom or in exclusively online courses. Instructors of traditional face-to-face courses often hesitate to implement active learning strategies, because they fear that the amount of time required for the successful implementation of such exercises will result in the sacrifice of content coverage. Conversely, instructors of exclusively online courses are hard pressed to find activities in which they can engage students online that will foster disciplinary habits of mind in the way that real-time, face-to-face student-centered learning activities do.

A Review of the Literature

Uses of the flipped classroom in biology and humanities classes are described in this section.

The Flipped Biology Classroom. In the face-to-face science, technology, engineering, and mathematics (STEM) classroom, the traditional lecture still remains the primary pedagogical approach of choice, despite a plethora of studies that demonstrate the relative ineffectiveness of this style of teaching (vs. implementation of active learning strategies) for fostering deep disciplinary learning in students (reviewed in Bauer-Dantoin 2008; Handelsman et al. 2007). The recognition of learning gains associated with the implementation of more active learning strategies—as well as the reluctance of many STEM faculty to adopt such strategies—has led several education advisory bodies, including the National Science Foundation (NSF 1996), the National Research Council (NRC 2003), and the American Association for the Advancement of Science (AAAS 2009), to issue calls for significant reform in undergraduate science and mathematics education. In particular, the undergraduate biology classroom has been singled out as being sorely in need of such reform (Handelsman et al. 2004).

If significant learning gains are associated with a more student-centered classroom, then what prevents STEM faculty from adopting active learning strategies? Many barriers exist to the incorporation of such strategies in the STEM classroom. These barriers include (but are not limited to) campus cultures that do not value or reward teaching innovation, lack of experience or professional development opportunities for STEM faculty to gain the skills and confidence needed to effectively implement active learning strategies, and students' resistance to classroom approaches that require their active participation in each class period (Allen and Tanner 2005; Wood and Gentile 2003). Perhaps the reason most often cited by STEM faculty for their resistance to implement student-centered approaches is their concern that such classroom activities will have to take place at the expense of content coverage (Allen and Tanner 2005).

A multitude of studies (particularly in the field of physics) have demonstrated that implementation of active learning strategies in the strictly face-to-face science classroom does not detract from students' acquisition of content knowledge, but in fact enhances it, in some cases twofold (Bauer-Dantoin 2008; DesLauriers, Schelew, and Weiman 2011; Handelsman et al. 2007). Nonetheless, science faculty who are reluctant to adopt active learning strategies in the traditional classroom for this reason often have a greater comfort level with the flipped classroom, in that the flipped classroom employs highly structured activities (e.g., lecture webcasts) outside of the brick-and-mortar classroom to ensure adequate opportunity for delivery of course content. With the assurance that students have a variety of tools at their fingertips to learn the vocabulary, concepts, and principles of the field, many instructors then have a greater comfort level with devoting face-to-face class time to student-centered activities that push students further up Bloom's taxonomic ladder, hone their critical thinking skills, and foster in them the habits of mind of a scientist.

A variety of strategies such as guided readings of textbooks or scientific papers, homework problems, podcasts, and online discussions are used by biologists to cover content outside of face-to-face class time in flipped courses. One that has recently gained in popularity due to the availability of affordable, user-friendly software and documented learning gains is the lecture webcast. Lecture webcasts are particularly valuable for biologists in that they provide opportunity for instructor-guided learning of terminology (including pronunciation), presentation of schematic illustrations with simultaneous verbal descriptions of the system of interest by the instructor; and progressive drawings of biologic processes that are most readily comprehended as they graduate from simple to complex. A variety of studies (both in flipped classrooms and traditional classrooms) indicate that lecture webcasts are a highly effective method for delivering course content, and in some cases, are more effective than face-to-face lectures for enhancing student learning (McKinney, Dyck, and Luber 2009; Parslow 2009; Shaw and Molnar 2011). For example, McKinney et al. demonstrated that exam scores were higher among students who learned about visual perception from a lecture podcast synchronized with slides than from an in-person lecture (71 percent vs. 62 percent, respectively; McKinney et al. 2009). This enhanced academic performance associated with learning via lecture podcast was attributed to students' ability to replay difficult parts of a lecture and take better notes. Additionally, Shaw and Molnar (2011) recently demonstrated that nonnative English speakers experience even greater learning gains (a 10 percent increase in exam scores vs. the 6 percent increase observed in the class as a whole) when course content is made available through lecture webcasts.

Course structure can also significantly influence the magnitude of the learning gains associated with the use of lecture capture technology in the flipped biology classroom. Bauer (2010) recently compared exam scores of students enrolled in two sections of a flipped biology course for nonmajors: one in which lecture webcast viewing of new material was required and one in which lecture webcasts of new material were simply made available to students as a learning tool, but viewing was not required. In both cases, reading material was provided that also addressed the new material covered in lecture webcasts, and student-centered learning activities conducted during face-to-face class time were identical. When identical exams were administered to both sections of students, overall student performance was a full letter grade higher when webcast viewing was a required component of the course. Of note is the finding that student behavior during webcast viewing can also significantly influence academic performance; McKinney et al. (2009) found that students who actively took notes during the viewing of lecture webcasts achieved higher grades than those who simply viewed the webcasts without taking notes. Both of these studies provide valuable information about the ways in which instructors can structure the flipped classroom in order to influence students' behavior and maximize the learning of course content delivered via lecture webcasts.

If course content in the flipped biology classroom can effectively be delivered via lecture webcasts and other study aids, what pedagogical approaches do instructors take during face-to-face class time to teach biology students the essential moves of their discipline? The specific approaches taken to teach students to think and act like biologists can vary (from case studies to problem-based learning to debates to small group discussions of primary scientific articles), but all of these approaches have one central characteristic in common: they actively engage students in the habits of mind (e.g., critical thinking, evidence-based decision making) and behaviors (experimental design, hypothesis testing, and analysis of data) of a biologist. Furthermore, the gains associated with active learning strategies apply to both content knowledge *and* the higher order cognitive skills that are essential to the habits of mind of a scientist. Consider the findings of Lord (1997), who conducted one of the first studies examining the impact of student-centered, constructive approaches in the introductory biology classroom. Lord found that students who learned via collaborative activities exhibited significantly greater gains in their ability to interpret data and apply scientific concepts to novel situations. This finding is echoed by other studies in which students exhibited greater gains in their ability to solve problems and design experiments when learning within a student-centered biology classroom (Burrowes 2003; Cortright, Collins, and DiCarlo 2005; Giuliodori, Lujan, and DiCarlo 2006; Wilke and Straits 2001).

Many of the earlier studies examining the impact of active learning in the biology classroom were not conducted within a course formally designated as "flipped" or "inverted," and often the findings represent data collected within a single unit or during only a fraction of the semester. Formally designating biology courses as flipped is a relatively new phenomenon, and thus the impact of a full semester's worth of active learning in the biology classroom remains relatively unexplored (at least compared to the extent to which the pedagogical approach has been studied within other scientific disciplines, such as physics; Mervis 2013). Those studies investigating the impact of semester-long flipped courses on student learning within biology courses have primarily focused on overall learning gains (Navarro and Shoemaker 2000; Riffell and Merrill 2005; Riffell and Sibley 2004) and have not parsed out assessment data according to the specific types of learning that the active learning components of the flipped classroom facilitate (recall of content knowledge vs. interpretive, critical, or projective understanding of the material). Given that studies on active learning within the biology classroom demonstrate that enhancement of higher order cognitive skills is proportional to the number of opportunities that students have to engage in active learning (Burrowes 2003; Goran and Braude 2007), we anticipate that formally designated flipped biology courses (i.e., classes that move more content out of class to create more time for the active learning) will be particularly effective in facilitating students' acquisition of the disciplinary habits of mind of a biologist, particularly when instructors include course design elements (such as requiring students to view lecture webcasts) that help them take full advantage of the hybrid format.

The Flipped Humanities Classroom. Unlike the plethora of studies on flipping the science classroom, relatively little has been published on hybrid courses or flipping the classroom in the humanities. Perhaps this is because many humanities classes—literature in particular—have long been performing low-tech versions of flipping the classroom wherein students engage in the content (reading the literature) beforehand and then class time is used to analyze the reading. In literature courses, students are expected to read the primary texts (works of literature) before coming to class with class time devoted to analyzing the texts according to the methods of literary criticism. However, depending on the pedagogical and theoretical position of the instructor, a good deal of class time may be spent giving students the historical context of the literature being analyzed, the author's biography, definitions of literary terms, lectures on writing an essay, or other content subsidiary to literary analysis itself. Much of this content could be delivered online, freeing class time to allow students to practice their own skills of analyzing a literary text and work in groups to grapple with conflicting interpretations. How well do flipped courses teach students the important moves of literary analysis? To date, there have been few published studies of the efficacy of flipped or hybrid humanities courses.

Some notable studies of online or hybrid humanities courses include Gau's (2011) chapter on teaching a hybrid world literature course, a lower level humanities general education course. Gau, along with an instructional designer, developed a series of online learning modules (which include interactive maps, reading questions, and quizzes) that help students master course material "at a literal, factual level of understanding" (Gau 2011, 91), preparing them for higher level learning in the face-to-face class. Gau highlights an attractive benefit of hybrid, flipping, and "just-in-time teaching" (JiTT), structuring the class so that students come to class having read (and usually actively engaged) the material. Gau used a combination of student surveys and student grades to measure the effectiveness of her redesigned course and her conclusions were positive: student mastery of the subject (reflected in final grades) went up over 10 percent (Gau, 112). A bolder strategy was employed by Hartwell and Barkley (2011), who created a team-taught music history course that allows students to select their preferred learning modality: face to face, hybrid, or fully online. The course sounds complicated to design and facilitate, but Hartwell and Barkley do an admirable job explaining how their design allows students to become more "autonomous and self directed learners" (125). Pace and Middendorf's (2009) essay, "Using Just-in-Time Teaching in History" and Cookman's (2009) "Using Just-in-Time Teaching to Foster Critical Thinking in a Humanities Course," although focused on JiTT, describe the authors' own course redesign, using the principles of JiTT—having students submit questions on the reading before class so that the instructor can tailor the in-class work to address students' misconceptions or other learning bottlenecks. Middendorf and Pace challenge humanities instructors to "break down the complex tasks that they wish their students to complete into discrete operations" (154). Pace and Middendorf's (2009) article is part of a movement in undergraduate history pedagogy toward "uncoverage": focusing less on delivering content and more on teaching students the important disciplinary moves that make up historical thinking (Calder 2006; Sipress and Voelker 2011) Cookman's chapter, on using JiTT in a large history of photography course, focuses more narrowly on one technique: using "Thinking about the Reading" papers that students submit prior to class in order to ensure that they come to class already having done initial stages of grappling with the material. Both chapters offer provocative ways to rethink large general education courses to allow for more active learning, although Cookman's evidence of student learning was limited insofar as it derived mainly from student feedback.

Best Practices in Flipping Classrooms

In order to fully use the benefits of a flipped class, instructors need to first ask deep, difficult questions about the nature of their discipline (Chick, Haynie, and Gurung 2012; Gurung, Chick, and Haynie 2009; Pace and Middendorf 2004). What are the distinctive values and practices of biology and literary studies, for example? As Chick and others have argued, the signature pedagogy of literature analysis is "unpacking" the literary text to "help students begin to recognize, value, practice and internalize these essential moves of literary studies" (Chick 2009, 48). However, traditional English classrooms often feature the professor's own analysis of the text—either as a lecture or as a "guided" discussion toward what is often a predetermined result. As Linkon has pointed out: "We may come to our teaching style without careful analysis, most often simply by imitating how we were taught or by doing what feels 'natural'" (2011, 35). In addition, in-class discussion can often give the illusion of student participation, when in fact fewer than half of the students offer their analysis. As Brookfield (2005) has pointed out, classroom discussion is rarely as democratic as instructors believe it to be: often a few students dominate and these students tend to be those who enter class already entitled. Many students fail to understand the tacit, implicit assumptions involved in choosing a literary text, in formulating an initial argument, and in selecting evidence to explore that analysis. A best practice in flipping the literary studies class would be where students not only read the literary text outside of class but also learn biographical information, review key literary terms, and see examples of literary analysis. Class time should be used to allow the instructor to demonstrate the "behind the scenes" work of literary analysis and then to guide students through their own processes.

The best result of a flipped class in literature is when the classroom becomes a place where students practice "these essential moves of literary studies": original textual analysis, historical context, and meta-discussions of the nature of literary study. For example, in Aeron Haynie's Survey of English Literature course (a sophomore-level course) students read sections of Virginia Woolf's *Mrs. Dalloway* outside of class and then contribute to a class wiki, making them responsible for doing the reading before class and giving them opportunities to formulate their own original analyses before class discussion. Additional information about Virginia Woolf, the Bloomsbury group, and modernism is posted on the class learning management system page. In class, students work in groups to examine specific passages from the novel, identifying aspects of Woolf's writing style that fit the definition of modernism and making claims about the tone, use of stream of consciousness, and development of character. As each group reports to the whole class, students hear differing interpretations of the same textual evidence, allowing them to see the ambiguity and complexity within a literary text.

Similarly, best practices within the flipped biology classroom allow for classroom activities that fully engage students in the "essential moves" of a scientist, as they work collaboratively to analyze and interpret data, to solve problems, and to apply basic scientific concepts or principles to real-world situations. Study after study has demonstrated that when instructors actively engage science students in these moves—rather than simply modeling them at the front of the classroom—deep disciplinary learning takes place. Thus, the flipped classroom offers an invaluable model whereby students can acquire, through direct immersion, the behaviors and habits of mind of a scientist. In Angela Bauer's flipped endocrinology course, for example, students view lecture webcasts and complete readings outside of class that teach them about the complex interplay of hormones that allows for typical sexual differentiation (masculinization or feminization) during embryogenesis. Then, while working in small groups within the face-to-face classroom, students apply this knowledge to predict the impact of specific genetic mutations on sexual phenotype. Additionally, they design experiments to test the impact of these mutations on a variety of endocrine parameters. In so doing, face-to-face time in the flipped endocrinology class allows students to engage in the essential moves of being a scientist, as they work collaboratively to predict outcomes, develop hypotheses, and design sound experiments to test their hypotheses.

Key Areas for Future Research

As the articles on flipped humanities classes illustrate, methodologies for assessing flipped pedagogies range from student surveys to pre- and posttests on student learning. Although these methodologies could be more empirically rigorous, it is important that humanities scholarship of teaching and learning (SoTL) researchers not be urged to become social scientists (Gurung 2014). Instead, they should be encouraged to use the methodologies of their own discipline (Chick 2013). In the case of literary studies, this methodology is the careful reading of texts, informed by theory and the practice of close readings. Closer attention should be paid, then, to student texts: these texts should be analyzed carefully to see changes in how students are able to make the disciplinary moves of literary studies. This type of qualitative work may seem murky to the scientist, but it is much more in line with the values of literary studies than more quantitative results. Can students develop better literary analysis skills if content (historical context, literary terms, biographical information of authors, etc.) is presented in podcasts and online quizzes and if in-class discussion is supplemented with online discussion in which every student has the chance to participate? A comprehensive analysis of student papers from similar courses—online and face to face—must be conducted to adequately respond to these questions.

To date, the methods used to assess the impact of the formally designated flipped biology classroom have consisted of (1) surveys that measure student satisfaction/perceived learning, and (2) comparisons of average exam scores from flipped versus traditional sections of the same course. In order to conclusively demonstrate that the flipped model results in the specific learning gains anticipated (in other words, the enhancement of higher order cognitive skills) through students' full immersion in active learning opportunities, it is critical that future assessment tools employ questions that are categorized according the specific cognitive domain(s) addressed (in other words, by "Blooming" the exam questions; Crowe, Dirks, and Wenderoth 2008). For it is only through this type of meticulous analysis will instructors determine whether the primary learning goal of the flipped biology classroom is being met (namely, instilling the habits of mind of a biologist).

As this chapter shows, existing research offers exciting models of how to flip the traditional classroom, but these areas of pedagogical research are still relatively new. Although research suggests that blended, flipped, and JiTT methods can be used to create more active learning and possibly a deeper understanding of the discipline, little research has been done to study how this new type of teaching affects different student populations. One notable exception is John Fons's article on gender differences in just-in-time "warm-up" exercises in his physics course: according to this study, a significantly greater number of women students felt the exercises were useful (2009, 32).[1] Another is the work of Haak and colleagues (2011), who found that active learning reduces the achievement gap between educationally and/or economically disadvantaged versus nondisadvantaged students in introductory biology courses. But are there any significant differences in the learning gains made by minority, first-generation, or older students in hybrid or flipped humanities courses?

Could the flipped classroom—one that is used in order to make clearer the implicit moves of the discipline—help to narrow the achievement gap in humanities courses or upper level science courses? Or, might the reduction of face-to-face time present new roadblocks to these more vulnerable students? What about the difference between the performance of majors versus nonmajors in different disciplines?

In attempting to answer any of these questions, we encourage a more rigorous methodology in assessing student learning, one that goes beyond student satisfaction surveys or end of term grades. In fact, if this revolution in educational technology ultimately becomes a revolution in pedagogy, it will be because flipping the classroom encourages instructors to think of better uses of class time, creates opportunities for more active learning, and forces us to make more transparent the values and methods of our disciplines.

Note

1. However, as Fons cites, women students also show greater appreciation for reading in general, according to a 2007 National Freshman Attitudes Report.

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