

Blended Learning and "Flipping" the Construction Management Classroom for Improved Teaching and Learning

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Blended learning is the combination of asynchronous student learning through technology use and synchronous classroom work. "Flipping" the classroom is the logical extension of blended learning, where the classroom is no longer the place where knowledge is transferred from the teacher to the student. This paper presents an observational study in the challenges of flipping a construction management scheduling class.

Key Words: blended learning, flipping the classroom, hybrid course, teaching technology, higher education.

Introduction

Until recently, courses that combined on-line instruction with face-to-face classroom work were referred to as "hybrid" courses or "hybrid" curriculum (Rogers & Ohrn, 2007). The more current term for this type of pedagogy is "blended learning" (Garrison & Vaughan, 2008). In practice, blended learning combines the best elements of face-to-face teaching with the best elements of online instruction to improve student engagement and learning.

While there are many kinds of blended learning, one emerging method focuses on the "flipped" classroom method (Bergman, 2011; Bergman & Sams, 2012). "The flipped classroom is a pedagogical model in which the typical lecture and homework elements of a course are reversed" (EDUCAUSE, 2012, p. 1). Flipping a classroom requires the replacement of traditional in-person lectures with asynchronous (or more rarely synchronous) on-line activities. Findings from Park's (2011) work in student perceptions of hybrid laboratory experiences support the notion that students need and desire the flexibility of asynchronous active engagement and learning.

In this paper, we share our experiences in developing, delivering and observing a fully flipped class with the goal to assist other faculty, who may be interested in trying to flip their own classrooms.

Literature Review

Although a variety of papers about on-line delivery platforms and individual courses have been presented in this forum (Carr, 2005; Guggemos, Gunderson, Khattab and Emam, 2006; Koch & Sener 2006; Orth & Jenkins, 2003; Orth & Long, 2005). There is little indication in construction education literature on ways to radically change how courses are delivered to undergraduate students. Monson and Hauck (2012a; 2012b) presented a professional inquiry-based curriculum at two universities where the curriculum is based on a philosophy of teaching and learning rather than a way of delivering the course content. Professional inquiry-based coursework can be delivered in a variety of ways including a blended learning approach. Lee (2011) provides a perspective on hybrid teaching and learning, stating that student learning is enhanced

> by posting educational materials on the interactive website and collaborative learning by supporting communication and exchange of information among students. Generally, in the web-enhanced course, students attend the face-to-face class but access the instructional materials via the web-based course delivery system used by the college, such as Blackboard and Moodle. (p. 67)

However, he made no reference to flipping the classroom for enhanced "active" learning, but rather laid out some appropriate strategies for introducing and supporting a hybrid learning environment, something that would more accurately be defined in the Scholarship of Teaching and Learning (SoTL) community as "blended learning" (Garrison & Vaughan, 2008).

Park (2011) presented work on student perceptions of blended delivery of a lab-based experience, in which the technical portions of planning, estimating, scheduling, and control were taught through asynchronous "video" lectures. This is the essence of flipping the classroom, although Park did not specifically use that term:

> Instead of combining technical lectures and lab exercises together in one class, in this new format, the instructor delivered the entire technical subject matter of a given week in one online course… through pre-recorded video lectures.... In this ensuing [face-to-face] class, the students were engaged in learning by relying on hands-on exercises ….(Park, 2011, p. 98).

Park's work was a study of student perceptions of the method and not on the details of curricular development of a hybrid or blended course. Park asked students about their perceived "learning style". While a student's response may indicate "learning preference", it should be noted that learning styles are not currently considered an innate trait (Stahl, 1999). In support, Park noted that student respondents acknowledged:

> ….the online portion of the hybrid delivery allowed them to study at their own learning pace. The flexibility that learning can be done around their busy schedule yet not losing contacts with the instructor was mentioned another positive reason why the hybrid was **preferred** (Park, 2011, p. 100, emphasis added).

From the literature search it is apparent that there is a significant amount of observational and anecdotal evidence about the pros and cons of flipping the classroom, but little formal analysis or rigorous study of classroom flipping.

"Flipping" the Classroom

A flipped class approach to teaching is difficult and risky work. The instructor must give up the control of a lecture and be open to spontaneous demands of the students (Felder & Brent, 1996). Flipping the classroom requires that the instructor start with the end in mind, asking questions like: Where do you want to lead the students? What, "exactly," do you want your student to be able to do or know?

Effective flipping means planning the class with "good practice in mind". It is compatible with good practice for higher education teaching and the using of blended and or "flipped" delivery does not alter the findings of Chickering and Gamson (Grant & Thornton, 2007). In their seminal work on teaching and learning, *Seven Principles for Good Practice in Undergraduate Education* Chickering and Gamson (1991) proposed that good teaching practice:

- Encourages contact between student and faculty.
- Develops reciprocity and co-operation among students.
- Encourages active learning.
- Gives prompt feedback.
- Emphasize time on task.
- Communicates high expectations.
- Respects diverse talents and ways of learning.

Fully flipping a class means switching the delivery system for lecture content, administration, and communication to an online system and using the face-to-face with students in a more meaningful and productive way. It means setting aside all or most face-to-face classroom time for students to participate in learning activities similar to homework assignments with both individual and group work. In order to achieve good practice it is not necessary to "fully" flip your classroom, but it is essential to think about how you will ensure good practice in a flipped classroom.

Switching from a traditional classroom to a flipped classroom can be daunting because there is a lack of effective models. Bennet, Kern, Gudenrath, and McIntosh, (2012) provide a vision of what a flipped classroom should look like:

- Discussions are led by the students where outside content is brought in and expanded.
- These discussions typically reach higher orders of critical thinking.
- Collaborative work is fluid with students shifting between various simultaneous discussions depending on their needs and interests.
- Content is given context as it relates to real-world scenarios.
- Students challenge one another during class on content.
- Student-led tutoring and collaborative learning forms spontaneously.
- Students take ownership of the material and use their knowledge to lead one another without prompting from the teacher.
- Students ask exploratory questions and have the freedom to delve beyond core curriculum.
- Students are actively engaged in problem solving and critical thinking that reaches beyond the traditional scope of the course.
- Students are transforming from passive listeners to active learners (para. 6, emphasis removed).

Why "Flip the Classroom?"

In the near and midterm, the pool of potential construction educators will become more stressed. The introduction of new construction curriculum requiring high-level skills and knowledge, such as Green Building, Alternative Delivery, Renewable Energy, Information Technology (VDC and BIM), Integrated Project Delivery/LEAN Construction, among others will require faculty to keep current and add sophisticated content during a time of shrinking budgets and higher expectations for assessments (Becker, Jaselskis, and McDermott, 2011).

Highly successful and productive online graduate programs have demonstrated the viability of increasing productivity and effectiveness of faculty through on- line teaching. (Battie & Connell, 2009). Blended teaching, especially the flipped classroom can:

- Increase faculty productivity by reducing non-teaching and administrative work revolving around students.
- Improve student learning through enhanced communication and rich content delivery.
- Improve student learning through targeted learning that uses faculty time to provide the best of online with the best of face-to-face teaching and learning..
- Increase student-faculty contact time for quality teaching and learning opportunities both inside and outside the classroom, by freeing up faculty time from menial and unproductive teaching tasks.
- Improve efficiency through the right level of teaching knowledge and skills at the right time. Using teaching assistants to supervise online work and with full time instructor tutoring and coaching in scheduled face-to-face classroom as opposed to "grading papers" and preparing the next lecture to a deadline.
- Enrich and deepen course content thereby enhancing individual student's learning experiences.

How does flipping the classroom lead to improved faculty effectiveness and improve the quality of student learning? The work of Grant and Thornton (2007) supports the conclusion that good practice in online learning is essentially the same as in a traditional face-to-face lecture. Intuitively these objectives can be reached in face-to-face teaching but also can be enhanced in a "flipped" classroom. See Table 1.

Table 1

Good practice in the flipped classroom.

Good Practice	**How we implement good practice**

Encourage student-faculty contact	Faculty in the face-to-face "flipped" classroom are walking around and constantly interacting with students.
Encourage cooperation among students	Faculty lead and group driven work in the classroom encourages collaboration between students.
Encourage active learning	Doing rather than listening, although good listening can often be an active learning activity.
Provide prompt feedback	Online work is graded and turned back before classes, teachers as coach, provides instant feedback in the face-to-face meetings.
Emphasize time on task	Online work and supervised activities in face-to-face classrooms expands the time on task but emphasizes both input and output.
Communicate high expectations	Flipping tells the student they are as important as the teacher, or more so.
Respect diverse talents and ways of learning	Flipping allows the student to find the right time and place and method for them to learn.

Note. Adapted from Grant and Thornton (2007), supported by the seminal work of Chickering and Gamson (1991).

Observations on Flipping the Classroom

Construction management students are often visual and graphical problems solvers, they are critical thinkers rather than analytical thinkers, they are technology savvy, and adapt well to the use of new technologies. Construction management students "tend to be very practical individuals" (Cairns, 2006, para. 2). Successful construction managers are team/group, action-oriented. The flipped classroom can be used to enhance these characteristic of our students.

One author of this paper (who is also the instructor in the class in this study) was an early adopter of fully online teaching, building his first engineering class in 2001. He has created over twenty fully online courses in engineering, project management, and construction management and has delivered over 100 fully on line courses for both undergraduate and graduate studies (primarily asynchronous graduate studies in project management). In 2010, after a several year gap, the author returned to face-to-face teaching of undergraduate students. Specifically he began teaching third year students in Construction Scheduling and Control. By this point in time, what had been called hybrid teaching had become "blended learning". The latest development in blended learning is referred to as flipping the classroom (Garrison & Vaughan, 2008).

The instructor was assigned to teach a course that had traditionally been taught in a face-to-face lecture method. This course is taught each fall and spring semester. Prior to his assignment of the class, some of the student work had been shifted to an on-line learning management system (LMS). The course was then considered to be a mildly hybrid. However, the on-line work could only be considered as supportive of the live class studies, as the LMS was used primarily for communication and administration such as email, grade book, supplemental readings, etc. The course was "blended" but not "flipped".

Because the instructor was familiar with the literature on "blended learning" he approached the idea of a new class preparation with the following question: How can this course be turned on its head using existing technologies? With his knowledge of fully on-line classes in project scheduling (as opposed to construction scheduling) he had a significant library of on-line relevant content available including:

- Use of a text common to many construction management programs.
- HTML lectures created by one of the authors.
- Specific audio files recorded by one of the authors.

- Graphic and photo libraries developed by one of the authors.
- A library of videos including access to you tube and specialized video by experts.
- PDF files by one of the authors and by others.
- Presentations such as PowerPoints and Prezi by the author and others
- A variety of assessment tools, such as exams, quizzes, work assignments and interactive activities.

The instructor developed 16 weekly learning modules, corresponding to the expected class activities and driven by the course learning objectives. Each module was developed to support skills in one or more of the expected learning outcomes. The following is an excerpt from the resulting course syllabus.

Upon successful completion of this course, the student will be able to:

- Prepare and defend a basic construction schedule or sub-schedule.
- Identify the critical path in a schedule and understand the importance of managing those activities.
- Understand and demonstrate the concepts of resource allocation and how those concepts influence project scheduling
- Understand and describe the effects of time/cost tradeoffs as they relate to schedule updating and compression.
- Prepare and manipulate a wide variety of project scheduling tools.
- Prepare, through the principles of earned value management a control plan for a project and demonstrate its uses.
- Demonstrate the ability to create and use S-curves for project control

Assessment of student learning in each of the 16 weekly modules included:

- An on-line, instantly graded quiz on content from the readings, presentations, audios and videos.
- A written assignment demonstrating some skill or knowledge taught in the on-line module to be submitted on line, (that would theoretically be graded by teaching assistants in a prompt manner).
- A written log book assignment that would be brought to the face-to-face class for review and comment by the instructor.

Overall assessment of student learning was accomplished through:

- In-class review and one-on-one discussion with individual students.
- Review of class work assignments and after class assignments.
- A written midterm examination based on comprehensive skills testing of individual students.
- A review of the student's individual semester project (a 200 activity plus, tracking Gantt CPM schedule) and an individually scheduled one hour comprehensive oral final examination with the student subject to detailed inquiry on any (or all) of the learning objectives.

In the first class of each semester the author provided a clear description of what the student would be expected to do on their own and what they could expect from the teacher in a flipped classroom. Students signed a written "contract" listing the learning objectives (skills acquisition) for the course, and were advised that they were to hold the instructor to teach the listed learning objectives. Students were now "contractually" obligated to learn the listed skills. These contracts are brought out in class several times during the semester and discussed, to ensure that teaching and learning to the objectives are being met. After the first class, face-to-face class time was completely given over to student work, excepting some time for course administration and reminders, mini lectures or demonstration on the topic, and/or short videos (totaling 12 minutes or less).

In-class time was spent doing group or individual work similar to the written assignments, quizzes and log book assignments that the student had completed as part of the on-line lecture work. The instructor would then spend most of the class moving among individuals and small groups observing and interacting, while assessing their mastery of skills and knowledge. A good portion of the teaching became group and individual coaching.

After the first year of using a "flipped" classroom approach the instructor performed a course improvement audit with the following suggested changes incorporated in the next annual teaching cycle:

- Create more of a structured learning environment in the class room, do a better job of describing the outputs and learning outcomes for each individual face-to-face class.
- Because the focus in classroom work became skill building and learning assessment, the instructor found more room for added content in the on-line modules and in face-to-face teaching. The course had previously focused on scheduling for commercial buildings. Content was added in the area of heavy-highway construction scheduling.
- Provide the students with end of class spontaneous assignments to be added to classes when the instructor judged they were appropriate, as a continuation of the work done in the face-to-face class.
- Teaching of activity on arrow was removed from the on-line class and done in a ten minute in-class presentation, thus reducing student time on this learning task.
- Eliminate audios from on-line content as they judged of little or no value to the students from their feedback.

For the third year of the class (2012/2013) the major change was elimination of the high cost text, replacing it by an inexpensive companion text and work book written by the instructor specifically for the course at a greatly reduced cost to the student. The spiral bound companion text provides space for class notes, and assigned space for log book assignments. Because this action was introduced this year, no formal response from the students has been received.

Analysis

The construction management program at Northern Arizona University uses the AIC level 1 examination as a primary assessment tool. Students who had taken the flipped class performed better in the Planning, Scheduling and Schedule Control the section of this examination in the spring of 2012 than those students who had taken the course as a general blended or hybrid learning course. While there are many variables that impact student performance from semester to semester, the authors believe that a significant portion of the observed improvement in learning was due to the flipped classroom environment.

Based on student feedback and personal reflective observation, over the course of each semester the instructor improved the on-line flipped portion of the class and did a better job of providing pre-lecture work, and controlling the flow of the classroom. As was previously observed the greatest risk for the instructor in the flipped classroom is that there are few effective models to follow. The teacher must be strong enough to initially give up control of the face-to-face class time. The instructor's experience and feedback from students was that the first semester face-to-face did not live up to expectations, however, over the course of four semesters, his ability to effectively manage the face-to-face chaos has drastically improved. Student evaluations of the class and the teacher showed significant improvement from the first year the course was taught flipped. Table 2 presents the students overall ratings for 2010 and 2011 academic years with the score from 1 to 5, with 5 as "strongly agree". The additional student review data points have been omitted for brevity and have been deemed irrelevant to this work. The authors recognize that the student evaluation rankings, as collected, are valid for descriptive but not statistical purposes.

Table 2

Student evaluations for the teacher and class after "flipping" the classroom.

Description	Fall 2010	Spring 2011	Fall 2011	Spring 2012
My general estimate of this course	3.81	4.32	4.50	4.60
General estimate of the instructor	4.06	4.32	4.62	4.70
Number of students	34	29	16	28

Typical student comments from the fall 2010 course evaluations:

> *This instructor made a great effort by providing materials for the Moodle portion of the course (which was good), but the classroom side of the course seemed altogether unnecessary and tedious.*
>
> *More rigid class structure.*

Typical student comments from the spring 2012 evaluations;

> *… Working through problems in class with the professor walking* (sic) *over shoulder to provide real-time feedback and assistance was a big plus. I find that is the type of interaction I gain the most from.*
>
> *The instructor made it the responsibility of students to study out of class. It was nice to get some study freedom and learn the material in ways which are most effective for me. Unique teaching style and a good and interesting class.*

One element of learning assessment, for this specific class, that was not part of the flipping process, is a final one hour oral exam. Students present their individual semester project work to the instructor and are subject to detailed inquiry on any (or all) of the learning objectives. The instructor reports (anecdotally) that the grades on the one in-class written major examination were not significantly improved. However; the students were perceptibly more prepared and confident to defend their work and demonstrate the required skills in the oral examinations. The authors attribute that improvement, at least in-part, to the increased one-on-one contact inside and outside the flipped classroom.

It should be noted that the instructor made a significant investment of time in preparing the course for flipping. The instructor observed that class preparation and grading time significantly diminished over each subsequent semester. The instructor re-assigned that effort into more student contact and scholarly/research pursuits.

Conclusions and Recommendations

In the flipped classroom the instructor gives up control of the flow of the work, and must remain nimble and flexible enough to take the class in new directions when interest flags, or to be prepared to offer additional mini lectures or demonstrations, sometimes performing calculations and analysis on the fly (without preparation) with the potential for errors and confusion by teacher and student alike.

Flipping a classroom requires a teacher to give up the white board and teach by walking around (TBWA) (Yahanpath & Yahanpath, 2012). TBWA forces the teacher to reduce the distance between the students and the teacher, thus making the students feel the presence of the teacher by their side:

> The reduction of the physical distance in order to achieve better learning outcomes, including a more interactive class, an engaged audience and a better understanding of students' needs is critical to the survival of the traditional face- to-face learning (Yahanpath & Yahanpath, 2012 para. 3).

By flipping the classroom, the teacher, even in larger classes, can regain a personal connection with students and promote those "aha" moments that happen among students, teachers and colleagues. Flipping has its risks, but the potential rewards of more effective teaching and more efficient student learning are great. The authors suggest that while flipping seems to offer the student and faculty productivity and effectiveness gains, more rigorous study on the topic should be implemented.

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