Flipping a Structures Class in a Construction Science Program

Dr. Lisa M Holliday P.E., University of Oklahoma

Dr. Holliday received her bachelor's degree from the University of Oklahoma. After working for several years in the industry both in engineering design and estimating, she returned to the University of Oklahoma to pursue a PhD. During her PhD she was a Fulbright Fellow and a David L. Boren National Security Fellow studying earthquake resistant structures in developing areas and has studied structures in Turkey, Nicaragua, Guatemala, and Haiti. She was also a National Science Foundation Teaching Fellow. She joined the Construction Science faculty at the University of Oklahoma in 2010. Dr. Holliday is a registered Professional Engineer. Her research interests have been in the areas of structural engineering, earthquake resistant buildings, low-cost earthquake solutions, and design and construction of earthen buildings – specifically Compressed Earth Blocks (CEB). Dr. Holliday participated in the assessment and evaluation following the May 20th 2013 Moore, OK tornado. Her most recent research interest is healthy and safe school designs.

Camilo Pena, University of Oklahoma

Camilo Pena is a Graduate Student in Architecture at the University of Oklahoma and a Research Assistant for the College of Architecture and the Center for Spatial Analysis at OU. His main interest is in understanding how social factors shape architectural design in order to provide a balanced environment between occupants and construction. He is also interested in climate responsive building design and the consciousness of using an effective design method for the reduction of the environmental impact.

Dr. Somik Ghosh, University of Oklahoma

Dr. Ghosh is an Assistant Professor in the Construction Science Division at the University of Oklahoma. Ghosh received his PhD in Environmental Design and Planning from Virginia Tech after completing his MS in Construction Management from Michigan State University, and Bachelor of Architecture from Jadavpur University (India). His teaching and research interests are focused on adoption of lean principles in the design and construction industry, and different pedagogical approaches.

Flipping a Structures Class in a Construction Science Program

Lisa Holliday, Camilo Pena, Somik Ghosh

University of Oklahoma

Construction Science Division

Structures topics such as Statics and Strength of Materials have traditionally been taught with the lecture format of teaching. In this format, the topic is: 1) Introduced by lecture to explain the principals involved. 2) Examples are worked in class to reinforce those principals. 3) Students perform homework to further reinforcing the materials. 4) Finally students are tested to determine their knowledge of the topic material.

Research has shown that during the lecture portion of the learning, students are not actively involved in the learning process. The lecture portion of the learning process is the largest amount of time the students and instructor spend together and during this learning step students are not actively involved. In this traditional teaching model, students are most actively learning during the homework assignments that occurs during a time students are working away from the instructor. The Construction Science Division structures professor at the University of Oklahoma has flipped this learning process by doing the more active and authentic learning in the classroom. The professor tasked the students with reviewing the lecture material in advance and then spent class time working on the homework in the hopes of increasing authentic learning. This learning model was generally successful but there were lessons learned. Using the lessons learned in the preceding year, the process was revised and repeated the next year with greater success. The process of flipping a structures class and the lessons learned are discussed in this paper with planned refinements to the process.

Keywords: construction science education, flipped classroom, structures education

Background

Historically education is one of the most important factors that shapes and transforms each generation. Even though students are changing through the generations, education is not keeping pace. The traditional lecture-teacher-centered model of delivery has prevailed for centuries. However, new technologies are making new delivery methods possible.

The traditional style of learning involves the professor providing lectures while the students listen and take notes. Then homework is assigned and students are dismissed. It is during the homework that students are engaged and work on challenging concepts. During the time when students are most engaged, the professor and students are separated and the students are working without oversight or guidance from the professor. During the lectures in class, students are passive and not actively learning. It is only later while doing the homework on their own that they become active. "Flipping" a classroom switches this learning style by getting students to do the active learning in the classroom in the presence of the professor. In a Flipped Learning Network™ publication, Hamdan, McKnight P, McKnight K, & Arfstrom (2013) describe the flipped learning model as such "In the flipped learning model, teachers shift direct learning out of the large group learning space and move it into individual learning space, with the help of one of several technologies." These technologies can be videos posted on-line or other forms of delivery systems. By giving students the independence to capitalize the course material outside the class, teachers are able to shift from teacher driven instructions to a student-centered model. This allows an

effective usage of the in-class time and creates the opportunity for instructors to transmit knowledge in an active learning environment (Rodgers, 2013).

However, technology is not always necessary to flip a classroom. The foundation of the model is based on inverting the typical lecture and homework elements of the course (EDUCAUSE, 2012). The main challenge of this system is to integrate the same curriculum without compromising the students' learning performance.

Previous Work and Outcomes

The concept of flipping a classroom is relatively new and as such there are not rigorously developed large scale research studies proving its effectiveness or impact on education. There are researchers at several universities experimenting with this teaching style including University of Washington, University of Michigan at Ann Arbor, University of British Columbia, among others and they are testing the method and gathering data about this pedagogical method (Hamdan, 2013).

A physics professor at the University of British Columbia has done a comparative study using half of the class as a control while flipping the material for the other half of the class. The overall analysis was to study three main components: student attendance, student engagement, and student test results. The experiment was conducted in a one week period of Quantum Physics Class. In this study, an experienced professor with high ratings in the subject lectured the control group. In contrast, a teaching assistant instructed the experimental group. Both sections were taught with the same pedagogical approach and compared to one another in the areas of student perception, behavior, and knowledge before the experimental flipped class. The control group was taught with the teacher-centered class model consisting of power point presentations and homework after the lecture. The experimental section used an instruction approach defined by pre-class reading assignments; pre-class reading quizzes, in-class clicker questions, with peer discussion, small group active learning tasks, and targeted in-class instruction feedback. The test results showed the two sections were indistinguishable (Deslauriers, 2011). However, the students in the flipped class showed increased engagement, increased attendance, and did twice as well on the test portion that covered that portion.

In a course with material more similar to construction curriculum, Professor Farrow at the McWhorter School of Construction at Auburn University has experimented with flipping his classroom. As part of this program he has developed an online learning academy focused on construction topics. These videos were produced to replace the introductory lecture in order to have more time in the classroom for active learning and hands-on applied activities. (Farrow, 2013)

Replacing text books with on-line lessons raises some concerns. Are these lessons peer reviewed. Textbooks are peer reviewed and go through rigorous editing and revisions. On-line lessons do not yet have a standard for quality or peer review. In the future as on-line lessons become more available a peer review process or some other measure of quality may need to be considered.

Student Preparation

This flipped model generally requires the students do some preparatory work (in the place of the lecture material) prior to the active learning. Motivating students to adequately prepare is the challenge for successful time spent in the flipped class. Others have elaborated on the need to gain student buy-in for the flipped classroom. For example, Scott Freeman (2014) has several student buy-in strategies including asking students to sign a participation agreement or contract (Pearson 2013). Freeman also uses group assignments so students are not only preparing for themselves but also their fellow group members. To determine if students have done the preparation work there must be some form of readiness assessment

and Freeman used a two-step assessment by giving first an individual quiz and then the same quiz to the group.

Flipped Lessons – 1st Year

The first year, the statics and strength of materials class at the University of Oklahoma was flipped for 3 of the 10 homework assignments. Students were assigned reading materials to cover the materials that would normally be covered in a traditional lecture. During the next class, students were given a test to measure their knowledge of the material. This is sometimes referred to as a readiness assessment. Then students were grouped together and assigned a homework problem to work in class as a group. The instructor mixed with the groups and provided guidance and support. Each group solved a problem and presented the solution at the end of the class period. All of the students were then responsible for understanding and turning in the whole assignment.

1st Year Results

The students that comprised the 1st year class were all generally good students. However the results of the quizzes were surprisingly poor. Based on the results it seemed students only glanced at the reading materials. Students were not able to answer basic information from the readings. Actually the grades on the quizzes were so poor they had to be curved in order to not penalize the class based on an experimental teaching approach. Also, because the students demonstrated weak readiness, the material had to be covered in class during the time allotted for authentic learning activities. It became apparent that readiness is essential.

One complication of flipping some of the assignments but not all of them is that it tends to bump two assignments into one another. This can happen because traditional assignments have the homework after being covered in the class. If this is followed by a flipped class where the independent work is done first, the two different styles of homework may bump into one another.

Flipped Lessons – 2nd Year

During the subsequent year several changes were made to the flipped lessons. First, some changes were made to the lesson topics that were flipped. Less critical topics were chosen for the flipped courses. This ensured that the information that is critical to continue was still delivered by a proven method (the traditional lecture followed by individual homework). Second, to improve student preparation, students were asked to not only read but also work through and turn in example problems in the readings. The thought was that this will require active participation prior to the flipped class. However it became evident that some student actively worked through the example problems while others mindlessly copied the example problems. This trend was also seen in group activities. Some students worked diligently on the problems while others simply followed along without contributing.

2nd Year Results

The 2nd year students were surveyed to determine their perceptions of the flipped lessons. The students were asked to agree, strongly agree, strongly disagree or disagree with nine statements. The statements and answers are shown below:

1. The flipped classroom is more engaging than traditional classroom instruction.
2. I would not recommend the flipped classroom to a friend.
3. The flipped Classroom gives me greater opportunities to communicate with other students.
4. I am more motivated to learn structures in the flipped classroom.
5. The flipped classroom has not improved my learning of structures.
6. I would rather watch a traditional teacher led lesson than a lesson video.
7. I spent less time working on flipped homework than traditional structures homework.
8. The flipped classroom gives me less class time to practice structures.
9. I would rather have the entire class flipped.

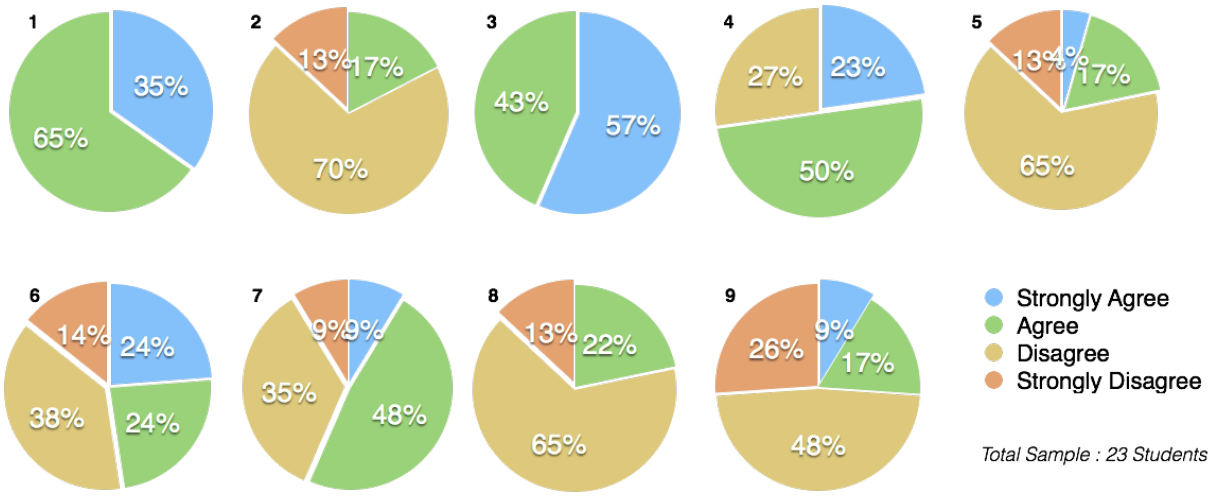

Figure 1 – Student Survey Distribution

From the responses it appears the students enjoyed the flipped lessons but do not want all of the lessons to be the flipped format. They find the flipped classroom engaging; they would recommend it to a friend and are more motivated. The response to the video was mixed, which was surprising. They did find it took less time, but perhaps that wouldn't be the case if all students prepared as they should.

The students were also asked a series of 5 open ended questions that allowed them to form their own responses. The five questions are listed below with a sample of student answers:

1. What are the advantages of the Flipped Classroom?

"Provides more collaboration and helps to motivate students."

"The students get the chance to do and learn the material before we go over it in class."

"It was very beneficial. It felt like it really challenged us to learn the material but it was also a bit frustrating at times struggling through the work."

"The primary advantage is that in-class homework requires collaboration and in theory should hold everyone accountable to study the material before class. Also, I think it is more beneficial than having quizzes."

"If you took the time to really examine the problems done in preparation, you can build on what you have already learned."

"We had the opportunity to ask questions about the homework as soon as we were stuck."
"I liked it because it helped me understand the material better while you went over it. It was almost like a review or verifying I was doing it correctly."

"I am very good at teaching myself and this allows me to better understand the material.
"Changes pace, encourages team work"

2. What are the disadvantages of the Flipped Classroom?

“Some students fly by without giving others the opportunity to participate.”

“Those that don’t understand tend to hide in back of the group and agree without knowing if correct or not.”

“For some students just reading and copying down the examples doesn’t help them learn the material. They need to watch the process unfold.”

“The biggest disadvantage for me was that I learn more from lectures than I do from studying the material at home.”

“Very few people participated making it hard than it should have been.”

“Some parts you have to teach yourself, book doesn’t explain it as clearly as the teacher.”

“Some students do not do the work before hand or do not understand the topic so they are not able to help with the in class assignments.”

3. Would the Flipped Classroom be useful for other subjects? Why or why not?

“Yes, I think collaboration is always useful and should be part of every class”

“Only math or science class. For example, physics, calculus, geometry”

“If you can get people to really do some background work before class, then yes, it cloud be useful”

“The class work is great, but I would prefer mastering topics I was already struggling with, instead of working on new material”

“Yes, it is a beneficial break from the other learning/teaching methods”

4. What improvements would you recommend to improve learning in the Flipped Classroom?

“I think a brief overview of the section should be covered in the class before the flip. Example: on Tuesday give a short overview and on Thursday flip the class. That way the student have some understanding before they learn it on their own”

“Online lectures with slides. A lot of work for teachers but very helpful to students”

“I think the way it is works very well, may be give students a problem or two without the steps so the students have to think their way through it”

“I would recommend quizzes or in class work instead of expecting students to learn new material independently”

“Because we don’t have a lecture for the in-class homework material, I think it would be best not to do in-class homework over material that is crucial for us to know and apply later in the semester”

“Keep quizzes out. I like how it was done. I wouldn’t change it”

5. Please state any other comment you wish to make about the Flipped Classroom.

"I really think it is a good idea. I believe that in life most of the time we need to teach ourselves and the flipped class gives us an idea of how it can be, but off course with the flipped class we still have total support of the teacher"

"I like it. It forces the student to think for themselves and use trail + error so that when you go over it in class you understand the process better"

"Overall at this time I found it unnecessary and somewhat pointless. However, it is a change of scenery and nice for hands on learning"

"Make sure there is collaboration among groups"

"Very helpful in understanding the topics"

"I enjoyed the flipped classroom, besides the other benefits, it was a nice change of pace"

From the comments it can be seen that not all student felt their classmates were prepared sufficiently for the assignment. There were also comments about the lack of student participation. Generally students enjoyed the flipped lessons and thought it brought value to the class.

Summary

The results show that students enjoy doing the more challenging part of the class work together as a group and in the class with professor assistance. Evidence suggests students learning is improved in this format. Our survey showed that student enjoyed a few lessons flipped but did not want all of the lessons changed to this format. There were many comments about other students not being prepared and not assisting in the group work and this portion of the flipped lessons will be improved in the future. The challenge is motivating students to do the preliminary work in order to make the working time in the classroom productive. Videos have been used successfully by others; however our students indicated they don't want videos. Also a video has the ability to be watched with little attention. Others such as C. Reidsema and L. Kavanagh (2014) suggest student buy in strategies such as quizzing groups so there is peer pressure to prepare. In the future the structures class will continue to contain several flipped lessons and new methods for developing student readiness with be determined including group grading strategies.

References

Aronson N., Arfstrom L. (2013). Flipped Learning in Higher Education. Flipped Learning Network & Kenneth Tam, Pearson.

Deslauriers, L., Schelew, E., & Wieman, C. (2011). Improved Learning in a Large-Enrollment Physics class. Science Magazine, vol 332, pp 862-864.

EDUCAUSE Learning Initiative (2012). Seven things you should know about flipped classrooms. Retrieved from http://net.educause.edu/ir/library/pdf/ELI7081.pdf

Farrow, C. B. (2013). The introduction of an Online Learning Academy. *49th ASC Annual International Conference Proceedings*.

Hamdan, N., McKnight, P., McKnight, K., & Arfstrom, K. (2013). A review of flipped learning. Retrieved from http://www.flippedlearning.org/review

Long K. (2012, December 16). Washington college instructors are ‘flipping’ the way they teach. The Seattle Times. Retrieved from bit.ly/YcstDH

Reidsema C.A., Kavanagh L., & Jolly L. (2014). Flipping the classroom at scale to achieve integration of theory and practice in a first year engineering design and build course. 121st ASEE Annual Conference and Exposition: 360 Degrees of Engineering Education. Indianapolis, IN.

Rogers, T., & Tingerthal, J. (2013). Blended Learning and "Flipping" the Construction Management Classroom for Improved Teaching and Learning. *49th Annual International Conference Proceedings*. Retrieved from http://ascpro0.ascweb.org/archives/cd/2013/paper/CEUE40002013.pdf