Students' Perception of Flipped Classroom Design in Engineering Courses

Lulu Sun, Hongyun Chen, and Shuo Pang
Embry-Riddle Aeronautical University

Abstract

Today many engineering instructors are struggling to include more course contents and exercises within the limited class time. To address student-centered learning, and enhance student learning and conceptual understanding, three engineering faculty flipped their classes so that students can study concepts online at their own pace and more active learning can be implemented in the class time. The online content module consists of audio/video lectures, lecture slides, and online quizzes. Students may begin module study as soon as the content is available. Online quizzes are used to check understanding of key study points in the lecture slides after their self-study within allocated time. Instructors will assist in student's exercises or assignment problems in class time and clear their questions they have in their online self-study. It is believed that self-study will encourage more questions and this increased communication between students and instructors will promote student's understanding and class involvement.

Keywords

Flipped classroom, Statics, Digital Circuit, graphics, online.

Introduction

Both the American Society for Engineering Education[1] and the National Academy of Engineers[2] have called for education reform that focuses on developing engineering graduates that are self-learners and problem-solvers. The idea of the flipped classroom is to train students to be self-learners, to study concepts before the class, and to dedicate more classroom time to learner-centered activities so that immediate feedback and assistance can be provided to the students[3-5]. Figure 1 shows Venn-diagram of several learner-centered learning theories and methods. Bishop and Verleger did a comprehensive survey of prior and ongoing research of the flipped classroom[6]. They pointed out that a flipped class is different from an online class because it still involves face-to-face class time with the instructor and it emphasizes interactive group learning activities during the class time. Especially in today's world, it offers students computer-based individual instruction and requires them to finish closed-ended quizzes and exercises online[7]. Instructors will clarify and reinforce the misconceptions through group-based interactive learning activities in the class based on the online assessment that is collected[8-10].

To address student-centered learning, and enhance student learning and conceptual understanding, three engineering faculty members did a pilot study of the flipped classroom on three engineering courses which includes Graphical Communications (EGR120), Statics (ES201), and Digital Circuit (EE203) at a private institution in the southeast in Fall 2015. The objective of the study was to incorporate the flipped classroom as part of the course to examine student's perception on flipped classroom design.

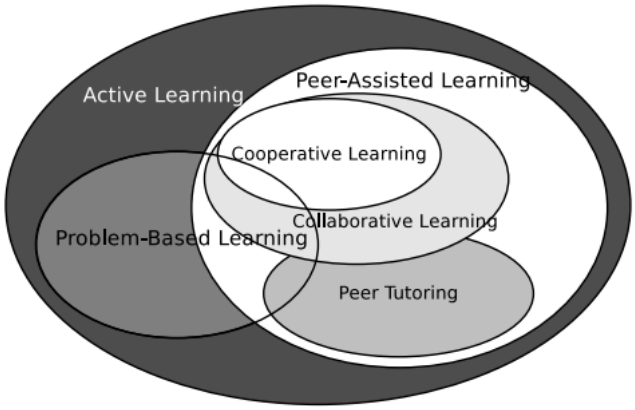

Figure 1. Venn diagram of several learner-centered learning theories and methods.

Course Structure

Students are required to view the lecture contents, as a series of about 10 minutes long video online and finish the quizzes after the online study. The videos cover the course concepts. Once students fully understand the concepts, instructor can use most of class time to work with the students interactively to solve engineering problems. Instructor gives a brief 10 minutes overview of the lecture material at the beginning of the class. Students, then work on the exercise problem in the class, with the assistance of the instructor if needed. Once all problems are solved correctly by all and clear demonstration of the understanding is given to the instructor. Students will be allowed to use class time to work on homework problems.

Results

To understand students' perceptions of the flipped classroom, an anonymous midterm survey was administered by Center for Teaching and Learning Excellence (CTLE) at the institution in each semester. Over 80% students (n=100) from three courses completed the survey. Table 1 shows the time students spent online doing the study by themselves. Depending on the difficulty level and instructor's requirements, the time students spend online varies by the course. Table 2 describes if students like the flipped class format comparing to the traditional lecture format. Over 68% students from three courses preferred flipped class format. Table 3 summaries if students put their best effort into online study. At least 55% students agreed that they put their best effort into online study. Table 4 indicates the confidence level of students after the online study. At least 73% students from all three courses showed certain level of confidence after the online study. Table 5 concluded that at least 61% students from three courses would like to continue the flipped classroom format for the rest of the semester.

Table 1. Survey question 1 responses

How long does it take you to finish each online study? (n=100)			
Course	< 1 hr	1 hr	> 1hr
EGR120 (n=45)	38%	31%	31%

ES201 (n=22)	86%	9%	5%
CEC220 (n=33)	3%	21%	76%

Table 2. Survey question 2 responses

How would you compare the flipped class format to the traditional lecture format?			
Course	I like it	Sort of	I do not like it
EGR120 (n=45)	38%	42%	20%
ES201 (n=22)	41%	27%	32%
CEC220 (n=33)	36%	39%	24%

Table 3. Survey question 3 responses

Comparing the flipped class to the traditional class, how do you evaluate these: [I studied and put effort into this course]					
Course	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
EGR120 (n=45)	24%	49%	16%	4%	7%
ES201 (n=22)	32%	23%	27%	5%	14%
CEC220 (n=33)	39%	42%	9%	3%	6%

Table 4. Survey question 4 responses

How confident do you feel about the material after online study but before coming to class to do problems?			
Course	Extreme confident	Somewhat confident but need more help	Not very confident
EGR120 (n=45)	27%	58%	16%
ES201 (n=22)	9%	73%	18%

CEC220 (n=33)	12%	61%	27%

Table 5. Survey question 5 responses

Would you like to continue with the flipped course for the remainder of the semester?			
Course	Yes	No preference	No
EGR120 (n=45)	60%	18%	22%
ES201 (n=22)	68%	0%	32%
CEC220 (n=33)	61%	0%	39%

The following are the comments from students regarding the flipped classroom approach (not corrected for grammatical errors or spelling mistakes). Overall students prefer the flipped classroom format. They like to preview the class materials online and get ready to do more active learning activities in the class time. Shorter, rather than longer videos are preferred.

- *The online resources like powerpoints and whatever help because we usually look over it at home before doing it in class, so we kinda get a preview and that helps. (EGR120 class)*
- *By going over examples and then being able to start the homework in class. We can watch her do examples and do them on our own as well. The study material being posted online was very helpful. (EGR120 class)*
- *The attention to detail; online study guides/power point presentations; the in class examples. The two chances to take the online quizzes at the beginning of the course was very helpful. (EGR120 class)*
- *The videos have given an overview and the knowledge to the expected topics before class which is good as it helped me to understand the materials better. (ES201 class)*
- *I think reading/doing activities on the material before class is helpful. Having solutions to check our answ ers. (ES201 class)*
- *Going over the flip my class quizzes and then reviewing the material in class helps solidify the information (ES201)*
- *The amount of examples we do in class really help me get practice but take away from the learning time leaving me with a sketchy understanding of most topics. (EE203 class)*
- *The online videos were great. The quizzes online were useful too. The power points are fair but not that good to study for a test. (EE203 class)*

- *With the transition to an online learning basis, more time is available in-class to cover examples and answer specific questions. When the material is easily understood through video lecture, this is highly effective. (EE203 class)*
- *I did like the online videos and quizzes for chapter 3. If you don't understand something in the video. a quick internet search can solve the problem. In class, if you don't understand something right away, I would miss out on the new content while trying to figure out the old content.*
  (EE203 class)

Conclusion

A pilot study of the flipped classroom in three engineering course was conducted in Fall 2015. A midterm survey was administered to understand student's perception in each course. From anonymous student surveys we found that because of the flipped classroom, students like to watching interactive videos than reading the textbook. Students preferred interactive class time more than in-person lectures. In summary, the flipped classroom approach is effective if it is used appropriately. It depends on interactive online classroom design, active learning in the face to face classroom, and continuous improvement based on student input. A pilot study is always recommended so that student's perception can be collected and it can help design both in-class and out-of-class activities in a right direction.

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Lulu Sun, Ph.D.

Lulu Sun is an associate professor in the Engineering Fundamentals Department at Embry-Riddle Aeronautical University. She received her Ph.D. degree in Mechanical Engineering from University of California, Riverside, in 2006. Before joining Embry-riddle, she worked in the consulting firm of Arup at Los Angeles office as a fire engineer. Her research interests include second language acquisition in programming languages, and online course design. She is a professional member of the Society of Fire Protection Engineers, and a member of the American Society for Engineering Education.

Hongyun Chen, Ph.D., P.E.

Dr. Hongyun Chen is an Assistant Professor in the Department of Civil Engineering at Embry-Riddle Aeronautical University (ERAU). Dr. Chen received her Master and PhD from the University of South Florida (USF) in 2008 and 2010. Her research interests include Transportation Safety, Highway Geometric Design, Traffic Signal Control and Operation, Intelligent Transportation Systems (ITS), and Statistical Application and Analysis in Transportation. Dr. Chen believes the goal of transportation research studies should be benefit to users, practical to designers and noteworthy to researchers. As a consequence, some of her researches have made significant contributions to improve the traffic safety and operation. For example, the comprehensive motorcycle project is assisting the Florida Motorcycle Safety Coalition from 2008 and a 24% reduction in motorcycle fatalities in Florida was observed in 2009 after a ten years increase in motorcycle fatalities. The coalition was selected to receive the prestigious Peter K. O'Rourke Special Achievement Award from Governors Highway Safety Association (GHSA) and Best Public Awareness Event by the National Transportation Public Affairs Workshop (NTPAW) in 2010 for its impact on reducing fatalities and injuries.

Shuo Pang, Ph.D.

Dr. Shuo Pang received his B.S. degree in electrical engineering from Harbin Engineering University, China, in 1997, and the M.S. and Ph.D. degrees in electrical engineering from University of California, Riverside, in 2001 and 2004, respectively. Currently, he is an Associate Professor in the Department of Electrical, Computer, Software, and Systems Engineering, Embry-Riddle Aeronautical University, Daytona Beach, FL. His research spans theoretical-algorithm development and application-driven intelligent systems. His current research interests include embedded control systems, robotics, and artificial intelligence techniques for autonomous vehicles.