Independent University **Bangladesh (IUB)**

IUB Academic Repository

School of Liberal Arts & Social Sciences Article

2016-09-01

A Case Study of Flipped Classroom Model in Engineering and Business Higher Education in Bangladesh

Miya, Mohammad Tohidul Islam

Center for Pedagogy (CP) Established under the Sub-project Titled “Pedagogical Development at Undergraduate and Master’s Level” (CP3357), Independent Univeristy, Bangladesh (IUB)

https://ar.iub.edu.bd/handle/11348/255

Downloaded from IUB Academic Repository

A Case Study of Flipped Classroom Model in Engineering and Business Higher Education in Bangladesh

Mohammad Tohidul Islam Miya [65] and Khawza Iftekhar Uddin Ahmed
United International University

Industrial revolution spurred standardization of education and digital revolution fosters customization of education. Digitalization intertwined with the Internet and social networking drives the education platform towards a more student-oriented (self-paced) and problem solving learning environment. This study analyzes the implementation of flipped classroom learning model, in signals and linear systems course and in marketing management course at United International University. In this model, students access asynchronous online video lectures outside the classroom and participate in in-class learning activities assigned, facilitated and assessed by the teacher. Application of this model requires continuous online access and pre-class preparation by students. It explores the potential of extending the learning platform outside the classroom by course website and expands the scope of teacher – student and student-student communication by course forum. This model brings more rigor in the course content and design in addition to scope of covering more content by developing lectures online and freeing up the class hour for learning activity and assessment. It may create extra course load for the students and create resentment about the flipped learning model. The case study extracts several critical factors in teaching staff such as tech readiness, project/problem solving oriented design, and factors in students such as tech savviness, self-starter for a self-paced course design as imperatives for successful implementation of the model. The study recommends institutional measures (curriculum redesign, continuous and activity based assessments strategies, technology integration) to help enable the teaching staff and students with skills and attitudes necessary to scale up the model university wide.

Keywords: *Learning model, flipped class room, learning activity, technology integration.*

Introduction

The conventional approach to university education, prevalent for hundreds of years, involves a lecture by the professor during the scheduled class period and students working on exercises outside of class (Veen`, 2013). A flipped classroom inverts this conventional process. It "moves the lectures outside the classrooms and uses learning activities to move practice with concepts inside the classroom" (Strayer, 2012). The philosophy behind the flipped classroom teaching methodology is that it allows instructors to teach both content and process (Findlay-Thompson & Mombourquette, 2014). The remaining sections of this paper reviews the literature on flipped classroom model, discusses on implementation of the model in the courses of Science & Engineering and Business, examines the impact of this model, analyzes the data collected on students' attitude toward this model and recommends measures to improve the impact of the model.

[65] Correspondence should be addressed to Mohammad Tohidul Islam Miya, E-mail: tohid@bus.uiu.ac.bd.

Literature Review

Education from industrial revolution has been transformed by two forces: technological developments & ideological developments (Bishop & Verleger, 2013). Innovations in education technology such as printing press in the 1400s have pushed the limit of developing educational contents in a larger scale (McLuhan 1962; Eisenstein 1980; Febvre & Martin 1997). Innovations in communication & computing technologies in the 19th and 20th century such as electronic telegraph, wireless radio, television, computers, internet and world-wide web have influenced and increased the choices of learners to educate themselves. The pervasive impact of social media in 21st century has its impact on how learners interact with potential sources of learning and peers. The technological developments help to overcome physical barriers to a free and open flow of information which inspired the ideology to remove artificial and man-made barriers as epitomized in free software movement (Stallman and Lessig 2010).

Massive Open Online Courses (MOOCs) is a derivative of developments in the technology of education and drive to keep education accessible beyond physical as well as financial barriers. Studies suggest that interactive online videos can outperform in- person classroom lectures significantly (Cohen et al 1981., McNeil 1989, Zhang et al. 2006). Research also supports the claim that paper- and – pencil homework can be effectively replaced by online homework (Bonham 2003., Fynewever 2008.). The use of datamining and analytics have made online tutoring system as good as human tutors (VanLehn 2011). MIT is the first university to break away from a close door educational model to launch its Open Course Ware (OCW) in 2001 (MIT 2016). It opens the door for major innovations in online educations such as Khan academy, Udacity, Coursera and edX (Udacity 2016, edX, 2016). An open and improved online education platform challenges traditional brick-and-mortar schools to catch up with best of innovations in education.

A flipped classroom offers a solution to a traditional brick-and-mortar university model to meet challenges from many sources. The ever-increasing cost of tuition for higher education can managed economically by scaling up the delivery of lectures and its accessibility. Pre-recorded video lectures and support learning materials can be uploaded online for students' homework and save the class time for interactive learning activities. This model allows application of problem-based learning methods to meet the demands of higher outcomes from education by students and accreditation institutions (Felder & Brent 2003.).

Defining Flipped Classroom

A flipped classroom most commonly refers to reversing or inverting the traditional model of in- and out-of-class activities. "Inverting the classroom means that events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa" (Lage et al 2000). In a flipped paradigm, the students are introduced to topics and basic concepts using video lectures or other means during their time outside of the classroom and spend the scheduled class period working on exercises under the supervision of the instructor. Instead of being a "sage on the stage" the instructor now becomes a "guide on the side" (King, 1993). The conventional paradigm treats the student as an empty container into which knowledge is poured, while the flipped paradigm treats the student as an active learner who reconstructs knowledge from information (Veen`, 2013).

A number of researches on flipped classroom employs group-based interactive learning activities inside the classroom, citing student-centered learning theories based on the works of Piaget 1967 and Vygotsky 1978. The exact nature of these activities varies widely between studies. Similarly, there is wide variation in what is being assigned as "homework". The flipped classroom label is most often assigned to courses that use activities made up of asynchronous web-based lectures and close-ended problems or quizzes. In many traditional courses, this represents all the instruction students ever get. Thus, the flipped classroom

actually represents an expansion of the curriculum, rather than a mere re-arrangement of activities (Bishop & Verleger, 2013). A simplified depiction of this is shown in Table 1.

Table-1
Definition of a Flipped Classroom

Inside Class	Outside Class
Questions & Answers Quizzes to assure video lecture listening performance	Video Lectures Learning materials (Slides) uploaded on course site. Peer 2 Peer, Student 2 Instructor networking on course forum.
Group-Based/Open-ended problem Solving	Quizzes & Practice Exercises to prepare for class.

Impact of Flipped Classroom Model

In studies where flipped classroom model has been used, the impact according to students' perception was relatively consistent. Students' attitude toward flipped model tends to be positive including a few students' disliking the change. Students tend to watch the video lectures as assigned and even when they are not. DeGrazia et al. (2012) observes a significantly better class preparation by students when they are assigned to watch optional video lectures instead of textbook readings. Students also recommend a required pre-class quiz on the lecture material which significantly improves the tendency of the students to watch the video lectures and prepare for the class. Student preference for interactive class time to in-person lectures is more than their preference for in-person lectures to video lectures (Toto & Nguyen, 2009). They also prefer shorter rather than longer videos (Zappe et al., 2009).

There are some issues noted in literature review on flipped classroom model which may limit its impact on students' performance. First, this type of teaching methodology can create greater chasm between high-income and low-income students (Findlay-Thompson & Mombourquette, 2014). Second, schools generally need access to software that may be prohibitively costly and beyond the capacity of educational budgets (Techsmith, 2013). Third, teachers need training on software and proper structure of a flipped classroom which costs time and commitment from teachers (Findlay-Thompson & Mombourquette, 2014).

Implementation of Flipped Classroom Model

This study implements flipped classroom model in two courses of a university in Bangladesh. Dr. Khawza Iftekhar Uddin Ahmed teaches Signals & Linear Systems (EEE 211) in three sections (A, B, C) (80 students in total) for Spring 2016 at School of Science & Engineering (SoSE). The students of this course are mostly in second year of undergraduate program. To facilitate the model in 24 classes, he creates 69 lessons (approximately 23 hours). In the beginning of the trimester, he provides course outline, sample questions and reading materials on the course page (http://www.elms.uiu.ac.bd/course/view.php?id=764) explaining the operational procedures of the course for the whole trimester. Lectures notes with contents of the video lectures for each class is also available on course page. The learning process generally followed the same sequence. First, prior to class, students are expected to watch three to five video lessons (1 hour to 1.5 hours). Second, in each alternative classes online quizzes are taken to monitor students' preparation for the class and level of understanding of the concepts. Third, after the quiz, students present the topic as covered in the video lessons for that class. They deliver the presentation as a group and it lasts for 15-20minutes and it is arranged in each class with Round Robin (RR) schedule. It provides the instructor formative assessment for each student by quiz and each group by presentation.

Fourth, then students work out in class activities to reflect on, discuss, and practice what they had learned in a group basis. Most of the in classroom activities are instructor led. Students are also assigned to explore problems with the scope of solving them by using concepts covered in the course.

The instructional materials are available on course page. In case students find problem to watch them online, they can download them to watch offline. A course forum is available on facebook to facilitate peer2peer communication and student2teacher communication more smoothly. Assignment submissions options and relevant notices are available on course page making the online course platform as complete as possible.

Mohammad Tohidul Islam Miya teaches Marketing Management (MKT 3336) in two sections (A & C) (60 students in total) for Spring 2016 at School of Business & Economics (SoBE). The students of this course are mostly in third year of undergraduate program. Unlike Dr Khawza, he has spread the trimester into three different periods (Mid1, Mid2 & Final). He followed flipped classroom model up to Mid1 exam and then, switched to traditional model of teaching up to Mid2 exam and afterwards, reverts to flip model up to final exam of the trimester. He develops 15 (approximately 4 hours) video lectures for the first nine classes of trimester before Mid1 exam. Like Dr Khawza, he provides course outline, sample questions and reading materials on the course page (http://www.elms.uiu.ac.bd/course/view.php?id=745) explaining the operational procedures of the course for the whole trimester. Lectures slides with contents of the video lectures are also available on course page. The learning process generally followed the same sequence as Dr. Khawza did with two exceptions that quizzes are arranged in each class and students are invited to participate or present the topic by cold call basis.

Methodology

For EEE211, survey data was collected from all students who agreed to participate (n = 56) by sending their reply through online survey. To encourage students to answer honestly , the survey data was collected anonymously. Student responses were collected in regards to the a) instructional videos assigned for out-of-class preparation, b) the in-class instructional activities, and c) the more general impact the course had on students (Enfield 2013). Descriptive statistics have been used to analyze the attitude of the students toward Flipped classroom instruction materials (Survey items 1-8), in-class activities (survey items 9-12) and the more general impact the course had on students (survey items 13-15). Survey item 16 gave students (*Please provide any additional comments and concerns as feedback that will help in improving the future classes*) gave students the opportunity to provide further information in an open-ended manner.

For MKT 3336, case study interviews were deemed appropriate as this course took flipped model of learning to explore the attitudinal as well as behavioral response of the student. Unlike EEE211, which has already experimented model in previous trimesters, this course wanted to gain a better understanding of the phenomenon by collecting students response on case study basis, specifically interviewing the participants (Flyvbjerg 2006; Zikmund 2003). In this study, open-ended questions were used to inquire about the students' experience with a flipped classroom. Open-ended questions were used because they encourage respondents to answer freely (Zikmund, 2003), respond in their own words, result in unanticipated answers (Zikmund, 2003), and often provide richer data compared to closed questions. So students were invited to personal in-depth interviews to share their perception and attitudes toward Flipped classroom model.

As noted above, the nine participants for the study were selected using a judgement sample. Students who participated in all assignments of flipped classroom model of the course MKT3336. Students were

asked open ended questions specifically toward Instructional Videos and In-class activities. There is commonality in questions asked in the survey questionnaire for EEE211 and personal in-depth interviews for MKT3336. But some questions were different to fit in the context of course and mode of data collection.

Analysis of the Findings EEE211

Instructional Videos

Responses to survey items 1-8 are used to collect multiple choice data on particular areas of interest in the use of instructional videos. Most of the students reported that they liked the way of learning using flipped class room model (75%). Almost all students (98.2%) found the lecture videos helpful. Majority of the students (69.6%) found the video length appropriate though a certain percentage (26.8%) found lengthy. Students seemed to find one hour video lecture to watch before class to demanding (50%). It is interesting to see that students like in classroom lectures preferred to keep notes (75%) while watching video lectures. However students found the video contents appropriately challenging (78.6%) to their cognitive level. Though students find watching one hour video lectures before class quite daunting but they mostly agreed (71.4%) to the learning process of watching the videos before coming to the class. Finally, the compliance of the students behavior with the process of the learning model is very high. Over 80% students have managed to watch most of the relevant videos (70% or more) before they joined the class.

Table-2

Survey Items for Instructional Videos

Question 1: Which one is true for you?	%
I like Watching videos at home and doing activities in the class because it makes my concepts clear.	75
I do not like watching videos at home and doing activities in the class because it demands lot of time at home.	25
Question 2: How effective did you find the lecture videos in helping you learn the contents of the course EEE 211, Signals and Linear Systems?	%
Very Helpful	58.9
Somewhat Helpful	39.3
Not Helpful	1.8
Question 3: The duration (15 minutes ~ 30 minutes) of each video clip	%
Appropriate for the given content	69.6
Too short for the given content	3.6
Too large for the given content	26.8
Question 4: Typically, you were asked to watch about an hour of instructional videos between each class session	%
The amount of video to watch was too much	50
The amount of video to watch was about right	48.2
The amount of video to watch was too little	1.8
Question 5: Did you find taking notes while watching the videos helpful in learning the content?	%
I never attempted this strategy	5.4
Very helpful in learning the content	75
Somewhat helpful in learning the content	19.6
Not helpful in learning the Content	0

Question 6: In general, I found the content of the videos to be:	%
Too difficult	8.9
Appropriately challenging	78.6
Too easy	12.5
Question 7:Watching videos before the class:	%
Is fine with me.	71.4
Is burdensome with me.	28.6
Question 8: What is the percentage of videos have you watched before the class?	%
All	14.3
More than 90%	19.6
More than 80%	23.2
More than 70%	23.2
More than 60%	7.1
More than 50%	8.9
Less than 50%	3.6
0%	0

In-class Activities

Responses to survey items 9-12 were used to collect multiple choice data on particular areas of interest in the use of in-class activities. Students strongly supported (60.7%) the incentive of doing well in the quiz as a reward of watching the video lectures. They very strongly welcomed the (approximately 90%) idea of working on problems in the class as a group basis based on concepts covered in the video lectures. Most interestingly, contrary to initial perception of the instructors students mostly liked (64.3%) the assignment of presenting their idea of concepts that they have learned through video lecture. Moreover, most students (80.4%) find that presentation assignment has improved in their achievement of skills.

Table-3

Survey Items for In-class Activities

Question 9: How did the use of quizzes impact your motivation to watch the videos?	%
I was more likely to watch the videos because there were quizzes.	60.7
I was equally likely to watch the videos whether there were quizzes or not	30.4
I was less likely to watch the videos because there were quizzes	8.9
Question 10: The group works to solve tasks that were introduced in the video was	%
enjoyable & effective	89.3
not enjoyable & not effective	10.7
Question 11: Did you like giving presentation in the class?	%
Yes	64.3
No	17.9
Not sure	17.9
Question 12: Do you think the presentation that you gave in the class improve your communication skills?	%
Yes	80.4
No	3.6
Not Sure	16.1

General Impact of the Course Students

Responses to survey items 13-15 were used to collect multiple choice data on particular areas of interest in how students were impacted by taking the course. One important driver of flipped classroom model is the reasoning that it helps the learners to progress with more choices and that will motivate them to take learning more seriously and with interest. From survey item 13, students showed greater willingness (57.1%) to sign up for a course based on flipped learning model. We also observed that almost all students find the course as beneficial (98.2%) based on flipped learning model. Finally, most of the (68%) students are investing more time than standard hours specified for a student to prepare for a class (in case of this course, EEE211 – 6 hours) ,which offers an interesting question to explore further : whether these extra hours are invested out of excitement or compulsion to catch up with course load.

Table-4

Survey Items for General Impact of the course on Students

Question 13: Do you think you will prefer a course following the flip model, i.e., watching videos at home and doing activities in the class	%
Yes	57.1
No	19.6
Not sure	23.2
Question 14:I believe the content/skills I learned in this class will be useful:	%
Professionally (career related) and Personally (non-career related)	67.9
Only professionally	12.5
Only personally	17.5
Neither professionally or personally	1.8
Question 15: How many hours have you studied EEE 211, Signals and Linear Systems Course in a week on average?	%
More than 10 hours per week	7.1
Around 8-10 hours per week	21.4
Around 6-8 hours per week	39.3
Around 4-6 hours per week	19.6
Less than 4 hours per week	7.1
Only before exam	5.4

Case Analysis of MKT 3336

The total number of questions can be classified into three categories: Instructional Videos, In-class activities and General Impact of course. Nine students participating in the interview were coded in numbers from 1-9. The initial questions were related to the outside class instructional materials and videos. Later came questions about the in-class activities and preference of students for particulars activities out all activities offered in the classroom. Finally, students were asked to rate the impact of the course according the expectation set in the learning outcomes of the course. In total, sixteen questions were asked in the interviews. Answers to two of those questions are shown as sample.

We find three distinctive groups in the responses of the interviews. In the first group (four students), students were appreciating outside class instructional materials and videos but they appreciate more about in-class activities which are led and guided by the instructors rather than the group working out the

problems independently. In the second group (four students), students also appreciate the outside class instructional materials and videos but they appreciate more about in-class activities where groups work out the problems independently rather than instructor led activities. In the third and final group (one student), we find that the student finds outside class instructional videos burdensome and in-class activities increasing the workload. It seems that the student is on the side of traditional classroom where the teacher will deliver in-person lecture and offer outside class assignments.

There are three personality groups observed in the classroom: Group one are the students who want flexibility in lectures but do not enjoy freedom of problem solving activities with the risk of being wrong; group two are the students who also want flexibility in lectures but they prioritize independence (freedom in thinking) in working out the problems as a group rather than getting a sure access to the solution by instructor's guidance; group three are the students (in our study only one student who prefers a traditional class room instead of a flipped classroom.

Table-5

Sample answers for two questions of in-depth interviews (total 16 questions)

What is your opinion related to the instructional videos used for this course?
1. I have nothing important to say *2. it was easy for us to make clear our concepts very well* *3. videos were very helpful for our learning method and clearing our concepts.* *4. I really enjoy your class and lecture. watching video system was so good.* *5. It's really useful to us, we can easily understand the topic in the classroom.* *6. It is helpful because I can watch those instructional videos again and again. Actually how many times I needed.* *7. In class I mistake many things. But when I see video, I can see it again & again that causes I do not mistake anything.* *8. It is very helpful. I appreciate.* *9. It would be better if the videos have better sound quality because while using the phone it wasn't easy to hear properly.*
What is your opinion related to the in-class activities used for this course?
1. The time for online quizzes was too short,,,,, it should be at least 15-20 min *2. basically online quizzes, audio lecture, videos were really helpful for us to understand the topic very well and online activities , class activities were a new experience for us* *3. using video's for clearing our concepts and so on. and in an effective way.* *4. I really enjoy your class.* *5. class practice is more effective than homework because we can work in a team and cope up with different types of people which is good for our job life.* *6. I guess it's good for our job life* *7. In class we have got many examples of real life marketing plan and how those are worked.* *8. I was learning better in video lecture than your class lecture. Class lecture did not any impact on my learning process.* *9. I strongly suggest that a small fun video on the lecture topic to be shown before the activities start so as to remind and easier to remember before the group activities.*

Conclusions

In this study we find that implementation of a flipped classroom model is not simply inverting the traditional classroom model. It is also the fact that some (though few) students do not prefer flipped classroom model to traditional classroom model. From both survey & case study, we find the insight that students find the videos interesting but they want more convenience in video instructions (size of the videos, average time to watch video before class, etc.). We also find that students' tendency to comply with outside class instructions increases if in-class activities are designed on out-side class instructions. The case study adds one insight: students are different with their preference of given choices of in-class activities, instruction led or independent group working out the problems. We also find that students find high learning outcomes and invest more time to prepare for the class but it seems that they are highly interested to repeat the behavior by sign-up for a flipped classroom.

Our findings in this research suggest that there needs to be further research on flipped classroom. We need to research to find the convenient work load distribution for outside classroom instructions. Further research is also necessary to find out the flexibility for students' in class assignment according to their level of growth cognitively and affectively. We also need research to better understand the choice of some students for traditional classroom over flipped classroom: are they against flipped classroom or against a poorly designed flipped classroom, which does not meet their personal requirement for education?

References

Bishop & Verleger, 2013. Bishop, Jacob Lowell, and Matthew A. Verleger. "The flipped classroom: A survey of the research." *ASEE National Conference Proceedings, Atlanta, GA*. 2013.

Bonham 2003.S.W. Bonham, D.L. Deardorff, and R.J. Beichner. Comparison of student performance using web and paper-based homework in college-level physics. Journal of Research in Science Teaching, 40(10):1050–1071, 2003.

Cohen et al 1981.P.A. Cohen, B.J. Ebeling, and J.A. Kulik. A meta-analysis of outcome studies of visual-based instruction. Educational Technology Research and Development, 29(1):26–36, 1981.

DeGrazia et al. 2012. Janet L. DeGrazia, John L. Falconer, Garret Nicodemus, and Will Medlin. Incorporating screencasts into chemical engineering courses. In Proceedings of the ASEE Annual Conference & Exposition, 2012.

edX, 2016. URL https://www.edx.org

Eisenstein 1980. Esenstein, Elizabeth L. *The printing press as an agent of change*. Vol. 1. Cambridge University Press, 1980.

Enfield 2013. Enfield, Jacob. "Looking at the impact of the flipped classroom model of instruction on undergraduate multimedia students at CSUN." *TechTrends*57.6 (2013): 14-27.

Febvre & Martin 1997. Febvre, Lucien, and Henri-Jean Martin. *The coming of the book: The impact of printing 1450-1800*. Vol. 10. Verso, 1997.

Felder & Brent 2003. R.M. Felder and R. Brent. Designing and teaching courses to satisfy the ABET engineering criteria. Journal of Engineering Education, 92(1):7–25, 2003. ISSN 1069-4730.

Findlay-Thompson & Mombourquette, 2014. Findlay-Thompson, Sandi, and Peter Mombourquette. "Evaluation of a flipped classroom in an undergraduate business course." *Business Education & Accreditation* 6.1 (2014): 63-71.

Flyvbjerg, B. 2006. "Five Misunderstandings about Case Study Research" *Qualitative Inquiry,* vol.12(2), p. 26

Fynewever 2008. H. Fynewever. A comparison of the effectiveness of web-based and paper-based homework for general chemistry. The Chemical Educator, 13(4):264–269, 2008.

King, 1993. A. King, “From sage on the stage to guide on the side,” College Teach., vol. 41, no. 1, pp. 30–35, 1993.

Lage et al 2000. M.J. Lage, G.J. Platt, and M. Treglia. Inverting the classroom: A gateway to creating an inclusive learning environment. The Journal of Economic Education, 31(1):30–43, 2000.

McLuhan 1962. McLuhan, Marshall. "The Guttenberg Galaxy." *The making of topografic man*(1962).

McNeil 1989. Barbara J. McNeil. A Meta-analysis of interactive video instruction: A 10 year review of achievement effects. PhD thesis, University of Idaho, 1989.

MIT 2016. MIT OpenCourseWare, 2016. URL http://ocw.mit.edu/about/our-history/

Stallman and Lessig 2010. R.M. Stallman and L. Lessig. Free Software, Free Society: Selected Essays of Richard M. Stallman. Free Software Foundation, 2010. ISBN 9780983159209. URL http://books.google.com/books?id=Rv9HewAACAAJ.

Strayer, 2012. Strayer, Jeremy F. "How learning in an inverted classroom influences cooperation, innovation and task orientation." *Learning Environments Research* 15.2 (2012): 171-193.

Techsmith, 2013. https://www.techsmith.com/education-flipped-classroom.html

Toto & Nguyn 2009. R. Toto and H. Nguyen. Flipping the work design in an industrial engineering course. In Frontiers in Education Conference, 2009. FIE 2009. 39th IEEE, pages 1–4. IEEE, 2009.

Udacity, 2016. URL https://www.udacity.com/

VanLehn 2011. Kurt VanLehn. The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. Educational Psychologist, 46(4):197–221, 2011.

Veen`, 2013. van Veen, Bart. "Flipping Signal-Processing Instruction [SP Education]."*Signal Processing Magazine, IEEE* 30.6 (2013): 145-150.

Zappe et al 2009. Sarah Zappe, Robert Lieicht, John Messner, Thomas Litzinger, and Hyeon Woo Lee. "Flipping" the classroom to explore active learning in a large undergraduate course. In Proceedings, American Society for Engineering Education Annual Conference & Exposition, 2009.

Zikmund, W. 2003. *Business Research Methods,* 7th ed. Thomson, South Western, Mason, OH

Zhang et al. 2006. D. Zhang, L. Zhou, R.O. Briggs, and J.F. Nunamaker. Instructional video in e-learning: Assessing the impact of interactive video on learning effectiveness. Information & Management, 43(1):15–27, 2006.