AC 2011-1126: WORK IN PROGRESS: ANALISYS OF MOBILE TECHNOLOGY IMPACT ON STEM BASED COURSES; SPECIFICALLY INTRODUCTION TO ENGINEERING IN THE ERA OF THE IPAD

Oscar Antonio Perez, The University of Texas at El Paso

Mr. Oscar Perez received his B.S. and Masters in Electrical Engineering from the University of Texas at El Paso with a special focus on data communications. He is currently pursuing a PhD in Electrical and Computer Engineering. Mr Perez has been teaching the Basic Engineering (BE) BE 1301 course for over 5 years. Lead the design for the development of the new BE course (now UNIV 1301) for engineering at UTEP: Engineering, Science and University Colleges. Developed over 5 new courses, including UTEP technology & society core curriculum classes specifically for incoming freshman with a STEM background. Mr. Perez has six years of professional experience working as an Electrical and Computer Engineer providing technical support to faculty and students utilizing Undergraduate learning center (UGLC) classrooms and auditoriums. Mr. Perez is committed to the highest level of service to provide an exceptional experience to all of the UGLC Instructors and students. Mr. Perez enjoys working on the professional development of the students' employees at the UGLC. He shares with his student employees his practical experience in using electrical engineering concepts and computer technologies to help in everyday real-world applications. Mr. Perez has worked with the UTeach program at UTEP since its creation to streamline the transition process for engineering students from local area high schools to college by equipping their teachers with teaching strategies and technologies each summer. Oscar enjoys teamwork, believes in education as a process for achieving life-long learning rather than as a purely academic pursuit. He currently works on maintaining, upgrading and designing new computer classroom systems. Mr. Perez is inspired because he enjoys working with people and technology in the same environment.

Virgilio Gonzalez, The University of Texas at El Paso

Undergraduate Program director in the University of Texas at El Paso ECE department.

Michael Thomas Pitcher, The University of Texas at El Paso
Peter Golding, The University of Texas at El Paso

Peter Golding is Associate Dean of Undergraduate Studies and Engineering Education Research at The University of Texas at El Paso. Contact: pgolding@utep.edu

Work in progress: Analysis of mobile technology impact on STEM based courses; specifically introduction to engineering in the era of the iPad

Abstract

This paper will demonstrate the impact on students' academic performance utilizing new technology (iPad) on a subset of course objectives within an Introduction to Engineering course - UNIV 1301. This paper inherently focuses on student perceived value and learning impact (comprehension of learning outcomes). An iPad was provided to students along with focused activities to gauge differences in comprehension of learning outcomes and student perceived value. Student perceived value was measured via a student attitude survey (Likert scale) prior to and after technology was implemented. For the assessment of comprehension assessment the following methodology was followed: both cohorts of student were taught the same way with the same technology tools up to the first semester exam to limit and account for the variance of the classes grades. Starting on week seven iPads were provided for the second cohort of students. Variances between the cohorts were again assessed on the second and again at the final class average. The results of this analysis show an increase in learning impact for exam II but show no change in the final class average. The results from the attitudinal survey show a very positive attitude towards the implementation of the iPad in the classroom and this yielded a very positive classroom environment.

Introduction

Throughout history there have been many attempts to incorporate different technologies in the classroom.[1] Some of these technologies have seen more success than others when looked at in comparisons.[2] The most commonly used classroom technologies are: PowerPoint, Computer, Chalk board, Web posting of Materials, Paper handouts, Transparencies, Laptops, Overhead projector, Classroom Computer, Online Course Management, White board, Online discussion groups, Document camera, Tablet PC, Streaming video, Clickers, VCR, Acrobat Connect, PDA.[3] However, the impact of one of the newest technologies available to the consumer and educational markets, the Apple iPad, has currently not been researched extensively as to its effects in the classroom. While there are several ongoing research efforts to measure the impact of the iPad in the classroom, most of them are focused on the K-12 environment exclusively. This presents a challenge, as currently no research exists within the engineering and science fields of first Year College students, whose demographics compare to those found at the University of Texas at El Paso (UTEP). This research specifically focused on the impact the "iPad" would have on a subset of objectives for a first year engineering class that portrait the university demographics.[4] This research will measure students' perceived value of using technology (specifically the iPad) inside and outside the classroom. This type of study has not been previously done given the demographics, content, and subject matter that are being focused on. Such research could yield important information into the engineering and engineering education fields. The possibility exists that such could increase the academic performance of incoming freshmen and it is hypothesized that such a study could discover the effect of a student's perceived value of the usage of new technology on academic performance.

The evolution of classroom technologies is variable and the rate at which they evolve changes from device to device. A key example of such is the board. Boards have been around for long

periods of time, then boards evolved into chalkboards, then into whiteboards, and then some of the functions of the boards were transferred to projectors and computers, thus creating smart boards.[3] Would the new generation of students perceive positively the impact of an iPad as a tool on their education? This new research used the iPad to merge some of the most used classroom technologies that were already implemented in the course into this mobile device. The previously used technologies were: PowerPoint, computers, online calendars, online notification systems, email, and Online Group discussions.

Materials and methods

The research was conducted on two UNIV 1301 Foundations of Engineering classes. The first class size was twenty-eight students and the second class size twenty-one students. These classes are part of a learning community. A learning community is a community of students that are enrolled in the same classes. In these specific learning communities all of the students were enrolled in Pre-calculus. All of the students in these classes are first semester freshmen and the class distribution represents the university demographics.[5] This was done to try to maintain most of the factors that influence student learning as constant and introduce the iPad as the only variable.

The materials used for this research were the following: twenty-one 16 gigabytes Apple iPads (Wi-Fi enabled only), the teaching material already used to teach the class. This teaching material for the class consists of: a group website in Microsoft SharePoint, a series of PowerPoint presentations, twenty one individual quizzes and fifteen team quizzes in text format, and several in class active learning activities focused in teamwork engineering problem solving.

The experiments conducted to analyze student perceived value and learning impact are detailed below. As an overview of the experiments this is how they were conducted. To find out the learning impact on students from the introduction of the iPad two classes were compared in academic performance. This was done after teaching the same material for both classes with the same weight for all of the components in the class. For the second experiment a pre-attitudinal and a post attitudinal survey were given to all of the students of the class that used the iPads.

UNIV 1301: Fundamentals of engineering class format

The UNIV 1301: Fundamentals of engineering class is a face to face class, it met for three hours a week and it is a three hour credit class. Attendance policy was enforced. This policy was a no more than three absences allowed. The grading areas of the class were the following: Homework, Quizzes & Projects, Exam I, Exam II, Final Exam, and Presentation. The material covered in the class focuses on these four areas equally: Basic engineering and science concepts, math applications, entering student life activities (focused on the engineering department), and engineering professions. The material of the class was divided into three segments of six weeks each. One examination was given at the end of segment 1 and segment 2. Finally after the last six weeks a final comprehensive exam was also given to all students.

Experiment 1 first six weeks

The first part of the experiment was to teach the two classes without the iPad for the first six weeks of the course and then compare their performance. This was done to generate a baseline of comprehension difference between the classes. At this point for simplicity the class where the

iPad was not used will be referred, as “class A”, and the class where the iPad was used will be referred as “class B”. The same test was given to both classes. The average of class A in exam one was 77.9 in a scale of 0 to 100. The average of class B in exam one was 74.8. Class A outperforms class B by 3.1 points on average.

Experiment 1 second six weeks

For the second six weeks all of the students in class B received one of the iPads with the above specifications while class A continued on in the course without iPad. Class B was now enabled to check the class site in the class and all places that Wi-Fi was available (95 percent of campus including all of the major buildings where the students take classes). After the second six weeks the average on exam 2 of class A was 59.7 and the average for class B was **62.2. Class B** outperforms **class A** by **2.5** points on average.

Experiment 1 final class grade

For the last six weeks all of the students in class B continued with the iPad. And class A continued on in the course without an iPad. After the last six weeks the average on the final grade of class A was 83.9 and the average for class B was **80.3. Class A** outperforms **class B** by **3.6** points on average on the final class grade.

Experiment 2 students perceived value

Three attitudinal surveys were administered during the length of the semester. A pre-attitudinal survey was conducted before any student knew there was a possibility to obtain an iPad for the rest of the semester. A second survey was administered at the 10 weeks mark. Finally a post-attitudinal survey was conducted after the semester was over. The surveyors were independent from the instructor and no feedback was given to the instructor at any point in time while the class was going on. The instructor was able to see the results after the class was finished and final grades were assigned to avoid any biasing from the instructor. After the class was over these three attitudinal surveys were analyzed and the result can be found in the results section.

Results

Below in Table 1 are the results of the class performance presented as a class average for each class on each of the areas to be graded. Figure 1 shows the percentage grade distribution of both classes of all three exams in an overlapping manner to facilitate the comparison.

Table 1. Average academic performance of two classes

Class areas	Class A	Class B	Difference from Class A
Exam I (no iPad for both classes)	77.93	74.79	-3.14
Exam II	59.7	62.2	+2.5
Final Class Grade	83.9	80.3	-3.6

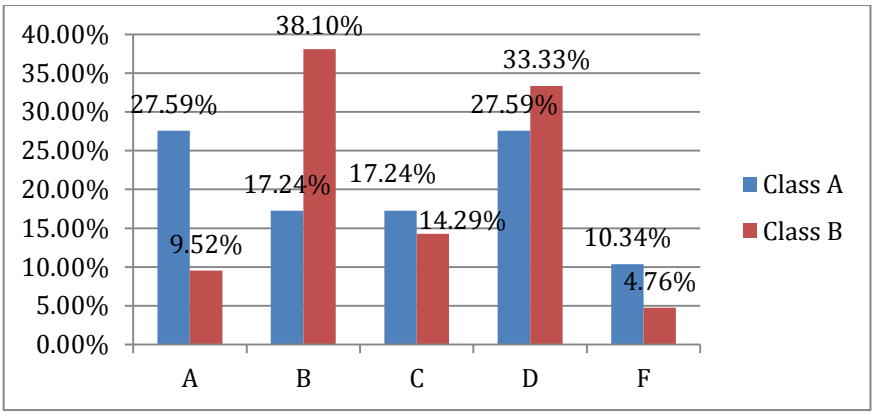

Figure 1. Exam 1 student percentage grade distribution comparison

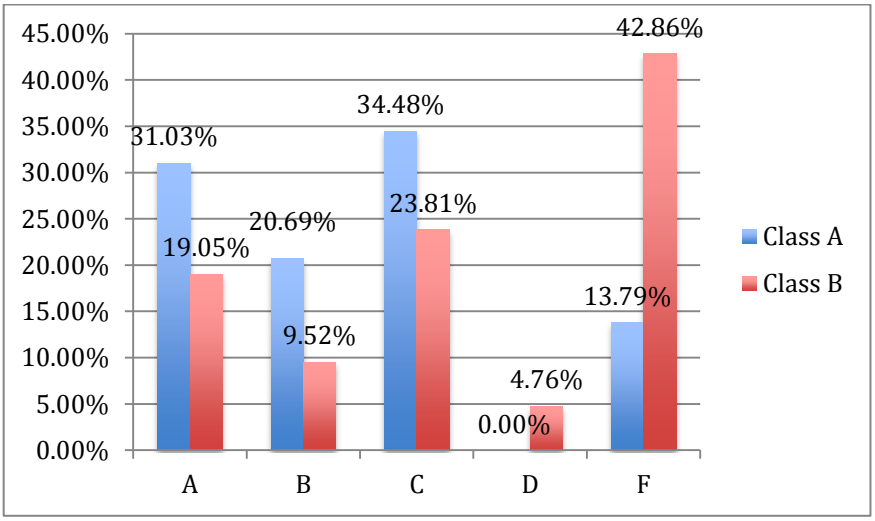

Figure 2. Exam 2 student percentage grade distribution comparison

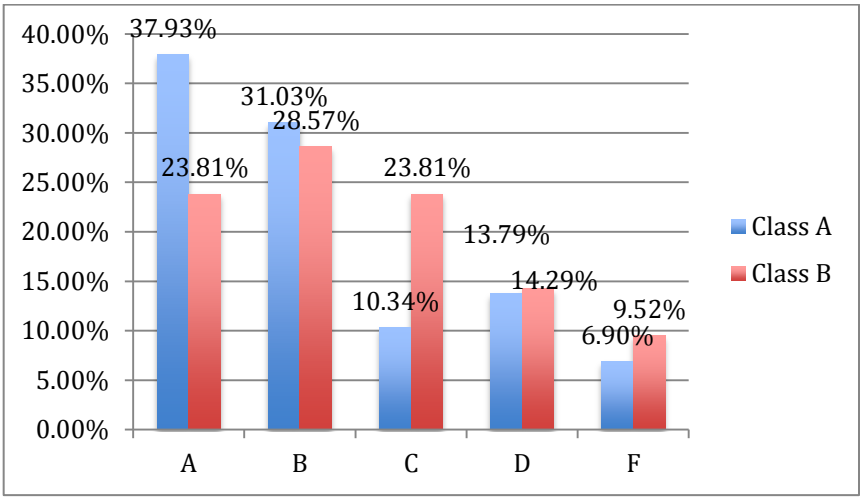

Figure 3. Final grade student percentage distribution comparison

Below in Table 2 and 3 show the pre and post attitudinal survey results. These results are discussed extensively in the discussion section as several important trends were discovered with this survey instrument.

Table 2. Pre/Post likert survey on factors of importance on learning

Question		Strongly agree with this statement		Somewhat agree with this statement		Somewhat disagree with the is statement		Strongly disagree with this statement	
Pre	Post								
Technology helps me understand concepts better:		36%	73%	64%	27%	0%	0%	0%	0%
If I was provided an iPad in this course I would use it regularly:		86%	80%	7%	20%	0%	0%	7%	0%
If we used iPads in this class; my instructor would expect more of me:		29%	40%	50%	33%	14%	27%	7%	0%
The internet is an important study tool:		79%	93%	21%	7%	0%	0%	0%	0%
I would rather have an eBook instead of a traditional textbook:		36%	60%	29%	20%	7%	13%	29%	7%
iPads are an important technology that should be used in the classroom:		14%	73%	57%	27%	14%	0%	14%	0%
Using an iPad in this course would change my expectations of it:		43%	47%	43%	53%	7%	0%	7%	0%
I would be more willing to take a course that:		14%	13%	7%	27%	79%	60%	0%	0%
Student computer labs are an important resource for me in this course:		36%	53%	50%	47%	14%	0%	0%	0%

Table 3. Pre/Post multiple-choice section of survey on factors of importance on learning

Question		Option 1		Option 2		Option 3		Option 4		Option 5	
When giving a class presentation I would prefer to:		Present verbally in front of the classroom without any type of media or presentation		Use a computer generated presentation (PowerPoint or similar)		A) Turn in a research paper instead					
Pre	Post	14	0	79	100	7	0				
If given an option to use technology in my class; I would choose to use:		A) Laptop		B) Desktop		C) iPad		D) Mobile Phone		E) Other technology	
Pre	Post	64	40	7	0	29	53	0	7	0	0
In my future career I expect to use technology:		On a daily basis		On a weekly basis		On a monthly basis		As often as I possibly can		Only when required of me	
Pre	Post	92	87	0	6	0	0	8	7	0	0
Using technology in the classroom is:		A) Very Important to me		B) Somewhat important to me		Not important to me		Prefer the instructor not use technology			
Pre	Post	57	93	29	7	7	0	7	0		
How important is it that your instructor have a good understanding of technology:		Very Important to me		Somewhat important to me		Not important to me					
Pre	Post	86	100	14	0	0	0				
I would be more willing to take a course that:		A) Was traditionally taught with lecture and textbooks		B) Was taught completely online		C) Was taught utilizing technology in the classroom on a daily basis					
Pre	Post	14	13	7	27	79	60				
Not considering cost of materials (books, computers, etc.) which course would you be more willing to take:		A) One that utilizes iPads on a daily basis in the classroom		B) One that utilizes laptops on a daily basis in the classroom		C) One that utilizes textbooks on a daily basis in the classroom		D) One that utilizes lecture and note taking on a daily basis in the classroom			
Pre	Post	43	40	50	53	0	0	7	7		

Which class would you expect to learn more from:		A) One that utilizes iPads on a daily basis in the classroom		B) One that utilizes laptops on a daily basis in the classroom		C) One that utilizes textbooks on a daily basis in the classroom		D) One that utilizes lecture and note taking on a daily basis in the classroom			
Pre	Post	14	33	71	53	0	7	14	7		
Which class would you expect to be the most expensive to take:		A) One that utilizes iPads on a daily basis in the classroom		B) One that utilizes laptops on a daily basis in the classroom		C) One that utilizes textbooks on a daily basis in the classroom		D) One that utilizes lecture and note taking on a daily basis in the classroom			
Pre	Post	50	47	29	40	14	13	7	0		
If the instructor knew nothing about technology which class would you be more likely to take:		A) One that utilizes iPads on a daily basis in the classroom		B) One that utilizes laptops on a daily basis in the classroom		C) One that utilizes textbooks on a daily basis in the classroom		D) One that utilizes lecture and note taking on a daily basis in the classroom			
Pre	Post	0	20	14	20	29	7	57	53		
Which instructor do you think is more knowledgeable in their content area:		A) One that utilizes iPads on a daily basis in the classroom		B) One that utilizes laptops on a daily basis in the classroom		C) One that utilizes textbooks on a daily basis in the classroom		D) One that utilizes lecture and note taking on a daily basis in the classroom			
Pre	Post	7	47	50	40	7	0	36	13		
In your personal life which describes you best:		I love new technologies and tinkering with them		I am interested in new technologies but take some time to learn them		My friends usually show me how to use new technologies		I try not to use new technologies until I am forced to do so			
Pre	Post	79	100	21	0	0	0	0	0		

Discussion

The first result up for discussion is the fact that class B in the first exam performed 3.14 points below class A. The framework for this exam was exactly the same for class A and class B. This implies that class B, if everything is maintained constant would probably perform 3 points below class A all the way until the end of the course. After looking at the rest of the results in Table 1 we can clearly see that class B has outperformed class A in exam II by 2.5 points. If the three-point starting difference (offset) were taken into account the difference for exam II would be around 5.5 points. This grade increase could be attributed to specific simple calculation topics where the iPad was used extensively such as: unit conversion, Area and volume calculations, speed, velocity distance and time calculations. The framework in which the iPad was used included several free applications already developed for the iPad by third party companies. Most

of these applications were downloaded by the students and used for the in class exercises and also for the homework. Unfortunately there are no free applications for all of the basic engineering types of problems used during the class and the most complex problems fall in the last third of the semester, the iPad was not used as heavily for the last third of the semester as for the second third that prepared the students for exam II. The results from Graphs I, II and III show that the distribution after implementing the iPad technology stayed for the most part constant and that the initial 3 percent difference was the same from class A leading class B at the final class average was still the same. This raises a future research question which is if apps where available for the content in exam III would class B continue to outperform class A by a margin of 2.5 points as seen in exam II?

More interesting results are found at the attitudinal surveys, since a high percentage of their answers changed from the pre to the post attitudinal survey after using the iPad. After analyzing the pre and post results of the attitudinal survey it can clearly be seen that students perception on technology and learning changed after the course. The percentage change on student's perception of the usage on technology usage increased in favor of using technology in the classroom in all categories as shown in tables 2 and 3. Analyzing the data of the pre and post survey we can see that "pro use of technology" in the classroom increased and was highly polarized on the fact that students prefer a class that uses technology and an instructor that is well versed in technology (A couple of results have been boxed in red to show this effect). After the course was over the students perceived that they have learned more because they used the iPad in the classroom and they felt that the instructor raised the expectations. Finally from the data on the pre survey it seems that a high percentage of students deem very important that technology is used in the classroom. Students believe that instructors that are well verse in the use of technology; specifically iPads and laptops are more knowledgeable in their content area. Finally from the attitudinal survey as a whole and after the class was over more students agreed with the statement "I love new technologies and tinkering with them". Finally from the day-to-day interaction with the students and from different conversations with them I found out that they were also using the iPad for all their other classes, and for different purposes such as time management and calendaring, online research, and campus life activities. More research needs to be done in terms of what impact student attitude has on the long term effects of student learning in STEM and whether such attitudinal changes have longer lasting impacts on student careers. If such findings reveal that student attitude is correlated to learning outcomes than the huge shifts in student attitude in regards utilizing technology in the classroom, iPads in this case, may very well make a convincing argument for technology implementation in STEM.

Conclusion

Finally this study was conducted in a framework that portraits UTEP demographics[5] in an entry level course in engineering and the even though the final class average was not affected by the usage of the iPad, the classroom environment was dramatically affected by the iPad in a positive manner. In conclusion from this study we can conclude that the class average was maintained 3 percent below from the class that did not use the iPad on the final class average as expected. And there is a strong argument that because the class B started 3 point below, the absolute impact is an increase on exam 2 was of 5.5 percent in comprehension of learning outcomes and not only 2.5 percent. This is attributed to the free applications that are available at this point to solve engineering applications that focus on the following topics: Unit Conversion,

Area and volume calculations, distance, time, velocity and speed calculations. Student's perceived value and learning impact of having used an iPad for the course was very positive. Most of the students seem to perceive learning more in a class that uses technology specifically with the iPad. In summary the use of the iPad maintained student's academic performance at the same level and there was a highly positive impact of student's perceived value of using an iPad in the classroom, which positively affected the classroom environment.

Future work

Future work on this early research should expand this experiment to replicate the framework used in preparation for the second exam in which there was an increase in the student grade on average. The challenge for this is that there are not currently iPad applications that are tailored for these engineering problems. The following areas are suggested for future iPad application development: Gravity calculations, vector operations, sum of forces, and acceleration problems. Another aspect that could affect student grades is the digitalization of the textbook and implementation on the platform of the iPad as an e-book. Other aspects could be the implementation of the iPad on higher-level classes, and measuring the effect of the iPad not only in the engineering class but as a whole in the student life; in example its effect in time management, note taking for all classes, online research, and student involvement in university life. A final area of work is the focus on how student attitude impacts student outcomes specifically in STEM related fields.

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