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A Three Year Longitudinal Study of Mobile Technology and Analysis of the Impact on STEM-Based Courses

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Mr. Oscar Perez received his B.S. and master's in Electrical Engineering from the University of Texas at El Paso with a special focus on data communications. He is currently pursuing a Ph.D. in Electrical and Computer Engineering. Mr Perez has been teaching the Basic Engineering (BE) – BE 1301 course for over six 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 five new courses, including UTEP technology and society core curriculum classes specifically for incoming freshman with a STEM background. Perez has eight years of professional experience working as an Electrical and Computer Engineer providing technical support to faculty and students utilizing UGLC classrooms and auditoriums. Perez is committed to the highest level of service to provide an exceptional experience to all of the UGLC guests. Perez strongly believes that by providing exceptional customer service that UGLC patrons will return to make use of the various services the university offers. 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. 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. Perez is inspired because he enjoys working with people and technology in the same environment.

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A THREE YEAR LONGITUDINAL STUDY OF MOBILE TECHNOLOGY AND ANALYSIS OF THE IMPACT ON STEM-BASED COURSE

We have progressively advanced student use of Apple iPads within introduction to engineering courses at The University of Texas at El Paso (UTEP). We report the findings of our analysis of three consecutive years of iPad use. The blossoming use of iPads and the pervasive student use of technology increase the pertinence of this study. K-12 and college classroom use of technology is increasing rapidly. These technological tools provide balance between cost, functionality and portability. This has caused a paradigm shift in the use of computing devices for mainstream course applications. Presently, we our analysis reflects the results from studying the impact of iPad use on students' academic performance. This has been achieved using a subset of course objectives for a first year introductory engineering course at UTEP. The inherent focus is 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. Student perceived value of using an iPad for a class was also measured, tested and re-evaluated within a learning environment featuring 21st century demographics for the science, technology, engineering, and mathematics fields (STEM). The effect of iPad inclusion in the STEM classrooms was focused on two key indicators: (1) academic impact and (2) student perceived value. Student perceived value was measured via a student attitudinal survey (Likert scale) and completed prior to and subsequent to iPad technology utilization and managed through an independent third-party testing entity. The perceived value pre-survey was done prior to students having knowledge that they were going to be receiving iPads for use in the 14-week course. The assessment for the comprehension component of the study focused on four cohorts of students. All cohorts of students were taught the same way from the commencement of the semester until the time of the first course exam. This was done to limit and account for the possible variance of class grades. At the beginning of week seven, iPads were then introduced and provided for the second, third and fourth cohort of students. The usage of the iPad in class assignments was focused on maximizing the impact of student learning on the following class areas: class assignments, homework, quizzes and exams. Variances between the cohorts were assessed as part of the second and third semester exams. Three years of results enabling longitudinal comparison are now possible. This research project has yielded data in a field that has not been previously explored within the associated demographic environment. The data gathered on the comprehension and student perceived value of iPad use in the classroom has been analyzed and very interesting results are presented within this paper. Continuous quality improvement of the instruments and use is included.

INTRODUCTION

Throughout history there have been many attempts to incorporate different technologies in the classroom.[1] When compared, some of these technologies have seen more success than others.[2] The most commonly used classroom technologies are: PowerPoint software, computers, chalkboards, web posting of materials, paper handouts, transparencies, laptops, overhead projectors, classroom computers, online course management programs, whiteboards, online discussion groups, document cameras, tablet PCs, streaming videos, clickers, VCRs, Acrobat Connect software, PDAs.[3] Currently, however, the impact and effects in the classroom of one of the newest technologies available to the consumer and educational markets, the Apple iPad, has not been extensively researched. 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 UTEP. This research specifically focuses on the impact the "iPad" has on a subset of objectives for a first year engineering class that represents 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 involved for three years in a row. This research provides important information for the engineering and engineering education fields. The possibility exists that the use of iPads in the classroom could increase the academic performance of incoming freshmen and this study measures the effect on student's perceived value of the usage of new technology on academic performance; specifically the iPad. This research also shows the trends on students' grades and student perceived value on the tools used to engage in learning.

The evolution of classroom technology 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 a long time and have 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 positively perceive the impact of an iPad as a beneficial tool for their education? This research used the iPad to merge some of the most commonly used classroom technologies that were already implemented in the course into this mobile device. The previously used technologies were: PowerPoint and Keynote software, computers, online calendars, online notification systems, email, and online group discussions. Will the impact of the iPad on the classroom outweigh its cost in this framework? This is one of our primary questions.

MATERIALS AND METHODS

This research has been on-going for three years as part of the UNIV 1301 Foundations of Engineering classes and taught by the same instructor. The classes participating in this research consisted of similar enrollment numbers. The first class consisted of twenty-eight students; the second class had twenty-two students, the third class twenty-six students, and the fourth class twenty-four students. These classes are part of a learning community. A learning community is a group of students that are enrolled in the same classes with the same instructors. In these specific learning communities all of the students were enrolled in the following classes: Fundamentals of Engineering, Pre-calculus, History, and Political Science. All of the students in these classes are

first semester freshmen and the class distribution represents the university demographics[5]. This reduced outside factors that influence student learning and allow the iPad as the only variable.

The materials used for this research consisted of the Apple iPads (16 GB, Wi-Fi enabled only) and the teaching material already used to teach the class. The teaching materials for the class consists of a group websites created using 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 engineering teamwork 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. Academic learning performance in four classes was compared to determine the learning impact on students when the iPad was introduced. This was done after teaching the same material to all classes with the same weight for all of the components of the class. For the second experiment, a pre-attitudinal and a post-attitudinal survey were given to all of the students of the classes that used the iPads. This same procedure has been followed now for the third year.

UNIV 1301: Fundamentals of Engineering Class format

UNIV 1301: Fundamentals of Engineering is a face-to-face class that meets for three hours per week and it is a 3-hour credit class. An attendance policy was enforced, which allows no more than three absences for the entire semester. The grading areas of the class were the following: homework, quizzes & projects, exam I, exam II, final exam, and a student presentation. The material covered in the class focuses on these four areas equally: basic engineering and science concepts, math applications in engineering, entering student life activities (focused on the engineering department), and engineering professions. The material of the class was divided into 3 segments of six weeks each. An 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.

Class Content research in the first six weeks

The first part of the experiment was to teach the four classes without the iPad for the first six weeks of the course and then compare their performance. This was done to generate a baseline for the differences in comprehension of content between the classes. At this point, for simplicity, the 2010 class where the iPad was not used will be referred to as “class A”, the class where the iPad was used during 2010 will be referred to as “class B”, the class where the iPad was used during 2011 will be referred to as “class C” and the class where the iPad was used during 2012 will be referred to as “class D”. The same test was given to all the classes. As a precautionary measure to prevent students from passing-on exams from one year to the next, students were not allowed to keep their exams and question order was varied. The exam used a grading scale of 0 to 100. The average of class A in exam one was 77.9. The average of class B in exam one was 74.8. The average of class C in exam one was 82.8. The average of class D in exam one was 81.6; class A outperforms class B by 3.1 points on average, class C outperformed Class A by 4.9 points and Class B by 8 points. Class D outperformed Class A by 4.7 points. All of these results are shown in Table 1.

Class Content research on the second six weeks

For the second six weeks all of the students in classes B, C, and D received an iPad and class A continued on in the course without an iPad. Class B, class C, and class D were now able to check the class website both during class and all locations where Wi-Fi was available (95 percent of campus including all of the major buildings where the students take classes). Students used the class website to download class materials and upload assignments among other things. After the second six weeks the **average on exam 2 of class A was 59.7; the average for class B was 62.2, the average for class C was 72.7 and the average for class D was 69.4. Class D outperformed class A by 9.7 points, Class C outperformed class A by 13 points, and class B by 10.5 points on average**.

Class Content research on the final Class Grade

For the last six weeks all of the students in class B, class C, and class D continued with the iPad and class A continued the course without the iPad. After the last six weeks the average on the final grade of class A was **83.9**, the average for class B was **80.3**, the average for class C was **80.6**, and the average for class D was **82.6**. **Class A** outperforms **class B** by **3.6** points **(.3 points taking into account the initial baseline), class C by 3.3** points **(8.2 points taking into account the initial baseline), and class C by 1.3** points **(6 points taking into account the initial baseline)** on average on the final class grade.

Experiment 2 - Student perceived value

Two attitudinal surveys were administered during the length of the semester to each of the classes using iPads. A pre-attitudinal survey was conducted before any mention of iPad use within the classroom was discussed and before equipment was distributed. A second survey was administered at the 16-week mark (end of the semester). The survey administrators 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 course concluded at the end of the semester and final grades were submitted to avoid any biasing from the instructor. After the class was over these two attitudinal surveys were analyzed and the results can be found in the results section below.

RESULTS

Below in Table 1 are the results of the class performance presented as an average for each class on each of the exams administered during the semester, along with the final course average. Figures 1, 2 and 3 show the grade distribution of the courses on all three exams in an overlapping manner to facilitate the comparison.

Class areas	Class A	Class B	Class C	Class D	Difference from Class A
Exam I (no iPad for all classes)	77.93	74.79	82.83	81.58	-3.14, +4.9, +3.65
Exam II	59.7	62.2	72.75	69.42	+2.5, +13.05, +9.72
Final Class Grade	83.9	80.3	80.55	82.66	-3.6, -3.35, -1.24

Table 1. Average academic performance of the four classes

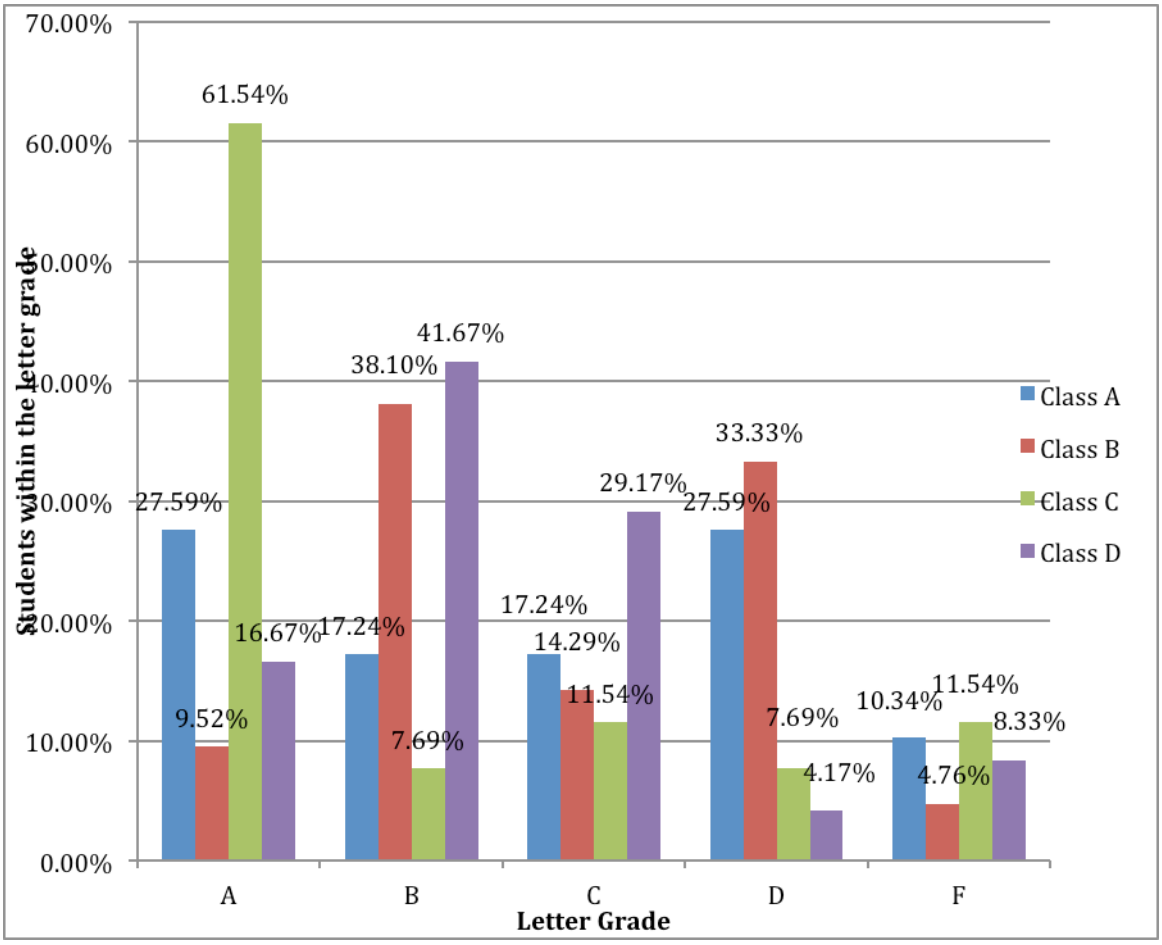

Figure 1. Exam 1 student percentage grade distribution comparison

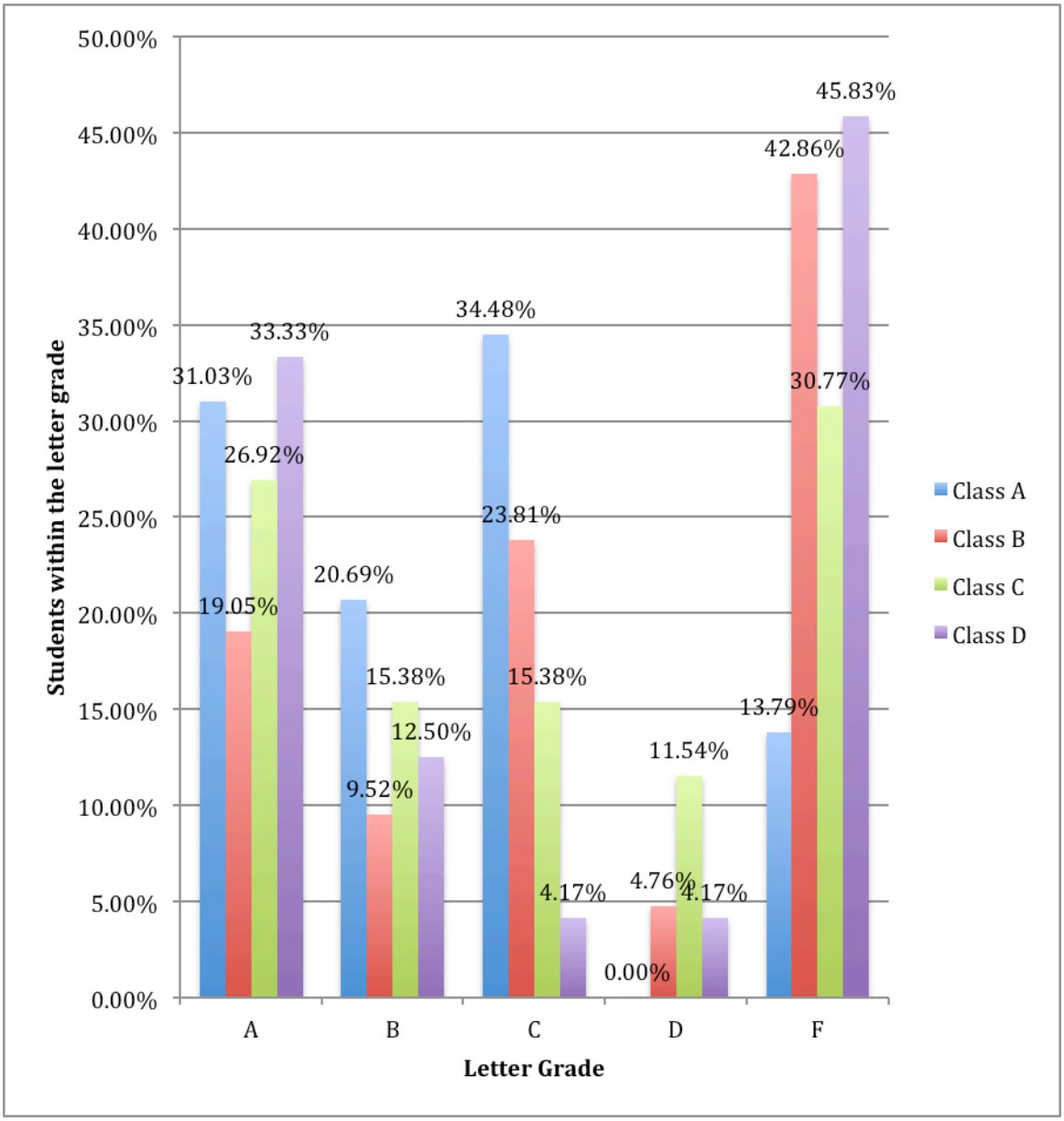

Figure 2. Exam 2 student percentage grade distribution comparison

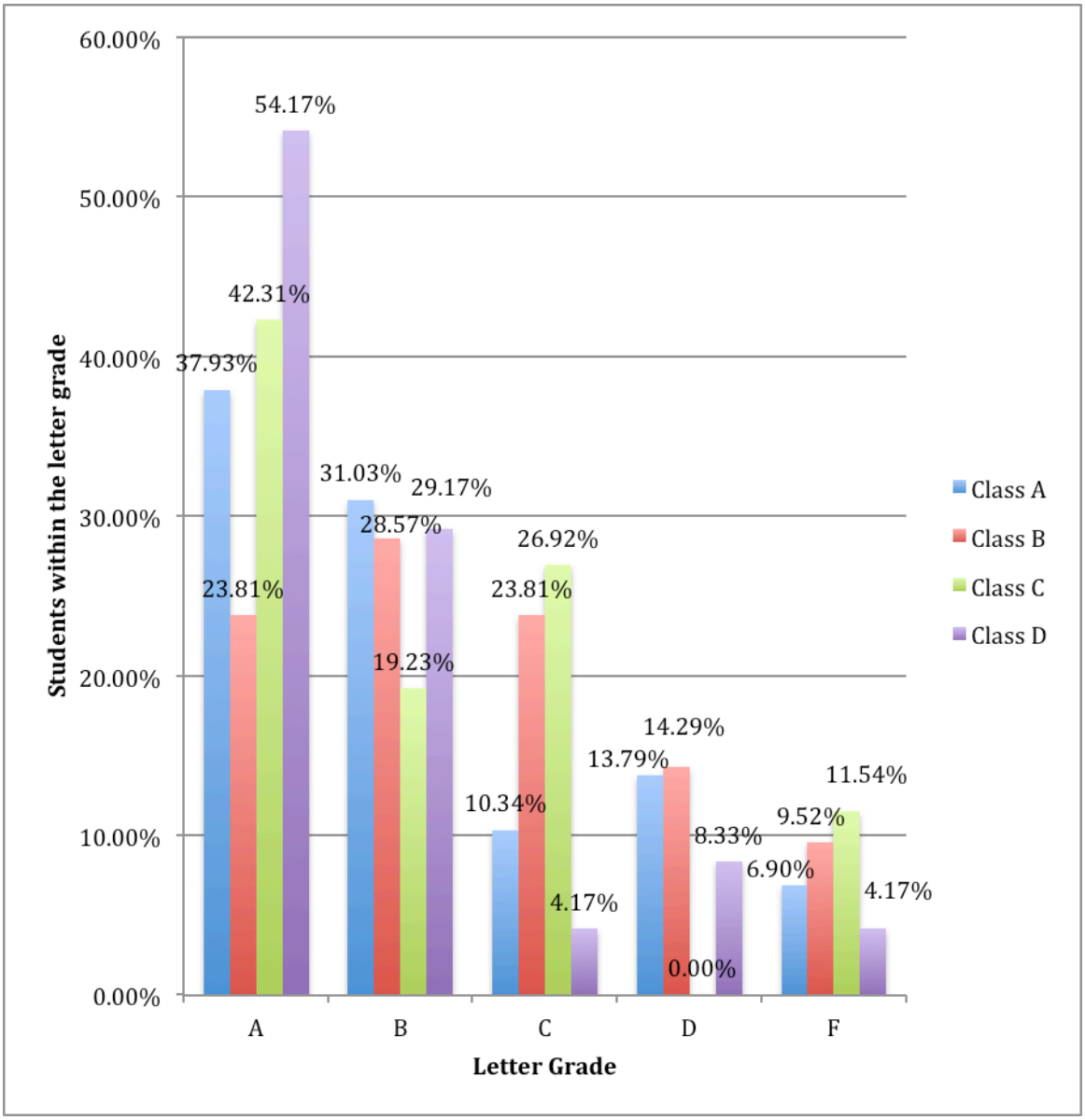

Figure 3. Final grade student percentage distribution comparison

Below tables 2, 3 and 4 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.

	Year 1		Year 2		Year 3		Year 1		Year 2		Year 3		Year 1		Year 2		Year 3		Year 1		Year 2		Year 3	
Question	Strongly agree with this statement						Somewhat agree with this statement						Somewhat disagree with the is statement						Strongly disagree with this statement					
Pre / Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Technology helps me understand concepts better:	36%	73%	74%	71%	54%	65%	64%	27%	26%	25%	42%	35%	0%	0%	0%	4%	4%	0%	0%	0%	0%	0%	0%	0%
If I was provided an iPad in this course I would use it regularly:	86%	80%	72%	71%	58%	78%	7%	20%	18%	25%	29%	9%	0%	0%	0%	0%	8%	13%	7%	0%	10%	4%	4%	0%
If we used iPads in this class; my instructor would expect more of me:	29%	40%	62%	42%	38%	48%	50%	33%	30%	33%	33%	39%	14%	27%	4%	17%	21%	13%	7%	0%	4%	8%	8%	0%
The internet is an important study tool:	79%	93%	89%	82%	83%	74%	21%	7%	11%	15%	17%	17%	0%	0%	0%	3%	0%	9%	0%	0%	0%	0%	0%	0%
I would rather have an Ebook instead of a traditional textbook:	36%	60%	48%	50%	50%	62%	29%	20%	30%	25%	17%	4%	7%	13%	13%	13%	8%	17%	28%	7%	9%	12%	25%	17%
iPads are an important technology that should be used in the classroom:	14%	73%	35%	63%	39%	57%	58%	27%	52%	25%	34%	26%	14%	0%	9%	8%	14%	17%	14%	0%	4%	4%	14%	0%
Using an iPad in this course would change my expectations of it:	43%	47%	52%	71%	46%	65%	43%	53%	35%	17%	29%	26%	7%	0%	9%	8%	17%	9%	7%	0%	4%	4%	8%	0%
Student computer labs are an important resource for me in this course:	36%	53%	87%	67%	75%	65%	50%	47%	5%	29%	17%	26%	14%	0%	4%	4%	8%	9%	0%	0%	4%	0%	0%	0%
	Was traditionally taught with lecture and textbooks						was taught completetly online						Was taught utilizing technology in the classroom on a dayly basis											
I would be more willing to take a course that:	14%	13%	31%	33%	25%	48%	7%	27%	4%	0%	13%	4%	79%	60%	65%	67%	63%	48%						

Table 2. Pre Likert survey on factors of importance on learning

	Year 1		Year 2		Year 3		Year 1		Year 2		Year 3		Year 1		Year 2		Year 3		Year 1		Year 2		Year 3	
Question	Option 1						Option 2						Option 3						Option 4					
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 similiar)						A) Turn in a research paper instead											
Pre / Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post						
	14%	0%	13%	13%	29%	17%	79%	100%	61%	75%	54%	78%	7%	0%	26%	13%	17%	4%						
If given an option to use technology in my class; I would choose to use:	A) Laptop						B) Desktop						C) iPad						D)Mobile Phone					
Pre / Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	64%	40%	48%	42%	71%	52%	7%	0%	26%	13%	4%	0%	29%	53%	26%	46%	17%	48%	0%	7%	0%	0%	4%	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					
Pre / Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	92%	87%	83%	79%	71%	78%	0%	6%	9%	13%	4%	13%	0%	0%	0%	0%	0%	0%	8%	7%	9%	4%	17%	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	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	57%	93%	70%	70%	63%	57%	29%	7%	26%	26%	25%	26%	7%	0%	4%	4%	13%	17%	7%	0%	0%	0%	0%	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	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post						
	86%	100%	91%	78%	92%	83%	14%	0%	9%	22%	8%	17%	0%	0%	0%	0%	0%	0%						
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	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	43%	40%	48%	50%	46%	57%	50%	53%	39%	42%	48%	26%	0%	0%	4%	8%	13%	0%	7%	7%	9%	0%	4%	17%

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

Pre	Post	43%	40%	48%	50%	46%	57%	50%	53%	39%	42%	48%	26%	0%	0%	4%	8%	13%	0%	7%	7%	9%	0%	4%	17%
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%	39%	50%	38%	52%	71%	53%	43%	38%	25%	30%	0%	7%	4%	13%	13%	0%	14%	7%	13%	0%	25%	17%
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%	35%	58%	50%	48%	29%	40%	43%	25%	38%	26%	14%	13%	17%	13%	13%	22%	7%	0%	4%	4%	0%	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%	17%	25%	17%	35%	14%	20%	30%	13%	17%	13%	29%	7%	26%	29%	25%	22%	57%	53%	26%	33%	41%	30%
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%	35%	33%	21%	52%	50%	40%	39%	38%	46%	26%	7%	0%	4%	13%	8%	0%	36%	13%	22%	17%	25%	22%
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%	70%	75%	63%	83%	21%	0%	26%	17%	33%	13%	0%	0%	4%	0%	0%	0%	0%	0%	0%	8%	4%	4%

Table 4. Pre/Post multiple-choice section of survey on factors of importance on learning (percent)

DISCUSSION

The first result up for discussion is the fact that class B in the first exam performed 3.14 (three) points **below** class A, class C performed 4.9 (five) points **better** than class A, and class D performed 3.6 (four) points **better** than class A. The framework for this exam was exactly the same for class A, class B, class C, and class D. This fact implies that class B and class A, if everything is maintained constant, would probably perform three points below class A; class C would perform five points above class A; and class D would perform four points above class A. 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, class C outperforms class A by 13.05 points, and class D outperforms class A by 9.72 points. If the three-point, five-point and four-point difference without technology were taken into account, this difference for exam II would be around **5.5 improvement points** for the first year, **8.6 improvement points** for the second year, and **6 improvement points** for the third year of the research. This could be attributed to specific topics where the iPad was used extensively during the second six weeks such as: unit conversion, area and volume calculations, speed, velocity distance and time calculations that were tested during exam II. Figures 1, 2 and 3 describe the student percentage distribution of exams I, II, and the final grade. These results 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 during the first year. Interestingly, in class C the percentage of students scoring less than 70 decreased dramatically by 9.15%. Another interesting fact for class C is that the final grade average was lower than expected by 8.25 points. Class D shows a similar behavior

as class C. The results on the last exam do not show an increase in academic performance. This could be attributed to the facts that the last six weeks consist of activities were the students have the option to use or not use the ipad to do the section problems, and the usage of the ipad is not as closely tied to the content as in the second exam.

After analyzing the pre- and post- results of the attitudinal survey for the first and second years it can clearly be seen that the students' perception of technology and learning changed after the course. The percentage change on student's perception of the usage of technology in the classroom increased in all categories as shown in tables 2 and 3 for the first year of the research. 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 the first year. During the second year this fact also holds true but it is not as polarized. From this attitudinal survey we can assume a high level of comfort from the student while using the iPad. This three-year longitudinal analysis also demonstrates the fact that students prefer a class that uses technology and an instructor that is well versed in technology. After the course was over the students in year-one, year-two, and year three perceived that they have learned more because they used the iPad in the classroom. Finally, from the data on the pre-survey it seems that a high percentage of students deem use of technology in the classroom very important. During these three years of researching this topic it is clear that the majority of students believe that instructors that are well versed 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". Comments like the previous one by students come from the fact that they got to use the iPad 1 in several exercises with a learning outcome in mind. An example of this was the usage of the application "Angry Birds" to explain force, mass, angle and trajectory, initial speed, and final speed. From this analysis we can determine that new technologies can be used to engage student in learning and that students like the usage of technology in their coursework and prefer courses that use cutting-edge technologies in the classroom. Additionally, we would like to note the possible influence of the Hawthorne Effect[6]. While every measure was taken to exclude the students from direct measurement to their knowledge, there is no precise way to remove the possibilities of this effect from any active learning exercise, as they require constant feedback as part of their nature. However we may have stumbled upon an equally important effect related to the use of new technology in the classroom, as it may create an effect similar to the Hawthorne effect in that by using a cutting edge technology students see themselves as early adopters and trendsetters.

CONCLUSION

Finally, this study was conducted in a framework that represents UTEP demographics in an entry-level course in engineering. From this study we can conclude that the class average increased and was maintained 3, 5, and 4 percent, respectively, from the class that did not use the iPad on the final class average of the first year of the ongoing research. For year two and three of the research, the increase on the exam II grade average was higher than during the first year. The material for exam II is where the iPad capabilities and software are at par with the content covered. A strong argument can be made that because class B started 3 points below class A, the absolute impact is an increase on exam 2 of 5.5 points for class B, 8.15 points for class C, and 6 points for class D in comprehension of learning outcomes. This is attributed to the applications that were used to solve

engineering problems that focused on the following topics: unit conversion, area and volume calculations, distance, time, velocity, and speed calculations. Students' perceived value and learning impact of having used an iPad for the course was very positive for the three years of the ongoing research. Most of the students seem to perceive that there was more learning in a class that uses technology. In summary, the use of the iPad increase student's academic performance when it's use was closely tied to the class content. For the most part 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

More work needs to be done on the lasting impacts of the concepts taught during Exam 2 (i.e. does the perceived value of an iPad on specific course objectives substantially impact content retention of those concepts later in the student's academic career?) As we progress into the fourth year of this ongoing research, some of the questions to be addressed include: does engaging a student with technology on a difficult learning objective give them better mastery of that content area later in the academic career; how does changing the perceived value of a course with technology, impact the long-term perception of students value of essential learning objectives and their performance and mastery of them throughout their career; does exciting students early on with technology increase the chances of them graduating due to positive first semester engagements with the content; does mobility of content and dynamic classroom technology increase course objective retention and problem solving abilities?

Further research and study on the perceived discovery that by using new technologies in the classrooms students view themselves as early adopters and trendsetters, subsequently makes technology a motivator for success. A key area is how such technologies impact students on the margins of passing and not passing the class, both short and long term. This research needs to focus specifically on whether such an effect exists and how it relates to the Hawthorne effect but is substantially different in nature as its key motivator is the usage of new technology and not participant observation.

Future work planned for this ongoing research should expand to the following areas: 1) development of an iBook for the iPad on the more complex engineering topics to increase classroom performance as shown from the Exam II results, 2) the digitalization of the course textbook and implementation on the iPad platform which could greatly impact the study habits of the students, and 3) the implementation of the iPad in higher-level engineering classes.

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