Exploring the Impact of iPads in Teaching Introductory Physics Courses at UAEU

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Abstract
One of the vital challenges in teaching introductory physics courses is making the students able to apply the basic physics concepts to solve real world problems. Mobile technology such as iPads might offer students an opportunity to improve their class engagement and apply physics concepts to a broad range of problems. This study investigates the impact of iPad usage in teaching introductory physics courses at United Arab Emirates University (UAEU). Four first year physics sections were selected to apply this study. Two have used iPads to view their lecture notes, taking online quizzes, online homework, accessing few interactive apps. The other two sections have used the traditional PowerPoint presentations. This study comes at a time when educators are questioning whether iPads should play a greater role in education, and particularly, in students learning. The results shows that the performance of the students enrolled in iPad sections have made a slight progress in their learning objective.

Keywords: e-learning, interactive learning, physics, teaching with iPad, UAE

Introduction

The retrogressive of students' performance in introductory physics courses is known to be a global issue (William, 1990). Improving students learning attracted the interest of physics educators for many years. It requires efforts on many fronts. One part of a solution involves helping students to improve their learning through the use of effective learning techniques. Hestenes, Wells, and Swackhamer (1992) have used the Force Concept Inventory instrument which provides a clear, detailed picture of the problem of commonsense misconceptions in introductory physic. Mazur (1997), and Benkraouda, Madi, Abada, and Qamhieh (2013) showed that a collaborative teaching and peer instruction method of teaching (PIMT), increases the level of understanding of the course material substantially.

Ausserhofer (1999) showed that the industrial revolution and the advances in computer technology allow transforming the method of instruction to a web-based one. The effectiveness of a Web-based teaching method on students' learning provides a new pattern of research, and it is widely used in higher education for delivering the material and assessing students' learning what so called e-learning.

Georgives, Smrikarov, and Georgive (2005) pointed out that the mobile education became more popular and accessible worldwide. Today there is a big variety of solutions for such systems, it can be conducted through (pocket size computers, cell phones, smart phones, notebooks or tablet PCs).

In United Arab Emirates University (UAEU), the use of new technologies such as laptop projects and blackboard course managing system has an impact on learning. Benkraouda (2006) showed that combining a method of teaching with technology helps students retain their interest and attention, which stimulate students for more participation, and emphasizes different learning styles. The students' homework performance using a web-based testing system and paper-based in introductory physics courses have been assessed. The result showed that students' perceptions about the web-based homework system were positive, and it suggests that students were motivated to complete more homework using the web-based method.

Angie, Jennifer, and Cindy (2009) and Hodge and Demirci (2010) have studied the effect of web-based assessment on student achievements in conceptual tests, exams, and homework assignments. It is found that the web-based homework scores were higher than that of the paper homework. Experiments carried out to evaluate the trustworthiness of the web-based computer homework showed a relatively strong correlation with student's scores in the final exams and the traditional written tests (Qamhieh et. al., (2013).

Recently a new medium (Mastering Physics) of learning is evolving which has been demonstrated to have a positive impact on teaching and learning. Mastering Physics facilitates the transfer of problem-solving skills through tutorial problems. It is supported by a student's helping system in the form of requestable hints, descriptive text, and feedback. MyLab and Mastering Science and Engineering: Data supported evidence of Mastering's positive impact on teaching and learning, Edited by Michelle and Speckler, Pearson publisher, (2014).

The use of blackboard, mastering physics and other similar packages requires students to have access to personal computers or laptops. Recently, advances in technology provide teachers and students with a more friendly and easily used mobile tools such as mobile phone, iPad, iPod, Portable PlayStation, etc. The mobile-learning tools facilitate the emerging applications from Apple- and Play- store like iTunes, iBooks, nearpod,…etc. suitable for the teaching and learning process.

Recently, the iPad has been implemented in teaching several Science and Engineering courses at the UAE-University. Al-Refai, Alshannag, and Syam (2014) found a positive impact of tablets (i.e. iPads) on student learning mathematical concepts in calculus I for Engineers.

In this paper, we investigated the impact of iPad usage in teaching introductory physics courses at United Arab Emirates University to offer researched-based data driven to assess part of our experience in mobile learning and using tablets in tertiary learning . In particular, this study aimed to answer the following research question: How iPads impact students' learning of basic physical concepts in introductory physics courses?

Methodology

Participants:
We chose to test the feasibility of using iPad in teaching introductory physics course by conducting a small pilot study in the spring 2013. Four sections from the Physics and Engineering Applications I course have been selected for this study. This course is offered for the first year students enrolled in the college of engineering. As mentioned in table1, 33 students (12 male, 21 female) were assigned randomly to the experimental group and 25 female students to the control group, the total number of students participated in this study was 58 students. All experimental group students were having iPads, and the smaller class size ensured that we would be able to give each student individual attention if they experienced problems with their device, while control group students studied the course on the regular way.

Table 1. Distribution of Study Sample according to group and gender

Group	Control		Experimental		Total	
Gender	Male	Female	Male	Female	Male	Female
	0	25	12	21	12	46
Total	25		33		58	

The course was being taught for 16 weeks with two lectures per week. The lecture's period was 75 minutes. The course aims at developing a clear understanding of the basic physics concepts in mechanics. It includes: vectors, kinematics, Newton's laws of motion, work and energy, linear momentum and collision, angular momentum, rotational motion about an axis.

Our efforts to utilize the iPad were focused on three ways. First, we sought methods that would integrate the use of the iPad into the academic components of the course.

Second, we also focused on methods of using mobile device in solving the course's assignments outside the classroom anywhere, anytime. Third, was using the mobile devices to encourage and enhanced communication and interaction among students.

The course content were designed and created as iBooks for 10 chapters that cover the whole course materials. Each iBook contained the lecture note, interactive questions and videos. We had created 22 iBooks in order to minimize the size of each iBook to be easily downloaded and viewed by the students on their iPads. These iBooks were posted on Blackboard (Course Management Learning System) to be downloaded by the students on their iPads. The students had access to course materials and they can study it anywhere at any time.

The course assignments (homework and quizzes) were conducted online outside the classroom by using a web-based tutorial system called mastering physics provided by Pearson publisher. Students were asked to work out an online homework and quiz at the end of each chapter. The assignment allows students to practice conceptual, problem solving and critical thinking questions related to the basic physics concepts covered during the lectures. The homework includes end of chapter problems and the quiz includes multiple choice questions. When a student login to the assignment site, he/she will find several questions that were carefully selected by the course instructor from the mastering physics tutoring system.

Questions were selected from the end of each chapter, test bank, and tutorial problems. The students were asked to complete the homework and quiz assignments outside the classroom and they can use the textbook or any other reference, since this activity was assessment for learning which based on thinking rather than memorizing. They might interact with each other; therefore, the learning process of individual student is affected. It is reported that plagiarisms is a very serious problem and it is the form of academic dishonesty. Therefore, assignment options and features in mastering physics allow restrictions in order to minimize students' plagiarism. In this work several restrictions were implemented:

1. Limit the due date for submitting their assignments; about 4-5 days' were given for students to complete an online homework.
2. Questions appear for students one at a time.
3. The variables of a question were randomized.
4. Quiz is given time limit of 45 minutes to solve 10 multiple choice questions. The 10 questions are randomly chosen by the system from a poll of 30-40 questions.

Moreover, a free app from apple store called Nearpod is used to assess the students' learning inside the classroom. Several (4-5) conceptual questions were selected by the instructor and posted on Nearpod. The students can access these questions using a password given by the instructor to solve them online. The app displays the statistics immediately showing how many students have solved the questions correctly. This method helps the instructor to assess the leaning outcomes of that particular chapter. Finally, students are advised to access few free apps available at apple stores and iTunes U related to the course contents.

Instrument

All students took the pre and the post tests that consisted of two parts: 11 multiple choice questions within the domains of knowledge and comprehension according to Bloom's Taxonomy and 3 problem solving questions as an open ended questions. To guarantee instrument validity, the test was reviewed by 5 experts from physics department and science educators from Curriculum and Instruction Department. The test was modified according to their notes. The instrument reliability was guaranteed by calculating the Cronbach's alpha coefficients for the instrument overall and the two domains: knowledge and comprehension, and problem solving. These values were (0.82, 0.83, 0.79).

Study Design:

Researchers used the quasi experimental design of the form:

$$O_1 \; - \; X - \; O_2$$
$$O_1 \; - \quad\quad - \; O_2$$

Results

Total Score:

Table 2 shows the mean (M) and standard deviation (SD) for the total score of control and experimental groups on the pre and posttests. The mean and standard deviation of the control group on the pretest was higher than the experimental group (0.40, 0.18; 0.36, 0.17). While the opposite was on the posttest (0.70, 0.18; 0.78, 0.22).

Table 2. Means and standard deviations of the total score results for control and experimental groups on the pre and posttests

Group	Pre test		Post test	
	M	SD	M	SD
Control	0.40	0.18	0.70	0.18
Experimental	0.36	0.16	0.78	0.22
Total Score	0.38	0.17	0.75	0.20

To test these differences ANCOVA test was conducted as shown in table 3, this table shows that none of these differences was significant except for the pretest.

Table 3. ANCOVA results between control and experimental groups on the total score

Source of Variance	Sum Squares	df	Mean Squares	f	P
Pre	0.34	1	0.34	9.24	*0.00
Group	0.06	1	0.06	0.15	0.70
Pre*Group	0.08	1	0.08	0.22	0.64
Error	2.02	54	0.034		
Total	35.37	57			

Table 4 shows that the adjusted mean of experimental group was greater than the adjusted mean of control group by (0.1) after eliminating the effect of pretest.

Table 4. Adjusted means according to total score

Group	Adjusted Mean	Standard Error	Number
Control	0.70	0.04	25
Experimental	0.80	0.03	33

Knowledge & Comprehension Domain (KCD):

Table 5 shows the mean (M) and standard deviation (SD) for the achievement of control and experimental groups on the pre and posttests on the KCD. The mean and standard deviation of the control group on the pretest was higher than the experimental group (0.54, 0.21; 0.51, 0.19). While the opposite was on the posttest (0.75, 0.15; 0.80, 0.16).

Table 5. Means and standard deviations results for control and experimental groups on the pre and posttests according to KCD

Group	Pre test		Post test	
	M	SD	M	SD
Control	0.54	0.21	0.75	0.15
Experimental	0.51	0.19	0.80	0.16

To test these differences ANCOVA test was conducted as shown in table 6, this table shows that none of these differences was significant except for the pretest.

Table 6. ANCOVA results between control and experimental groups on the KCD score

Source of Variance	Sum Squares	df	Mean Squares	f	P
Pre	0.10	1	0.10	4.13	*0.04
Group	0.01	1	0.01	0.03	0.86
Pre*Group	0.01	1	0.01	0.46	0.50
Error	1.30	54	0.024		
Total	36.81	57			

Table 7 shows that the adjusted mean of experimental group was greater than the adjusted mean of control group by (0.05) after eliminating the effect of pretest on the KCD.

Table 7. Adjusted means according to the KCD score

Group	Adjusted Mean	Standard Error	Number
Control	0.75	0.03	25
Experimental	0.80	0.03	33

Problem Solving Domain (PSD)

Table 8 shows the mean (M) and standard deviation (SD) for the achievement of control and experimental groups on the pre and posttests on the PSD. The mean and standard deviation of the control group on the pretest was higher than the experimental group (0.13, 0.23; 0.10, 0.21). While the opposite was on the mean score on the posttest (0.81, 0.45; 0.94, 0.41).

Table 8. Means and standard deviations results for control and experimental groups on the pre and posttests according to PSD

Group	Pre test		Post test	
	M	SD	M	SD
Control	0.13	0.23	0.81	0.45
Experimental	0.10	0.21	0.94	0.41

To test these differences ANCOVA test was conducted as shown in table 9, this table shows that none of these differences was significant except for the pretest.

Table 9. ANCOVA results between control and experimental groups on the PSD score

Source of Variance	Sum Squares	df	Mean Squares	f	P
Pre	1.50	1	1.50	9.15	*0.00
Group	0.51	1	0.51	3.10	0.08
Pre*Group	0.15	1	0.15	0.91	0.34
Error	8.82	54	0.16		
Total	56.72	57			

Table 10 shows that the adjusted mean of experimental group was greater than the adjusted mean of control group by (0.16) after eliminating the effect of pretest on the PSD.

Table 10. Adjusted means according to the PSD score

Group	Adjusted Mean	Standard Error	Number
Control	0.80	0.08	25
Experimental	0.96	0.07	33

Discussion

The results showed that the performance of the students enrolled in iPad sections have made a slight progress in their learning objective. These results came out as an assessment to students' achievement on the pre and posttest. However, Fluharty, Wood, and Hiebsch (2014) mentioned that there are many ways to measure success, for example, academic quality that results in successful students is one measurement. The number of students who-enrolled in these sections might be another indicator. In other words, having observed students engaged on their learning activities and expanded their learning time and opportunities might be considered another indicator for success.

Through researchers' direct observations, we noticed high level of students' involvement on their learning tasks, and student-student and student-teacher interaction and communication. Students tried to understand basic physical concepts and deploy them in new context. Their ability to solve authentic real life problems were improved.

Conclusion

From the previous results, we can draw the following conclusions:

- Fear of experiencing new methods & Technology for both students and instructors.
- Implementing this technology requires more time span to become part of students' learning culture.
- Some of students weren't series and motivated.
- Over all, students' achievements were below expectations on both groups.

At the end of this article, we recommend by:

- Think of strategies to improve students motivation in using new learning methods and technology
- Design blended learning environment
- Train Faculty members
- Train students
- Establish learning resources to enhance teaching & learning process (for example apps & software's)

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