Journal of Engineering Science and Technology
Vol. 10, No. 2 (2015) 249 - 257
© School of Engineering, Taylor's University

EVALUATION OF THE USE OF IPAD IN TEACHING GENERAL CHEMISTRY LAB TO FRESHMEN STUDENTS

N. EID[1], S. AL-ZUHAIR[2,*]

[1]College Requirment Unit, College of Engineering, UAE University, 15551 Al-Ain, UAE
[2]Chemical and Petroleum Engineering Department, College of Engineering, UAE University, 15551 Al-Ain, UAE
*Corresponding Author: s.alzuhair@uaeu.ac.ae

Abstract

It is generally accepted that the use of iPad enhances students' engagement in the classroom. However, assessing the benefits of using iPad in teaching laboratory sessions have seen less attention, due to the hands-on nature of these courses. To do this assessment, iPad was applied in teaching two pilot sessions of the General Chemistry Lab, and students' evaluation was compared to that of other students in sections taught by conventional teaching techniques. The evaluation was based on the students' assessment of their achievements in meeting the main course outcomes, which indicated that the students in the classes taught using iPad showed more satisfaction with the course, and believed that they have better achieved the outcomes of the course compared to the conventional classes. Furthermore, the comparison process included the overall students' quantitative performance, which showed insignificant difference between the two classes, with slightly better performance of students in normal classes in quizzes, whereas final exam marks were almost the same for both the iPad piloted students and conventional class students. The differences in quizzes results were attributed to the normal variation in the students' academic merits. In addition, the piloted students were asked about their experience of using iPad in class and their satisfaction by using different iPad apps. The feedback was collected and analysed, and the results showed that the students generally enjoyed using iPad in the class and appreciated all apps.

Keywords: iPad teaching, iPad apps, Students' evaluation, Students' performance.

1. Introduction

Since the first launch of iPad in April 2010 [1], several colleges and universities have launched iPad initiatives. The main objective was to enhance student interactive

learning in classrooms. iPad have become popular educational devices because of the availability of significant number of educational applications. There are apps available ranging from study aids to collaborative and interactive learning apps. Most of these applications support traditional learning activities instead of enhancing them [2]. Despite the rapid adoption of iPads for educational and professional purposes, the extent to which this technology enhances student engagement and learning in the classroom is not well understood. However, studies by [3, 4] have found positive correlations between the use of educational technology and student engagement, particularly in the form of active learning and student-faculty interaction.

A link between use of instructional technology and increased student engagement is strongly supported by [5] with a lack of evidence that the increased student engagement resulted in higher grades or higher exam scores. However, their studies showed that female students were more favourable toward instructional technology than were male students. Early analyses showed that students using iPads for group assignments in a math class were more in sync than were students in a section not using iPads which indicated that iPads promote active learning, collaboration, and student engagement. [6] is among those who asserted that collaborative learning helps students to develop valuable skills that have long-term benefit.

The UAE University was one of the first institutions worldwide to integrate iPad-based teaching and learning into its curriculum. The iPad initiative was first introduced at the entering Foundation Program level in September, 2012. In the following semester, the iPad teaching was applied in the College of Engineering, at the engineering freshman level. Among the first courses in the College of Engineering to experiment using iPad in classroom was the General Chemistry Lab.

The effective use of iPad definitely enhances students' engagement in the classroom, and it is generally believed that students prefer more classroom sessions that utilize iPads [6]. However, the effect of such an enhanced engagement in the overall learning process in a laboratory course is not well understood. To better evaluate this, two pilot sections out of total six sections of General Chemistry Lab were taught using iPad. The content of the lab manual was included in an interactive i-Book that included videos, photos, lecture notes and practice questions. Videos showing demonstrations of the experiment, which students have to watch before attending the lab session, were included. In addition, videos showing the relationship between chemistry and engineering were also included. iPad was used to conduct the introductory presentations, which usually precede the actual experimental work, and to discuss class questions. Besides this enhanced interactive engagement of a normal class, the iPad allowed students to virtually carry out the experiments prior to actually do them. Making mistakes in the virtual experiments are safer than in the real experimental work, especially when a harmful chemical is used, with no waste.

2. Evaluation Process

Two sections of chemistry I lab for engineering were selected to be taught using iPad whereas the other four sections were taught using the conventional teaching techniques. The effect of using iPad, compared to conventional way of running the lab sessions was mainly evaluated based on the students' assessment of their achievements in meeting the main course outcomes.

Students' assessment form, shown in Table 1 was distributed to all sections at the end of the semester. However, questions 6 and 7 were modified for the iPad sessions to be more compatible with iPad, so Excel Spreadsheet and PowerPoint presentations were replaced with Numbers and Keynote apps, respectively.

In addition, the students' satisfaction with using different iPad apps was assessed using the evaluation form shown in Table 2. The students' feedback on using iPad in classrooms were collected and evaluated using the form shown in Table 3. All forms were uploaded to a website, and the students were asked to fill the forms on-line.

The comparison process also included the students' performance in written tests and quizzes. In addition, the course contained an experimental project on recycling of waste aluminium to produce alum. The students were asked to prepare a technical report based on this project and orally present their results. In the non-iPad classes, this was achieved using M.S. Office packages, namely Word, Excel and PowerPoint. However, in the iPad classes, iPad apps replacements of these packages were used, which are Pages, Numbers and Keynote, respectively. The quality of the project reports and the effectiveness of presentations of both class types were also compared.

iTunes U app was used as course portfolio were materials related to each experiment such as videos, lecture notes (PDF presentations), theoretical background, experiment procedures and resource materials were posted one week before the experiment day to allow enough time for the students to prepare for the lab session. The first fifteen minutes of each lab session was used to assess the student preparation of the lab session using Nearpod app. Different questions about each experiment were prepared and passed to the students using this App. Students 'answers for the posted questions were shown on the smart board and the areas of weakness and confusions were detected which resulted in more explanations and elaboration for such areas. Adobe reader and annotate apps were used to deliver the theoretical aspects of each experiment and solve its related examples. Students used those iPad apps to take notes on their provided PDF notes and solve the related exercises.

After experiment was demonstrated by the lab instructor, each group was asked to conduct the experiment and record their data in a log sheet and perform the required calculations related to the conducted experiment. Numbers and pages apps were used by the students to develop the project report and its related figures and tables while the project presentation was developed using keynote app. Blackboard app was used to deliver the course material and on-line quizzes and exams.

3. Evaluation Results

3.1. Students' assessment of the course

The questionnaire shown in Table 1 has been distributed among six sections of the General Chemistry Lab. Two classes were taught using iPad, referred to here as iPad1 and iPad2 and the other four were taught in the conventional way, referred to here as Normal 1 to 4. The average answers from each section for the seven questions are shown in Fig. 1. The error bars shown in the figure represent the standard deviation of the students responses.

As shown in Fig. 1 the students in the classes taught using iPad had exactly the same qualitative average, 4.7 which was higher than all the normal sections. The t-test was applied to check if there is a significance difference between the two approaches, namely iPad and normal, in terms of students assessment, with an initial hypothesis that there is no differennce. To run the t-test, the mean and standard deviation of each sample and a level of significance, α, are used. The degree of freedom is the smallest sample size, which was the number of students in the iPad classes (29 students) - 1. The t-test was then applied with $\alpha = 0.05$, averages of 4.7 and 4.5, and standard deviations of 0.3 and 0.35 for the iPad and normal clasess, respectively, and a degree of freedom of 28. The calculated t-value was found to be 2.5, which is larger than the value found from the t-Table at the used α and degree of freedom, which is 1.7. Therefore, the initial hypothesis was proven wrong and it there was a significant difference in the qualitative outcomes of the students in the iPad classes and their peers in the normal classes. This indicates that students taught using iPad have shown higher satisfaction, with the course, and believed that they have better achieved the outcomes of the course compared to the conventional classes. In addition, using iPad apps such as iTunes u, Nearpod and Annotate have clearly boosted the interest of the students and enhanced their interaction, which was positively reflected in their assessment of the course, as shown in Fig. 1.

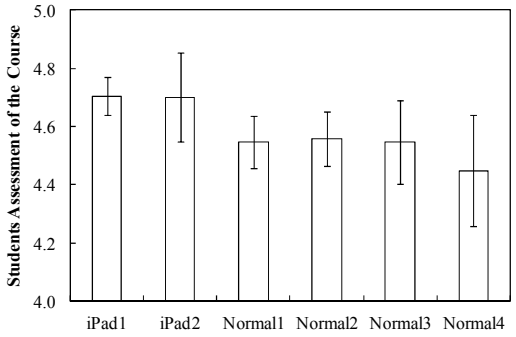

Fig. 1. Results of the students' assessment of the course.

Table 1. Students' assessment of the course.

Course intended outcome	*Very Low* ← → *Very High*				
	1	2	3	4	5
1. Acquire practical and transferable skills related to applications of general chemistry.	☐	☐	☐	☐	☐
2. Find and/or demonstrate significant chemical relations.	☐	☐	☐	☐	☐
3. Carry out laboratory experiments using written instructions	☐	☐	☐	☐	☐
4. Learn and apply safety rules in laboratories	☐	☐	☐	☐	☐
5. Work in a team and contribute effectively to team effort in laboratory work	☐	☐	☐	☐	☐
6. Apply computational tools such as spreadsheets to carry out calculations on laboratory data, to draw graphs and make statistical analysis to assess reliability of experimental results.	☐	☐	☐	☐	☐
7. Prepare a good quality written project reports and Powerpoint presentations.	☐	☐	☐	☐	☐

3.2. Students' evaluation of iPad apps

The questionnaire shown in Table 2 was conducted by students in the iPad sections of the General Chemistry Lab. The average evaluations of each App are shown in Fig. 2.

Table 2. iPad apps questionnaire.

Rate the following iPad App

Mark only one oval per row.

	poor	Fair	good	V.good	Excellent
Pages	◯	◯	◯	◯	◯
keynote	◯	◯	◯	◯	◯
numbers	◯	◯	◯	◯	◯
nearpod	◯	◯	◯	◯	◯
Annotate	◯	◯	◯	◯	◯
Blackboard	◯	◯	◯	◯	◯
Adobe Reader	◯	◯	◯	◯	◯
dropbox	◯	◯	◯	◯	◯
iTuens U	◯	◯	◯	◯	◯
iBooks	◯	◯	◯	◯	◯

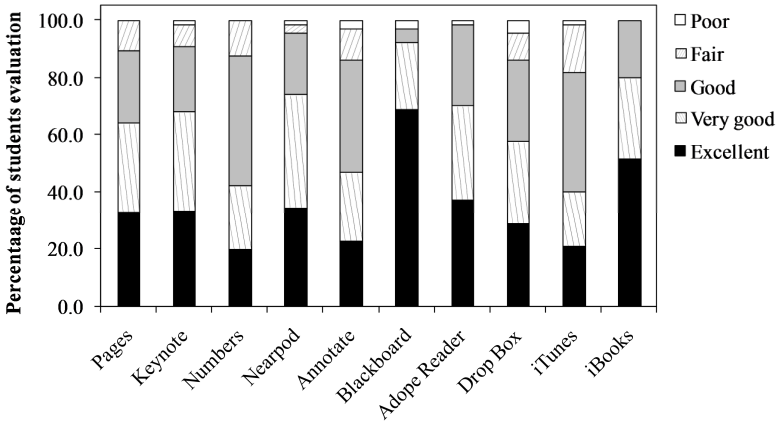

Fig. 2. Results of students' evaluation of iPad apps.

As shown in the figure, Blackboad appeared to be the most useful with 68.7% of students finding it Excellent and 23.9% finding it Very Good Nevertheless, 3%

of the students thought it is a Poor App. iBook was second best with 51.5% finding it excellent and 28.8% finding it very good, with no evaluation of Poor or even Fair. On the other hand, Numbers has the lowest percentage of students, of 19.7%, evaluating it as Excellent, followed by iTunes with 20.9%. The highest percentage of students evaluating an App as poor was 4.5% for Drop Box. Having said so, the students generally appreciated all used apps.

3.3. Students' evaluation of using iPad in classrooms

The questionnaire shown in Table 3 was conducted by students in the iPad sections of the General Chemistry Lab. The detailed evaluations of each question are shown in Fig. 3. The figure shows that question 1 received the highest agreement among all other questions in the questionnaire, where 50 % strongly agreed, 40% agreed and 8 % were neutral. This reflects that the iPad was used efficiently used by the instructor in the tested course. Questions 4 and 5 had the next highest agreement of the students, which suggests that the students believed that iPad helped them to access more resources and allowed easier interactions with the instructor and other classmates. The results also illustrate that 20 % of the students preferred regular Smartboard lecture than iPads. Even though iBooks received high rank in the apps questionnaire, 30 % of the students still prefer to use printed books and Notebooks rather than iBooks and eBooks. The results also showed that 85% of the students found the use of different iPad apps made studying more interesting and 80 % believed that iPads helped them learn better and wished that more classes use the iPad.

Table 3. Using iPad in class rooms questionnaire.

Rate the following	Strongly Agree	Agree	Neutral	Disagree
Q1. My instructor is familiar with iPads and uses them efficiently in the class	☐	☐	☐	☐
Q2. Compared to a regular Smartboard lecture, iPads are really much better	☐	☐	☐	☐
Q3. I like iBooks better than printed material (lecture notes)	☐	☐	☐	☐
Q4. iPads allow us to have access to many useful resources of our course	☐	☐	☐	☐
Q5. The iPads apps we use allow easier interactions with the course instructor and our classmates	☐	☐	☐	☐
Q6. Using different iPad apps made studying more interesting	☐	☐	☐	☐
Q7. Some of my classmates use iPads for other things during the lecture	☐	☐	☐	☐
Q8. iPads help us to be independent learners	☐	☐	☐	☐
Q9. In general, iPads are helping me learn better?	☐	☐	☐	☐
Q10. I really wish more of my classes used iPads	☐	☐	☐	☐

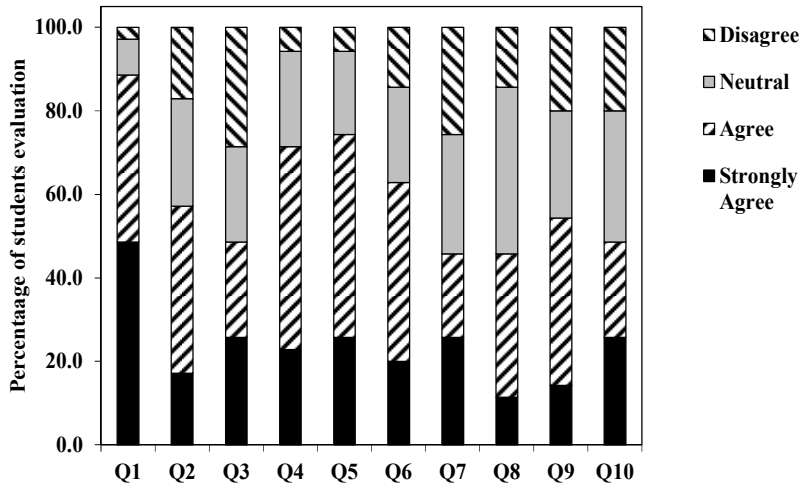

Fig. 3. Students' evaluation of using iPad in class rooms.

3.4. Quantitative assessment

The average quantitative performance of the students in all parts of the Chemistry I Lab for Engineering course, which included the final exam, quizzes, and project reports and presentation, is shown in Fig. 4. The error bars shown in the figure represent the standard deviation of the students responses.

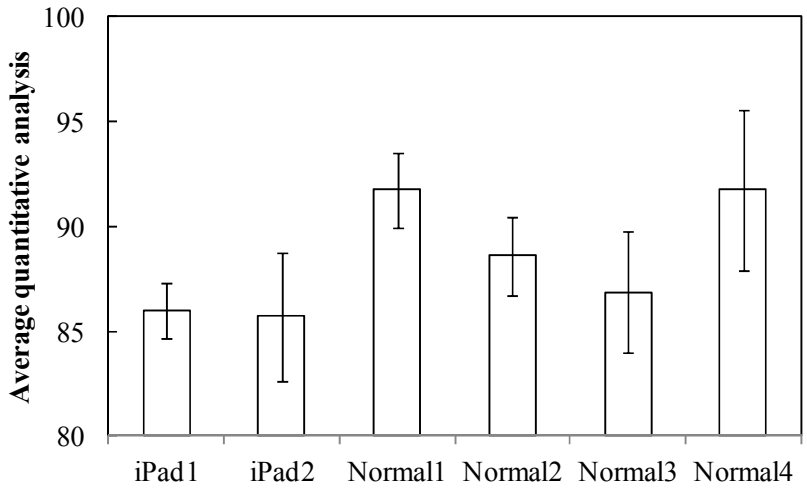

Fig. 4. Results of the quantitative analysis of the course.

The results of Fig. 4 show that the average quantitative results of students in the iPad1 and iPad2 classes were exactly the same, 86. But they were slightly

lower than the overall average of all classes, 88. Applying the t-test on the quantitative results with $\alpha = 0.05$, averages of 4.3 and 4.5, and standard deviations of 0.24 and 0.28 for the iPad and normal clasess, respectively, and a degree of freedom of 28. The calculated t-value was found to be 3.5, which is larger than the value found from the t-Table at the used α and degree of freedom, which is 1.7. This also proves that there was a significant difference in the qualitative outcomes of the students in the iPad classes and their peers in the normal classes.

The performance of the students in the final exam is shown in Fig. 5. The error bars shown in the figure represent the standard deviation of the students responses.

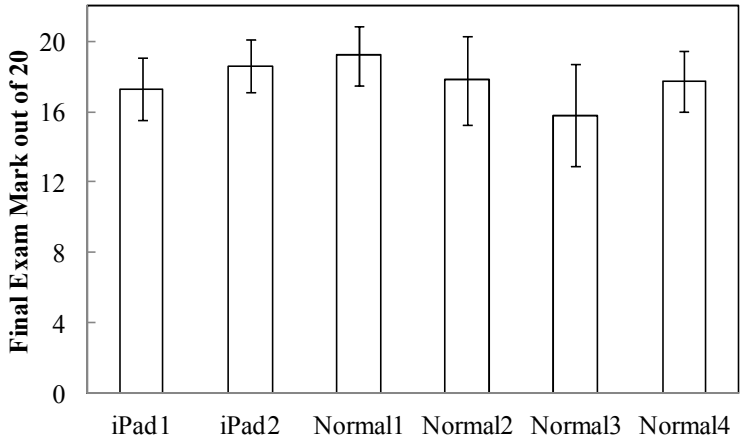

Fig. 5. Results of the quantitative analysis of the final exam.

Analysis of the final exam resultsindicate that the average of the iPad1 class, 17.3, was slightly lower than the overall average, 17.7, while the average for the students in iPad2 class, 18.6, was relatively higher than the overall average of all sections. Applying the t-test on the quantitative results with $\alpha = 0.05$, averages of 15.3 and 16.0 and standard deviations of 3.65 and 4.56 for the iPad and normal clasess, respectively, and a degree of freedom of 28. The calculated t-value was found to be 0.22, which is smaller than the value found from the t-Table at the used α and degree of freedom, which is 1.7. This proves that there was an insignificant difference the final exam results of the students in the iPad classes and their peers in the normal classes. This indicates that it took the students some time to get used to the new way of using iPad in the classrooms. However, once they get used to it, they started to perform better. In addition, since this was the first time the iPad is used in teaching this lab course, as the course progressed, more iPad resources were developed and made available for the students, which had a positive effect on the students' performance. Such a drawback will not be of significance as the iPad course is fully developed. In addition, since this was the first time iPad is applied to this course many resources such as the ibook and iTunes were not fully developed at the beginning of the course.

4. Conclusions

The following findings were obtained:

- Using iPad in General Chemistry Lab was successful and received a very high appreciation by the piloted students.
- The students in the classes taught using iPad showed more satisfaction with the course, and believed that they have better achieved the outcomes of the course compared to the conventional classes.
- All used apps were highly appreciated by the students and students believed that the used apps made their studying easier and more interesting.
- Using iPad in classroom boosted the interaction of students with their instructor and other class mates.

References

1. Kane, Y. (2010). *Apple's iPad sales pass two-million mark*. Wall Street Journal – Eastern Edition, p. B7.
2. Thinley, P.; Geva, S.; and Reye, J. (2014). Tablets (iPad) for M-Learning in the context of social constructivism to institute an affective learning environment. *International Journal of Interactive Mobile Technology*, 8(1), 16-20.
3. Chen, P.S.D.; Lambert, A.D.; and Guidry, K.R. (2010). Engaging online learners: The impact of Web-based technology on college student engagement. *Computers and Education*, 54(4), 1222-1232.
4. Nelson Laird, T.F.; and Kuh, G.D. (2005). Student experiences with information technology and their relationship to other aspects of student engagement. *Research in Higher Education*, 46(2), 211-233.
5. Parker, R.E.; Bianchi, A.; and Cheah, T. (2008). Perceptions of instructional technology: Factors of influence and anticipated consequences. *Educational Technology & Society*, 11(2), 274-293.
6. Wieder, B. (2011). iPads could hinder teaching, professors say. *Chronicle of Higher Education*, 57(28), 22-23.