USING IPAD APPS FOR ENGINEERING LESSONS

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Abstract

Engineering subjects are generally very technical. The conventional methods of teaching engineering studies can be monotonous and may not appeal to students. Engineering Educators have started to adopt technology in the classroom – from creating interactive presentations to polling to make lessons more engaging for the students. The introduction of mobile tablet devices such as the iPad, along with the vast number of apps which can used on it, has been redefining the ways lessons can be conducted. The Apple iPad and its sophisticated apps ecosystem have redefined the conduct of lessons and added significant learning value both within and beyond the classroom. This is especially so in Engineering Education where some dry and technical subjects were made more engaging and appealing to the students.

The School of Engineering (Electronic & Computer Engineering) in Ngee Ann Polytechnic has adopted some of these iPad apps to change the learning experience for the engineering students. The use of apps such as Keynote, Prezi, and Slideshark are helping to change didactic lecture delivery into a more engaging, interactive learning experience. Other apps such as the “Socrative” app allows educators to conduct real time polling exercises with the students. The results of the polling exercises are used to engage students in discussions and gauge their understanding of the subject matter. Learning within the engineering classroom can also be made more interesting through apps such as “Explain Everything” and “Swivl” which can allow educators to create their own videos and audio recordings and share with their students. The ability to make annotations and insert technical diagrams onto the clips also creates opportunities for learning to be more interactive, engaging and participative. Specialized engineering applications such as Gyroscopes and Hardware Tools can demonstrate to students the practical use of sensors, mobile hardware platform and technology.

This poster presentation will share how these educational iPad apps are used to create a learner centred learning environment where Engineering students can be more participative and engaged in the learning process.

Keywords: iPad, Engineering, Technology, Apps, Interactive, Teaching & Learning

Introduction

Engineering studies can be very technical – a plethora of theories, concepts, mathematical equations, diagrams and flow charts. In a traditional lecture setting, the lecturer will dictate continuously while the students will be mindlessly review notes, often not understanding what is being taught. And this monotonous learning environment certainly does not help make a technical topic any easier to understand.

The traditional lecturing methods appear to be losing its traction with students’ learning. Bales (1996) in his research on learning pyramid estimates that students will remember approximately 5% of the information provided in a traditional lecture. This contrasts sharply with retention rates of 50% and 75% for discussion groups and practical exercises, respectively. Educators are also observing that students generally have short attention span and are easily distracted (Lanir, 2012).

To counter the short attention span of students in class and to increase the engagement and retention rate of students, educators have started to look at the use of technology for a new approach to learning. Engineering educators have started to embrace technology in the classroom to increase effectiveness of learning – from using interactive presentations to polling, all in effort to make engineering lessons more appealing for the students. The iPad and its sophisticated applications or apps ecosystem have redefined the conduct of lessons and added significant learning value both within and beyond the classroom.

The iPad apps enable educators to engage a multipronged approach to facilitate teaching and learning. These aspects are shown in Figure 1.

Figure 1: iPad Apps used in several areas to engage students in engineering lessons
Materials and Methods or pedagogy

Live Polling

Felder and Brent (2008) pointed out that one of the common mistakes made by educators is to turn their classes into PowerPoint shows. The educator narrates while the students spectate – an outright passive form of learning. However, when educators start to weave an interactive system cleverly into the slides, it elicits participation from students.

Tapping on the existing mobile system infrastructure, iPad apps, such as Socrative, allow educators to conduct real-time interactive exercises with the students. This online student response system is a useful technology that enables educators to post questions to students and gather responses immediately. Questions may be structured in simple true/false, multiple choices to the more complex open-ended formats.

Unlike the conventional clicker system which requires students to individually own a clicker, students can now transmit their responses through their smartphones which are just required to have an Internet connection. The Socrative app collects responses received from the students and tabulate the data into simple bar charts which educators will be able to share with the class (see Figure 2).

In the Telecommunication Principles (TP) module for year 2 students, Socrative app has been used during the tutorial session to gauge students’ understanding of the module. Students’ responses were set for discussion within their groups. The lecturer could further challenge the students to convince their peers who have chosen to poll different answers from themselves. A re-poll could be conducted to observe if there was a shift in responses. During this peer exchange, active learning is promoted as students learnt to articulate their thoughts and helped each other understand the subject matter better (See Figure 3). According to Felder and Brent (2009), active learning is any course-related activity that all students in a class session are called upon to do other than simply watching, listening and taking notes.

To assess students’ understanding level in the TP module, the lecturer has incorporated questions structured in an open-ended format, in between the lecture slides in the TP module, to which students were required to respond using short phrases. With the anonymity of the responses, students found it easier to participate as it eliminated the fear of looking bad in front of peers for providing the wrong answers. The responses gathered also helped the lecturer gauge if there was a need for remedial actions - a need to slow down the pace of the lecture or revisit some of the topics covered earlier.

Keynote for Apple’s iOS is an app which is able to create aesthetically appealing presentation slides. Its simple-to-use functions allow educators to construct stunning presentation slides as easy (if not easier) as it is to work PowerPoint. It works not only for iPad, but also works seamlessly between Mac and other iOS devices. In a classroom context, an iPad can be used as a teaching tool coupled with a MacBook connected.

Figure 2: Socrative app allows the students to answer questions on their mobile phones and instantly view results on the screen

Figure 3: Students discussing in a group during a live polling session.

Poll Everywhere is another alternative student response application which is similar to Socrative. This application is used to conduct simple polling and demographic data gathering during the introduction of a new topic. For instance, in the Mobile Device Technology (MDTE) class for final year students, the lecturer has asked the students for the type of operating system used on their smart phone. The results of the poll were instantly tabulated and shown on the screen (see Figure 4). These results can be used for discussion and comparison with the actual demographics of the popular operating system used worldwide. The lecturer can then expound on the data and engage the students to examine the latest technological trends and how technology has evolved through the years.

Figure 4: Poll Everywhere allows educator to instantly poll for answers to encourage student participation

Interactive Presentation

A traditional transmission approach involves a presenter showing content heavy slides to an increasingly passive audience (Koppi & Pearson 2005). The educator packs a colossal amount of information onto slides, and as Tufte (2003) criticized in his paper, the presenter unveils and reads aloud the single line on the slide, then reveals the next line, reads that aloud, on and on, as audience members impatiently await the end of the talk. While presentation software is a mere tool, it is the educator who has to use the tool to create presentations which are visually stimulating and interactive. One such interactive presentation tool available on the iPad is Keynote.

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to the projector. The Keynote presentation can be synced between these two devices through Bluetooth connectivity. With this convenience, the lecturer is free to move around the classroom with an iPad in the arm and annotate effortlessly at the same time. This is especially useful in the TP module where the lecturer is able to write equations and illustrate correlation on the block diagrams as seen in Figure 5. In addition, with a simple point to the iPad, it now works as a virtual laser pointer.

Quoting writer and politician Jean-Nicolas Bouilly (1763 – 1842), “Whatever we possess becomes double value when we have the opportunity of sharing it with others”, Keynote allows educator to share the slides with their students through iCloud.

Figure 5: Annotation on iPad made easy with Keynote

Moving onto an online cloud-based presentation tool for presenting ideas on a virtual canvas is Prezi. Unlike typical slide-by-slide based presentation tools, Prezi has the capability to design dynamic, non-sequential and non-linear presentations. Educators will lay out the information to the subject matter on a simple canvas, before starting to arrange them in the way they like.

Prezi has a zooming user interface, which allows users to zoom in and out on any part of the presentation. This is especially useful for engineering studies that require students to understand relationships between concepts. Figure 6 below depicts one example of work used in Mobile Device Technology (MDTE) module. The presentation slides allow the lecturer to first provide the students with an overall view of a mobile device before progressing into the minute details of the important elements of the mobile device. As such, it is a very visually oriented presentation (Strasser, 2013).

Figure 6: Using Prezi in the MDTE module

Video/Audio Recording

Apps such as “Explain Everything”, “Educreations” and “Swivl Capture” empower educators to create their own videos and audio recordings both in and out of class, and then share them with their students. Having additional video recordings reinforce learning as students would then be able to review them at their own pace and convenience (Coghlan, et al., 2007). Through this self-paced learning, the students can now pause, rewind, fast-forward and replay lessons when needed. The video acts as an additional resource to complement the typical lecture notes provided. This can be beneficial to students who would want to revise engineering lectures with more challenging technical content.

Swivl is an innovative device which can be used to record audio and video in the classroom. Primarily designed to record video for conferencing, educators are now using this device to record their own lectures. Without the need for sophisticated video recording tools and a dedicated videographer, Swivl allows the lecturer to record his own lecture without much hassle. The Swivl has a motorized turntable that is able to track the user’s movement anywhere within the classroom. An iPad or iPhone is mounted on the Swivl thereby replacing the need for a complex video camera (see Figure 7). It has the capability to move freely with 360-degree pan and 20-degree tilt. The Swivl hardware comes together with the Swivl Capture app which marries the lecture slides with the video recording. Students can then review the lecture captured in MDTE class using Swivl with the accompanying slides (see Figure 8).

Students, too, can make use of the Swivl to record their presentations. With the convenience of the videos automatically stored in the Swivl Cloud server, students can choose to share the video recordings with their classmates for peer feedback, thus promoting collaborative and student-centered learning.

Figure 7: Swivl Capture app on iPad integrated with the Swivl hardware

Figure 8: Using Swivl in the MDTE class

The multi-touch capability of an iPad has created more avenues for educators to design more engaging presentations. Explain Everything is one of the tools created that utilizes this technology to allow educators to annotate on the screen while doing screen recording. The recording comes in the form of screenshot and audio recording. Unlike the conventional whiteboard app, multi-page presentation slides and graphics can be inserted easily into this app. This enables the lecturer to go through the slides and at the same time annotate the engineering diagrams (see Figure 9). This is especially useful in the TP module where there are
many diagrams and equations. All these actions can be recorded and stored in the cloud server. The ability to make annotations and insert technical diagrams onto the clips also generates opportunities for learning to be more interactive, engaging and participative. Educators can expand and illustrate further on the presentation slides. With this app, educators no longer need to be stationed near a visualizer to annotate on a piece of paper. The educator is able to move around freely with the iPad once it is synced to the MacBook connected to the projector. It is definitely a cheaper replacement of the physical interactive whiteboard.

![Figure 9: Multi-slides can be imported into Explain Everything and colourful diagrams can be drawn to explain technical concepts to the students](image)

Another app that has similar capabilities to Explain Everything is the Educreations app. It is a good personal recordable whiteboard that is able to capture voice and digital handwriting. One distinct feature of this app is the graph-like background which can be particularly useful for assisting engineering and mathematics educators in drawing graphs, saving them the need to repeatedly draw the x and y axes. This is particularly useful in the TP module where the lecturer uses it to illustrate specific communication concepts through graphs (see Figure 10). Like other apps covered so far, Educreations allows the recorded screencast to be saved and shared with the students. Students can download these screencasts as revision materials to aid their learning.

![Figure 10: Using grid lines on Educreations to draw graphs in the TP module](image)

**Demonstrations using Engineering Apps**

Conventionally, engineering educators had to bring in physical engineering products to demonstrate certain engineering concepts. Demonstrations to reflect specific concepts in engineering classes are believed to aid students to learn better.

With the abundance of iPad engineering apps, educators can now demonstrate things that could not be done many years ago. Due to its portability, the iPad gives flexibility to educators to conduct demonstrations both in and out of the classrooms.

Demonstrations will be merely show-and-tell unless students are actively participating in the process. According to the research by Crouch, Fagen, Callan and Mazur (2004), students who passively observe demonstrations understand the underlying concepts no better than students who do not see the demonstration at all. Therefore, to encourage active participation from students during demonstrations, the lecturer in his MDTE class gets the students to engage in reflective observation, by analyzing and answering questions related to the demonstration. The lecturer will then facilitate discussion to emphasize certain key points. This stimulates higher order thinking and creates better understanding of the concepts behind the demonstration.

![Figure 11: MDTE demonstration using GPS Data app done out of the classroom](image)

![Figure 12: During a MDTE class demonstration, the iPad is tilted to a specific angle and based on the values of the accelerometer displayed on the app, the students are required to calculate and analyze the values based on the theoretical knowledge they have learned in class](image)

There is no one-size-fits-all engineering app that caters for all engineering applications. Often, educators have to identify a few relevant apps and adapt them to achieve learning objectives of the lessons.

For the MDTE module, specialized engineering applications such as Gyroscopes, Hardware Tools, Data Collection and GPS Data are used to demonstrate the practical use of sensors, mobile hardware platform and technology (see Figures 11 and 12). Primarily designed to assist engineers in their work, these apps can also be utilized in class for educational purposes. Apart from engineering apps, the lecturer has also made use of game apps such as Showdown, which brings fun to the classroom, and also exhibits the fundamental use of sensors (see Figure 13). The lecturer first allows students to play the game followed by an explanation of the underlying mobile device sensors used in the game.
Using these apps in the classroom converts the typical didactic lecture to a more engaging classroom where educators can demonstrate the application after delivering the technical knowledge of the specific topic.

**Students’ Perceptions and Academic Performance in an Enhanced Module (MDTE)**

A small-scale survey involving 20 participants was conducted with the Mobile Device Technology module class, to check if students have benefited from the use of the iPad apps during lectures. The questions to the survey are as follows.

1. Do you think the student response system helps you understand the key concepts better?
2. Do you think the live polling session using Poll Everywhere encourages your participation?
3. Do you understand the concepts behind the demonstration using iPad?
4. The lecturer uses live annotation on the iPad. Do you think it is helpful?
5. Do you think presentation slides used by the lecturer help you understand the content better?

From the survey, approximately 95% of students agreed that the iPad apps have aided learning and encouraged them to participate in the class (see Figure 14). Specifically with regards to question 3, all the students agreed that demonstration helped them to understand the concepts better. This is most likely because demonstrations allowed the students to experience the practical application of concepts.

**Academic performance of the MDTE class for April 2013 Semester**

Students’ academic performance in the module was analysed by comparing their results on the Common Test, Final Test and final grades (n = 21). As this module was newly introduced into the curriculum, comparison could not be done across more semesters. For a typical module in Ngee Ann Polytechnic, students will attend classes for about 8 weeks and followed by Common Test. Students will then continue for another 8 weeks of classes which will prepare them for the final exam. However, for the MDTE module, the final exam is replaced with a Final Test that has a similar weightage as the Common Test.

With this in mind, a comparison of the results obtained from the Common Test and on the Final Test was made. T-test analysis done had shown that improvement was statistically significant with two-tailed p-value of 2.61% (p<5%), confirming that students had shown progress in their results. In addition, more than 57% of the students had seen improvement in their results (see Figure 15). This might be attributed to the use of demonstration and active learning in the second half of the semester. This may also be cross-referenced to the survey results in Figure 14 where all of them agree that demonstration helps them to understand the concepts better.
experience on the modules they have attended in that semester. The objective of this survey is to gather students’ feedback of the modules through questions directed in areas namely students learning, teaching and learning approaches used, module materials, activities and skills acquired. In Question 3, students were asked to rate the extent to which the teaching and learning approaches were appropriate for this module/project and in Question 6, whether the module activities enhanced their overall learning. Students from the MDTE module, in which iPad apps and activities were incorporated in classes, participated in the MES.

The results tabulated from 32 students’ responses (70% confidence level) showed that for Q3 and Q6, the mean ratings were 4.78/6 and 4.88/6 respectively. This was higher than the average ratings for module section, school average and Ngee Ann Polytechnic average. This suggests that students agreed that the use of iPad apps and activities in class were appropriate and has helped them to understand and learn better.

Written feedback from the Student Evaluation of Teaching (SET) survey for the MDTE and TP modules also indicated that students found the use of apps in the lectures helpful for their understanding:

“The lecturer always goes the extra mile to do PowerPoint slides (using Keynote app), videos, questions (using Socrative apps) in every lecture. And all those PowerPoint slides, videos and questions really help me understand the chapter more.”

“He has used various materials such as devices (demonstration using iPad apps) that allow us to incorporate well what we’ve learned in theory”

Conclusions

Engineering education has gone through an accelerated evolution in the last couple of decades, given how technology has advanced by leaps and bounds. This has also shaped the profile of students and the way they learn. Teacher-centred approaches may no longer achieve effectiveness in engineering lessons as the students today seek to be engaged in learning.

While we teach our children to be creative, there is also a need for today’s educators to “think out of the box”, continually seeking new methods to captivate an audience which live in a world with more distractions, compared to the past.

iPad apps are tools that are widely used by educators and its effectiveness is apparent and well supported by many surveys done by numerous academicians. Research on iPad usage in classroom from Learning Exchange (2011) and Gikslman (2011) have findings that concluded that iPad usage had aided educators in producing positive learning outcomes and added educational value in the classroom. In the small study described here, student feedback results indicated that iPad apps helped them understand concepts better and encouraged participation in class. Therefore, this could have led to their marked improvement over the 2 tests’ results.

Yet a tool remains merely a tool, until it is put to good use. Like a chisel in the hands of a mason creates nothing, until the mason puts the chisel to use; with each stroke and roughing of the surfaces, the mason transforms a piece of stone into a fine piece of art. Let me aptly end with an anonymous quote, “Never be afraid to try something new. Remember amateurs built the ark, but professionals built the Titanic.”

References


Learning Exchange (2011). iPad in schools: Use testing. CED Parramatta