

# **USE OF WIRELESS TABLET PCS AS AN EFFECTIVE LEARNING AND TEACHING ENHANCEMENT TOOL**

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## *Abstract*

*This paper examines the concept of using Tablet PCs as a potential effective learning and teaching (L&T) enhancement tool in classroom environments. It reports on findings and recommendations of a faculty sponsored L&T enhancement project in the Faculty of Engineering and Surveying at the University of Southern Queensland (USQ), which aims to investigate the role of wireless enabled Tablet PCs as a L&T enhancement tool and its impact on student retention and progression.*

*The project has identified scenarios of using Table PCs by educators in classroom settings. These include using Tablet PC as a presentation medium with hand-drawing functionality, an electronic assignment marker, a lecture recording tool, and a wireless video projector.*

*Pedagogical aspects of wireless tablet PCs are widely exploited in this paper. It has been discovered that the use of tablet PCs as a teaching tool helps improve on parity between on-campus and external students, improve on interactivity between teachers and students, illustration of concepts, and turnaround of marking assignments.*

## **1. INTRODUCTION**

Most contemporary university lecture rooms are equipped with non-interactive computer technologies, such as data projectors that have the ability to project a computer display on a large screen for all students to view. As a consequence, many

university instructors are shifting away from the traditional white board (or perhaps a chalk board) to PowerPoint (PPT) presentations using the data projector. However, PPT slides are prepared entirely before the delivery. The effectiveness of using PPT slides for the cognition of complex engineering concepts is to be questioned. Such formats focus upon passive learning, but fail to promote interaction between the instructor and their students in a classroom setting since the PPT's content is unable to be adjusted in accordance with audience reaction.

The emergence of tablet PC technologies has heralded a growing use of new information and communications technology (ICT) for traditional classroom environments. In combination with state-of-the-art mobile technologies, wireless enabled tablet PCs are pushing the boundaries of established practice and challenging the traditional practice of non-interactive face-to-face teaching, where the instructor assumes the role as a "supplier" of knowledge whilst students are passive recipients of that knowledge.

In this paper, the efficacy of a tablet PC as an effective learning and teaching (L&T) enhancement tool is investigated and compared with white boards, overhead transparencies, and static electronic presentations. Studies to date on the use and uptake of tablet PCs as an L&T tool have explored the technical and operational features surrounding the physical device. Few have addressed issues around the implications for teaching and learning in different contexts. These deficiencies are addressed in this paper. We report on findings and recommendations of a faculty L&T enhancement project in the Faculty of Engineering and Surveying at the University of Southern Queensland (USQ), which aims to investigate the role of wireless enabled Tablet PCs as a L&T enhancement tool and its impact on student retention and progression.

The remainder of the paper is organised as follows. Section 2 presents a brief overview of tablet PC technologies. Section 3 is concerned with the project scope, whilst Section 4 focuses upon the project methodology. Section 5 presents major project outcomes and discussions that contribute to a deeper understanding of these results. Concluding remarks are drawn in Section 6.

## **2. Brief Overview of Tablet PC Technologies**

The term "Tablet PC" was coined by Bill Gates in a keynote address at the 2001 Comdex Conference (Gates, 2001). Since then, the tablet PC has ushered in a new era of mobile computing as a single, fully functioning PC that's practical and comfortable either when the user is on the go or at work in an office.

By definition, a tablet PC is a portable computer equipped with a touch screen and special pen that allows users to 'handwrite' on the screen. The handwriting of the user is displayed on the tablet screen. There are two common models of tablet PCs. Slate tablet PCs have no lid or keyboard, which makes them slimmer and lighter in weight than most convertible tablet PCs. By comparison, the convertible model has the combined benefits of both laptop and slate tablet PCs through working in either the laptop mode or tablet mode. Both models allow an instructor to write notes on the screen of the tablet PC. If the Tablet PC is connected to a data projector, the contents written on the screen together with any presentation slide material is projected at the front of the class. With an integrated pen, touch-screen support,

digital-ink input, handwriting recognition technologies, and innovative hardware, ultra-portable Tablet PCs are comfortable to use and productive virtually anywhere and anytime. This makes the table PC a perfect interactive L&T instrument in classroom environments.

Tablet PCs possess several advantages over traditional presentation media in the sense that they build and expand upon the benefits of conventional instructional technologies in a classroom setting. Firstly, in comparison with static pre-prepared electronic slides, the tablet PC presentation is dynamic and adaptive in the sense that a lecturer can add contents in real-time in accordance with students' rate of comprehension. On the other hand, compared with the white board, the tablet PC can seamlessly integrate multimedia instructional aids and does not obstruct the students' view as the lecturer writes on the board. Walker *et. al.* (2008) presented a comparative feature list for tablet PCs, electronic slides, white board, and transparencies.

Wireless connectivity through the interface of either IEEE 802.11a/b/g or 802.16 WiMAX adds a new much-desired feature to most recent models of tablet PCs. By using radio communications technology, wireless tablet PCs can connect to a wireless network through a wireless access point. This greatly enhances the effectiveness of using wireless tablet PCs as an L&T tool.

### **3. PROJECT SCOPE**

The University of Southern Queensland (USQ) is an regional university in Australia with a nationally and internationally recognised excellence in distance and flexible education. In effect, 75% of USQ's 26,000 students study off-campus through various flexible delivery modes, whereas only 25% of the student cohort enrolled at the university study in the traditional on-campus mode.

The University has five faculties including the Faculty of Engineering and Surveying (FoES), which offers a variety of undergraduate and postgraduate programs. The undergraduate programs are made up of a two-year Associate Degree, a three-year Bachelor of Engineering Technology, a four-year Bachelor of Engineering, and five-year Combined Degree programs. These programs offer flexible entry points and cater for students with diverse educational backgrounds.

FoES allocated \$20,000 in its 2007 budget to be spent on enhancing learning and teaching in the Faculty's undergraduate programs. The four priority areas of the faculty funding program were student retention and progression, internationalisation of the curriculum, student diversity, and professional benchmarking. This paper reports on the outcomes and results of a faculty funded project in the priority area of student retention and progression.

Entitled "Implementation and Evaluation of Tablet PCs as a Teaching Aid in Selected Engineering Courses", the project aimed to investigate two fundamental benefits that Tablet PCs can provide for educators in their teaching and research activities, particularly for 1st Year and "large class size" courses. One was to enhance student learning and retention in both on-campus and external modes, while the other one was to improve productivity and response time for assessment marking.

A variety of diversified courses from different engineering disciplines were trialled and experimented in the project, i.e., ENG2102 Problem Solving 2, MEC1201 Engineering Materials, MEC2202 Manufacturing Processes, MEC3203 Materials Technology, and ELE3107 Signal Processing. More specifically, the following issues in relation to the Tablet PC were investigated in the project:

- 1) Initial investigation and trialling the capability of the Tablet PC;
- 2) Plan and develop action plan for implementation to utilise the Tablet PC;
- 3) Presentation of Tablet PC's capabilities to faculty staff;
- 4) Implementation of action plan in the selected courses;
- 5) Collect data on productivity improvement and student learning; and
- 6) Analyse data and develop recommendations.

#### **4. METHODOLOGY**

This study utilised both quantitative and qualitative research methodologies. Surveys were used to evaluate the impact of the use of Tablet PCs as an efficient and effective teaching aid. The survey results were analysed using qualitative methods such as interviews and focus groups to gain a deeper understanding of these results.

At USQ, we have identified through this study that there are four significant problems with the current teaching methodology:

- 1) Traditional white board and static PowerPoint presentations appear less appealing to students and especially the external student cohort. The Tablet PC as a dynamic and interactive presentation medium is likely to better capture students' attention in engineering classrooms.
- 2) On-campus lectures presented with PowerPoint slides are not supported with additional notes which are often put onto whiteboards and not recorded.
- 3) Marking paper-based assignments require significant turn-around time in receiving, marking, recording and despatching activities.
- 4) Inability to interactively illustrate the teaching materials to external students. Some of the stated problems associated with student learning may be improved by using other tools such as "Breeze" to record PowerPoint lectures with audio recording, or using MS Word (Insert Comments) for electronic marking. However, Tablet PCs go further by incorporating hand-scribing, which when used during lectures or tutorials, can be particularly useful to illustrate engineering concepts.

Based upon the above observations, this study implemented and evaluated the use of Tablet PCs in three ways to address the problems listed above:

- 1) Record the PowerPoint slides with additional notes and audio during the presentation, and make it available for external students.

2) Receive, mark, record and return assignments on an online basis but using “handscribing”.

3) Use as an interactive teaching aid for tutorials and external student consultation. Further to this, it is envisaged that other usages of the Tablet PC may arise from this project in enriching student learning and enabling “flexibility” in course delivery.

This study was conducted in a number of courses from different engineering disciplines were trialled in this study. Among which, MEC1201 Engineering Materials and MEC2202 Manufacturing Processes are first and third year mechanical engineering courses, respectively. ELE3107 Signal Processing is a senior-level electronic engineering course. ENG2102 Problem Solving 2 is a second year engineering problem solving course, which is based upon the pedagogical concept of problem based learning (PBL). PBL is a pedagogical learning paradigm where students are organised into small groups and engage in open-ended, contextualised real-world problems, which are scoped sufficiently around the technical learning objectives (Brodie and Borch, 2004). PBL now becomes a widespread didactic teaching method in engineering disciplines, where students are required to seek, acquire and apply knowledge rather than just acquire it. As a result, we consider implementing the Tablet PC technology to the faculty PBL course ENG2102 in this study.

All these courses are delivered to both on-campus and distance learning students based upon an open-source course management system (CMS) dubbed as Moodle (Moodle, 2008). This is delivered through a student “StudyDesk”, which provides course management functionalities such as discussion boards and chat facilities, electronic submission of both individual and team work, and the ability to deliver online assessment and surveys.

## **5. RESULTS AND DISCUSSIONS**

Initial experimentation with the technology capabilities of the Tablet PC has resulted in very promising student responses and teaching productivity improvements. Detailed experimental settings and discussions ensue.

### **5.1 Hand scribe function of Tablet PC**

We have identified in this study that one of the most acclaimed features of the Tablet PC is that it allows the instructor to freely “hand scribe” on the computer screen using an electronic pen. Traditional PowerPoint presentations are static and non-interactive. The lecturer shows the slides one after another to the audience. All PPT slides are prepared before the lecture, and therefore can not be adapted to audience’s responses. If the lecturer was to develop a solution of a student’s question from scratch, he or she has to rely on another medium, e.g., a whiteboard or an overhead projector. While this solution enables interactivity between the lecturer and students, no electronic copy of what was written during the lecture is retained. This is highly undesirable for a distance educator like USQ, where the majority of students study off-campus. Our external students can not have the same level of interactivity that is enjoyed by on-campus students.

The above problem can be readily solved through the use of the Tablet PC in the classroom. Tablet PCs are shipped with a specialised Tablet PC operating system, i.e., Windows Vista Tablet Edition, which is a full version of Windows Vista Professional with tablet specific additions such as handwriting recognition. These functionalities allow an instructor to incorporate into their static presentation slides any additional materials in an interactive, dynamic, and real-time manner through electronic ink. The lecturer can spontaneously develop any diagrams, solutions and concept maps in real time using the electronic pen, engage and promote student directed learning in any way he or she desires. All the handwritten notes during the lecture will be saved to the original presentation slides for later reference by both on-campus and distance education students. Furthermore, this capability of Tablet PCs is not limited to the MS PowerPoint format. The in-built software in the Windows XP Tablet Edition is able to add the handwritten contents to virtually any existing document format that is supported by an application program installed in the Tablet PC, e.g., the popular PDF format.

It should be mentioned that the recent releases of MS PowerPoint offers a pen mode, which allows adding electronic ink to a slide during presentation. However, our experimentation revealed that using a mouse as the pen to hand scribe on the screen of a conventional desktop PC or a laptop is cumbersome and awkward to use.

## **5.2 Lecture recording using Tablet PC**

At USQ, lectures were previously recorded through a system termed the Internet PowerPoint Lecture on Demand (iPLOD). The Voice and PowerPoint slides are recorded and synchronised for replay via the Internet using Windows MediaPlayer. After the lecture the recording is transferred to a server and becomes accessible for students through the *USQConnect StudyDesk*. However, there are several limitations for lecture recording using the iPLOD system. Firstly, the iPLOD system is only available in selected lecture theatres at USQ. Any lecturer who wishes to use this facility needs to book an iPLOD lecture room through an online booking system. Secondly, lecture recordings are automatically converted to streaming media formats for online watching only. Neither the lecturers nor the students are able to save a local version of the recordings. This prohibits students from watching recorded lectures off-line. This will cause inconvenience for those students who do not have a fast Internet connection and unnecessary Internet traffic through repeat online watching. Lastly, the iPLOD is only compatible with the PowerPoint format. If a lecturer chooses to use PDF as his or her presentation format, the iPLOD system can not be used to record lectures.

In this study, we conducted lecture recording using the Tablet PC for the pilot courses mentioned in Section 4. Two different lecture recording software programs were evaluated and compared. The first program we experimented with is *Camtasia Studio* by *TechSmith*, which is a screen recorder program for presentations. It allows the presenter to define the area of the screen or the window that is to be captured before recording begins or to recorder the entire screen area. After the presentation has been recorded, the lecturer is able to edit the video by cutting and pasting different parts as needed. The software also allows the user to overlay their voice as well as sound effects onto the recorded presentation. We have found that that *Camtasia Studio* is a rather sophisticated presentation recording program and its video editing

capabilities are very powerful. It has been identified that the added benefits of lecture recording using *Camtasia Studio* on a Tablet PC is that the entire handwriting process can be recorded rather than just the end results. However, the downside of the software is that it is a heavyweight program and post-recording video editing can be fairly computationally lengthy. Besides, it is not freeware. The cost is around \$150 per academic licence.

Audio was recorded by a wireless "Sennheiser" hands free microphone (\$900) and standard hands free (\$150) Bluetooth wireless headset. Both equipment used up to expectation although the Bluetooth had lesser audio quality.

### **5.3 Wireless Table PC**

Most recent Tablet PC models have in-built IEEE 802.11b/g WLAN functionality. Wireless connectivity is a much desired feature for Tablet PCs. It allows a Tablet PC to connect to the Internet wirelessly so that the lecturer can get access to the Internet anywhere in the lecture room. Our investigations have found that wireless Table PCs give lecturers the ultimate freedom of roaming in the lecture room without any constraint.

However, a wireless Internet connection alone does not fully realise the potential of a wireless Tablet PC. To enable video projection from the Tablet PC screen when a lecturer freely roams in the lecturer room, the tablet PC needs to be connected to the data projector wirelessly. There are two different methods to achieve this objective. One method is to employ a wireless video projector with an in-built 802.11 Wi-Fi interface so that the Tablet PC can transmit video signals wirelessly to the projector through the 802.11 interface. Wireless full-motion video transmission is currently not supported because the 802.11 technology does not provide the required bandwidth. However, this constraint does not appear to be a major concern because most PowerPoint presentations have limited animations. Moreover, it is envisaged that full-on HDTV video transmission with the resolution of 1900×1280 will be supported by the next generation of Wireless LAN standards IEEE 802.11n (Perahia & Stacey, 2008) in the near future.

Unfortunately, the above method is not an option for USQ because all the LCD projectors currently installed in lecture rooms are not wireless capable. It is neither realistic nor economically viable to replace these projectors with wireless ones. As a result, we resorted to a cost effective solution through the use of wireless projector adapters. The product we trialled is ViewSonic WPG-150, which is compatible with virtually any LCD projector and wireless IEEE 802.11b/g computers. The adapter connects to a projector's VGA or DVI port and enables a Tablet PC to display to the projector without any cable. Presenters no longer are limited by the cable length from the computer to the projector. Moreover, the adapter is capable of toggling video display between multiple input sources with ease. This is ideal from a pedagogical perspective, where a lecturer asks a question and students can display the answers on their own computers. Student feedback has testified that wireless video projection greatly improved on the interactivity between the lecturer and students, and encouraged the participation of students in classroom discussions.

Our study has shown that wireless video projector adapters are much more cost effective than wireless video projectors. The unit cost is around \$250, and it is therefore suitable for large-scale deployment at USQ.

#### **5.4 Tablet PC versus other low cost alternatives**

The final stage of this study was to investigate a couple different low cost alternatives to Tablet PCs.

We first compared low-cost graphics tablets with Tablet PCs. A graphics tablet is a computer input device that allows one to hand-draw images and graphics. It consists of a flat surface upon which the user may draw an image and a pen-like drawing apparatus. Our study found that the graphics tablet was awkward to use because the hand-drawn images did not appear on the tablet itself but displayed on the computer monitor that it was connected to. The user had to pay attention to what he or she was drawing on the tablet and what was displayed on the computer screen simultaneously. This significantly distracted the user from focusing on their presentation. Therefore, it was concluded that graphics tablets were unsuitable for teaching despite their attractive prices.

We next compared “low spec” PDA laptops with Tablet PCs. A PDA laptop made by Asus was evaluated and compared with Tablet PCs. The Asus PDA laptop is a very low spec laptop with limited CPU power and memory resources but an 802.11 Wi-Fi networking interface. Our study found that the major advantage of the PDA laptop lies in its superior mobility due to its lightweight, which was convenient for an instructor to roam in the lecture room. However, its major shortcoming was the lack of tablet drawing function, which made it unsuitable for classroom teaching.

#### **5.5 Students’ survey results**

In order to gauge students’ perception towards adopting Tablet PCs as a L&T tool, we have undertaken a quantitative method to gather and present survey results below.

Total 28 students were surveyed, out of which 25 were distance learning students. Fig. 1 shows the students’ responses regarding the question how written examples illustrated during lectures may enhance their understanding of the course material. As can be seen from the figure, 16 out of 25 students *strongly* agreed that illustrated written examples were helpful, whereas 8 students agreed the same.

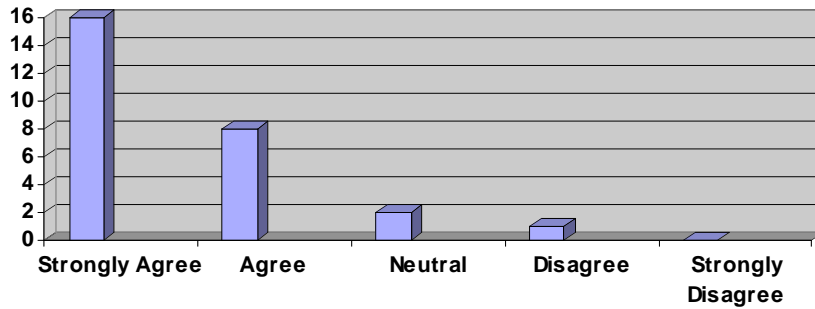


Fig. 1. Written examples, illustrated during lectures enhanced my understanding of the course material.

Fig. 2 shows the students' responses as to how handwritten illustrations or animations can enhance students' understanding of the course material. The major of responses are positive as evidenced from Fig. 2. that 15 out of 25 students strongly agreed and 8 students agreed with the question.

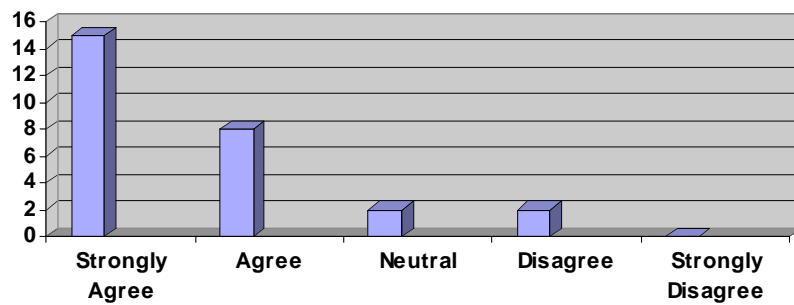


Fig. 2. Handwritten illustrations or animations enhanced my understanding of the course material.

It is interesting to see that students' responses on whether they think writing/illustrations on the computer screen is critical to their understanding of the course as presented in Fig. 3. 17 out of 25 students were very positive, whereas 8 students were not as affirmative. However, none of the students gave a negative response.

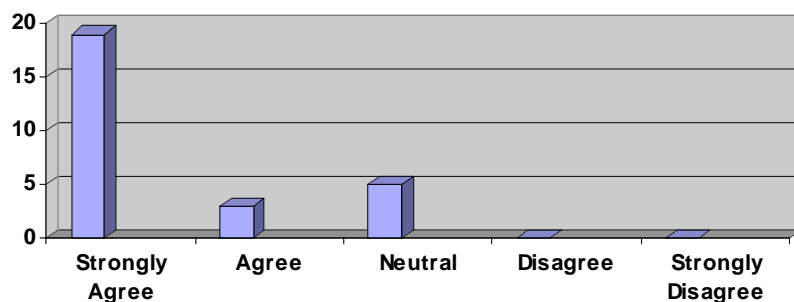


Fig. 3. Is writing/illustration on the computer critical to your understanding of the course material?

Students' attitude towards using Tablet PCs as a lecturing recording tool was also surveyed. The results shown in Figs. 4 and 5 clearly testify the usefulness of using Tablet PCs as such a tool.

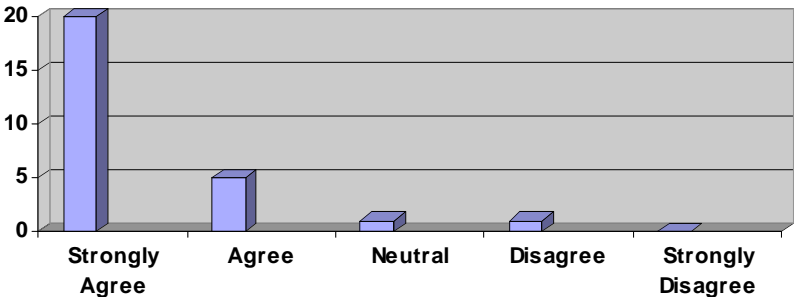


Fig. 4. The recorded lectures should be part of regular USQ study package.

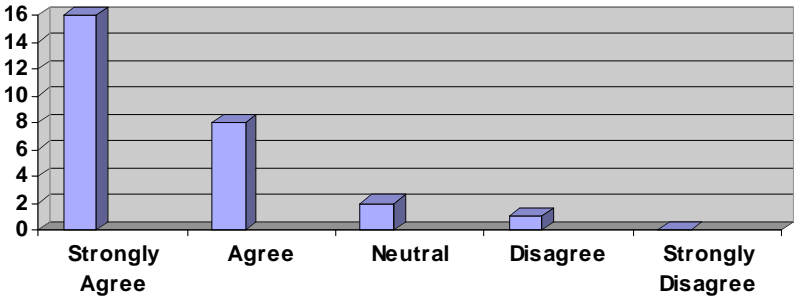


Fig. 5. Reviewing recorded lectures are an essential part of my studies.

**6. CONCLUSIONS**

This study undertook a comparative review into investigating pedagogical and technological aspects of using wireless tablet PCs as a potential teaching tool. We reported on findings and recommendations of a faculty sponsored L&T enhancement project, which aimed to investigate the role of Tablet PCs as an L&T enhancement tool and its impact on student retention and progression. We evaluated in several different classroom scenarios the use of the Tablet PC as a presentation medium, a lecture recording tool, and a wireless video projector, and its comparison with other low-cost alternatives.

Analysis of our surveyed results suggests that students are overwhelmingly in favour of introducing Tablet PCs to lecture rooms and distance education. Though the authors acknowledged that the initial familiarisation with the technologies and its use took time and effort before achieving relative competency, Tablet PCs are an effective and affordable technology that will significantly improve on the existing learning and teaching practices in engineering disciplines. Adequate training for lecturers is of critical importance to ensure smooth and engaging delivery lectures. It would defeat our original aims for the Tablet PC if the lecturer spends most of his or her attention on the technologies rather than the students.

## 7. ACKNOWLEDGEMENTS

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