Wireless Tablet PCs for enhanced teaching at an Australian regional university teaching both campus and distance modes

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Wireless Tablet PCs for Enhanced Teaching at an Australian Regional University Teaching On-campus and Distance Modes

Abstract

This paper examines the concept of using Tablet PCs as a potential effective learning and teaching (L&T) enhancement tool in classroom environments for on-campus and distance teaching modes. 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 teaching and learning enhancement tool and its impact on student's 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 projection. Pedagogical aspects of wireless tablet PCs are also briefly discussed in this paper. It has been noted in our project that the use of tablet PCs as a teaching tool has assisted to improve parity between on-campus and external students, improve interactivity between teachers and students, illustration of concepts, and turnaround of marking assignments.

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 and mathematical 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 and students no longer see the unfolding of these concepts in real time "low fidelity" boards..

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. Not only can they bring back the advantages of the whiteboard, but can take the whiteboard to the student in a new active learning environment.

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 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.

Brief Overview of Tablet PC Technologies

The term "Tablet PC" was coined by Bill Gates in a keynote address at the 2001 Comdex Conference[1]. Since then, the tablet PC has ushered in a new era of mobile computing as a single and fully functioning PC that's practical and comfortable; whether the user is on the go or at work in an office or in a classroom environment. Readers should refer to the work by Condon[2] on tablet PCs in education.

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 and can have positive effects on student learning.

Tablet PCs possess four 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, explore different paths to a solution, or to adjust a lecture based on audience reaction[3]. Secondly, 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.* [4] presented a comparative feature list for tablet PCs, electronic slides, white board, and transparencies.

Third, 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 a learning and teaching tool by allowing the teacher to move around the classroom[5] or, if students have tablets as well, allows shared whiteboard space and more collaborative sharing of information. Reins[6] suggest that when students use tablet PCs they become an integral part of the lesson. Tutty and White[7] argue that the tablet PC classroom environment is very effective as it increases the emphasis on the social aspects of learning and on meaning making. Finally, by incorporating screen capturing software, the tablet PC allows lecturers to create recorded lectures and other screencasts to explain concepts quickly and easily, Evidence to date suggest this can make a difference[8]; As well as these presentation media advantages, the Tablet PC can be used to improve support for students, particularly those in the distance mode. In particular it can be used for one-to-one consultations[5] and improve productivity and response time for assessment marking[9,10].

Project Scope

The USQ is a 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.

The university is particularly interested in technologies that can enhance the distance students' experience with learning. Recently USQ has invested in tablet technology in a number of L&T projects. Three learning and teaching projects have been sponsored by the university in pen-enabled screens in lecture theatres, in scaffolding distance learning and in investigating lecturers' and students' use of tablets[5]. Results from this research suggest Tablet PCs are useful facilitators of communication with remote online students, allowing both teachers and students to use electronic handwriting to give and receive knowledge and skills[11].

In addition the 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 aim 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:

- Initial investigation and trialling the capability of the Tablet PC;
- Plan and develop action plan for implementation to utilise the Tablet PC;
- Presentation of Tablet PC's capabilities to faculty staff;
- Implementation of action plan in the selected courses;
- Collect data on relative cost, productivity improvement and student learning; and
- Analyse data and develop recommendations.

There were four significant problems with the current teaching methodology:

- 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.
- On-campus lectures presented with PowerPoint slides are not supported with additional notes which are often put onto whiteboards and not recorded.
- Marking paper-based assignments require significant turn-around time in receiving, marking, recording and despatching activities.
- 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" or "Camtasia" 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:

- Record the PowerPoint slides with additional notes and audio during the presentation, and make it available for external students.
- Receive, mark, record and return assignments on an online basis but using "handscribing".
- 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.

Methodology and Methods

This study utilised quantitative and qualitative research methods. Survey instrument were used to evaluate the impact of the use of Tablet PCs as an efficient and effective teaching aid. Additional survey comments were also collected and analysed. This approach is typical of mixed method research.

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[12]. 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[13]. 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.

Discussions

Initial experimentation with the technology capabilities of the Tablet PC has resulted in very promising student responses and teaching productivity improvements. It is observed that one of the most useful 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 any distance educator, 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 Table PC in the classroom. Tablet PCs are shipped with a specialised Tablet PC operating system, powered 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 Window 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.

Lecture Recording Using Tablet PC

In our study, lectures were previously recorded through a system termed the "Internet PowerPoint Lecture on Demand" (iPLOD) and in recent times via "Camtasia" or "CamRelay". The Voice and PowerPoint slides are recorded and synchronised for replay via the Internet using Windows MediaPlayer or equivalent media players. After the lecture the recording is transferred to a server and becomes accessible for students through the USQ*Connect StudyDesk (USQ Learning Management System)*. However, there are several limitations for lecture recording using the iPLOD system. Firstly, the iPLOD system is only available in selected lecture theatres. 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 Table PC for the pilot courses. 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. The other is a similar program developed in-house by one of the lecturers participating in the study. Both programs allowed 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.

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 [14] in the near future.

Unfortunately, the above method is not an option 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 AUD $250, and it is therefore suitable for large-scale deployment. However, as the cost of wireless enabled projects are reduced over time, or are part of the standard features of any projectors, this technology solution may be redundant.

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.

Student Survey Results

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

A total 80 students were surveyed, 78 of which 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, 91% of students *strongly* agreed or agreed that illustrated written examples were helpful.

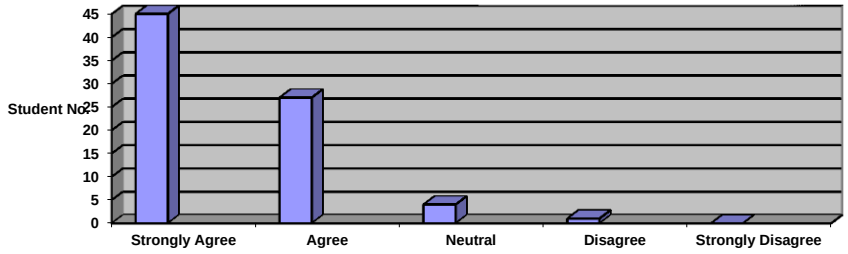

Fig. 1. Written examples illustrated during lectures enhanced my understanding of the course material.

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. 86% of students strongly agreed or agreed with the question.

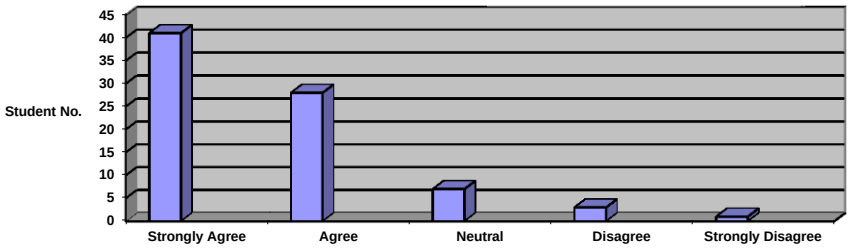

Fig. 2. Handwritten illustrations or animations enhanced my understanding of the course material.

It is interesting to see the 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. 68 out 80 students were very positive, whereas 11 students were not as affirmative. However, only one of the students responded negatively.

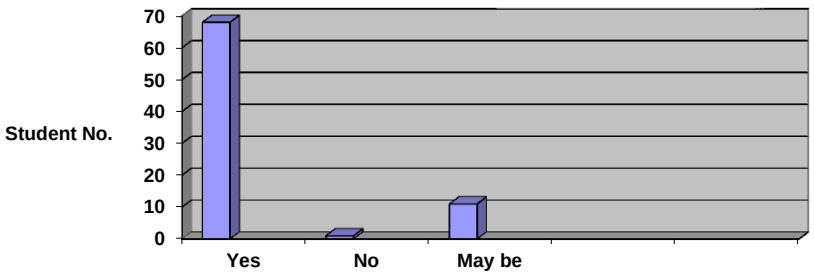

Fig. 3. Is writing/illustration on the computer critical to your understanding of the course material?

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.

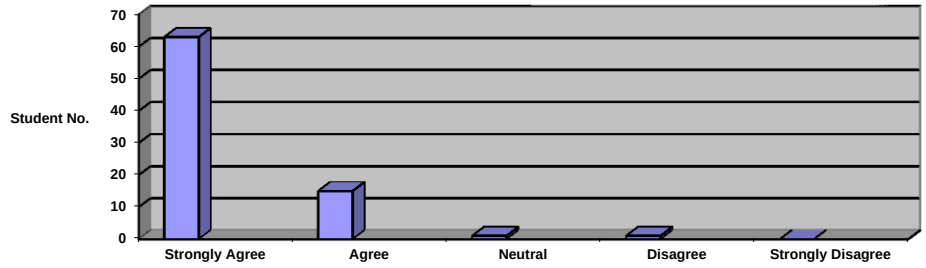

Fig. 4. The recorded lectures should be part of regular study package.

In Fig. 5, we can see that most students consider viewing recorded lectures an essential part of their studies. The positive responses from the students are very encouraging.

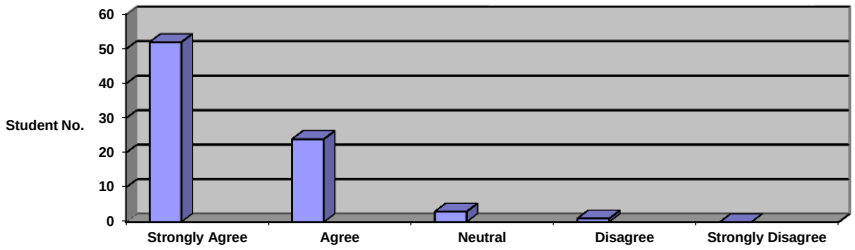

Fig. 5. Reviewing recorded lectures is an essential part of my studies.

The students also approved of the recording quality of the wireless tablets, as shown in Fig. 6. This feedback is particularly encouraging because wireless connections sometimes could have an adverse impact on the lecture recording; however the authors believe improvements could be made with upgrading of existing internal wired and wireless infrastructure, but critically for USQ, the external broadband network around Australia and the world to enable richer and larger video streaming and downloads.

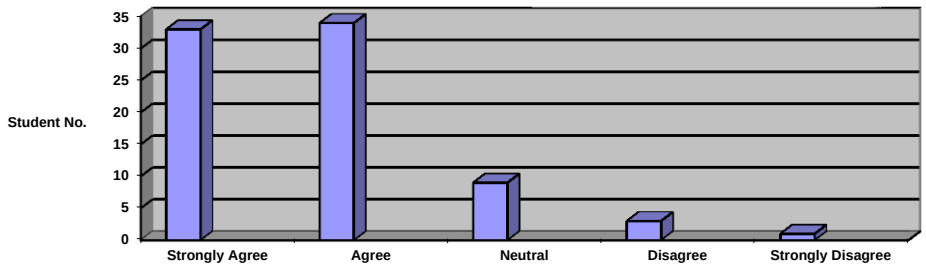

Fig. 6. The recorded lectures are audible and the video is clear.

Results in Fig. 7 clearly indicate that the majority of students prefer the option of viewing recorded lectures offline. We believe that the results reflect the fact that a large portion of external student cohorts at USQ are working professionals, who are busy with their day employment and other commitments, but would like to view recorded lectures anytime whenever possible.

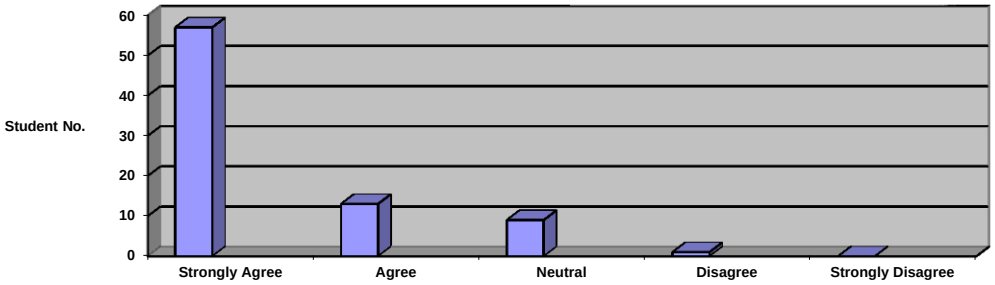

Fig. 7. Recorded lectures should be downloadable to play at a later time (not just streamed from the web).

As part of the survey, very positive written feedback was received from surveyed students in terms of user experience. Some of them are extracted as follows:

"*It's great to have some other ways of learning other than reading. Wish all my courses have this option*."

"*Recorded lectures are a valuable study tool for me as an external student. Without them can be the difference between a high mark (due to increased understanding) and a lower mark. I would love to see every subject have such lectures*."

It is interesting to note that even though the survey results show that the students found the use of tablet PCs and recording of lectures were engaging and were perceived as enhancing their learning, this was not reflected in the final grades of students when compared to previous years (without the use of tablet PCs and lecture recording). This suggest that there is a disconnect between students perceptions and their actual learning outcomes, which should be investigated in further studies.

Staff Survey Results

Staff surveys were also conducted in order to understand the perception of the staff members at USQ at the Faculty of Engineering & Surveying towards adopting the new technology in the classroom. Five engineering lecturers from various engineering disciplines at USQ participated in the survey. The engineering lecturers trialled the wireless tablet PC with five different engineering subjects.

The survey results suggest that tablet PCs are mainly used by the lecturers for recording and annotating. Some user comments from participating lecturers are quoted below:

"*Captures information that I would normally write on the board - which is now available for EXT students.*"

"*Mainly for EXT students - captures discussion which occurs in the classroom.*"

"*It is particular useful for dual-mode course delivery*."

"*I see the benefit to off-campus students from its lecture recording function.*"

"*Better understanding - less time spent on the telephone with individual trying to explain issues best explained with diagrams and sketches.*"

"*I think tablet pc was useful but had trouble with connectivity and compatibility with USQ AV system; and had to get familiarised with how to make full use of it. So it wsn't really effective or efficient at the start of it. The learning aspects is a bit tricky because at this time, we are still using the same classroom teaching methodology, whereas we should explore to see what the "real" potential of the technology can deliver for student learning*."

From the above comments and feedback, one can conclude that the lecturers are mostly satisfied with the new wireless tablet technology's ability to improve on their productivity and particularly students' learning experience. It may be concluded that though there may be potential benefits to student learning, it is unclear on the effectiveness or efficiency using this technology if it is not fully integrated into existing technologies and users are appropriately trained and skilled in using the tablet PCs.

Realising the full potential and intergreating the new technology within the current teaching methodology requires more in-depth investigation. A focus group or individual interviews with relevant users is planned to gather further insights into the utilisation and benefits of tablet PCs to enhancing student learning.

Conclusion

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 PCs if the lecturer spends most of his or her attention on the technologies rather than the engaging students.

There seems to be a disconnect between students perceptions and their actual learning outcomes in the use of tablet PCs and lecture recording. Perhaps its use may be confined as an engagement tool rather than a learning and teaching tool. Noting that the findings of this

project are preliminary in nature, further investigative work is recommended to gather in-depth insights into the utilisation and the benefits of tablet PCs in delivering enhanced learning outcomes for engineering students (not just as an engagement tool).

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