

# Experiences from a wireless-enabled tablet classroom

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## Abstract

Traditional lecture/tutorial/laboratory format employed in many university courses, despite the best intentions of teaching staff, can place students as passive receivers of knowledge rather than active participants in the learning process. Wireless enabled tablet classrooms offer the opportunity to challenge the boundaries of traditional place-based instruction so that educational considerations rather than the physical infrastructure drive the teaching and learning process (Bleed, 2001). This paper reports the outcomes of restructuring the delivery of several courses taught by two IT lecturers using mobile tablet technology to create constructivist type learning environments. Notwithstanding challenging technical problems in the first deployment, both students and staff were generally positive about the approach and willing to participate in future tablet classes.

## 1 Introduction

Like many of our academic colleagues, the lecturers involved in this project believe that learning is an active, social process where learners need to engage with and respond to the concepts, processes and knowledge of the subject matter being taught to be successful. These views are located within constructivist approaches that explain how knowledge and understanding are developed in learners (Reeves 1998; Jonassen 1996; Laurillard 1993). In common with most educators we struggle in our teaching to create learning environments that truly embody our beliefs. We find the traditional structure of university courses often inhibits and restricts our teaching choices. Technology used in traditional computer laboratories has rigid structures determined by cabling, which can impede the learning needs of students and teachers. Similarly, lectures encourage a knowledge transmission rather than knowledge construction model of teaching and learning (Laurillard 1993).

In 2003, as part of Hewlett Packard's *Applied Mobile Technology Solutions in Learning Environments Grant Initiative*, the School of Information Technology at

Charles Darwin University received a mobile classroom that included 45 tablet PCs and associated wireless technology. Using mobile technology as the enabler, we hoped to “fuzz out the boundaries” of traditional teaching blurring the distinction between lectures, tutorials and practical as distinct activities and allow educational considerations rather than the physical infrastructure to drive the teaching and learning process. The aim was to create a leaning environment that focused on the learner being an active and responsible participant in a collaborative learning process.

## 2 Learning theories

For constructivists “[r]eality (or at least what we know and understand of reality) resides in the mind of each knower, who interprets the external world according to his or her own experiences, beliefs, and knowledge” (Jonassen 1996, p. 12). This is radically different from the instructivist view, which sees knowledge and truth as existing outside the learner. “Learners are told about the world and are expected to replicate its content and structure in their thinking” (Jonassen 1991, p. 6). Thus the role of education in the instructivist view is to transmit to a learner a chosen set of skills and knowledge that helps the student learn about the real world (Tam 2000).

Constructivists view learning very differently from instructivists. Learning is concerned with the process of how learners construct and come to know knowledge as well as the results of the constructive process. Reality is different for each individual, as it is their unique interpretation of their own experiences. Teachers cannot simply map their interpretations and representations of knowledge onto students, as their experiences and interpretations are not shared (Reeves 1998, Jonassen 1996). Instead, students must build or construct their own interpretations. These individual interpretations depend upon the content, context, experiences and goals of the learner and so what is learned will depend on how it is learned. A variety of different experiences are unlikely to lead to the same understanding (Savery and Duffy 1995).

In this process, learning is active, as “information may be imposed, but understanding cannot be, for it must come from within” (Tam 2000). The emphasis here is on students as active participants, as “knowledge builders”, not simply passive receivers and reproducers of information. Knowledge is constructed through the activity of the learner in trying to articulate their own personal understandings of new concepts and ideas.

Meaningful learning demands that the information is internalised and located in a student's pre-existing knowledge representation. Learners need opportunities to reflect on the new material, discuss their tentative understandings with others, actively search for more information to throw light on areas of interest or difficulty and build conceptual connections to their existing knowledge base (Laurillard 1993). Old ideas and concepts may need to be restructured (Spiro, Feltovich, Jacobsen and Coulson 1991). Learners who actively build their own knowledge representations of the world have more ownership of these representations, which are therefore less likely to degenerate over time (Jonassen 1996).

While learners construct their own knowledge representations, "all views, or all constructions, are not equally viable" (Savery and Duffy 1995, p. 33). Learners must be able to justify their position and its viability (Tam 2000). This often happens when learners interact with others and so test their understanding and examine the understanding of others. Through this social negotiation of meaning, learners can come to a shared understanding (Savery and Duffy 1995). This accords more with Vygotsky's social constructivist theory (or cultural-historical theory) which emphasises the social and cultural interaction of the learner with others in cognitive development (Rice and Wilson 1999) rather than Piaget's personal constructivist theory where learners undertake a much more solitary exploration of their environment (McInerney and McInerney 1998).

In the learning environment there is always some stimulus or goal for learning, regardless or not whether the teacher makes it apparent. In Piaget's terms it is the new experience that cannot be explained by the current scheme and so requires accommodation (McInerney and McInerney 1998). Savery and Duffy (1995, p. 31) call it the learner's "puzzlement" and state "it is a primary factor in determining what the learner attends to, what prior experience the learner brings to bear in constructing an understanding, and, basically, what understanding is eventually constructed."

Thus constructivists see meaningful learning determined by the "complex interplay among learners' existing knowledge, the social context, and the problem to be solved" (Tam 2000). Tam believes that two characteristics are central to descriptions that have been given of constructivist instruction. The first is the problem or stimulus and the second is collaboration with others, often peers, to develop solutions. The dialogue that occurs allows learners to test and refine the validity of their understanding in an ongoing process (Savery and Duffy 1995, Jonassen 1996, Laurillard 1993).

In this environment the role of the teacher is as a guide or facilitator in creating a collaborative problem-solving environment in which students actively construct knowledge. This does not mean that the role of the teacher is less significant but that the relationship between teacher and student takes on a different dynamic. Burge (1989) describes the teacher's role as:

knowing my own strengths, weaknesses and value positions; providing resources; helping clarify the boundaries of course content; ensuring that academic rigor is maintained; and helping the learner exercise real freedoms in how learning is carried out and assessed.

For the student, the change is equally challenging. It gives greater freedom, choice and power but at the cost of accepting a greater level of self-responsibility for learning than in a more hierarchical transmission model. The prize involved in this effort is that students can take greater ownership of their own learning and experience greater commitment and satisfaction.

Based upon this research, we framed our learning principles for this project as

- Learning is lifelong – students learn all the time – with us or despite us
- Learning occurs best in a cultural context that provides both enjoyable interaction and substantial personal support
- Learning is a social process – a process of individuals actively making meaning through interaction with the knowledge community in which they are participating
- Learning requires stimulation, real problem solving and reflection
- Direct experience helps shape a learner's understanding (Pascoe, Tutty and White 2003)

### **3 Learning and the tablet classroom**

Having identified the learning principles for the project, the challenge was constructing a learning environment to embody them. As with all media and technologies the tablets and wireless technologies themselves do not have unique instructional effects. It is the instructional methods, the teaching tasks and student activities that account for learning. Reeves (1998 & 1999) argues most variations found in learning outcomes when different technologies are used can be explained by differences in instructional design, novelty effects or other such factors.

Further, the delivery mode should not and does not define the instructional approach (de Verneil & Berge 2000). Some educational objectives, however, are more easily achieved using some technologies rather than others. For example, conducting an experiment is likely to be more powerful and meaningful than reading about the same experiment (Reeves 1998 & 1999).

The first challenge for this project was to identify the strengths of the tablet classroom. What learning activities and approaches were most suited to the environment? How could they be deployed to improve the learning environment?

Over the first semester deployment, our perceptions on the tablet classroom evolved significantly and they have continued to do so as we gain more experience. Initially

the tablets were to be used in a programming class. As concepts were introduced in a lecture, students would have the chance to download code and experiment with the ideas. From these experiments, discussions on the major points would evolve. The use of digital ink technology by students to completely replace traditional note taking was also seen as important. The challenges were seen with ensuring “a seamless integration of the new generation mobile environment into the traditional lecture so that the focus would shift to being student-centred” (Pascoe, Tutty and White 2003).

#### 4 Preparing to teach with the tablets

In preparing to deploy the wireless tablets in the first semester’s teaching, a number of spot deployments depicted in *Figure 1* were trialled:

- two early childhood classrooms – 25, five year olds; 28, eight year olds; five teachers at two primary schools
- University of the 3rd Age group – 65 members of 50+
- three on campus lectures with three different lecturers, 40 first year students in Web development, 40 first year humanities students and 20 third year students in database development



Figure 1: Spot deployments

These spot deployments indicated the potential of the technology for learning with disparate groups. All

involved engaged extensively with the technology, used it for a range of different tasks and the learning curve appeared relatively small regardless of the technical experience of the user. In particular, we were astounded by the uptake amongst the very young and very old, and doubt that this would have occurred with traditional devices.

While our original concerns over the acceptance of the technology by learners and its potential for integration into a teaching program were allayed by these deployments, it was also apparent that some adjustment of our initial ideas was necessary. The integration of the tablets into teaching and the logistics of managing the physical equipment would need to be rethought.

In the three deployments into traditional lectures we had tried to enhance the traditional lecture in different ways:

- in a database lecture, the tablets were used to introduce the JADE software and the principles of OODBs.
- the web development lecture was on accessibility principles and accessed different web sites and tools during the lecture. Students were encouraged to use the digital ink for note taking.
- in a humanities lecture the tablets were used to fill in an online student evaluation.

In particular, the first two deployments were largely based on traditional lecture plans that had been adapted to include the tablets. With the tablets the dynamics of the lectures changed significantly. For example, after the database lecture, the lecturer jotted the following notes down:

Affected my teaching much more than I thought it would. The whole process was quite different and found the dynamic of the classroom changed. ... Students were intent on the tablet and responded much less. ... Felt less the centre of proceedings and less in control. ... Found it much harder to pick the mood of the students. Normally feel like I can work out if they are awake, understanding, bored etc. Couldn't pick it through the lecture.

Comments from students were also revealing. Most students appreciated being active and seemed to find it easier to focus for the two hours. A few were ambivalent but none were overly negative. Several students admitted to playing games or playing with the technology. The note taking was felt to be of limited value other than as a starting point to familiarise the students with the technology.

On reflection, these experiences align well with the shift in the role and responsibilities of both the lecturer and student that we see as a characteristic of active learning. As lecturers we were changing from the ‘sage on the stage’ to the ‘guide on the side’ (Sherron and Boettcher, 1997). Similarly students had greater responsibility for their own learning.

As a result of these experiences, we decided that if tablets were to create an active learning environment we would need to reorganise the course structure. Instead of having separate lectures, tutorials and practicals we would have one integrated 3 hour workshop where the time was used flexibly to include some direct teaching (lecture style), hands on practice in collaborative groups, and problem solving discussions. Each session would have at most 25 students

With this approach the educational enhancements would facilitate:

- increasing emphasis on social aspects of classroom learning where traditional lectures and tutorials disappear and are replaced with active learning sessions where ideas and concepts are actively explored, constructed, applied and critiqued.
- students actively engaging with learning materials, problem solving individually or collaboratively.
- the teacher's role shifting to mentor/facilitator: someone to model processes, challenge students to think more broadly and support students in this innovative environment.

Such integrated workshops overcome many of the teaching choice restrictions inherent in a traditional lectures/practicals/tutorials program. No longer need the distinction between these activities and their physical infrastructure so strongly influence the choice of teaching approach and style of learning activity. Tablet enabled workshops also overcome the rigid structure of traditional laboratories that often hinders interaction and learning needs of students and teachers.

To support the change in focus from predominantly lecturer-centred to a more inclusive learning environment the layout of the learning space was also changed. Rows of desks all facing the front of the room are unlikely to foster lively interactions between students and staff whether in private discussions or class activities. Instead grouped tables as shown in *Figure 2* were used.



Figure 2: The learning space

Changing to the workshop format required institutional support and led to a lively debate within the School. While most academic colleagues were supportive of the project some expressed reservations that the model would not provide sufficient time for instruction. One lecturer felt strongly that courses without dedicated lectures were inappropriate at the higher education level. Despite these

reservations, in semester 1, 2004, three different units used the mobile wireless technology in the new format:

- 40, first year students in an introductory Web development unit
- 20, second year students in a database unit for the first half of the semester
- 20, first year students in an Indigenous studies unit

The programming unit initially earmarked was not chosen due to staff changes within the School.

All three units relied on Web resources. Online discussion boards formed an integral component of both the Web and Indigenous studies unit. The Web and database unit also had significant practical components.

While the goal of this project was educational change, the spot deployment did raise logistic and management challenges that needed to be resolved. Some of these issues included:

- the tablets are quite heavy to move in numbers greater than three or four,
- the tablets need to be recharged after every workshop, and
- establishing/dismantling the wireless network takes time.

A locally designed and built trolley, depicted in *Figure 3*, was essential to be able to move and recharge the tablets efficiently. Familiarity with the technology and good equipment organisation helped streamline establishing and dismantling the wireless network. While now solved, at the start of the project all these equipment and management issues were time-consuming and had to be addressed if the project was to continue.



Figure 3: The trolley

## 5 Experiences from the first deployment

Unfortunately in this first semester deployment there were sufficient technical difficulties to almost totally overshadow the teaching and learning issues. This was particularly disappointing as in the spot deployments technical problems had not arisen.

The two main technical problem areas were with the University wireless infrastructure and the configuration of the tablets for classroom use. Wireless infrastructure problems included:

- not being able to get internet access outside the university domain due to issues with the network infrastructure and authentication process.
- bandwidth problems leading to network bottlenecks and slow response times
- wireless connections dropping out with users having to continually log on to the network

In the trial deployments we had avoided this issue by connecting directly to the *DMZ*<sup>1</sup> and so bypassed the authentication process. Some of the technical issues were solved with the development of a greater understanding of the wireless access points and the purchase of new equipment in this area. Some infrastructure issues were out of the control of the project members and involved the wider University bureaucracy.

At the start of 2004, the university underwent a substantial re-organisation, and inter-departmental issues interfered in the seamless integration of the technology. Unfortunately, though the infrastructure improved throughout the semester, it was not until second semester that a satisfactory level of network connectivity was achieved.

Tablet configuration issues included:

- multiple passwords for different tasks compared to student computer laboratories where a single central log in to all systems was in place
- difficulties accessing central student data storage which proved to be beyond all but the second year IT students
- slow response time of the tablet computer when using applications like word, notepad, acrobat, IE and Mozilla browsers.
- interference with network connectivity due to the default power management system within the tablets

Manually adjusting the tablet's setting improved both the response time and enabled students to have more reliable wireless connectivity. In second semester, passwords on the tablet were removed and memory sticks used instead of the central student storage. In the initial spot deployments a different image had been used on the

tablets and it was not realised how changing the tablet set-up would so negatively impact its performance.

While these technical issues were resolved in second semester they dominated the experience in semester 1, particularly the first six weeks. For example, in week 3 the Indigenous studies lecturer wrote:

... talk talk talk... then ok write something down about our discussion on the spot on the web.. no network, computers are on standby. log in, do the pix thing and then write, get halfway through writing and the wireless connection drops out, ... get the connection up and running again and then go out of IE, get back in again and do the pix thing... if I'm not careful, its going to take up too much of the time.

I can see the potential, but they are going to have to be a bit more seamless to make it work in a non-IT class??

Probably, not surprisingly a couple of weeks after this the class stopped using the tablets and moved into a normal classroom environment without any computer technology. A shame as at the start the lecturer had been enthusiastic about the potential of the technology and had written:

I can see how you can just have the machines sitting on people's desks and them actually being as invisible as paper is in the classroom. Exciting and fun stuff.

In the normal classroom, the group were obviously unable to access either the discussion boards or the extensive web resources used to support the unit. A traditional computer laboratory was not considered, as it would hinder the group work and discussions that form an integral part of this unit. The potential of the tablet classroom to overcome these limitations is indicated by the decision of the lecturer to return to the tablet classroom in semester 1, 2005.

The IT classes fared better probably as the students not only had a higher level of technical skills but were naturally more curious and interested in the new technology. This seemed to give them a higher tolerance level for the technical problems. Even so students were frustrated by the problems and this was a contributing factor in two students discontinuing from the two IT units. The technical difficulties were more marked in the Web unit than the database unit as it required more bandwidth and processing speed.

These frustrations can be seen in student responses to the question:

Outline the positive, negative and interesting aspects of the tablet computers.

A summary of the results is given in *Tables 1* and *2*. Twenty-two out of twenty-eight responded in the Web unit and eleven out of twenty-one in the database unit.

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<sup>1</sup> DMZ: demilitarized zone or subnetwork that sits between the university's network and Internet.

|   | Web unit | Database Unit |
|---|----------|---------------|
| Exposure to new technology beneficial   | 7        | 4             |
| Tablets were compact and portability  | 13       | 1             |
| Improved learning environment due to increased interaction and more flexible course structure | 4        | 4             |
| Tablets were easy to use  | 7        | 2             |
| Using the tablets was a good idea   | 2        | 1             |

Table 1: Positive aspects of the tablets

|  | Web unit | Database Unit |
|--|----------|---------------|
| Network connectivity and bandwidth were a problem                            | 13       | 5             |
| Tablets were too slow  | 5        |               |
| Problems with using the tablet (e.g. keyboard, pen or trackball are awkward) | 6        | 1             |
| Battery life was too short and ran out before the session was over           | 5        |               |
| Preferred a lab to the tablets   | 1        | 4             |

Table 2: Negative aspects of the tablets

As the lecturers in these units, we found very stressful both the uncertainty of whether the technology would work for a particular session and the lack of control, as we were dependant on others to solve the problems. Just how stressed we were in first semester has become apparent in the second semester deployment which has been substantial free of technical problems.

On the positive side, we have been impressed with the positive influence this less-obtrusive technology can have on the learning environment. The dynamics of the classes have changed with a greater focus on individual student work and an increase in both the quality and quantity of student discussion. For example, in one database session other students called upon two quiet students sitting at the back of the room to join with them in working on tutorial exercises. The lecturer was astounded as it had been done quite naturally, all involved seemed happy with the development and that interaction continued for the remaining weeks of the course.

The student response has also supported this view. 81% of the database unit and 64% of the Web unit thought that the workshop mode integrating lecture, tutorial and practical was beneficial and kept them on track more. This is very encouraging given that IT students have been

reported as being very conservative in regards to teaching and learning innovation:

Students were generally seen as conservative in terms of the types of teaching and learning activities they expected and desired in their courses, with ICT educators reporting that students were often resistant to innovative, non-traditional teaching (DETYA 2001, p xii).

Further, as *Table 3* shows, significantly more students wished to be involved in future tablet units than those who do not.

| <b>Question:</b> After this experience with the tablet computers, I would:                                   |          |               |
|--|----------|---------------|
|  | Web unit | Database unit |
| Like to be involved with another tablet class  | 6        | 4             |
| Be prepared to be involved with another tablet class if robust and reliable network connectivity was ensured | 10       | 8             |
| Don't mind either way  | 8        | 5             |
| Prefer to have all future classes in real labs   | 2        | 1             |
| Not consider a tablet class an option  | 2        | 3             |

Table 3: Involvement in future tablet classrooms

Meaningful statistics on student pass and drop out rates have been difficult to obtain. In 2004, the University substantially changed its enrolment processes<sup>2</sup> making comparisons to previous years problematical as the discontinuation rates before census data have increased dramatically. While this rise in students discontinuing before census date occurred in both the Web and database units it appears largely unconnected to the teaching approach. An analysis on the database unit showed over 70% of the students who discontinued did not attend a class and another 15% failed a prerequisite unit. The increase is also comparable to the increase observed in other IT units.

After census date, dropout data is only relevant to the Web unit as the database unit only used the tablets for another week after census date. In the Web unit the

<sup>2</sup> Prior to semester 1, 2004 students had been able to enrol at any time up to census date. Typically the numbers turning up to the first lecture were much higher than those registered on the system. Discontinuation rates tended to be artificially low as students had often not yet enrolled in a unit. For 2004, students were required to enrol in October 2003 and this produced exactly the opposite behaviour. Anecdotally, about 20% less students attended the first lecture than were registered on the system and the discontinuation rate has increased significantly.

dropout rate was 9% compared to a 26% rate in the previous year. While this is clearly encouraging, considerable caution is needed given the substantial change in the enrolment systems.

The pass rates, those achieving pass or better, are also consistent with other IT units. The database unit replaced 2 previous units and was taught for the first time in 2004. For this unit the pass rate was 83%, which compared to an 85% average rate for the previous units. For the Web unit the pass rate increased from 66% to 77%. Again care is needed in interpreting these figures, as the effect of the change in the enrolment system is hard to quantify.

## 6 Conclusions

While the first deployment was marred by technical problems it has produced some interesting results.

Firstly, as with all projects involving technology, the importance of ensuring the technology works cannot be underestimated. The integration of technology needs to be seamless and as invisible as the paper on the desk.

The tablets have a marked “wow” or engagement factor regardless of the age or technical literacy levels of the users. In an environment where at home younger people in particular have access to the richness of the Internet including interactive multimedia, simulations and games this factor should not be discounted in helping to give formal learning relevance and even validity (Elliot, Findlay, Fitzgerald and Forster 2004). As our experience showed, students valued the exposure to new technology.

For us, the most exciting aspect of this project is that we have found a course delivery method that helps, rather than hinders us, in creating the type of learning environments we believe in. Students too, despite all the technical difficulties and frustrations are still mainly positive about the technology. Early indications from the second semester deployment where the technical problems have been resolved strongly support this belief.

As Elliot (2004) writes, “for a decade education has been ‘poised’ to capitalise on the potential of technology” without yet realising it. The tablet classroom may be one of many ways this potential can be reached.

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