

Enhancing Learning Through Mobile Computing

Abstract

The mission of this chapter is to explore ways in which mobile computing via the employment of Tablet PCs can assist the human computer interaction in the design and project development process and thereby enhance learning. We follow the process of ethnographic action research and report on the learning, observations, communications of students in a multimedia program who were given the use of a Tablet PC for their second year of their degree. We discuss the educational design and customised agent software developed for this project and draw conclusions for wireless networks, and benefits and issues involved in enabling mobile computing and encouraging group dynamics among students.

Introduction

It is interesting to consider how much people learn when mobile. When on the train traveling from home to university all manner of observations might influence the way a person thinks and reinforce some learning experience. It is also often a good time to revise notes before an exam, or interview. Similarly, when walking from one lecture to another or over to the cafeteria, students may exchange information which contributes greatly to their learning. In the study discussed in this book chapter, we observe and analyse the learning experiences of students who were each given a Tablet PC for a semester of their course.

Ethnographic action research is a methodology for investigating the impact of technology on a community. It was first devised in 2002 to explore the use of computers on communities in India (Tacchi 2004). Its principles are that one change rarely impacts on only one individual and changing one aspect, may affect many other aspects of a student's life within their community.

Background

In this chapter we report our research into mobile computing and the design process. This research has been supported by HP Mobile Technology for Teaching Grant Initiative - 2004 Higher Education and we have undertaken exploratory ethnographic action research to explore and analyse to what extent Tablet PCs enhance learning within the context of students learning the design development process.

Formal RMIT student surveys¹ indicate that students would like to engage more fully with the University and fellow students in a manner that meets both their social and academic needs. Observations and conclusions drawn from this research indicate that students:

- undertake more hours of paid employment to support their study costs, resulting in increased pressure to maximise time and resources in academic hours;
- want to interact with the University in ways that best suit their personal circumstances and preferred learning practices; and
- have limited amounts of quality contact time with fellow students on campus.

¹ "The top ten student concerns" available through RMIT.

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

Tablet PCs have the potential to facilitate students' engagement with the University and fellow students in a manner that does meet their social and academic needs and our research explores the extent to which this may occur through the use of mobile computing devices.

We chose students from a multimedia design degree (Bachelor of Design (Multimedia Systems)) for this study because they spend considerable time engaged in group projects. It is also a challenging use of mobile technology as students spend considerable time generating, analysing and collaborating around images. The students are diverse, with academic interests ranging from creative media design to software development. The aim of this study trial is to explore new methods for applying mobile technologies within both formal and ad hoc study groups. Students from the multimedia design program are generally expected to work in their groups both in and outside of the classroom on design projects. Interaction between students is not moderated, rather it is supported by a learning program that emphasises team skills. Students enrolled in this program are typically local school leavers and have completed Year 12 Mathematics and English. A very small proportion are international students, mainly drawn from China.

Applications used in multimedia design are typically CPU intensive and require a large display screen with keyboard, mouse and WACOM Tablet as input devices. The Tablet PCs with digitized screen, and pen and ink technology presented an opportunity to explore the extent to which Tablet PCs would become an enabling technology for students learning design processes. A detailed description of Tablet PCs follows.

The features we believed to be enabling were the digitized screen and ink technology, wireless capability which meant we could examine the use of enabling web technologies such as blogs, and mobility which meant that students could capture inspiration as and when it occurred and store it locally on the hard drive or in a blog when in a wireless zone.

The Design Process

The design process can be described as cyclical with iterative loops whereby an initial idea is developed into a concept, Feedback is sought then the concept is expanded further into a proof of concept (in this case electronic) and finally manufactured into a product (in this case a website) that is ready for consumption with feedback sought and integrated at key junctures in the production process.

The participants in the study reported in this chapter were drawn from the students enrolled in a core second year design course of a Bachelor of Design (Multimedia Systems) degree program. In this particular course students engage in a group project where they design and build a website for a client so as to gain direct experience of working for a client with specific team role responsibilities. The student learning is scaffolded through a design and production process modeled on a simulated student – centred work based learning approach that is described in the section below.

Workplace Based Learning

Industry practice is often explored and tested in an educational institution via simulated projects that seek to meet specific and relevant learning outcomes. However a simulated

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

project can be less than effective as it often may lack critical detail and commercial imperatives to solve specific problems and challenges.

Central to the strategy of situated learning in the workplace is the direct experience and subsequent knowledge gained in the process. However, guided learning in the workplace can be limited due to commercial constraints and lack of mentoring skills and processes. In the absence of a structured pathway of learning, students are required to integrate the formal theory gained in a university and practical knowledge gained in the workplace.

“Leaving learners, particularly novices, to piece together a picture of the complex workplace environment without guidance is more likely to result in incorrect and fragmented understandings” (Cornford and Beven 1999).

The issue then is how to integrate the hands-on learning that occurs in industry and then bring that back into a formal learning environment that will assist in contextualising their experiences and skills gained.

“Guided learning can augment many of the strengths of learning through everyday activity, and also be able to address some of its weaknesses” (Billet 2001).

As Billet proposes, a combination of strategies is required to achieve a meaningful outcome for students. An integration of the strengths of the workplace based model, coupled with the benefits of a face to face learning environment (such as a tutorial seminar program) and underpinned by a lecture program would provide an effective structure in which to enhance learning outcomes.

In the absence of situated learning where students are located in the workplace, the structure of the curriculum focuses on the development of commercial projects over the duration of the semester within the educational institution. Students form small working groups within their tutorial classes and are provided with a commercial project and a client.

The design of this problem-based learning environment supports constructivist teaching and learning practices. Students are guided through a process that encourages, through the design process, a construction of knowledge and understanding based on direct experience. Savoie and Hughes (Savoie and Hughes 1994), outline several actions to put this into effect :

- Identify a problem suitable for the students;
- Connect the problem with the context of the students' world so that it presents authentic opportunities;
- Organize the subject matter around the problem, not the discipline;
- Give students responsibility for defining their learning experience and planning to solve the problem;
- Encourage collaboration by creating learning teams;
- Expect all students to demonstrate the results of their learning through a product or performance.

Mobile Computing and the Design Process

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

Like those in the design industry, students are often working together in concentrated patches, and then continue development largely on their own. They frequently juggle multiple projects and other concerns. Communication can be patchy and often is not centralized. Retrieval of communication items and files can also be unreliable. The result may take up valuable resources and development time and manifest in poor outcomes, frustration and lack of momentum.

Development of a communication strategy and document retrieval process has been implemented to facilitate the design and development process. This is made possible by the use of mobile computing in the form of streamlining processes. The group members are asked to maintain a personal blog (weblog) that is intended to provide a record of their research into their specific area of concern, and at the same time, also make this research transparent to the rest of the group. An RSS aggregate has been put in place to alert other team members that the new posts are up on the blog and can be viewed at their convenience. RSS is described in wikipedia as:

RSS is a family of web feed formats, specified in XML and used for Web syndication. RSS is used by (among other things) news websites, weblogs and podcasting. The abbreviation is variously used to refer to the following standards:

- * Rich Site Summary (RSS 0.91)
- * RDF Site Summary (RSS 0.9 and 1.0)
- * Really Simple Syndication (RSS 2.0)

Web feeds provide web content or summaries of web content together with links to the full versions of the content, and other metadata. RSS in particular, delivers this information as an XML file called an RSS feed, webfeed, RSS stream, or RSS channel. In addition to facilitating syndication, web feeds allow a website's frequent readers to track updates on the site using an aggregator.
(http://en.wikipedia.org/wiki/RSS_%28file_format%29)

RSS feeds allow people to remain up to date with changes that have been made to a blog or website that they visit regularly. An aggregator is a way of getting a customised and consolidated view of all the sites one regularly visits.

A group blog has also been set up to facilitate group communication. The groups use these in different ways:

- introduction of a new item of interest to the group overall;
- meeting minutes and actions to be taken;
- posting up documents, drafts or approved designs;
- general considerations or concerns to the group;
- miscellaneous items such as notification of next meetings, introduction of new group members and communication with tutor/exec producer.

Additionally, a client blog (now largely standard industry practice) has been put into place, with clients being given read and write access to monitor development and design of their project. This has been particularly useful in confirming outcomes and minimizing unnecessary client contact (usually in place to prevent clients being uninformed).

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

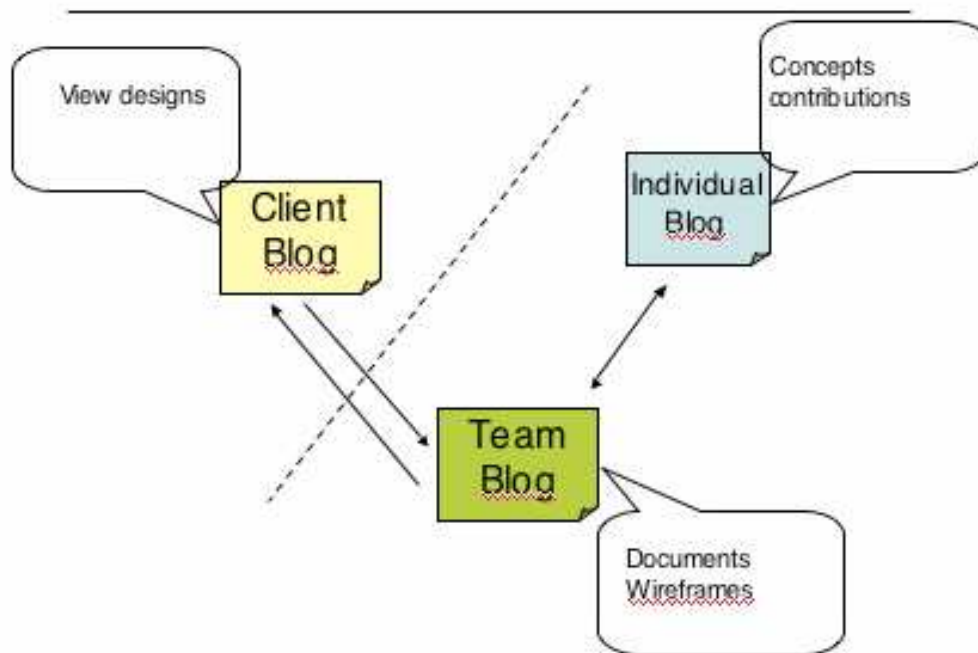


Figure 1: Team communication using three blogs

Customised agent software has also been developed to facilitate document retrieval and assist in the process of design and programming. The agent is required to locate files on the server via a server agent and report back to the Tablet holder using a Tablet agent to notify updates to files and filing systems.

The overall intention of these items is to:

- maintain communication across the groups and their clients;
- provide a map of next steps and actions;
- maintain momentum and focus throughout the design process;
- help members locate themselves within the framework of the group (particularly useful when they are involved in other projects or other commitments);
- aid group dynamics as lack of communication can contribute heavily to unsuccessful outcomes;
- enable contact maintenance with the client.

Tablet Personal Computers

Sixteen Hewlett Packard TC1100 Tablet PCs are given to the students, as well as three docking stations and two digital cameras for shared use. The Tablets have Microsoft Windows-XP Tablet Edition installed and we include the following software under University licence:

- Microsoft Office (Word, Excel, Powerpoint, Frontpage);
- Adobe Acrobat;
- Macromedia products (Flash, Studio-MX2004);
- Appropriate WiFi VPN network access software, including customised security and virus-checking software. This enables limited internet and university website access,

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

but also allows wireless communication between Tablets, which is the primary focus of this project;

- Remote access to a personalised blog server for use in delayed project-related intercommunication and archiving. WordPress is installed on a server which is rendered visible to the WiFi network for student use.

Customised Agent Software

Customised agent software has been developed, primarily for content synchronisation between Tablets within each project group, and between Tablets and blog, or server-based data storage. Major check-points in content developments are stored on a communal server and could be accessed by participants and also the project coordinator(s) for progress verification and eventual project assessment.

We include an overview of the software model or architecture employed and the role each component plays in it. As will be explained in the section below, actual student usage of the software did not precisely follow the usage patterns envisaged by the above design. However, this provides insight into the students' view of the environment, and how they adapt it for their own use.

Part of the process of designing a supportive environment includes the specification of the agent based software. It must be able to provide automated support for a range of tasks such as proactive notification to students if the group files have been updated, to ensure that they check and access any relevant changes. This removes the tedium of repetitive manual checking. Intelligent agents are a popular technology for open environments such as the internet (Singh and Huhns 2005). Small autonomous pieces of software (agents) can reside on different machines, and communicate with each other to achieve tasks. In this project we have an agent on each Tablet, which communicates with an agent on the central file server where files are located. Figure 1 shows the interaction between the agents that results in the user being notified if there are any updates.

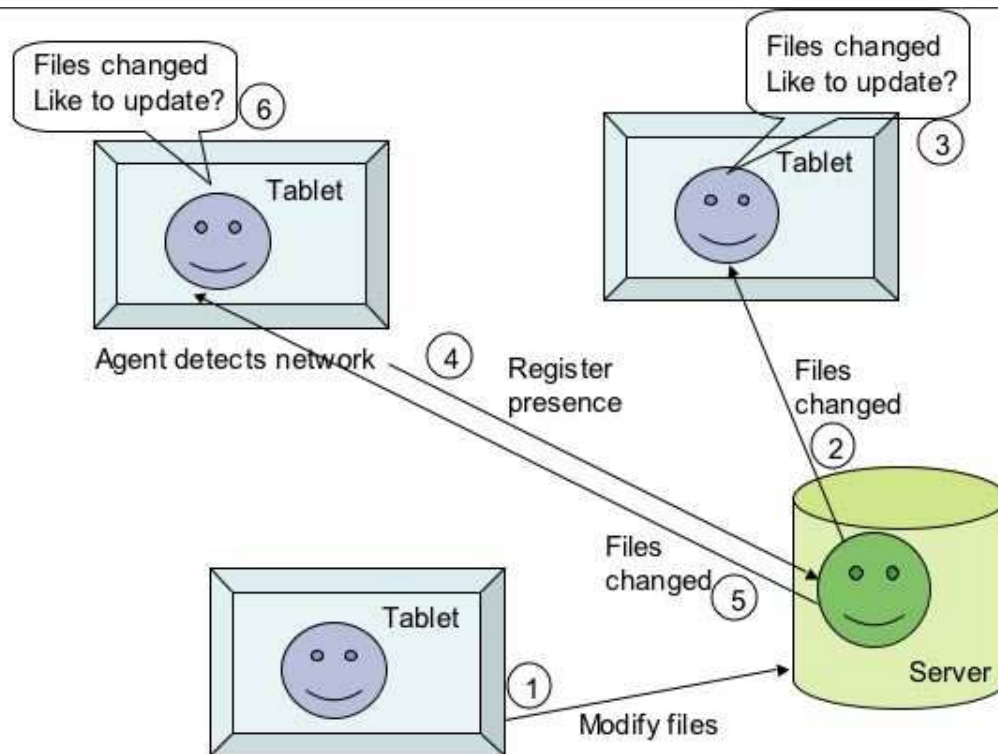


Figure 2: Specification of the Customised Agent-based Software

While this initial task is quite straightforward, it is envisaged that there will be potentially a range of automated tasks that can be performed by the agent software on behalf of, or in support of the user. The intention is to interact with students to develop the particular support they will find useful. Observation of student behaviour during the trial period indicates that the availability of the wireless network to the Tablets led to far less use of the central server and the file structure contained there than had been the case previously. Consequently we consider that it would be advantageous to adapt the agent software to better support the communication mechanisms the students actually use. For example they email versions of their files to each other frequently. While this appears to have worked for this small project, this mechanism does not offer the same level of back-up and support as does storing files on the central file server. We could, for example, adapt the agent functionality to better support the way the participants end up doing things, by having the Tablet agent recognize when new files are sent to other team members, and automatically store these into the central server.

The agent approach used is what is referred to as *Belief Desire Intention* (BDI) agents. This approach develops agents in terms of these mental concepts, as developed in philosophy, to explain how focused practical reasoning happens in humans (Bratman 1987). Beliefs are the information that the agent has (or believes it has, as it may not always be accurate) about the world, other agents, or even itself. Desires are the goals the agent wishes to accomplish – which may arise based on information from the environment: for example if a file is updated in the central repository, an agent managing that repository may then have a goal to ensure that all group members are notified of the change as soon as possible, potentially using various communication means such as email or even sms, if the user was not accessible via the network. Intentions are the plans the agents has regarding how it *intends* to accomplish its goals. If during execution of the plan, there is some problem, the agent will adapt its intentions

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

(or plans) to attempt to still achieve the goal. One advantage of this approach is the ease with which it can be adapted and evolved to manage an extremely large number of complex interactions regarding which decisions should be made. This enables the kind of support to be easily tailored to both very specific situations, and also to individual groups and/or users. For example the agent residing on a particular user's machine can build up beliefs regarding the way that user likes to work. Agent technology also facilitates pro-active behaviour on the part of the system (to achieve *desires*, or goals). The agent software can persist in trying to achieve a particular goal (of which user notification of change is a simple example), using alternative approaches if attempts are unsuccessful. This makes it possible to build flexible and robust systems in dynamic environments.

Wireless Networks

One of the problems with the implementation of the system described above is the use of a specialized network protocol for the communication between agent and server. The TCP/IP port 3500 is used as the communication port by default. Although the software allows any port to be chosen, it would need to be a previously unallocated port to avoid any 'misunderstanding' by intermediate network elements such as routers.

The use within our University of a virtual private network as the wireless medium initially causes some concern because of the necessity to customize the VPN settings for using this port. In addition, our security policies do not directly allow access to the internet (via port 80 – HTTP) and prevent direct access to the internal wired network.

As discussed previously in the section on Mobile Computing and the Design Process, students are required to access their blogs which are installed on a server on the wired intranet. For this project, special provision had to be made to enable access to this server from the wireless network. This exposed the server to the wireless network, exchanging its internal security status for the wireless security arrangements. So the safety of a private intranet needed to be exchanged for that for a VPN. Because of the differing security models for these two configurations, it would be preferable to have a wirelessly accessed server dedicated to this task alone, and any unrelated server activity be moved to a different separate internal wired server.

Research Questions

In this research, we consider the question of how Tablet PCs help human computer interaction in the design and project development process. Our focus is on:

- The immediate circle of students in terms of how they are organised, how they carry out their work and how the Tablet PC fits into their lives as students of multimedia design;
- The everyday lives of the participants, their ways of doing things and the impact mobile technology in the form of wireless Tablet PCs has on this (if any);
- The construction of knowledge and meaning through the use of blogs and the impact mobile technology in the form of wireless Tablet PCs has on this (if any);
- The wider social context in terms of access to a wireless intranet, access to mobile computing, access to a personal blog.

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

Discourse analysis and ethnography provide the base for qualitative research into the contents of the blogs, structured interviews and focus groups. Ethnography, in its literal sense, means “to write or represent a culture”(Tacchi 2004). Ethnography is an approach that may encompass several methods rather than a specific methodology. The methods are integrated to provide a holistic account of a culture, in this case, students enrolled in the Bachelor of Design (Multimedia Systems) and their use of Tablet PCs in their everyday design studies. The structured interviews, informal feedback conversations with participants recorded as field notes by the researchers, questionnaires, blogs, and focus group conversations will be integrated so that the knowledge and experience gained through one method informs the other methods. This is in keeping with ethnographic and action research principles.

Our intervention was the introduction of the Tablet PCs, the wireless network and the use of blogs. Students were provided with Tablet PCs for the whole semester and were able to carry them around with themselves wherever they went and to take them home. This allowed the Tablet PCs to become a part of the students normal daily living and learning routines.

What the Students Said

In his discussion of the computer for the 21st century, Mark Weiser introduces his concept by suggesting that:

“The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it”(Weiser 1991).

In this study, we are interested in how the students have woven the use of the mobility afforded by the Tablet PC into their lives. To this end, we administer an initial survey to measure their initial use and experience of computers generally. We find that the majority of students consider themselves as novices and have no experience of using pens with their computers. However, all indicate they believe they have average or expert internet skills. All have computers at home, and all save one has internet at home – most have broadband. The details of this questionnaire and the student responses have been published in (Berry and Hamilton 2006). These results bear out our initial assumptions about the communicative ecology of the students.

The second part of the survey is designed to collect baseline information about the participants perceived skill levels in human computer interaction. The survey items fall into several categories: drawing skills, ability to use pens and Tablets or digitised screens, ability to use wireless networks, experience with handwriting recognition software, ability to use and maintain blogs, general use of the internet to locate information, download and/or install software, ability to use mobile devices (specifically PDAs), and web design and development skills. The snapshot that emerges from the survey response data indicates that a significant number felt themselves to be either novices or average users across most items except those dealing with use of the internet to locate information, and downloading and installing software.

Insert a table showing results of the survey as percentages

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

Next, we conduct focus group meetings so we can meet the students face to face and discuss how they initially use the Tablet PCs, what they intend to do, and any issues they currently have. The questions for these focus groups may be viewed at <http://raws.adc.rmit.edu.au/~e01913/blog/> and a discussion of the results is also in our earlier paper, (Berry and Hamilton 2006), as well as selected segments posted on a University website, <http://www.lts.rmit.edu.au/mobcommec/index.htm>.

For the first semester, the students mostly work individually, however, for the second semester, they are required to work in groups on an industry-based project as discussed above. They are placed in groups regardless of whether they have a Tablet PC or not, as the majority of students in the class do not have a Tablet PC. Originally we had wanted all participants in a particular group to have a Tablet PC, however, in practice, this was not possible, as groups are composed of friendships, which are formed irrespective of how the Tablet PCs have been allocated. Each group of students has four or five members, and all have Tablets in the majority of groups, however, there are two groups where only one student has a Tablet PC, and one group where all except one member has a Tablet PC.

We analysed the focus group tapes using discourse analysis and selected the comments that best reflected the general trends. Discourse analysis is a technique that has its origins in linguistics and is also used in ethnography which examines lived experience as its subject. We allowed the students, our research collaborators, to speak for themselves. They became the experts in the uses and usefulness of the Tablet PCs. We adopted and maintained a nonjudgmental position and treated everything as valid. Sharp et al (2000) also used discourse analysis as part of their methodology to study software engineering practices. Sharp et al (2000) who followed the principle that “all views should be attended to, and given equal weight”. We also adhere to this principle in our presentation of the student views. Ethnography is not empirical in its approach to phenomena.

In this section we present the student responses reflecting their lived experience and the impact possession of a Tablet PC has had on their learning and group work practices. We asked a very open ended question that led to conversations about how the Tablet PCs fitted into their work practices in their work groups. We chose to allow their voices to speak instead of overlaying their responses with an empirical set of categories. This is in keeping with postmodern anthropology and ethnography. Clifford foregrounds the dilemma of writing about lived experience and suggests possible ways of structuring and articulating the text:

Whatever else an ethnography does, it translates experience into text. There are various ways of effecting this translation, ways that have significant ethical and political consequences. One can “write up” the results of an individual experience of research. This may generate a realistic account of the unwritten experience of another group or person. One can present this textualization as the outcome of observation, of interpretation, of dialogue. One can construct an ethnography composed of dialogues. One can feature multiple voices, or a single voice. One can portray the other as a stable, essential whole, or one can show it to be the product of a narrative of discovery, in specific historical circumstances. (Clifford 1986, p.115)

Tyler (1986) discusses the multivocal or polyphonic nature of post-modern writing that aims to set down lived experience:

A post-modern ethnography is a cooperatively evolved text consisting of fragments of discourse intended to evoke in the minds of both reader and writer

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

an emergent fantasy of a possible world of commonsense reality, and thus to provoke an aesthetic integration that will have a therapeutic effect. (Tyler 1986, p.125)

We asked the students the following question:

How are you using the Tablets so far this semester?

Their responses range from:

“I have found the Tablet extremely useful in this scenario [work group]. I have used it in a way, so as a group, we can have lunch in the cafeteria and also discuss/browse relevant internet sites- this makes it convenient and efficient instead of having lunch first then going over to the labs to discuss websites (since we are very busy students). Sometimes, when our lab is too packed, or fellow students use two computers at once to render images, etc... i take out my Tablet and use it instead. As a group, we did our proposal presentation to the client today, we had to use the Tablet to set up with the class room projector to run our powerpoints and flash files. Without this, we would have had to do it in our client’s office, which would have not been a terribly good experience.”

And

“I have used the Tablet to create the Flash, and showing other team members, and students the work. I have also used the Tablet to do other course homework.”

From students who have the only Tablet PC in their group, to:

“really good, been using it to do the wireframes, site maps and some other stuff. also working on my blog banner with it which I will be animating in Flash.”

and

“I have been using the Tablet for all of my project work this semester. Some examples are using Flash to do some test animations, using Dreamweaver to put together some html docs, and we have all been taking notes using Windows Journal. We have been attempting to create a wireless network between our Tablets for easy transfer of files; I'm still working on that...”

both from students who all had Tablet PCs in their group. Hence it would appear that while the majority of students are adopting the use of the Tablet in their immediate circle of friends, if their friends don't have one, they are becoming the note-taker, keeper of resources and demonstrator of group work for the client.

Other responses include:

“The Tablets are a great resource. When developing our proposal for our client, we took in mind that using a multimedia enriched presentation, especially for a children’s writer, allows for the group to typically show where they are heading with the project. There is nothing easier than images and animation to describe the design flow of the group. The Tablets have allowed us to work with this content and to have it displayed on big

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

projectors easily, knowing that it will work the way we want it to. We have been able to do designs on the spot for our client as well as take notes and even voice record our whole meeting so we know exactly what the client likes and dislikes about the project.”

“I am using my Tablet in every design class and also out of class for this project. It is very useful as when we have meetings we can view items on this Tablet and the work we have produced on this Tablet.”

The use of Tablet PCs is becoming part of the everyday lives of the participants and their ways of doing things.

“This semester I used my Tablet PC mainly for updating the blog and maintaining design research in folder stored on my laptop that can be easily taken from home to school.”

The students are adopting it not just for their coursework, but for their own construction of knowledge.

“I have also been using the Microsoft Journal program to consolidate design ideas and do rough sketches (as I find firework's FreeHand far too awkward because of it's vectors), so essentially I just use it as good old 'butchers paper' in terms of sketching and making notes as design ideas come to me.”

“I use the Tablet to do a lot of writing as I'm a writer, I write on the train a lot thanks to the Tablet and this writing often includes rationale for my designs to post on my blog. I use the laptop to connect to the RMIT wireless to send emails in the caf [student union cafeteria] and our group often meets in the caf so we can access the internet and do any kind of research, emailing or other internet related tasks together whilst discussing our design project.”

“People have been using them for virtually every aspect of their studies, from note taking to sketching out designs.”

“This semester I have decided to use the Tablet PC for everything. This means any notes taken, and design ideas, web page development, assignments etc I am doing with the Tablet. Thus far it has been pretty good. We have tried to establish a wireless link between the Tablets, but have been so far unsuccessful.”

Unfortunately access to the wireless network has been patchy:

“I was having a great run with the wireless access, and was looking past the constant connectivity failures. Unfortunately what this meant was that I am now getting the message that I have logged on too many times.

Other than that, the Tablet has been a success and is most definitely a very good tool in the learning environment. In regards to using the imaging and graphics software on it. The small screen has been my major issue, as well as the processor not being able to handle images with a large file size.”

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

and there have been issues with screen size. Some students have found the processing power slower, especially when they are using a large package like photoshop:

“I have decided to use the Tablet PC for everything. All note taking, all assignments, and most of my internet research via the wireless network. This has been relatively successful, although I have had many complications with wireless connectivity, and now with me getting the message saying that I have exceeded the maximum amount of login's.

I have used the Tablet for alot of the design development, and have basically transferred all of the usual things I would do on paper, onto the Tablet. All of my note taking and assignment thoughts are now done on the journal software.

More recently the PC has been running exceptionally slow. I am not sure, but I think it may be a virus. I have noticed a file labelled MediaGateway.exe which should not have been there. I must have accessed in to view something on the web. And has rendered the Tablet almost unusable at the moment. I can still operate the pc in safe mode and have uninstalled that file following the Windows instructions.

Anyway, I have backup plans in the interim, and will push on regardless. Other than this, the Tablet has been running exceptionally well and has been a brilliant asset to my development this year, and much more so this semester.”

The majority of students have found using the Tablet PC enhanced their social context in terms of their access to the wireless intranet from the cafeteria, to their interactions with their clients.

“So far this semester I have been using the Tablet pc in a number of ways. I used to the Tablet to construct the Home Hardware website proposal presentation. It was useful because I was able to carry it around anywhere my group members and I where all able to work on the presentation outside of class (eg. Cafe).

- I also used it to and from uni in the train to construct mock-ups for the website.*
- The Tablet PC was also used after our clients meetings to type up any notes which where then uploaded onto my blog.*
- I have also been using it to ‘sketch’ in ideas using the journal.”*

Some students are experimenting with the construction of knowledge beyond their immediate classrooms, to experimenting with various different new aspects provided by the mobility and wireless access to the internet:

“sketching, and listening to music. I bring it to meetings and use my handwriting to jot down notes. We haven't managed to set up msn meeting or use the agent, so it is like a laptop, to type up documentation .”

“- i'm actually utilising my Tablet quite a lot this semester. i'm currently using it for taking notes in lectures and classes, brainstorming, doing work

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

on public transport, in the city, and at rmit. i'm mainly using the programs word, photoshop, illustrator, journal, notepad on the Tablet."

"Some light flash work and using it as more of a tool to take down notes in class/lectures. More handy then a normal book that we write in as we dont have to search through annoying papers etc. Also use it sometimes in the cafeteria to research for our projects whenever other classes are taken. Very handy."

Other students are aware of these different options, but are busy enough adapting the technologies to their everyday needs as students.

"So far we are using our Tablets like normal laptops, bringing them to class and working on them with flash, photoshop and illustrator. We haven't actually made use of the Tablet function in any way as our project design is quite basic and comprised without the Tablet . It is good for us all to have one to bring and log on to wireless."

"The Tablet goes everywhere, it's my test environment at home and at uni. I keep the most up to date information on my Tablet and I access it over a network to modify files stored on it's web server. I don't think i've rebooted it for about 2 weeks, it's great to turn on and off very quickly. I'm amused on the train with it, and wherever I go I can get work done."

It's the Tablet's portability that's most valuable to me. It's very flexible in how I can use it (standing up/sitting down), and it's powerful enough to do my HTML / PHP / CSS work for the project."

"During client meetings I am using the Tablet to take notes and track the meeting."

I am also using it to check my emails at uni and to transfer data from home to uni."

"Tablets this semester are really helpful!

They have been great when working on my ideas for design and being able to show the other members in my group my work by simply turning on my computer. It almost works as a folio for me, in that i can transfer my work onto the Tablets (or even the work i have produced on the Tablets) bring it to uni and connect it up to the net to do simple things like update the blog and share my ideas with my team mates."

I have been using the wireless connect a lot more this semester- once again really helpful. Where as now we can have meetings in the caf- and not have to reply on computer rooms to be able to connect to the internet to discuss our work, and ideas during the meetings. "

Of the sixteen allocated to students in this design course, only one student found he was not using his Tablet PC, and his issues were:

"To be totally honest, I haven't been using the Tablet at all this semester. I'm finding that the Tablets are extremely slow loading and laggy. Everytime when you open up a browser, email or any application at all the system just hangs and you cannot do anything else until the application has

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

opened. On top of that, because my role consists of using the keyboard a lot, the small keyboard makes things difficult to work with, therefore, I haven't used the Tablet at all."

We have the distinct impression that the Tablet PCs with their digitized screens and capacity for wireless networking have largely disappeared in to the fabric of the students' everyday life (Weisner 1991). To check this impression we administer the final survey that contains items identical to the baseline survey. The results indicate that while their general abilities with the use of the internet remained unchanged, the responses in the other categories at the beginning of this section are all now at the Average and Expert skill level, thus indicating that the participants feel their skills have definitely improved over the study period, especially with regard to using digitized Tablets with a pen and wireless networking.

Insert percentage table of final survey

Conclusions

Implementation of mobile computing effectively facilitates the establishment of a learning community among the students. Many of the structures initially set up seem to have broader application than originally anticipated. Mobile computing assists project groups by extending their communication beyond traditional methods.

Students are able to communicate with other groups effectively and solve a wide range of problems. Instant messaging and email are a key component of contact over this semester and appear to be more prominent than previously observed. Additionally, alternate forms of record management such as document posting on secure sites to be retrieved seem to also be utilised. Weblogs are a key component in record keeping and are often linked to other student weblogs recording a series of interesting or relevant information.

Many of the strategies set up to facilitate the mobile computing in fact benefit all projects. Teaching staff are able to monitor project development with ease and often recognise issues that come up early in the piece, as the process is far more effectively documented. This has enabled early intervention and in many circumstances provided the group with clear direction to move forward and work through the challenges faced in each project.

The students are able to monitor their own work in relationship to their team members. Problems encountered in previous semesters do not appear to be the status quo with the presence of the mobile computing. There are often typical issues in the teaching and learning process such as:

- students being unprepared for meetings;
- leaving items at home and not available for discussion;
- technical difficulties of transporting files and data across platforms and via email;
- lack of opportunity for meetings with each other out of class times due to work or study constraints;
- difficulties of interpretation or communication between group members and the client;
- progress slowed by weekly meetings.

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

The capability of the Tablet PCs and mobile computing allows students to communicate, review and update their information and development strategies with fewer delays.

Future Trends

So far our findings have been encouraging. However, our investigations have opened up further avenues to explore and have posed future research questions relating to allowing all students access to Tablet PCs for all their courses.

Our tentative answers and areas to explore include the following ideas about Tablets:

- They help students by providing a communication strategy to expand and support development process;
- They provide a platform for the development of ideas;
- They provide an immediacy to what students are doing, by-passing some pen and paper steps (An aside: we noticed 40% of students in the cafeteria in Building 8, on Thursday July 28, at 10:30am were using notebook computers);
- More information and record-keeping can be provided at meetings;
- Projects are moving along faster
 - more ground work is being covered in a more sophisticated way;
 - can see progression of ideas;
- not losing information – scraps of paper are easily lost, misplaced;
- they enable centralizing notes, sketches, media, stuff.

Acknowledgements

The authors acknowledge the help and support of Dr Jim McGovern, Associate Professor Vic Ciesielski, Professor Mark Shortis, Evan Smith, Laurie Davies, Matt Maddocks all members of the HP Mobility Grant team within our University. Also, this research is partially funded by HP by means of their HP Mobile Technology for Teaching Grant Initiative - 2004 Higher Education.

Bibliography

- Berry, M. and M. Hamilton (2006). Mobile Computing, Visual Diaries, Learning and Communication: Changes to the Communicative Ecology of Design Students Through Mobile Computing. the Eighth Australasian Computing Education Conference (ACE2006), Hobart, Tasmania, Australian Computer Society, Inc.
- Billet, S. (2001). Learning in the workplace: Strategies for effective learning. Sydney, Allen & Unwin.
- Bratman, M. (1987). Intentions, Plans, and Practical Reason, Harvard University Press.
- Cornford, I. R. and F. A. Beven (1999). "Workplace learning: Differential learning needs of novice and more experienced workers." Australian and New Zealand Journal of Vocational Education Research: p 28.
- Savoie, J. M. and A. S. Hughes (1994). "Problem-based learning as classroom solution." Educational Leadership: p 54-57.
- Singh, M. P. and M. N. Huhns (2005). Service-Oriented Computing: Semantics, Processes, Agents, John Wiley & Sons, Ltd.
- Tacchi, J., Slater, D., Hearn, G. (2004). Ethnographic Action Research.

Enhancing Learning Through Human-Computer Interaction

EDITOR : Elspeth McKay PhD

Weisner, M. (1991). "The Computer for the 21st Century." Scientific American: 94-110.

Sharp, H, Woodman, M and Robson, Hugh. Using Ethnography and Discourse Analysis to Study Software Engineering Practices.
doi.ieeecomputersociety.org/10.1109/52.819967
IEEE Software January/February 2000 (Vol. 17, No. 1)

Tyler, S. 1986 'Post-Modern Ethnography: From Document of the Occult to Occult Document', in Clifford J and Marcus GE (eds) *Writing Culture: The Politics of Ethnography*, University of California Press

Clifford, J. 1986, 'On Ethnographic Allegory', in Clifford J and Marcus GE (eds) *Writing Culture: The Politics of Ethnography*, University of California Press

Clifford, J and Marcus, GE (eds) 1986, *Writing Culture: The Politics of Ethnography*, University of California Press.