

INTEGRATING MOBILE TECHNOLOGIES INTO THE CONSTRUCTION CLASSROOM: DRIVERS AND CONSTRAINTS FOR UBIQUITOUS COMPUTING

K. Davies, C. Prigg

Unitec Institute of Technology

kdavies@unitec.ac.nz

ABSTRACT

Within Unitec Institute of Technology, the Department of Construction is currently planning the introduction of mandatory use of laptops or other mobile devices within the Bachelor of Construction programme. This paper explores the principal drivers and constraints around formal integration of mobile technologies, also referred to as ubiquitous computing, into the construction teaching environment.

Many studies investigating the impacts of mobile technologies have identified benefits to students from their use in the classroom. These stem partly from the skills developed by the students from exposure to technology as well as from specific software and applications related to the subject matter involved. In addition, however, there are potentially significant gains to be made in student engagement and active learning, student directed learning and collaborative and group learning. All of these aspects support the Unitec Living Curriculum model. In contrast, unstructured or unmanaged use of technology in class has been shown to cause significant problems in student attention, disruption to other students and to be generally detrimental to learning.

Interviews with staff and students indicate that there is strong support for such a move, but a number of concerns have also been identified that require resolution before any such change can be fully implemented. Key limiting factors include the provision of devices and specification of minimum standards; infrastructure including wireless capacity and room design; and staff access to technology and development opportunities. On the positive side, cloud computing offers significant potential for enhanced computing power and consistency in classroom applications.

Keywords: Construction education, computers, mobile technology

BACKGROUND

In the current construction environment, computers have become widely accepted as essential tools in many industry roles. Correspondingly, education providers need to ensure that students have the opportunity to learn up-to-date skills, and also to experience some of the more cutting-edge technology that leading industry players are embracing. For the Bachelor of Construction (BCons) programme at Unitec Institute of Technology, the emphasis on greater integration of computing tools and skills into existing courses has put increasing pressure on resources.

For many courses, computer labs are too small to allow one computer per student. In addition, there is pressure on labs as many other disciplines compete for access. The most common approach to managing this dilemma is to base learning around group activities, with students sharing computers. However, it is difficult to ensure that all students are able to get hands-on experience during class time. Alternative solutions are to divide the class and use two separate computer labs, with the lecturer either enlisting a second person to assist or dividing their time between the two locations, or to use one computer lab but at different times, with the lecturer repeating the class for each group. Less structured computer training is also an option, where the lecturer demonstrates the computer-based activity in a lecture room, or where students are provided with on-line tutorial material, and student work on the computer-based activity is completely out of class using their own computer or student labs.

An increasing number of students are now choosing to bring their own laptop computers or other mobile computing devices into the classroom. This prompted an exploration of the possibility of instituting a formal requirement for students on the Bachelor of Construction programme to bring their own devices for use in teaching and learning, in order to create a ubiquitous computing environment. The aim of this paper is to explore the principal drivers and constraints around formal integration of ubiquitous computing into the BCons. A review of literature helped to identify some of the challenges and opportunities that arise from such a move, and unstructured interviews with staff and student representatives contributed additional viewpoints. This paper seeks to examine a number of the central issues identified, and reports on current progress.

INSIGHTS FROM LITERATURE

Mobile technologies - models of use in education

The use of mobile technologies within a learning environment is commonly categorised into three models (Kay and Lauricella, 2011): rejection (students are not permitted to use mobile technologies in the class); unstructured (students may use mobile technologies if they wish but their use is effectively ignored by the teacher); and structured

(deliberate integration of mobile technology-based activities into teaching and learning).

Rejection model

Despite a widespread emphasis on e-learning in higher education, many universities, programmes or individual teachers completely exclude laptops, tablets and mobile phones from classrooms. Where mobile technology use is rejected, teachers' reasons usually focus around the distractions that it creates for students. Some also cite the disparities created between those students who have access to the technology, and those who do not, and see a ban on in-class use of technology as 'levelling the playing field' (Young, 2006).

Another form of the rejection model is to allow mobile devices into the class but to control wireless availability so that the internet is less accessible. Removing access to wireless is seen as a compromise that allows students to use note taking tools and programs while excluding the range of distractions offered by the internet through games, social media, email and messaging, etc. However, this approach also precludes the use of internet-based material or tools by teachers.

Critics of the rejection model argue that there are always distractions available to students, regardless of the accessibility of devices or the internet. They suggest that the fault lies not in the technology but in the way the teacher negotiates and articulates expectations around acceptable behaviour (Young, 2006).

In addition, mobile technologies now play a fundamental role in the way students find and manage information. If these tools are excluded from the formal learning environment, an artificial barrier is created between how and what students learn "in the real world", and the approach presented to them for learning for their degree and beyond. Workplace applications of mobile technologies are also ubiquitous, especially in the construction industry (Bowden et al., 2006), and so to disassociate education from the realities of what students will encounter in practice not only disadvantages them in the future but also leaves them feeling that what they have learnt is not current or relevant in their career.

Unstructured use model

Unstructured technology use appears to be a common model in universities, where students have gradually adopted a variety of technology options and integrated them in an ad hoc fashion into their own learning environments. This has accelerated with the recent increase in availability and affordability of smart phones in particular, but also applies to laptop and tablet use. Few students now do not have constant access to computer tools and the internet (Gong and Wallace, 2012).

Overall, unstructured use of mobile technologies appears to be the most problematic model, and is the scenario imagined by teachers who consider technology to be a problem because of the inherent distractions (Fried, 2008; Lindroth and Bergquist, 2010). Problems arise from the amount of time individuals spend in off-topic activities, especially social media and email, or in partial-attention activities (ie switching between on-topic material and pop-up windows for chat or instant messaging). In addition, students without access to the technology may be distracted by both off-topic and on-topic activities on other users' screens. Specific teaching activities designed to make use of the technology available are not possible because not all students have access to the same interface or applications.

Structured use model

Structured use of mobile technology requires integration of devices and software into in-class activities, so that students can make use of the technology in a managed and directed manner. This may require all students to use the same or equivalent devices and software, for example. It also implies changes to teaching practice and is not possible by simply adding mobile technologies into a traditional lecturing context.

Ubiquitous computing can result in a significant improvement in student productivity and engagement, although the findings on overall student outcomes are mixed. However, it has been suggested (Kay and Lauricella, 2011b) that poorer results come from attempts to integrate technology into courses where there is no obvious need or application for that technology.

Educational benefit

Student skills development

Through the use of mobile technologies, students can be given access to a variety of skills that transfer into other learning contexts as well as into the work environment. These may be from increased or in-depth use of course- and industry-specific software that is harder to achieve in a lab context, or in general computer skills and digital literacies that apply in a wide range of situations.

There is often an assumption that today's students are comfortable and familiar with technology (ie "digital natives"), and therefore there is no need to teach them the underlying skills around use of the technology in an educational setting. Not only has this been shown not to be the case (Margaryan et al., 2011), it has also been identified that students often have an inflated perception of their own proficiency (Grant et al., 2009). Although the majority of students use technology extensively, they do not use it with any degree of sophistication, and have a low level of understanding of what tools are available or how to use them effectively.

Learning contexts

Integrated use of mobile technologies in classroom learning has the potential to deliver real benefits. It offers the opportunity for real time feedback on student work from both the teacher and other students; it allows students to engage with models or materials beyond what would normally be available within the limits of the classroom; it provides a medium for shared project development in group work; and it facilitates a variety of approaches for student assessment and self-assessment.

A secondary benefit of the adoption of mobile technologies within a programme is that students then have access to the device when they are out of class as well. At the very least, this leads to greater familiarity with the capabilities and use of the device, which can support classroom activities. Where the students have internet access they can connect with further activities that develop skills or knowledge, allowing them to build on what they have learnt or to prepare for other course work. They can continue to contribute to discussions or shared projects outside of class times.

Pedagogical impact

Teaching methods

Changes to teaching methods are required for effective use of mobile technologies in the classroom (Kay and Lauricella, 2011b). If students are using the technology as a replacement for pen and paper in note taking, they will gain only limited benefit from the activity and are likely to become distracted. A traditional lecture will face competition for students' attention from the wide variety of alternative activities that mobile devices and especially internet connectivity offer. This situation is the reason why unstructured technology use becomes a negative influence in students' learning.

Students need to take part in active learning in order to optimise the benefits of mobile technologies in the classroom. The technology has to be integrated with the course delivery so that the technology drives the learning and is less likely to become a distraction. Similarly, the technology must work with the course content and not simply be overlaid on a course which has no real need for it (Kay and Lauricella, 2011b).

Resource development

There are challenges for teachers adapting existing teaching material to make full use of mobile technologies. The time required for familiarisation with software and other tools, and the often intensive process of developing new ways of presenting and connecting students with content, are frequently cited as the reasons for limited adoption of e-learning (MacKinnon, 2007). Effective technical and teaching support is necessary to help staff make the transition to greater use of the technology.

INSIGHTS FROM INTERVIEWS

Staff perceptions

Current teaching in the Department of Construction at Unitec reflects a largely unstructured use of mobile technology. However, different lecturers take different standpoints on what is considered acceptable use, with some restricting use of laptops and tablets altogether (while noting the surreptitious use of smart phones), others requiring students to close laptops during lectures but allowing access during group and individual activities, and others taking a laissez-faire approach with no restrictions. Students have been observed in on-topic activities such as note-taking, access to Moodle (Learning Management System) for lecture slides and other related material, general searches for further information related to the lecture topic, and work on assignments which connect lecture material to assessment activities. Commonly identified off-topic activities include unrelated Google searches, YouTube videos, Facebook and other social media, email and games. None of the lecturers interviewed currently incorporate smart phone activities into their teaching, although several identified Twitter as a possible in-class feedback mechanism. Smart phone use by students during class time was identified as almost always off-topic, for texting, games and social media such as Facebook.

The majority of staff interviewed were dissatisfied with current arrangements. However, student use of their own mobile devices in a classroom setting was not considered sufficient in addressing this problem. The main issue raised was the layout of lecture rooms, which prevent the lecturer from moving around the class to interact with individual students. The availability of appropriate teaching spaces was identified as a high priority to enable ubiquitous computing.

Student perceptions

While the majority of students have mobile devices and are highly connected, there is a minority who have very limited use of mobile devices. This includes not having (or using) mobile phones for text messaging and phone calls, let alone internet access. Several students commented that they would find it difficult if greater emphasis were placed on e-learning and use of internet outside of class, as they have only slow dial-up connections at home, or no internet access at all.

CORE CHALLENGES

Provision and cost

One of the key questions raised by both staff and students was how to ensure the required devices are affordable to students. This depends significantly on hardware and software requirements, but also includes additional factors such as insurance, and maintenance and repair costs.

There are essentially three models of provision available:

Student ownership - course fees

The most common model internationally appears to be the case of student ownership, with the devices purchased by way of increased course fees. This is an attractive model in the New Zealand context, because students are able to borrow the money through the student loans scheme as it is then part of their compulsory fees. The advantage for teachers is that all students are working on the same device, with the same software (at least initially), improving the consistency of instruction or advice that can be provided.

Drawbacks to this approach are that students may already own or have access to mobile devices that then become redundant. Students' perception of value for money in this model may be a problem (Orr et al., 2008), since they have to pay the fees and have no choice over the type of device or the software and peripherals that come with it.

Student ownership - self-purchase

The easiest model when moving from unstructured to structured use of mobile devices is to require students to purchase the device themselves. This allows those who already own a device to continue to make use of that. Those who have not already bought a device get control over what they spend their money on. Full-time students have access to \$1000 for course-related costs through the student loan scheme, which could be used for this purpose, although this necessarily restricts the device specifications and software.

Some degree of compatibility between devices can be achieved by stipulating minimum specifications, but there is scope for a wide variety which is likely to give rise to inconsistencies between different operating systems or different software versions.

One problem with this model is that not all students will have their devices ready to go at the start of the course, and may take days or weeks to make the purchase and be ready to actively participate in the course. Students will also need to purchase software, and arrange their own insurance and technical support. Another issue is that of equity, where students who can only afford the minimum specification may be at a disadvantage compared with students who can afford more advanced hardware or software, or have it provided by an employer.

Department ownership - lease or long-term loan to student

Alternatively, the department can retain ownership of the devices, and provide them to students on loan or lease arrangements. This would also be based on adding a charge to course fees, but the cost to students would be lower as they do not retain ownership of the device. This allows

upgrades of the device over time so that students are not required to use the same (potentially out-of-date) model for their entire degree.

This approach can result in students adopting a low level of responsibility towards the device, and so damage is likely to be greater. There may be debate around responsibility for maintenance and repair costs when the student does not have ownership of the device. This also leads to a problem around availability when there are technical issues, with students believing that the programme is responsible for providing them with devices for use in class.

IT support

The most pressing need for IT support is a commitment to wireless provision that meets the needs of the students. Once teaching spaces have been established and upgraded to support the wireless requirements, there should (in theory) be no problem in maintain access to them for our teaching, as the wireless access needs would get priority for timetabling in those spaces.

Ergonomics/room layout

The current design of lecture rooms is a very poor layout for e-learning classes. Seating in rows is not appropriate for collaborative learning, as all students see are the backs of their colleagues. Such an arrangement also does not allow for interaction with the lecturer. This factor was identified by staff as the key reason why integrated technologies in the classroom could not replace computer labs altogether. The other physical concerns noted from the literature were the impact of lighting and windows on screen visibility, and changes in air conditioning requirements due to the increased equipment load.

OPPORTUNITIES

Building Information Modelling (BIM)

The Department of Construction is progressively integrating Building Information Modelling (BIM) into all aspects of the Bachelor of Construction programme. Although individual access to mobile technologies is not essential for use of BIM, such a move would allow independent active learning to a much greater degree. In particular, it would be useful for students to be able to work with 3D and 4D visualisation tools in class. In-class computing would allow these tools to be integrated with taught material, so students could actively explore models, rather than passively observing while having them demonstrated.

The desire to work more extensively with BIM technology and integrate it with other course material was expressed both by students and staff. BIM was perceived as a key driver for greater use of computers in the BCons.

Cloud computing

Leading practices in the construction industry are now adopting cloud computing as a platform for improving collaboration and integration (Zhang and Issa, 2012). The introduction of a cloud environment has the potential to work well in combination with mobile technologies. Establishing a cloud platform which supports all of the software required by the students reduces the computing requirements of the devices they need. This removes the equity issue by putting all students on equal footing regardless of the sophistication of the equipment they are using. It also removes the problem of inconsistencies between different operating systems and different software versions. Software upgrades would all be managed centrally and all students would have access to the same version.

The disadvantage of a cloud environment is that the wireless requirements become much higher as all of the course work takes place over the internet rather than on local computers.

CURRENT PROGRESS

The Department of Construction has opted to implement a ubiquitous computing model for the BCons, which will require students to own an appropriate mobile device in order to participate in the course. There are clear educational benefits from adoption of such technology for in-class activities. Conversely, there are well-documented problems stemming from unmoderated and unstructured use. Since the Department considers it counterproductive to ban use of mobile devices in classes, it is necessary to actively engage with the technology and make it an integrated part of the course.

A move to cloud computing is being considered in parallel with the move to ubiquitous computing. This provides a valuable level of standardisation of software and access across all devices used and removes the requirement to dictate the type of device required by students. It also provides a connection to leading practice in the industry.

The model for ownership of devices is still being established. The favoured option currently is that students be responsible for purchase and provision of their own devices, to a specified minimum standard. Because of the limit of \$1000 available through Studylink for course materials, the Department is working to ensure that the minimum specification is easily affordable within this amount. The decision to pursue a cloud computing platform simplifies the specification requirements.

Institutional support in terms of wireless connectivity and provision of suitable teaching spaces is currently under discussion.

REFERENCES

- Bowden, S., Dorr, A., Thorpe, T., Anumba, C. (2006). 'Mobile ICT support for construction process improvement', *Automation in Construction*, 15(5), pp. 664-676.
- Fried, C. B. (2008). In-class laptop use and its effects on student learning. *Computers & Education*, Vol. 50(3), pp. 906-914. doi: 10.1016/j.compedu.2006.09.006
- Gong, Z., Wallace, J. D. (2012). 'A comparative analysis of iPad and other m-learning technologies: Exploring students' view of adoption, potentials, and challenges', *Journal of Literacy and Technology*, 13(1), pp. 2-29. Retrieved from <http://www.literacyandtechnology.org>
- Grant, D., Malloy, A., Murphy, M. (2009) 'A comparison of student perceptions of their computer skills to their actual abilities', *Journal of Information Technology Education*, 8(1), pp. 141-160. Retrieved from www.jite.org
- Kay, R., Lauricella, S. (2011a). 'Unstructured vs. structured use of laptops in higher education', *Journal of Information Technology Education: Innovations in Practice*, 10, pp. 33-42. Retrieved from www.jite.org
- Kay, R. Lauricella, S. (2011b) 'Exploring the benefits and challenges of using laptop computers in Higher Education classrooms: A formative analysis', *Canadian Journal of Learning and Technology*, 37(1), pp. 1-18. Retrieved from <http://cjlt.csj.ualberta.ca>
- Lindroth, T., Bergquist, M. (2010). 'Laptops in an educational practice: Promoting the personal learning situation', *Computers & Education*, 54(2), pp. 311-320. doi: 10.1016/j.compedu.2009.07.014
- MacKinnon, G (2007) 'A decade of laptop computers: The impact on the pedagogy of university faculty', *Journal of Instruction Delivery Systems*, 21(3), pp. 7-20.
- Margaryan, A., Littlejohn, A., Vojt, G. (2011) 'Are digital natives a myth or reality? University students' use of digital technologies', *Computers & Education*, 56, pp. 429-440. doi:10.1016/j.compedu.2010.09.004
- Orr, C., Sherony, B. and Steinhaus, C. (2008) Student perceptions of the value of a university laptop program. *College Teaching Methods & Styles Journal* 4(6) 23-30. Retrieved from <http://journals.cluteonline.com>
- Young, J.R. (2006). 'The fight for classroom attention: Professor vs. Laptop', *Chronicle of Higher Education*, 52(39), pp. A27-A29.
- Zhang, L. and Issa, R. (2012) 'Comparison of BIM cloud computing frameworks', *Computing in Civil Engineering* (2012), pp. 389-396. doi: 10.1061/9780784412343.0049