

## **Post-PC devices: A summary of early iPad technology adoption in tertiary environments**

**Glen D. Murphy**

School of Management

QUT Business School

Queensland University of Technology, Australia

Email: [gd.murphy@qut.edu.au](mailto:gd.murphy@qut.edu.au)

### **ABSTRACT**

*In just under 3 months worldwide sales of Apple's iPad tablet device stood at over 3 million units sold. The iPad device, along with rival products signify a shift in the way in which print and other media products are purchased and consumed by users. While facing initial skepticism about the uptake of the device numerous industries have been quick to adapt the device to their specific needs. Based around a newly developed six point typology of "post-PC" device utility this project undertook a significant review of publicly available material to identify worldwide trends in iPad adoption and use within the tertiary sector.*

**Keywords:** m-learning, ubiquitous computing, e-learning, mobile technologies, iPad.

## Introduction

In 2010 Apple released its much anticipated tablet computing device into the market. The nature of the device and its utility was much debated prior to and immediately after its launch. Opinions were divided as to whether the device indeed represented a “new category” of computing device or whether this was yet another example of Apple’s now legendary hype. One year on and into its second variation (iPad 2) doubts as to whether consumers would vote with their wallets are few and far between. To date the total number of iPads sold worldwide is over 20 million units sold with an average 1000 device activations per month in the United States (Etherington, 2011). While the sales figures are impressive, the most significant aspect of the iPad phenomenon is the extent to which corporate environments have adopted what essentially began life as a consumer media-consumption device. Pundits are now referring to these devices as post-PC devices (PPDs), a recognition that this type of device perhaps does indeed deserve its own category, possessing significant differences over and above existing desk-bound or mobile technologies such as smart-phones and laptops (Melhuish & Falloon, 2010). While many within the education sector have talked in general terms of the potential of PPDs, the nascent nature of the devices presents some difficulties in determining exactly how they can be used in the tertiary sector (Brand & Kinash, 2010). The first aim of this paper is to present a typology of PPD capabilities underpinned by the e-learning, mobile and ubiquitous learning literatures. In summary a six-point typology is presented around the capability of PPD’s in tertiary education contexts including: course materials; enrolment and administration; content generation; research and material yielding; collaboration and engagement; and productivity enhancement. The second aim of the paper is to gain insight into the various ways in which PPDs are being used in the university sector, with a survey of universities identified as using the iPad 12-18 months after its release. The paper concludes with a number of observations and considerations for future research and practice.

### **m-learning, ubiquitous computing and the iPad**

While the origins of e-learning date as far back as the 60’s, the nature of technology facilitated learning has experienced exponential rates of change even in the last decade. Unsurprisingly this has been mirrored by a transition in the literature from discussions of e-learning, to m-learning (mobile-learning) and now more recently, the idea of ubiquitous learning. Sharples & Rochelle (2010) discuss the emergence of a “third phase” of mobile learning where learning becomes embedded in everyday life, citing augmented reality as an example where mobile devices offer sophisticated learning opportunities. The existing literature in the ubiquitous and m-learning literatures note several advantages available to tertiary education stakeholders flowing on from the use of mobile technologies (see Table 1 for a summary). Melhuish & Falloon (2010) for example outline five capabilities offered by mobile devices including portability; affordable and ubiquitous access to content; situated “just-in-time” learning opportunities; connection and convergence to other devices, networks and technologies; and finally, individualized and personalized experiences. Taking a slightly more sophisticated approach Park (2011) presents a “mobility hierarchy” arguing that mobile technologies offer

capability in four increasingly sophisticated areas; enhancing productivity; allowing flexible physical access; enabling the capturing and integrating of data; and facilitating communication & collaboration. Park (2011) then overlays a continuum of collaboration (from individual to group activities) suggesting that a key advantage of m-learning is its ability to allow students a mechanism to transition between both individual and collaborative learning spaces with ease. Peng, Su, Chou & Tsai (2009) extend the debate, considering the potentially deeper implications of curriculum design in the context of ubiquitous computing. One of their key arguments centres around the ability of emerging ubiquitous technologies to drive curriculum design based around “student-centred learning”. Consistent with others in the field (e.g. Sharples, 2000) they consider social constructivism as a fundamental component of future curriculum design, regarding mobile technologies as the key mechanism underpinning collaborative knowledge acquisition, student managed learning and individualised self-driven discovery (Cresente & Lee, 2011). Of particular interest however is a review by Wang et al. (2009) noting that the full potential of m-learning was hampered by mobile technology limitations including small screen sizes, lack of data input capability, short battery life, limited processing power and low storage capacity.

**Table 1:**

*Advantages of mobile devices in the facilitation of learning objectives*

Park, 2011	Sattler et al., 2010	Melhuish & Falloon 2010	Peng et al. 2009	Muyinda 2007	Pettit & Kukulska-Hulme 2007	Motiwalla, 2007	Sharples, 2000
Physical access to content		Access to content		Connectivity	Access to content	Connectivity	Available anywhere
	Blending of formal & informal learning environments	Situated learning opportunities			Ubiquitous learning	Ubiquitous learning	Adaptable to learning opportunities
	Learning as an act of self-service	Individualised & personalised learning	Student-centred learning	Individualised learning	Self-publishing & on-line participation	Personalised content	Individualised learning
Enhanced productivity	Housekeeping administration				Multi-tasking		Useful & easy to use
Capturing & integration of data				Context specific data capture			
Collaboration & communication device	Facilitating teamwork & community			Social interactivity	Sharing ideas and information	Collaborative content	
		Portability		Portability			Portable
		Affordability					Unobtrusive

It is not the intent of this paper to provide an extensive overview of the technical attributes possessed by PPDs (e.g. Meurant, 2010) rather it is concerned with the capabilities of these devices to facilitate teaching and learning in a tertiary context. In summary however PPD’s such as the iPad are

highly portable (between .5 – 1kg), are able to connect to the internet via wireless or by 3G/4G network; typically have a viewing surface of 7"-11"; possess extended battery life (10hrs); a high degree of possible user-customisation via multiple applications (apps); a sophisticated high definition touch-screen interface (Meurant, 2010) and "offer all the functionality and connectivity of a laptop with the portability of a smart-phone" (Melhuish & Falloon, 2010, 5). As such, current and future PPD devices appear to address most if not all of Wang's (2009) concerns with the capabilities described above. Therefore in light of the technological advancements represented by PPDs and in response to observations such as those made by Brand and Kinash (2010) and Park (2011) regarding the "unknown quantity" that PPDs represent, the remainder of the paper provides specific insight into the capabilities of PPDs from an education provision perspective. Building on previous work in the m-learning and ubiquitous learning literatures, and extending it by virtue of the new capabilities offered by PPDs a newly developed six-point typology of PPD utilisation is put forward. As such this work aims to highlight the functionality of PPDs over and above their technical specifications. In doing so I demonstrate how PPDs represent a potentially significant step-forward in realising the benefits offered by m-learning, but not fully realised to date due to previous device limitations. Each typology is discussed in detail below before presenting a summary table of thirty-six universities surveyed in relation to their utilization of Apple's iPad during 2010-2011 (see Table 2.0 below).

### **Typology 1 – Ubiquitous Access to Course and Subject Materials**

One of the most obvious capabilities of PPDs is their ability to act as highly efficient repositories and delivery mechanisms for course materials. The advantages of PPDs in this context are extensive, beyond the most obvious advantages of portability and immediacy of access to digital content. Melhuish and Falloon (2010) make the observation that often the education sector adopts and forces the use of technologies perhaps unsuitable for a learning environment. At its most fundamental the iPad in particular is a first and foremost a media consumption device. Specifically designed with multi-media and e-book reading in mind, PPDs such as the iPad would appear to be ideal candidates for the delivery of course content, particularly given the increasingly dynamic nature of course content beyond the print text-book. The ability to store a vast diversity of materials such as interactive e-texts, PDF files, slideshows, videos, podcasts, and word processing documents on one highly portable and readable device has clear advantages to both educators and students (Economides & Nikolaou, in-press). Universities may choose to develop their own custom applications to manage lecture and course content delivery or instead use commercially available applications that operate in the wider context of their learning management system. For example, the BlackBoard application offers students a mobile platform to manage and interact with their course content including accessing reading material, lecture material, submitting assessment, view grades and to collaborate with fellow students. Examples of this in the field include the University of California Irvine Medical School who deployed iPads to their medical students with preloaded coursework for the entire year [[LINK](#)]. The device hosts podcasts, online tutorials and activities that students can review before group meetings and class discussions. The university has also

developed a digital stethoscope application that is currently being tested. In Australia the University of Adelaide's Science department are providing iPads for their first-year science students in 2011 (Cross, 2010). This will enable students to access lecture notes, documents, and textbooks through tailored web-based apps. This is a long term initiative for the university and it has reported it will take some time to phase out text books and transfer all content to the iPad.

### **Typology 2 – Enrolment and Administration**

A fundamental aspect of university life often ignored is the enrolment and administration activities that are essential to the smooth running both of a university and the successful completion of an individual course of study. In order to progress through their course students are often required to select units to complete on a semester by semester basis, manage their tutorial schedules and tuition fees. Of course it is in the interests of the student and the university that these activities are as resource efficient as possible. However the rise of ubiquitous computing in society is a double-edged sword for university administrators - while the increasingly flexible nature of technology allows universities to push tasks once handled by administrators to students, students also have a greater expectation that these tasks be able to be carried out as, when and where they desire. While many universities have moved to on-line portals that allow students the ability to manage their course enrolment via the Internet and while it may have been theoretically possible to interact with these portals with a smart-phone, issues around navigation, browser compatibility and small screens reduce the utility of this capability. In addition to PPDs having improved navigation capability (by virtue of their larger screens) the ability to purposely build an application allows the potential for a highly customised student management interface that is less subject to the vagaries of browser requirements and device displays. While less common than Typology 1 there are some examples of universities exploiting this capability. Duke University students and staff owning an iPad can now access the Duke University Blackboard application. Although Duke recognizes that this app is similar to the web browser version, the mobile app is considered a more user-friendly experience for accessing course content and online discussion boards (Sussman, 2010). Similar to other institutions the Illinois Institute of Technology (IIT) is using the iPad to enhance delivery of software, e-texts, and other educational resources. IIT is also releasing a university application (app) for all Apple devices (including iPhone, iPod and iPad) providing current students and university visitors with access to course listings, events, news, and maps. The app will also enable IIT to deliver emergency alerts directly to the mobile devices, extending on the traditional modes of SMS, text, and email delivery.

### **Typology 3 – Peer-to Peer and Peer-to-Educator collaboration**

As discussed, a key advantage of PPDs in the context of curriculum design is the ability of these devices to allow learning activities designed around the idea of social constructivism. Critical to this perspective is the notion that collaboration is an essential element in the generation of meaningful and individualised knowledge (Caballe & Xhafe, 2010). PPDs such as the iPad enable collaboration in two ways, in a physical sense when students are in

close geographical proximity, and in a virtual sense whereby students can gain and generate knowledge within a broader social network via interactive technologies.

In the first instance the unobtrusive and tactile nature of the device is considered an important element in facilitating rather than hindering discussion and interactions between groups of students. Initial evidence suggests that the device acts as a central focal point for discussion, rather than a distraction during group activities (Meurant, 2010). However, the digitally integrated nature of the device also allows it to take full advantage of emerging social media and web 2.0 technologies. For example, the latest iteration of the iPad and other devices such as Motorola's Xoom have the additional capability of inbuilt cameras allowing the use of VOIP video calls via free services such as Skype or more complex video conferencing with the use of tools such as Cisco's WEBEX application. Other interactive technologies such as social media technologies (SMT) have the capacity to allow interaction between disparate groups regardless of their affiliation or geographical dispersion thanks to the portability and utility of PPDs (Meurant, 2010). These applications allow a vastly enhanced connectivity with greatly improved levels of information richness than traditional ICTs such as email or early web forum/discussion boards. Popular current examples include social networking sites such as Facebook, Twitter and corporate collaboration tools such as Yammer.

The ability of PPDs to facilitate this interaction via a highly portable and high utility interface is this most obvious to consider when thinking of using social media software in a learning environment. Drapeau and Wells (2009) make an essential observation in relation to the value of Web 2.0 technologies in their ability to generate a constant transparent stream of user defined data. This allows users to develop an "ambient awareness of other's behaviour" as well as increasing the potential for the serendipitous discovery of knowledge from previously unconnected sources. These tools provide a mechanism that facilitates tacit knowledge transfer through both socialization and internalization of knowledge. This appears particularly relevant in tertiary environments populated by students building knowledge within their own groups, but perhaps unaware of potentially valuable developments in other groups that may also assist in their learning.

#### **Typology 4 – Content generation**

Increased screen sizes, larger storage capacity and the ability to run word-processing, spreadsheet and slideshow applications allow students the ability to generate, rather than simply consume material on PPDs. In an example of the increasingly rapid rate of PPD evolution, the latest version of Apple's iPad (iPad2) now allows users to create videos (via iMovie) and music (via Garageband) indicating the increasing capability of these devices to generate content in a number of diverse ways. Other third party applications such as PDF annotators and drawing applications such as the free "Adobe Ideas" are available to students, allowing a wide range of possibilities within a group work environment - allowing the creation and sharing of output easily and quickly between interested parties. The multi-faceted nature of the devices present some exciting opportunities for educators in terms of learning tasks

and subject assessment. Backer (2010) reported an overall positive response from students required to undertake a piece of assessment using the social media application Facebook on their smart-phones. Given the enhanced user experience of PPDs over those of smart-phones it can be seen that increasingly creative and relevant learning exercises could be employed thanks to the versatility of PPDs. In an example of PPDs utilized in the post-graduate arena University of Maryland have issued iPads to their honors students [[LINK](#)]. The students are using the device to retrieve materials and multimedia content, as well as developing their own apps for the device. This program is part of UM's 'larger mobility initiative' designed to integrate technological devices into the current curriculum.

### **Typology 5 – Research/material yielding**

The portability and connectivity of PPDs offer students the opportunity to carry out a wide range of activities related to the searching, collating, storage and interpretation of data and information relevant to their course. However, in addition to search activities such as web-browsing and the use of social networks such as Twitter, PPDs offer a number of additional research capabilities for students. The iAnnotate app for example allows students to highlight sentences of a PDF document and then email those highlighted sections to themselves as notes that can then be manipulated and combined with other material. Abilene Christian University's College of Business Administration (COBA) students are using iPads to conduct market research as part of the university's summer abroad program in Oxford, England [[LINK](#)]. Students were required to use their iPads to conduct surveys, collect data, take notes and present new product pitches. Similarly, health faculty Masters students of Duke University have been given iPads for use in medical field work (Winograd, 2010). Students have 3G iPads with preinstalled apps to use for collecting data, importing media files, and graphing results.

### **Typology 6 – Productivity enhancement**

"Native" or pre-loaded software on the iPad such as the e-mail function, notes and calendar are all useful tools that may be used by students to improve their levels of productivity due to improved planning, time management and scheduling. As a simple example, the use of an integrated calendar allows educators to automatically schedule dates within student diaries, detailing when assessment is due with automatic alerts and reminders. Numerous after-market time management and "task manager" style applications are available to download that may be of use to students wishing to balance the various demands of academic, professional and family life (Gil-Rodriguez & Rebaque-Rivas, 2010). The ability of PPDs to effectively connect to "cloud" document repositories such as Dropbox and Google Docs either via web browsers or applications allows students to share and access information in a timely, resource efficient fashion. The recent addition of wireless printing to the iPad is also an essential element in helping students use a range of digital and hardcopy materials in achieving learning outcomes. Additional third party applications such as Evernote allow students the ability to take notes and draw conclusions between multiple documents and course materials, all of which can be synced across multiple devices. The University of Notre-Dame has explored the potential for the iPad to increase productivity levels by


encouraging students to synchronise their calendar and email applications to enhance productivity levels (Woyke, 2010).

### **Results - iPad Adoption & Utilisation Survey**

The second stage of the study was to compare usage of PPDs with the typology presented above. At the time of data collection the only PPD successfully released to market was Apple's iPad and therefore data was collected on universities reporting on this device. Data were collected on tertiary institutions either conducting pilot programs or actively using the device over a range of courses. Qualitative secondary data were obtained via a number of sources including industry and business press, organization press releases, industry commentaries, reports and technology web-blogs. The use of secondary data offers researchers advantages such as timely access to descriptive data, and given the descriptive intent of the study (rather than perform a function akin to theory testing or building) it was considered an appropriate research method (Cowton, 1998; Sandelowski, 2000). In all thirty-six educational institutions were identified as having adopted the iPad in forms consistent with the typology. The results are summarised below in Table 2.

**Table 2:**  
*Summary of iPad adoption and utilisation per PPD typology (November 2010- June 2011)*

Institution	Course Materials	Enrol Admin	Collab	Content Generation	Research	Productivity Tools	iPad Issued	Size
Rutgers U.	X		X	X			X	L
Georgia State U.	X		X	X		X	X	L
U. of Kentucky*	X		X				X	L
U. of Maryland	X	X					X	L
Abilene Christian U.	X	X		X		X	X	S
Melbourne U.*	X	X	X	X				M
U. of Southern California	X	X	X					L
Seton Hill U.	X		X	X			X	M
U. of Notre Dame*	X						X	M
Buena Vista U.	X						X	S
Scottsdale Comm. College	X		X	X			X	S
Indiana U.	X			X	X			L
Northern Arizona U.	X			X				M
National U. of Singapore	X		X	X			X	M
UC San Diego				X	X		X	L
Nyenrode Bus. Universiteit				X	X		X	M
Cumberland U.				X		X	X	S
Long Island U.*	X	X					X	M
U. of Houston (Valenti)	X						X	
Stanford U. (Med)	X						X	S
U. of Adelaide	X						X	S
U. of Minnesota*	X						X	L
Oklahoma State U.*	X						X	L
U. of California	X						X	L
U. of Houston	X						X	L
Virginia Tech (Pamplin)	X						X	L
Northern U. of Kentucky	X						X	
U. of Pennsylvania (Wharton)	X						X	S
NYU (Stern)	X							L
Hult Int. Business School	X							S
Georgetown U.			X		X			M
Illinois Inst of Technology		X					X	S
Duke U.					X		X	L
Briar Cliff U.*							X	S
George Fox U.							X	S
Arizona Christian U.							X	S
<b>Total % of Sample</b>	83%	13.8%	25%	33%	13.8%	1%	80.5%	

\*indicates a confirmed pilot program  indicates reporting the use of the device, but provided no details

## Discussion

An initial motivation for this study was the author's observation that many people when initially confronted with the idea of using iPads in an educational context immediately considered it as an e-text reader. However Amazon's less than successful foray into the educational sector with the Kindle DX

(Aaltonen et al., 2011) demonstrates the growing expectations on the part of students. In particular, that the technology students use be multi-dimensional and consistent with the emerging social trends aligned with ubiquitous computing (Symonds, 2010). This paper has attempted to provide some insight into the breadth of application that post-PC devices are capable of in a tertiary environment. Further it has reported on a survey of tertiary institutions identified as using the iPad in a teaching and learning capacity as those uses relate to the six point typology outlined in the paper. At its most fundamental the data presented in Table 2.0 provides initial support for the typology, with evidence of adoption in all six elements being incorporated in a tertiary context. Further, at the time of data collection no reported use was identified as sitting outside the six elements that would require an additional category, or a refinement of those proposed here. However one of the most obvious interpretations of Table 2.0 is the high degree of fragmentation in iPad use across universities, spread over the full spectrum of the typology.

Unsurprisingly perhaps given the characteristics of the device overwhelmingly it was introduced primarily as content delivery tool, with content generation, collaboration and research activity reporting similar, reduced rates of adoption motivation. Only three universities out of the sample specifically reported iPad adoption relating to “productivity tools” which may come of some surprise given the celebrated nature of the iPad’s email application. It is suggested that this is perhaps a function of the data collection, in that the data collected were related to university “intent” rather than actual use by students. Universities are more likely to report on the key motivations for device adoption (e.g. flexible content delivery) rather than activities perhaps regarded as expected or “standard practice”. In short it is highly likely that in terms of actual use students are using PPDs consistent with productivity enhancement (e.g. Perkins & Saltsman, 2010), but the current study was unable to collect data supporting this assertion. There was no apparent pattern evident in adoption relating to size of university, or whether the device was issued to students or not.

It does appear however that there are three distinct approaches or motivations for introducing the iPad into the classroom. On one hand universities such as Abeline Christian University (ACU) see this as a logical extension of their already extensive e-learning and blended learning program (Chen, 2010). In these instances there appears a genuine and consistent attempt to build a curriculum around mobile devices, incorporating a range of activities designed to integrate and fully exploit their capabilities. At the other end of the spectrum some appear to have used the iPad purely as a point of differentiation from a marketing perspective, such as Stanford who freely admit that “we don’t really know yet how the incoming medical students will use them [iPads] ”(White, 2010). While an extreme example there are others that have reported extensively on their adoption of the iPad into the classroom, but appear to have concentrated purely on the delivery of course materials. In these instances institutions appear to be using these devices (at best) in parallel to existing, more conventional forms of content and course delivery. Further, there does appear to be a relationship between university size and the adoption of the device, with many of the smaller universities in the highly competitive United States education sector moving quickly to explore the potential of the device. While the data collected in this study

doesn't allow us to confirm that smaller universities are quicker to adopt PPDs, it does appear that they are more motivated to communicate to the market of these initiatives and in that sense appear to recognize the kudos factor associated with PPC technologies. In this sense universities are perhaps using it as a visible symbol of their "technology differentiation".

Between the two extremes are a substantial number of universities conducting iPad pilots. In effect, these institutions are conducting student centred action research - iPads issued with an idea to examine user behaviour prior to any significant m-learning strategy being developed. The general impression in this case appears to be "we suspect this may be important, we just don't know how yet". The Trinity College of University of Melbourne in particular has invested a considerable amount of time, effort and resources into their pilot project, the details of which can be found at (Jennings, Anderson, Dorset & Mitchell, 2011). Trinity chose to run an iPad pilot based on its educational flexibility and value, cost, weight, size, battery life, perceived low maintenance, and the unique interface that was considered applicable to a wide range of visual, auditory and kinaesthetic learning styles (Jennings et al., 2011, 2). Trinity has reported successful student outcomes consistent with the typology in the areas of active learning techniques, individualised content, real time access and collaborative learning. An associated observation that almost all of the universities issued the device to students as part of their iPad initiative. It appears that at the current time, despite the widespread consumer appeal of the device, adoption among students is not yet sufficient for universities to run programs or establish PPD learning environment for student-owned devices (Kolowich, 2010). In the increasingly competitive domestic and international education sector it does appear that not only are universities under pressure to provide the infrastructure for the use of PPDs but provide them as well, perhaps at the expense of investing in the re-development of curriculum designed to fully utilise the capability of such devices.

A final, more critical observation in light of the ubiquitous and m-learning literatures is that very few universities appear to be building curriculums specifically around PPD capabilities. As alluded to previously, many universities appear to be looking at the device as an effective content delivery device, complementing other forms of conventional content delivery with learning management systems like Blackboard or Moodle. While this does represent a number of advantages for students, it tends to ignore the advantages of teaching and learning initiatives built around social constructivism advocated by the likes of Sharples (2000). The PPD typology presented here demonstrates that institutions wishing to leverage the capabilities of the iPad need to consider the wider m-learning architecture within which it is embedded. The current "poster child" for this approach is Abeline Christian University (ACU) which in 2008 introduced the 'Mobile-Learning Initiative' and has invested heavily in both curriculum design and infrastructure development, including the deployment of iPod touch, iPhone and iPad devices over the last three years (Perkins & Saltsman, 2010). Staff at ACU have been using the mobile devices for classroom interaction such as quizzes, attendance checking and in-class research. To enhance in class interaction, staff use polling tools to interact in with students learning during class time. Further, ACU has made efforts to integrate their efforts with

relevant stakeholders such as advisory boards and consulting agencies. For example, ACU and Inkling have partnered to look into the possibilities of digital learning content in higher education. They are due to partner with Cambridge University Press, Alcatel-Lucent and Bell Labs on a new digital publishing venture. ACU to date have developed multiple apps for the iPod touch, iPhone, and most recently, for the iPad. The “Optimist” digital newsletter app has been downloaded 1,420 times and downloaded in over 48 nations. With more than their 4,000 undergraduates operating mobile devices for educational purposes, ACU has the critical mass, e-learning culture and IT/IS infrastructure to fully exploit PPD capabilities (Peters, 2010).

Both ACU and Duke report the incorporation and utilisation of the iPad was made significantly easier due to the groundwork laid down due to previous extensive investment into the use of iPod touch devices into the learning environment (Crescente & Lee, 2011). Having an infrastructure, teaching staff and student body previously exposed to m-learning devices allowed quicker adoption and exploitation of the devices. Whether ACUs commitment to m-learning as a cornerstone of their curriculum will be validated in terms of student outcomes remains unclear at this point. However what is important is that their commitment to blended and ubiquitous learning ACU has been complemented by a consideration of the social and educational architecture that must support such devices (Peng et al., 2009). Importantly ACU appear to recognise that in order to genuinely extract the full value out of mobile devices a fundamental reconfiguration of teaching delivery methods, curriculum design, staff attitudes and skills as well as the obvious IT/IS infrastructure and resources such as a significant upgrade of wireless broadband provision is required (Garaj, 2010).

The use of technology in the education setting is a dynamic and ever changing landscape, and as such is a default limitation of this type of research. While this study is a useful snapshot of how tertiary institutions are incorporating these devices into their contexts, the cross-sectional nature of the research must be recognised. The study’s reliance on publically available data, while timely and illustrative of possible trends, it is also an acknowledged limitation. It is entirely possible that tertiary institutions around the world are adopting PPD’s in ways consistent with the sample represented here, or in ways that reflect a different pattern, but have not reported on those efforts. The primary aim of this paper was to compare the utilisation of tablet technology to the six-point typology to confirm the six categories of usage and refine its development. Future research may wish to expand on the secondary aim of the paper, to provide a more comprehensive examination of how tablet technology continues to be used within the tertiary sector by the use of direct survey methods, for example. It is also important to consider that a key focus of the study was to examine those universities that were engaging in an iPad program aimed at some form of curriculum enhancement, rather than the development of singular applications at a course or subject level. A more comprehensive study may see value in reviewing the development of applications within specific learning and subject content areas. Deeper case based research into the ways in which tertiary institutions better incorporate mobile devices into their curriculums over the long term is also required, along with some more critical robust discussion around the precise role ideally

played by PPD and other mobile devices in achieving optimum teaching and learning outcomes.

## **Conclusion**

*"Tablets like the iPad will make it second nature to not just facilitate but actually make effective pedagogical use of ubiquitous learning, that is, teaching and learning that can take place any time, in small burst, convenient to all, asynchronously or in real-time, as students and teachers alike immerse themselves in a more engaging and practical learning dialog, seamlessly forming part of the aforementioned digital continuum."*  
(Ed Garay , Assistant Director for Academic Computing at UIC cited fr. Kolowich, 2010).

This paper sympathizes to an extent with the sentiments reflected in the quote above, presenting a six point typology demonstrating the breadth of functionality offered by PPDs in a tertiary context. Consistent with previous work in the ubiquitous and m-learning literature the six-point typology presented here demonstrates that devices such as the iPad represent significant potential in facilitating the aims of learning outcomes. On the other hand it is also apparent that numerous challenges remain, with the survey highlighting many universities using the device in a limited, content delivery capacity and others still unsure of the best way to incorporate it into their existing programs and curriculums. The survey results indicate initial support for the typology, but indicated that universities overwhelmingly focused on typology one – delivery of course materials. Many of the initiatives reported here were pilots, designed to explore the potential of the device and to clarify its utility in the classroom. As such it is likely that as familiarity and experience with these devices matures, institutions will explore more fully the potential of PPDs in the learning environment.

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