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'Net Generation' medical students: technological experiences of pre-clinical and clinical students

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Abstract

Background: While institutions have been keen to integrate information and communication technologies into medical education, little is known about the technological experiences of the current cohort of so-called 'Net Generation' students.

Aims: This study investigated the technological experiences of medical students and determined whether there were differences between pre-clinical and clinical students.

Method: In 2006, 207 pre-clinical and 161 clinical students studying medicine at a major Australian university were surveyed. The questionnaire asked students about their access to, use of and skills with an array of technologies and technology-based tools.

Results: The results show that access to mobile phones, memory sticks, desktop computers, and broadband Internet connections was high while technologies such as PDAs were used in very low numbers. A factor analysis of students' use of 39 technology-based tools revealed nine clear activity types, including the 'standard' use of computers and mobile-phones, and the use of the Internet as a pastime activity, for podcasting and for accessing services. A comparison of pre-clinical and clinical students revealed a number of significant differences in terms of the frequency and skill with which these students use distinct technology-based tools.

Conclusions: The findings inform current technology-based teaching and learning activities and shed light on potential areas of educational technology development.

Introduction

It is widely recognised that the use of information and communication technologies (ICTs) is an increasingly important part of medical education (Ward et al. 2001; Whitcomb 2003). There is now an established repertoire of ICT implementations in medical education internationally including the use of online course materials, course management systems, educational multimedia, videoconferencing and wireless Internet access for notebook and laptop computers (Kamin et al. 2006; Keppell et al. 2001; Lau & Bates 2004; Liaw et al. 2000). The last decade has seen a phenomenal proliferation of easily accessible and usable technologies, many of which are web-based or seamlessly integrated with the Internet. The popularity and pervasive use of some of these technologies is well documented (for example, eBay, Amazon, Nintendo, iTunes and mobile phone texting). The medical education community is often exhorted to take advantage of this phenomenon and to customise these ICT applications to support learning and teaching from the pre-med level through to continuing professional development (Boulos et al. 2006; Giustini 2006). The rationale for such innovation may be couched in generational terms; painting a picture of mostly middle-aged educators who have a limited understanding of this ICT culture and who struggle to make their teaching relevant and engaging for a 'Net Generation' of students who have a seemingly innate affinity for it (Skiba & Barton 2006).

Practice points

- Medical students of the 'Net Generation' are more experienced with some emerging technologies than with others, and there is considerable diversity among students, both within a single-year cohort and between year levels.
- Educational implementations of emerging technologies must provide multi-modal resources, to cater for students' diverse access to hardware and varying technology use habits, as well as contextual differences between campus and clinical learning settings.
- 'Net Generation' medical students' uneven personal access to owning, subscribing to or maintaining some emerging technologies mean that issues of educational equity must be addressed as part of implementing these technologies to support their learning.
- Students' readiness to work with the chosen technologies of medical practitioners cannot be assumed, so specific implementations of emerging technologies may need to be prioritised by educators in order to build students' professional skills.

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The Net Generation, born since 1982, are said to have developed distinctive attitudes and practices in the use of ICTs during their upbringing. Students of the Net Generation are said to believe that: computers are not technology; the Internet is better than TV; doing is more important than knowing; learning resembles computer games more closely than it resembles logic; multitasking is a way of life; staying connected is essential; delay is intolerable; handwriting is inferior to typing; and the roles of consumer and creator are blurring (Frand 2000; Prensky 2001; Oblinger & Oblinger 2005). It is reported anecdotally that such students find the established repertoire of ICTs in medical education less than optimally effective, efficient or satisfying (Brower 2004). In the literature on education for health sciences professions it is not hard to find examples of teaching innovations that aim to be more interesting for this generation of students; for example, Johnson et al. (2006); and Mostaghimi et al. (2006).

But there is controversy over whether and how medical curricula and assessment, medical teaching practices and the design of learning environments in medicine ought to change in response to the Net Generation of students now enrolled in medical schools (Gonnella & Hojat 2001). A fundamental problem is that there is little research about the ICT experiences and characteristics of the current generation of medical students on which to base valid and appropriate approaches to teaching and learning with technology. One of the very few studies of Net Generation medical students provides a close analysis of their personality traits and concludes that more information about them is needed before we can understand how generational changes may affect medical education and professional practice (Borges et al. 2006).

An additional unresolved question is whether new and emerging ICT implementations adequately account for different teaching and learning contexts in medicine and whether the specific context into which ICTs are implemented have been considered so as to provide students with the most appropriate, effective and satisfying educational experiences (Kerfoot 2005; Valcke & Wever 2006). For example, approaches to technology-enhanced education may need to respond differently to pre-clinical and clinical educational contexts (Barry & Reznich 2005; Silk et al. 2006), recognising that medical students who are on a university campus may have different ICT-based learning requirements compared to medical students who are on clinical placements in various settings. Moreover, students who are at these different stages in their medical education – pre-clinical and clinical students – may have accumulated very different experiences with ICTs. The assumption that all medical students are now equally advanced in their technology access and use habits may be unfounded, at least in some respects (Oberprieler et al. 2005; Link & Marz 2006). Thus, the potential diversity within the Net Generation, combined with the known differences in the learning contexts, may make the introduction of ICT innovations in medical education a complex task.

It is imperative, therefore, that as medical educators move towards developing and implementing a more sophisticated mix of technology-based learning tools and facilities (that integrate wireless, mobile and handheld devices and Web 2.0 applications, for example) we understand the extent to which our students conform to the stereotypical description of a student of the Net Generation. We need evidence of whether students' life experiences have prepared them for the introduction of new technologies, or indeed whether these technologies are already passé for them. We need to be mindful of students' habits and skills with new and emerging technologies while planning our initiatives for technology-supported learning. We need to have a clear picture of whether and how the technological experiences of students at different stages in their study vary in order to design and implement technologies appropriate to specific learning contexts.

The objective of this study was to document the technological experiences and habits of medical students, with a particular emphasis on determining how homogeneous they were as technology users. Specifically this study investigated the regularity with which medical students accessed and used technologies and technology-based tools. It sought to determine the technologies and tools that were more and less favoured by medical students and also examined whether there were differences between pre-clinical and clinical medical students in both the degree to which they used technology-based tools and their skill levels with these technologies.

Method

Participants

This study was carried out with 368 students at a major Australian university enrolled in a medical course of six years' duration, where students spend the first two and a half years in a non-clinical environment, a middle year in a research setting and the last two and a half years in a hospital or other clinical environment. The sample used in this study comprised 207 (56.3%) pre-clinical students and 161 (43.7%) clinical students. The pre-clinical students were all commencing first-year undergraduates who had not been to university before. The clinical students were drawn from two metropolitan clinical schools and one rural clinical school. The mean age of the pre-clinical students was 20.6 years and 24.7 years for clinical students. Approximately the same number of females (52.2%) and males (47.6%) participated in the study and this gender balance was broadly consistent within pre-clinical and clinical sub-samples. The numbers of international students and Australian students participating in the study were (30.9%) and (69.1%) respectively and this proportion was also broadly consistent within pre-clinical and clinical sub-samples.

Measures

The questionnaire used in this study was developed as part of a broader investigation of university students' experiences and familiarity with ICTs. Only items relevant to the current investigation are reported here. The first questionnaire item used in this study asked students about the degree to which they had access to hardware and the Internet (such as a mobile phone, laptop computer, broadband Internet, MP3 player and personal digital assistant or PDA). The second question asked students about the frequency with which they had used 39 computer-, mobile phone-, and web-based technologies and tools in the previous year. The final item asked students to report their skills with these 39 technologies and tools. It is important to note that pre-clinical students were asked to report their technology experiences outside formal school environments over the past year.

Procedure

This research had human research ethics clearance. Data collection was done independently for the pre-clinical and clinical sub-samples, in March and July 2006 respectively. Both groups completed an anonymous paper-based survey. These were distributed and collected by staff other than the students' teachers or lecturers, during scheduled class sessions – in an orientation lecture attended by approximately 250 pre-clinical students, and in classes of between 30 and 80 students in the clinical schools.

Results

Descriptive data for the entire sample were initially reviewed to determine the degree to which students had access to different types of technological hardware and Internet ('Unrestricted', 'Limited' or 'No' access). These analyses revealed that the use of mobile phones by this sample of students was almost ubiquitous (only 1.4% of students reported no access and 97.3% reported unrestricted access). A high number of students reported having unrestricted access to a memory stick (85.9%), a desktop computer (85.3%) and a broadband Internet connection (81.0%). However, more variability in access was seen with other technologies. For example, while 59.5% of students had unrestricted access to a dedicated MP3 player, 32.1% reported having no access to this technology. Only 14.9% of students reported having unrestricted access to a PDA while 78.3% reported having no access to one of these devices.

The differing degrees to which students had access to technological hardware were mirrored by the degree to which they used technologies and technology-based tools. There were clearly 'core' technology-based tools that were used daily or weekly by the vast majority of students (using a computer to write documents, using a mobile phone to call or send text messages to people, using the web for email, instant messaging, to access study references or to browse for general information). There were also 'emerging' technology-based tools that a significant proportion of students (between 20% and 40%) were using on a daily or weekly basis (using social networking software on the web, reading blogs, uploading and downloading MP3s, sharing digital material via the web, taking and sending pictures using a mobile phone). However these technology-based tools were by no means ubiquitous, with typically between 30% and 50% of the sample not using them at all. Finally, there were a significant number of technology-based tools that were not being used by the majority of students. These included using PDAs as personal organisers (77.5% not used), using a mobile phone to access the web (74.1%), using a mobile to send or receive email (83.7%), using web conferencing (76.7%) and contributing to the development of a wiki (86.0%).

The main set of analyses undertaken for this paper sought to determine whether there were differences between pre-clinical and clinical students with regards to their experiences with technology. In order to make the data more manageable for inferential tests, a factor analysis was conducted using students' reports of how frequently they used technology-based tools. An initial principal components factor analysis with a varimax rotation revealed ten factors that explained 60.8% of the variance. After viewing the eigenvalues for this solution, the scree plot and the rotated factor matrix it was decided that a nine factor solution may capture the data adequately without greatly reducing the amount of variance explained in the solution. The nine factor solution (principal components with varimax rotation) explained 58.2% of the variance and the rotated factor solution is presented in Table 1. Two items ('Editing audio/video using a computer' and 'Use the web to send or receive email') did not load on any factor in this solution and were discarded from further analyses.

In general, the factors that emerged from this solution were conceptually distinct. Factor 1 (labelled *Social Web Producers*) is defined by behaviour associated with Web 2.0 technologies, particularly those associated with social publishing (blogs and social networking) and file sharing. Factor 2 (labelled *Web Pastime and Podcasting*) is defined by using the web as a pastime, particularly for podcasting and instant messaging. Factor 3 (*Advanced Mobile Use*) is dominated by the 'advanced' use of mobile phones (taking and sending pictures, accessing email and the web) whereas Factor 9 (*Standard Mobile Use*) is defined by more 'standard' mobile phone use (calling and texting). Factor 4 (*Standard Computer Use*) is characterised by the relatively 'standard' use of a personal computer. Factor 5 (*Advanced Communication and Information*) is defined by the use of contemporary mechanisms of web-based communication (Voice-over IP and web conferencing) and the use of a PDA. Factor 6 is defined by *Website Publishing*, Factor 7 clearly represents *Gaming* and Factor 8 is characterised by the use of *Web Services* (using a web vendor or a business portal).

The items that comprised each factor were then used to create nine independent scales. Mean scores from these scales were indicative of the frequency with which students engaged in each of the nine technology-based activities (each scale ranged from 1 to 5 and a high score indicated more frequent use). The mean scores and reliabilities for the scales are presented at the bottom of Table 1; reliabilities range from moderate (0.59) to very good (0.84).

The nine scales were then used in a MANOVA to determine whether the degree to which students engaged in various technology-based activities differed as a function of whether they were a pre-clinical or a clinical student. A significant multivariate effect was recorded for this analysis ($F\ (9,356) = 20.63$; $p < 0.001$). Univariate tests revealed that there were significant differences between pre-clinical and

Table 1. Rotated factor solution for students' frequency of use of technology-based tools.

	Factors								
Item	1	2	3	4	5	6	7	8	9
Read blogs on the web	0.81								
Comment on blogs on the web	0.78								
Keep a blog on the web	0.75								
Social networking on the web	0.66								
Share photos via the web	0.51								
Download MP3s via the web		0.74							
Use the web to listen to audio		0.66							
Upload MP3s via the web		0.63							
Instant messaging via the web		0.55							
Listen to audio using a computer		0.54							
Use the web as a pastime		0.53							
Use the web for general information		0.50							
Send pictures using a mobile phone			0.77						
Take photos using a mobile phone			0.69						
Use a mobile phone as an organiser			0.66						
Use a mobile phone for email			0.59						
Access the web using a mobile phone			0.51						
Write documents using a computer				0.73					
Create multimedia using a computer				0.65					
Use the web for study references				0.61					
Study using a computer				0.60					
Create graphics using a computer				0.49					
Make phone calls via the web					0.65				
Use RSS feeds on the web					0.62				
Use web conferencing					0.60				
Use a personal organiser (PDA)					0.53				
Build and maintain a website						0.67			
Create web pages with a computer						0.64			
Contribute to a wiki						0.62			
Play games on a computer							0.66		
Play games using a console							0.65		
Play games via the web							0.58		
Use the web to access services								0.76	
Buy and sell things on the web								0.74	
Access a learning/school portal via the web								0.47	
Make calls using a mobile phone									0.82
Send text messages using a mobile phone									0.81
Mean	2.11	3.47	2.15	3.38	1.71	1.44	2.26	2.80	4.69
Alpha	0.83	0.79	0.81	0.65	0.66	0.66	0.70	0.59	0.84

clinical students for three of the nine variables and a trend towards significance was seen for one further variable. Table 2 shows that pre-clinical students were using the web as a pastime and for podcasting and were using technology to play games more frequently than clinical students. Pre-clinical students also tended to engage in social forms of web content 'producing' (like blogging) more frequently than clinical students. Conversely clinical students were using web-based services more frequently than pre-clinical students.

Table 2. Differences between pre-clinical and clinical students' technology-based activities.

	Frequency of use					
	Pre-clinical		Clinical			
Scale	M	SE	M	SE	F	*p*
Web pastime and podcasting	3.61	0.06	3.29	0.07	11.34	0.001
Gaming	2.56	0.07	1.88	0.08	42.75	<0.001
Web services	2.45	0.06	3.24	0.07	81.09	<0.001
Social web publishing	2.21	0.08	1.99	0.09	3.63	0.058

The next set of analyses considered whether there were differences between pre-clinical and clinical students with regards to their skill with technology-based activities. Students who reported not using a particular technology were given a skill rating of '0' and mean scores of students' self-reported skill were calculated for the nine scales. A significant multivariate effect was recorded for a MANOVA analysis using these scales ($F\ (9{,}351) = 22.23$; $p < 0.001$) and the univariate tests indicated that pre-clinical students reported greater *Gaming* skills than clinical students (see Table 3). However, clinical students perceived themselves as more skillful than their pre-clinical counterparts for four other technology-based activities (Standard Computer Use, Advanced Communication and Information, Web Services and Standard Mobile Use).

Discussion

The aim of this study was to examine the kinds of technologies that medical students were using and the purposes to which they were putting these technologies. The results clearly show that some technologies and technology-based tools enjoy widespread and frequent use. Computers, mobile phones and

Table 3. Differences between pre-clinical and clinical students' technology-based activities.

	Skill					
	Pre-clinical		Clinical			
Scale	M	SE	M	SE	F	*p*
Standard computer use	3.29	0.06	3.60	0.06	12.47	<0.001
Advanced communication and information	0.89	0.09	1.17	0.10	4.84	0.028
Gaming	2.26	0.11	1.57	0.12	18.99	<0.001
Web services	2.09	0.09	3.53	0.10	126.19	<0.001
Standard mobile use	4.35	0.07	4.69	0.08	10.71	0.001

the Internet now seem entrenched in medical students' lifestyles. The great majority of students have unrestricted access to these technologies and many are using them on a weekly, if not a daily, basis. They are used both for study and for recreation; they are used for searching, browsing, playing, creating, sharing, and storing digital content and, importantly, for communicating. These technologies and tools appear to be instrumental in medical students' daily lives.

However, while all students consistently reported using a core set of technologies and technology-based tools, there was a great deal of individual variation across the cohort regarding other technology-based tools. While emerging technologies – blogging, podcasting and social networking – are certainly capturing the attention of a significant minority of students, there is some way to go before these technologies are used by and familiar to the majority. Moreover, other technologies are clearly not used by the majority of students (for example, PDAs, web conferencing and wikis). The results from this study show that the group of medical students sampled is by no means a homogenous 'Net Generation' in terms of their technological experiences and aptitudes.

The comparison of pre-clinical and clinical students also revealed diversity; it produced a clear snapshot of differences in technological experiences and aptitudes between current pre-clinical and clinical students. It is only possible to speculate as to why these differences were recorded. The fact that more recent ICT innovations such as podcasting, instant messaging, social networking and blogging tend to be embraced more by the younger pre-clinical students, may reflect the important role 'new' and 'cool' recreational and social technologies play in secondary school students' lives. On the other hand, clinical students who have been at university for at least three and a half years, are more likely to be working to support themselves financially while living away from home which might explain their greater reliance on web-based services like banking and paying bills. It may be that current first year students will use these technology-based tools more frequently as they make the transition from 'high-school student' to 'university student'. This question, as well as whether pre-clinical students will retain their current technological habits as they progress through their degree, will be the focus of further longitudinal investigation.

Except for *Gaming*, clinical students perceived themselves as more skilful with particular technologies than pre-clinical students. (However, the high mean scores for both pre-clinical and clinical students on *Standard Mobile Use* indicated that, while statistically different, both sub-samples perceived themselves to be very skilled in using a mobile phone for calling and texting). The differences in perceived skill may be attributed to students in the later years of their studies having more overall confidence in their abilities than incoming first year students. This could be a result of an interplay between a number of factors: general young-adult maturation, broader experiences and successful progress through the medical school.

Conclusion

The general diversity of experience and differences between pre-clinical and clinical students this study identified has clear implications for any proposed implementation of emerging technologies in teaching and learning. Generally speaking students are more experienced with some emerging technologies than others. Given this, when developing learning activities that could usefully employ new technologies it may be prudent for educators and curriculum developers to harness technologies that are more familiar to students and do this with an understanding that, within a single discipline, some students are likely to be inexperienced, requiring additional training.

In cases where there is an obvious fit between desired learning objectives and general technological capabilities, findings such as those reported in this study can help to guide specific decisions about local implementations. For example, Barrett (2006) showed how repeated listening to audio files can improve students' skills in heart auscultation. In the context of this study, if digital audio files were to be used to support this learning objective, it would be important to ensure that multi-modal implementations were developed to cater for students' diverse access to hardware (e.g. MP3 players), habits and contexts. Digital audio files would need to be developed and delivered so that they could be downloaded, streamed or syndicated as podcasts for use at both computer workstations and from portable handheld devices.

The results of this study also give an indication of educational technology implementations that may be needed to improve students' readiness to work with the chosen technologies of medical practitioners. We were particularly interested in the low number of students in the pre-clinical and clinical groups who had access to a personal organiser (or PDA), especially since studies show that PDAs are widely used in North America as decision-support tools by residents and senior medical staff (Kho et al. 2006). Clearly such access and use is not yet reflected in this medical student population. While it is acknowledged that pre-clinical students may not perform tasks that warrant the use of a PDA, this tool would seem to be appropriately suited to the activities of students undertaking their studies in clinical placements. The relatively high cost of PDAs in Australia may discourage student ownership; or from the perspective of rapid technology change, the functionality of new generation mobile phones may be making these devices redundant (Wireless Healthcare Report 2007). Either way, improving students' professional work readiness relies on creating educational tasks that focus primarily on students' mastering appropriate information usage rather than enhancing their competence with devices destined for obsolescence.

Finally, the results of this study have implications with regards to the equity of students' access to technology-enhanced learning activities. Given the diversity of technology-based experiences among this population of medical students across a six year course and the high cost, at least in Australia, of personally owning, subscribing to or maintaining some of the technologies that were studied, one option is to ensure that learning activities are designed to allow for variations in access to and familiarity with technologies and technology-based tools. Where expensive technologies are educationally necessary to produce valuable learning outcomes, another option is to develop sustainable schemes to lease, lend or donate technology to students (and staff), as for example, with tablet PCs (Crudele & Iannello 2003).

The research reported in this paper grounds the rhetoric of the Net Generation in the reality of the student experience, and gives direction to more student-centred ways of teaching with new and emerging technologies. The information it provides about medical students' technological experiences, preferences and habits can assist both individual educators – lecturers, tutors, clinical teachers – and curriculum developers. The findings of this investigation may usefully inform current technology-based teaching and learning activities as well as highlight areas of potential educational technology development. They may be used to ensure that ICTs are being used in ways that accord with different stages and sites of student learning. They may be used to identify where formal learning about ICTs may need to take place and also areas where students are already adept with the technology. Similarly they may be used to highlight areas where teaching staff may find efficiency and satisfaction gains in their work through becoming conversant with the technologies that students are using. The findings from this study can be used as a benchmark against which changes in curriculum and learning support can be systematically implemented and evaluated.

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