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Can we teach digital natives digital literacy?

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In recent years, there has been much debate about the concept of digital natives, in particular the differences between the digital natives' knowledge and adoption of digital technologies in informal versus formal educational contexts. This paper investigates the knowledge about educational technologies of a group of undergraduate students studying the course Introduction to eLearning at a university in Australia and how they adopt unfamiliar technologies into their learning. The study explores the 'digital nativeness' of these students by investigating their degree of digital literacy and the ease with which they learn to make use of unfamiliar technologies. The findings show that the undergraduates were generally able to use unfamiliar technologies easily in their learning to create useful artefacts. They need, however to be made aware of what constitutes educational technologies and be provided with the opportunity to use them for meaningful purposes. The self-perception measures of the study indicated that digital natives can be taught digital literacy.

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1. Introduction

The concept of 'digital natives' was first proposed by Prensky (2001) as a generation of people born in or after 1980. He described digital natives as people who lives their lives immersed in digital technologies and that they learn differently from previous generations of people. According to Prensky, digital natives have a culture of connectivity and online creating and sharing. They have e-lives that revolve around the Internet, where they access information and interact with others, for example blogging, playing online games, downloading music, purchasing and selling online and socialising via social media networks. Digital natives are active experiential learners who like receiving information quickly, are multi-taskers and parallel processors and prefer graphics first over texts.

In recent years, the concept of digital natives has been put under the microscope by researchers (e.g. Bennett, Maton, & Kervin, 2008; Brown & Czerniewicz, 2010; Helsper & Eynon, 2010; Kennedy, Judd, Churchward, Gray, & Krause, 2008). The arguments against the digital native description lie primarily in the lack of empirical evidence to support the claims made. The main tenets of the arguments are centred around:

1. *the generation factor where those born in and after 1980 are digital natives.* The researchers argued that it is not the age that should be considered in describing the youths of today but other more important factors such as the availability of technology and breadth of use, prior experience, self-efficacy and education.
2. *the availability of technology to digital natives and their ubiquitous usage.* The researchers argued that the use of technology by young people is different in education in that most lack the skills and strategies to use them for learning.
3. *the rhetoric that because young people have grown up in a world surrounded by technology, their brains develop differently to the adults of previous generations.* The researchers argued that there is no empirical evidence to suggest that the brain structure is different between adults and those who use the Internet and other technologies frequently.

Prensky's generalization of a generation of young people as digital natives is no different from the 'baby boomers' (Jones, 1980) who are people born post-world war II between 1946 and 1964. Society and the media often describe baby boomers with certain types of

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stereotypical characteristics such as being work-centric, goal oriented and competitive (Kane, nd). Digital natives are born in the digital age, which began in the late 1970s with the advent of the personal computer followed by the Internet and information 'explosion' in the 90s. They have grown up in a digital environment where immersion in digitally-related activities is part of their everyday lives. According to [dictionary.com](#), 'native' means the place or environment in which a person was born. This by definition, qualifies them to be called 'natives'. The argument that many digital natives do not know how to use technology for learning school/university-based curriculum does not disqualify them from being called digital natives. It could be argued that young people do not necessarily think or know about educational technologies unless they are exposed to them. Educational technology in this context is the considered implementation of relevant tools and processes that enhance teaching practices and facilitate improved learning (Aziz, 2010). As tools for learning, educational technologies could be situated in both formal and informal education, for example researching on the Internet. This paper argues that it is the task of educators to raise awareness of the range of educational technologies that the digital natives could use for learning. They need to be taught about these technologies, just like people born into a community needs to be taught how to speak the language or use tools and equipment that are available to the community. Unlike the learning about and use of social networking and other entertainment tools which are largely peer-driven and learnt through 'tinkering' (Ito et al., 2008), it is unlikely that digital natives would seek out, explore and use educational technologies unless they are introduced to them and/or there is a need to use them for a useful purpose.

The ability of digital natives to embrace information and communication technologies (ICT), in particular the use of mobile phones and social media technology, means that they possess a certain level of digital literacy. They are able to use desktop computers, laptops and mobile technologies (e.g. mobile/smart phones, iPods, MP3/4 players and tablets) for texting, capturing information, researching on the Internet, locating using global positioning system (GPS) and downloading music and video files. They are part of online communities and are able to use social media networks to communicate with friends and families as well as access services (e.g. banking, purchasing) on the Internet. Most of these digital literacy skills and knowledge would have been developed outside of formal education (Ito et al., 2008).

The aim of this study was to explore the 'digital nativeness' and investigate the digital literacy of a group of undergraduate pre-service teachers (born after 1980) undertaking the *Introduction to eLearning* elective course at a university in Australia. A component of the course was to integrate a variety of learning, presentation, collaborative and assessment tools into the students' learning. An underlying objective of the course was to develop the students' digital literacy so that knowledge and skills obtained could be transferred to the broader context of their future studies and career. As will be discussed in the section below, digital literacy has several dimensions to it.

The research was aimed at capturing the level of digital literacy that these undergraduates perceived themselves as having and whether it could be developed further. A hypothesis made in the research was that if the undergraduates were unfamiliar with educational technologies, their 'digital nativeness' would enable them to pick up new and unfamiliar educational technologies with ease and comfort. The unfamiliarity with educational technologies for the undergraduates could be due to the inconsistent and/or lack of integration of ICT into their learning at schools and at the university. Research (Becker 2000; Cuban, 2001; Kozma, 2003; Ng & Gunstone, 2003; Romeo, 2006; Strategic ICT Advisory Service, 2009) has indicated that the level of ICT integration and its impact in classroom curricular remain low. This results in a lack of exposure to, hence awareness of, educational technologies in these young people's repertoire of digital knowledge. However given their frequent 'tinkering' with technology, they should be able to learn to use unfamiliar technologies rather easily.

2. Digital literacy: a conceptual framework

The framework underpinning the research is digital literacy. Digital literacy in this paper refers to the multiplicity of literacies associated with the use of digital technologies. These technologies are a subset of electronic technologies that include hardware and software used by individuals for educational, social and/or entertainment purposes in schools and at home. They include desktops, mobile devices (e.g. laptops, tablets, ultramobiles, mobile phones, smartphones, PDAs, game consoles), interactive whiteboards, datalogging equipment, digital recording devices (e.g. cameras, flipcams, voice and video recorders), Web 2.0 technologies and other resources on the Internet (e.g. information and multimedia resources, communication and collaborative resources such as *Skype*, *Moodle*, *Edmodo*, *Popplet*, blogs, glogs, wikis, concept-mapping tools such as *SpicyNodes* and *cMap* and storage spaces such as *Dropbox* or *SkyDrive*) and the variety of software packages for learning that are either commercial, downloadable for trial for fixed periods of time, or are totally free and accessible from the Web.

The rapidly changing landscape of digital technology over the last decade has seen a range of terms related to its literacy proposed in the literature, for example ICT literacy, information technology literacy, media literacy, net literacy, online literacy, multimedia literacy and new literacies (for reviews, see Markauskaite, 2006 and Oliver & Tomei, 2000). 'New literacies' is a relatively new concept in the literature. According to Australia's [newliteracies.com.au](#) website, new literacies are digital literacies characterised by SMS (short message service), MMS (multimedia messaging service), social networking activities and mobile technologies such as mobile phones, smartphones and tablets. The website describes 'new literacies' as a combination of "letters, symbols, colours, sounds and graphics to extend language and the ways we communicate". Similarly, Lankshear and Knobel (2003) described new literacies as new types of knowledge associated with "digitally saturated social practices". They described new literacies (p. 16–17, cited in Martin & Grudziecki, 2006) as:

... 'posttypographic' forms of textual practice. These include using and constructing hyperlinks between documents and/or images, sounds, movies, semiotic languages (such as ...emoticons ('smileys') used in email, online chat space or in instant messaging), manipulating a mouse to move around within a text, reading file extension and identifying what software will 'read' each file, producing 'non-linear' texts, navigating three dimensional worlds online and so on.

While 'new literacies' emphasise social practices that are shaped by emerging technologies, within educational contexts, digital literacy is a broader term that embraces technical, cognitive and social-emotional perspectives of learning with digital technologies, both online and offline. While 'new literacies' is adapting literacy, digital literacy is developmental, that is, progressively builds on foundational and achieved skills and knowledge. Theoretically, a digitally literate individual should be able to adapt to new and emerging technologies quickly and pick up easily new semiotic language for communication as they arise. The more digitally literate the individual, the easier it is for him/her to adapt, that is switch to the 'new literacies' mode.

Digital literacy has been defined in the British Futurelab's handbook on *Digital Literacy Across the Curriculum* (Hague & Payton, 2010, p. 2) as:

To be digitally literate is to have access to a broad range of practices and cultural resources that you are able to apply to digital tools. It is the ability to make and share meaning in different modes and formats; to create, collaborate and communicate effectively and to understand how and when digital technologies can best be used to support these processes.

Another similarly broad definition of digital literacy is one that is formulated by the *European Information Society* (Martin, 2005, p. 135) which states:

Digital Literacy is the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process.

Both definitions emphasise the ability to create meanings and communicate effectively with others through digital tools with the latter definition making more explicitly the ability to search, assess and synthesis from digital resources. At a more specific level, Eshet-Alkalai (2004) suggested that there are five types of literacies that are incorporated within the term 'digital literacy':

- (i) *photo-visual literacy* - learning-to-read from visuals. It is a cognitive skill that uses "vision to think".
- (ii) *reproduction literacy* - the art of creative duplication. This involves the use of digital tools that have the capabilities to edit or combine/recombine new and pre-existing materials (text, audio, video, images) into new works of art or writing
- (iii) *branching literacy* - the use of hypertext in the creation of non-linear medium of information and the ability to navigate through the displayed information freely. Branching-literate individuals have good spatial orientation and the ability to create mental models, concept maps and other forms of abstract representations in hypermedial environments (Eshet-Alkalai, 2004 citing Lee & Hsu, 2002).
- (iv) *information literacy* - the literacy associated with critical thinking and the ability to search, locate and assess Web-based information effectively.
- (v) *socio-emotional literacy* - the literacy associated with the emotional and social aspects of online socializing, collaborating and undertaking day-to-day chores e.g. banking and purchasing online. It requires the ability to be highly critical and analytical, to avoid online 'traps', for example being able to identify pretentious people in the chat rooms and avoiding hoaxes and viruses.

2.1. Dimensions of digital literacy

This research is underpinned by the digital literacy framework of Ng (2012). The framework, as shown in Fig. 1, draws together the above mentioned broad definitions of digital literacy, the specific concepts of Eshet-Alkalai (2004) and the New London Group's (1996) multi-literacies concept. Ng's (2012) digital literacy results from three intersecting dimensions that are the (i) technical (ii) cognitive and (iii) social-emotional dimensions of digital literacy. The relationships between these dimensions are shown in Fig. 1.

As shown in Fig. 1, the **technical** dimension of being digitally literate broadly means possessing the technical and operational skills to use ICT for learning and in everyday activities. It means being able to connect and use input and peripheral devices for example earphones/headset, external speakers and smartboards. It assumes knowledge of working parts, the protection of files and the ability to troubleshoot by reading manuals or through 'Help' functions and other web-based resources e.g. *YouTube*. A digitally literate individual is able to operate

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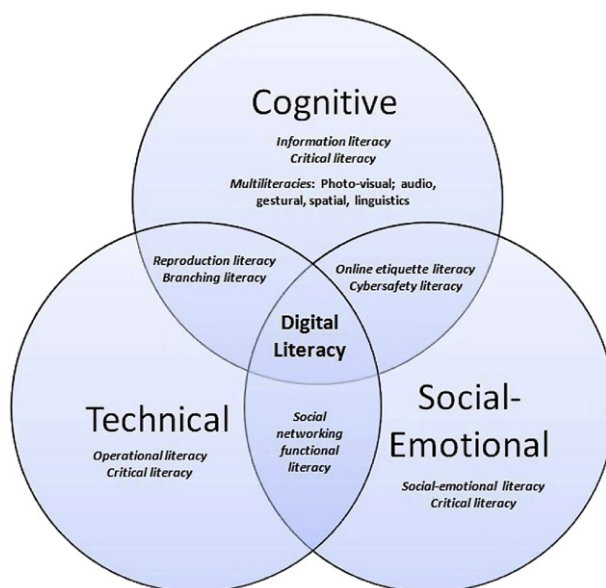


Fig. 1. Digital literacy model (Ng, 2012).

technologies adequately, for example, through understanding file structures; managing data transfer that includes understanding file sizes and space required for storage; finding, downloading and installing applications (and uninstall when not needed); use of infra-red and/or Bluetooth for mobile devices; understanding data charge costs associated with downloading data; setting up and using communication and social networking tools; updating/changing user account information on the Internet; sending and retrieving attachments via email and/or Dropbox; opening them with appropriate applications such as unzipping folders; knowing about the key features of software programs e.g. user interface elements – cues that define interactivity (e.g. menu, sizing, dragging, scrolling, collapsible lists) and understanding tabs and their relationships to content.

The **cognitive** dimension of Ng's (2012) digital literacy model is associated with the ability to think critically in the search, evaluate and create cycle of handling digital information. It also means being able to evaluate and select appropriate software programs to learn with or to do a specific task. This dimension of digital literacy requires the individual to be knowledgeable with the ethical, moral and legal issues associated with online trading and content reproduction that make use of digitally-based resources (e.g. copyrights and plagiarism). The individual should have an understanding of multiliteracies (New London Group, 1996) and be able to decode information that are text-based as well as information from images, sound bytes (e.g. podcasts), videos, maps and models – these involve multiliteracies skills that are linguistic, visual, audio, spatial, gestural (as captured in videos) and multimodal (as in multimedia resources).

At the intersection between the technical and cognitive dimensions are Eshet-Alkalai's (2004) hyperlinking and reproduction literacies. These involve being able to navigate intelligently through hypermedia environments to construct knowledge and to synthesise new understandings using appropriate online or offline tools that will convey the meanings in the best sense.

The **social-emotional** dimension of digital literacy and the intersecting areas between the social-emotional and cognitive dimensions (as shown in Fig. 1) involve being able to use the Internet responsibly for communicating, socializing and learning by (i) observing 'netiquette' through the application of similar rules as in face-to-face communication such as respect and using appropriate language and words to avoid misinterpretation and misunderstanding (ii) protecting individual safety and privacy by keeping personal information as private as possible and not disclosing any more personal information than is necessary and (iii) recognising when (s)he is being threatened and knowing how to deal with it, for example whether to ignore, report or respond to the threat.

Central to all three dimensions of the digital literacy framework is critical literacy – understanding that people behind the scene writing the information have their own motivations and being able to critically evaluate whose voice is being heard and whose is not is important for learning as neutrally as possible. According to the Tasmanian Department of Education (2009) website, critical literacy involves “ways of looking at written, visual, spoken, multimedia and performance texts to question and challenge the attitudes, values and beliefs that lie beneath the surface”. As all three dimensions of digital literacy involves ‘texts’, such as

- reading digital manuals or watching a video on *YouTube* when troubleshooting (technical dimension);
- picking up cues from the conversational content and tone of the postings, including text abbreviations and emoticons (social-emotional dimension);
- assessing opinions from written materials, videos and images (cognitive dimension),

it is important that the individual critically analyse digital materials in more depth to understand the underlying meanings in the information.

In summarising the above discussion, being digitally literate requires the development of a set of key skills that are technical, cognitive and social emotional. The basic skills that a digitally literate person should be able to demonstrate are the abilities to:

- carry out basic computer-based operations and access resources for everyday use
- search, identify and assess information effectively for the purposes of research and content learning
- select and develop competency in the use of the most appropriate technological tools or features to complete tasks, solve problems or create products that best demonstrate new understandings and
- behave appropriately in online communities and protect oneself from harm in digitally enhanced environments.

Teaching these skills in context and providing opportunities to practice them in ways that demonstrate their significance in the choices made and in using them appropriately are essential and invaluable to both the personal and academic development of students. Hence these perspectives of developing digital literacy that are underpinned by the integration of the three dimensions of the digital literacy framework, formed the theoretical basis for this research. The research related the ‘digital nativeness’ of the students in the study to levels of digital literacy, as perceived by the students themselves, and sought to investigate if these levels could be increased through the teaching of a range of educational technologies and through the exploration in the ease by which the students embraced the unfamiliar ones for learning.

3. Context of the study

The undergraduate students participating in this study were mostly pre-service teachers (see Demographics Section 6.1) who elected to do the *Introduction to eLearning* course. The course was operated in a blended-learning mode with the virtual learning component facilitated by *Blackboard*. Aside from the theoretical aspects of the course, a part of the course assessment required the students to create an ePortfolio in the open source ePortfolio system, *Mahara*, to demonstrate their understanding of how ICT could be integrated into learning, presentation, collaborative and assessment activities. A selection of programs was recommended, for example *Inspiration* (concept-mapping software), *Prezi* (presentation software), *Hot Potatoes* or *SurveyMonkey* software (for quiz creation) and *VoiceThread* and *Wikispaces* as collaborative platforms to respectively upload the students' digital stories and construct a collaborative WebQuest. While software programs were suggested for the tasks, there was considerable flexibility in the students' choices, for example one of the students constructed her ePortfolio using *GoogleSites* instead of using *Mahara* while five students used *Wildform Flair Program* or *Quiz Creator* to create their discipline-specific online quizzes. The meaningful use of these technologies was the emphasis of the course and the students were encouraged to create artefacts that they could make use of in their future teaching. The ePortfolio systems provided the platform for the

students to write reflective comments and justification for the artefacts created. Fig. 2a shows a screenshot of pre- and post-course concept maps of eLearning and the student's reflective comments while Fig. 2b shows a screenshot of a digital story from VoiceThread and a Prezi presentation, both embedded into the student's ePortfolio in Mahara.

In exploring the undergraduates' 'digital nativeness' and investigating the digital literacy of the undergraduate students, the research questions were: How familiar are the undergraduates with a selected range of technologies that are popular (e.g. Facebook, YouTube) and for educational purposes (e.g. Inspiration, Prezi)? How do they learn to use educational technologies that they are not familiar with? What are their attitudes towards the use of ICT and their perceptions of their own level of digital literacy before and after the course?

4. Data gathering methods

The research paradigm employed for this research is a pragmatic paradigm (Johnson & Onwuegbuzie, 2004) that embraces the mixed method (quantitative and qualitative) approach to seeking answers to the research questions. Ethics approval for the research was obtained prior to the administration of the research instruments, which were pre- and post-project questionnaires. The questionnaires were validated by two lecturers with expertise in ICT education. The pre-course questionnaire was administered in the first week of the course (semester 1, 2011) to establish the demographics and characteristics of the group of students. Questions related to access to computers, familiarity with a selected array of digital tools and concepts, proficiency in using digital tools and frequency of use of web-based resources were asked. The 'familiarity with digital technologies' questions distinguished between whether the students have just heard about (i.e. some familiarity with) the technologies or whether they have actually used (i.e. very familiar with) the technologies. The questions on 'frequency of use of web-based resources' were adopted from Kennedy et al. (2008, p. 114) questionnaire with first year university students.

The post-questionnaire was administered in the last week of the course and contained questions that sought to understand the processes the undergraduates engaged with when learning about new technologies and adopting them to create tangible outcomes for their ePortfolios. The first question (see Table 1) asked for the amount of time spent on creating each of the artefacts and was based on the division of labour in creating each artefact. There were three broad processes identified – learning about the capacity of the technology, planning the content and creating the product using the technology. The last process brings together the first two processes. The question asked the students to place numbers (in ascending order) in the appropriate process columns to indicate the most amount of time (using code 1) spent to the least amount of time spent (using code 3) for each of the artefacts created. The second question sought for more details in open-ended questions that asked the students to comment on the design and planning of the tasks and the issues encountered and how they were resolved in creating their Prezi presentation (an individual task) and the WebQuest that was hosted on Wikispaces (a collaborative task conducted in pairs). The data obtained from these two questions would inform the research of the extent of the difficulty or ease the undergraduates experienced when adopting unfamiliar technologies into their learning. Indirectly the data would provide an insight into the degree of digital literacy of these students.

There was a common set of 5-point scale (strongly agree to strongly disagree) statements in both the pre- and post-questionnaires, that aimed at investigating the students' attitudes towards the use of digital technologies for learning and their perceptions of their own digital literacy. The statements are shown in Table 2. Of the 17 statements, nine of them were aimed at eliciting the technical, cognitive and social-emotional aspects of digital literacy at the start and end of the semester. These statements attempted to capture broadly any changes in these dimensions of the digital literacy of the students.

In addition, there was a question in the post-questionnaire, as shown below, asking the students to reflect back and rate their own digital literacy over two times: at the beginning of 2011 and at the end of semester 1 (i.e. the end of the course in June 2011).

I think my level of digital literacy is (Please circle on the scale of 1-10 below)

	Very low									Very high
In January this year	1	2	3	4	5	6	7	8	9	10
Now-June (end of sem. 1)	1	2	3	4	5	6	7	8	9	10

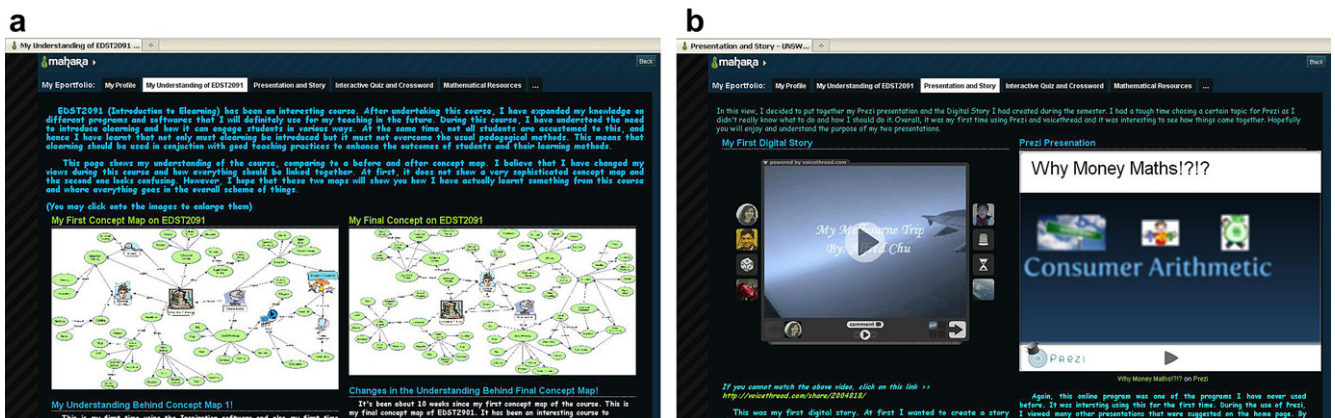


Fig. 2. Screenshots of a (left) pre- and post-course concept maps of eLearning and b (right) embedded VoiceThreads and Prezi presentations.

Table 1
Capturing the amount of time taken for each of the three processes in the adoption of new technologies for learning.

Product	Processes involved		
	(i) Learning about the technical capabilities of the technology	(ii) Planning & preparing the content i.e. the details of the topic	(iii) Designing and creating the product using the technology
<i>Example: Powerpoint</i>	3(<i>spent least time</i>)	1 (<i>spent most time</i>)	2
Concept maps using <i>Inspiration</i>			
<i>Prezi</i> presentation			
Quiz using <i>Hot Potatoes</i>			
WebQuest in <i>Wikispaces</i>			
ePortfolio in <i>Mahara</i>			

5. Data analysis

SPSS software was used to analyse the quantitative data. For Likert-scale statements, the means, standard deviations, modes (in some cases) and frequencies were calculated. Paired sample *t*-tests were performed to investigate differences in attitudes and digital literacy between the pre- and post-questionnaire responses. Cronbach alpha was calculated for internal consistency of the responses. Qualitative data obtained from the open questions were analysed for themes that emerged and coded against them.

6. Results and discussion

6.1. *Demographics*

Fifty-one out of 53 students in the course participated in the research, constituting a 96% participation rate. Table 3 summarises the statistical characteristics of the participants. There were 28 (55%) females and 23 (45%) males, with the majority (78%) being in the 18–22 year old age group and in their 2nd year of university studies. Most of the students were pursuing either the Bachelor of Arts/Bachelor of Education (47%) or the Bachelor of Science/Bachelor of Education (37%) double degrees. The remaining 16% were from other faculties pursuing a general education elective – seven of these students were studying for their Bachelor of Music and Bachelor of Fine Arts degrees, with one student studying for his Bachelors of Arts/Bachelor of Medicine double degree.

6.2. *Access to digital technologies*

As shown in Table 4, all the students in the study had some form of access to mobile phones and laptops with 98% and 90% of the students having unlimited access to mobile phones and laptops respectively. It appears that they have more access to laptops than desktops. The vast majority of the students (90% or more) have some or unlimited access to the Internet via broadband and/or wireless.

6.3. *Familiarity with technologies*

Table 5 shows an array of selected technologies or concepts associated with digital technology. These technologies/concepts were selected from a list of items that were to be discussed and taught in the course. The technologies/concepts surveyed that are web-based were *YouTube, Facebook, VoiceThread, Prezi, Hot Potatoes, Dropbox, SurveyMonkey* and those that are not – *MovieMaker, Photoshop* and the

Table 2
Statements investigating attitudes and digital literacy dimensions in the pre- and post-course questionnaires.

Attitudes towards ICT for learning	Dimensions of digital literacy		
	Technical	Cognitive	Social-emotional
1. I like using ICT for learning	7. I know how to solve my own technical problems.	12. I am confident with my search and evaluate skills in regards to obtaining information from the Web	15. ICT enables me to collaborate better with my peers on project work and other learning activities
2. I learn better with ICT	8. I can learn new technologies easily.	17. I am familiar with issues related to web-based activities e.g. cyber safety, search issues, plagiarism	5. I frequently obtain help with my university work from my friends over the Internet e.g. through Skype, Facebook, Blogs
3. ICT makes learning more interesting	9. I keep up with important new technologies.		
4. I am more motivated to learn with ICT	10. I know about a lot of different technologies.		
6. ICT enables me to be a self-directed and independent learner	11. I have the technical skills I need to use ICT for learning and to create artefacts (e.g. presentations, digital stories, wikis, blogs) that demonstrate my understanding of what I have learnt		
13. There is a lot of potential in the use of mobile technologies (e.g. mobile phones, PDAs, iPods, smartphones etc) for learning	16. I have good ICT skills		
14. Teachers/lecturers should use more ICT in their teaching of my classes			

Table 3
Demographics of participants ($N = 51$).

Characteristic		Frequency	Percentage
Gender	Females	28	55%
	Males	23	45%
Age	18–22	40	78%
	23–26	8	15%
	27–30	3	6%
	30+	Nil	Nil
Year of study	1	Nil	Nil
	2	33	69%
	3	7	15%
	4	6	13%
	5	2	4%
Degree pursued	BA/BEd	24	47%
	BSc/BEd	19	37%
	Others	8	16%

interactive white board (also known as *Smartboard*). The technological concepts covered were WebQuest, ePortfolio, digital storytelling, wiki, blog, podcast and cloud computing. Familiarity was based on whether they have heard about the technology or technological concept and whether they have used it. Having heard about the technology/concept would indicate a low level of familiarity of the technology or concept. However, having experienced using the technology e.g. edited photos with *Photoshop*, participated in collaborative work in *VoiceThread* or transferred files for storage in *Dropbox* would indicate a substantial amount of skills and knowledge associated with using the technology. Similarly having created a product e.g. a wiki, blog, digital story, WebQuest, *Prezi* presentation, crossword or multiple choice questions with *Hot Potatoes*, would indicate a substantial amount of familiarity with the concept.

The results in *Table 5* show that all the students bar one or two students (for *YouTube* and *Facebook* respectively) were very familiar with these two technologies and have used them. While the majority of students have heard of the more 'popular' technologies such as wikis, blogs, *Google Docs*, podcasts, *Movie Maker/iMovie*, *Photoshop* and *Smartboard*, the number of students having used them were much less. While *VoiceThread* and *Google Docs* could be considered social media (web-based technologies with capacity to enable interactive dialogue), only 10% of the students have heard of the former and less than 50% of the students have made use of the latter. The other technology of high familiarity is *Photoshop*, the photo editing software that 78% of the students had made use of, presumably for editing personal photos or academically for assignments.

Even though there are, in the literature, attempts to incorporate *Facebook* into education (e.g. *Schroeder & Greenbowe, 2009*), the reported incidences are few, hence the technology is largely for social networking. The rest of the items in *Table 5* could be considered educational technologies and were incorporated into the students' learning in the course. It can be seen that the majority of the students were very unfamiliar with many of the technologies such as *Prezi*, *VoiceThread*, *Hot Potatoes*, *Dropbox*, *SurveyMonkey* and *SmartBoard* and with the concepts of WebQuest, ePortfolio, cloud computing, digital story and podcast (even though most have heard of podcast, the majority has not used it).

6.4. Proficiency with use of digital technologies

Proficiency with using ICT-based tools was measured on a scale of 1–4 with 1 being Not Proficient and 4 being Very Proficient. The results show that almost all the students (96%) considered themselves very proficient or proficient in using word processor software for writing documents but the majority (55%) considered themselves not proficient at all in creating web pages (see *Table 6*) with only 11% indicating being proficient or very proficient with these tools. When dealing with multimedia software applications such as movie making and photo editing, the majority (55% and 53% respectively) were somewhat proficient or not proficient with using the technologies, although more students indicated themselves to be somewhat more proficient with photo editing software than movie making software. While there is a spread in terms of the use of spreadsheets, presentation tools and mobile devices as personal organisers, the majority of the students considered themselves as being proficient or very proficient in using these tools.

A possible explanation for the less proficient results with the use of web design, photo editing and movie making software is that the students have had little exposure to these applications in formal educational settings or had little purpose for using them in their informal learning activities.

6.5. Frequencies in use of web-based technologies

Web 2.0 is becoming a lifestyle for young people who are accessing the web for services, socialising, exchanging ideas, collaborating on projects, sending emails, video conferencing, seeking for information, buying and selling goods, downloading games, videos and music and creating new resources online. The statements in *Table 7* sought to capture the frequency of use of the web for these and other activities by the undergraduate students. The data show that the vast majority of the students were accessing the web on a daily or weekly basis to logon

Table 4
Access to digital technologies ($N = 51$).

Access to technology	Desktop computer	Mobile phone	MP3/4 player or iPod	Laptop computer	Broadband	Wireless
Not sure	–	–	–	–	6%	2%
No access	4%	–	2%	–	4%	4%
Limited	20%	2%	10%	10%	12%	22%
Unlimited	76%	98%	88%	90%	78%	72%

Table 5
Students' familiarity with selection of technologies or technological concepts (N = 51).

Familiarity with the <i>technology</i>	You Tube	Face book	Voice Thread	Hot Potatoes	Google Docs	Survey monkey	
Low (heard of)	100%	100%	10%	2%	57%	41%	
High (made used of)	98%	96%	2%	0%	45%	29%	
Familiarity with the <i>technology</i>	Prezi	Dropbox	Smart board	Movie Maker/iMovie	Photoshop		
Low (heard of)	20%	47%	72%	82%	96%		
High (made used of)	0%	35%	45%	47%	78%		
Familiarity with the <i>technological concept</i>	Digital story	WebQuest	ePortfolio	Podcast	Wiki	Blog	Cloud computing
Low (heard of)	23%	28%	49%	90%	94%	98%	23%
High (made used of)	6%	6%	8%	45%	69%	51%	12%

to Blackboard, to look up referencing materials, browse for general information, listen to sound recordings, access online services, send/receive emails, chat and socialise online, download music/multimedia files and for other pastime activities. The majority of the students, however, were not using the web to build and maintain a website, to keep their own blogs, to contribute to the development of wikis (Table 7, items 11, 21 and 22 respectively). This suggests that the students were not creators of online materials. For the rest of the web-based activities in Table 7, the students did not carry them out or did so very infrequently (more than monthly). These activities include trading online (item 7), sharing MP3 files and photographs (items 14 and 15), making phone calls or videoconferencing (items 16 and 17), read RSS feeds (item 18), reading or commenting on other people's blogs/vlogs (items 19 and 20).

It is interesting to note the similarities and differences in the results of this study and that of Kennedy et al.'s (2008) study. The latter study was conducted in 2006 and there is a 5-year gap between this study and Kennedy et al.'s study which surveyed some 2000 first year undergraduates from across the university's faculties. Even though this study is small in comparison with only 51 participants and hence not generalisable, the results indicate that there are both similarities and differences in the students' responses. The notable differences include a larger percentage of the 2011 students using email, accessing course management system, listening to sound recordings, buying/selling online, using RSS feeds and using the web for seeking general information, pastime activities, socialising, and accessing services more frequently than their counterparts in 2006. These differences reflect the increased ownerships, hence use of computers by the 2011 students and the advancement of technologies, especially Web 2.0 technologies that are more user-friendly and easier to use. The similarities in the two studies are that both groups of students do not play networked games, create a website, share MP3 files or photographs, read blogs, keep their own blogs or contribute to wikis frequently. As will be further discussed in the last section of this paper, the young people need a purpose to engage with these online activities. Sharing photos and conversations with peers in social network sites such as Facebook and other selected platforms (e.g. Twitter and blog groups) means that there is not a need to share photos or websites specifically on another site e.g. Flickr and Blinkis which were provided as examples for item 15 in the questionnaire.

6.6. Process of learning about and integrating new technologies

6.6.1. Time taken by the undergraduate students for different processes when adopting new technologies into their learning

As described in the 'Data gathering method' section, students were asked to identify, for each of the products created when using unfamiliar technologies, the most amount of time (using code 1) and the least amount of time (using code 3) spent for the processes of (a) learning about the new technology (b) planning the content and (c) creating the product. As shown in Table 8, the general pattern for the process that most of the students spent *most time* on is in the preparation of content and the process that most spent the *least time* on is learning about the technology. The two instances which deviated from the pattern are for:

- (i) using Mahara, the ePortfolio platform, where the largest number (40%) of students indicated they spent the most time on creating the product. To create their ePortfolio, the students would need to have created their artefacts to be uploaded onto the Mahara ePortfolio system. Apart from embedding and attaching the artefacts, they were required to ensure that all the links were active and the embedded artefacts such as their digital stories and Prezi presentations (see Fig. 2) were working. On top of this, they were required to write reflective comments about each of the artefacts. The platform was new to all the students, hence it is not unexpected that they would spend a substantial amount of time on putting the ePortfolio together.
- (ii) using Prezi to create a presentation where the process that most of the students (48%) spent the least amount of time was in creating the product. The Prezi software is not a complicated program with relatively fewer features compared with the PowerPoint software. Hence creating the product would take the least time.

Table 6
Mean proficiencies (and standard deviations) and frequencies of using different ICT-based technologies (N = 51).

	Mean (SD)	Mode	Frequency (%)			
			4 Very proficient	3 Proficient	2 Somewhat proficient	1 Not proficient
Word processor: Word or Pages	3.76 (.51)	4	80	16	4	–
Spreadsheet: Excel, Numbers	2.76 (.99)	2	29	28	33	10
Presentation: PowerPoint, Keynote	3.16 (.81)	3	39	39	20	2
Video editing: iMovie, MovieMaker	2.35 (1.18)	1	23	22	22	33
Photo/image editing: Photoshop, Photoscape	2.47 (.95)	2	16	31	37	16
Web design software: Dreamweaver, Frontpage	1.72 (.99)	1	10	8	26	55
Mobile devices organiser: address book, appointments	3.06 (1.03)	4	43	31	14	12

Table 7Mean, standard deviation, mode and frequencies of the use of different web-based technologies. Scale adapted from Kennedy et al.(2008, p. 114). $N = 51$.

	Mean (SD)	Mode	Frequency (%)				
			5 Daily	4 Weekly	3 Monthly	2 More than monthly	1 Not used
1. Use the web to access a school portal or Course or Learning Management System e.g. Blackboard, Moodle	4.63 (.49)	5	63	37	–	–	–
2. Use the web to look up reference information for study purposes (e.g. online dictionaries, content specific websites etc)	4.39 (.57)	4	43	53	4	–	–
3. Use the web to browse for general information (e.g. news, holidaying, event timetables)	4.69 (.55)	5	73	23	4	–	–
4. Use the Internet/web or a LAN to play networked games	2.45 (1.4)	1	12	12	23	16	37
5. Use the web to listen to sound recordings (e.g. via streaming audio or iTunes)	4.14 (1.15)	5	49	33	6	6	6
6. Use the web for other pastimes (i.e. for leisure activities)	4.73 (.66)	5	80	16	–	4	–
7. Use the web to buy or sell things (e.g. eBay, Amazon, air tickets.)	2.75 (1.13)	2	4	25	27	27	17
8. Use the web for other services (e.g. banking, paying bills)	3.67 (1.24)	4	25	43	16	4	12
9. Use the web to send or receive email (e.g. Hotmail, Gmail, Yahoo, Outlook)	4.78 (.54)	5	82	16	–	2	–
10. Use the web for instant messaging/ chat (e.g. MSN, Yahoo, ICQ)	4.14 (1.28)	5	59	17	10	6	8
11. Use the web to build and maintain a website (e.g. Wikispace, Yola)	1.69 (1.2)	1	4	8	14	2	72
12. Use social networking software on the web (e.g. Facebook, MySpace, Trendster)	4.71 (.86)	5	84	10	2	–	4
13. Use the web to download MP3 files (e.g. music, videos, podcasts)	3.82 (1.09)	4	27	45	16	6	6
14. Use the web to upload and share MP3 files (e.g. music, videos, podcasts)	2.41 (1.37)	1	10	14	21	18	37
15. Use the web to share photographs or other digital material (e.g. using Blinklist, Flickr)	2.61 (1.33)	1	8	21	23	18	30
16. Use the web to make phone calls (e.g. VoIP using Skype)	2.59 (1.42)	1	14	12	23	18	30
17. Use the web for web conferencing (e.g. using a webcam)	2.04 (1.28)	1	8	6	17	20	49
18. Use the web to read RSS feeds (e.g. news feeds)	2.41 (1.48)	1	16	8	19	16	41
19. Use the web to read other people's blogs or vlogs	2.84 (1.58)	1	22	16	20	8	33
20. Use the web to comment on other people's blogs or vlogs	2.68 (1.63)	1	22	14	17	6	41
21. Use the web to keep your own blog or vlog	1.76 (1.3)	1	6	10	10	4	70
22. Use the web to contribute to the development of a wiki	1.44 (.84)	1	2	2	4	22	69

6.6.2. Processes of design and construction with new technologies

The processes that the undergraduate students adopted in integrating new technologies in their learning were further elicited qualitatively in the open section of the post-questionnaire. The students were asked to comment on how they planned and constructed the Prezi presentation task (an individual task) and the Webquest in Wikispaces task (a group task).

Table 9 shows that most of the undergraduate students (more than 70% for both the individual and group tasks) went straight into the construction process with little or no prior planning. They indicated that they learnt to use the technology, designed and created the content concurrently, with little or no planning depending on the task. For the group task, some level of planning was done, especially to agree on the distribution of work and the content pages each member of the group would construct. As the structure of WebQuest has different distinct components – Introduction, Task, Processes, Resources, Evaluation, and Conclusion, it made splitting up of the group work more equitable. Examples of comments by the students are shown below.

For both the individual and group tasks, less than 10% indicated that they explored the technologies first. For 17% (individual task) and 21% (group task) of the students, the content was prepared first before using the technology to construct the product.

Examples of typical comments by the students on the process of construction are shown below:

Those who explore the technology first

I made sure I understood how to use the (Prezi) technology well enough before integrating information

We explored the capacity of the wiki software first

Those who prepared the content first

Got the materials first because of my experience of learning new (Prezi) software is really easy

Had materials ready and written plan (for Prezi task)

Plan the Wiki topic first, search the materials and form the Wiki

We had most of the content in a word document and then finalised it in Wiki

Those who did a little planning and constructed the product in a concurrent manner (learnt the technology, planned content, designed and constructed the artefact concurrently)

Had a basic plan but did most of the (Prezi) construction as I went along

I did a rough outline on paper and as I constructed the Prezi added things in such as videos or images

Straight into Wiki. Outlined who would do which part and then constructed as we went along

Those who did no planning and constructed the product in a concurrent manner (learnt the technology, planned content, designed and constructed the artefact concurrently)

No (planning), I put the information straight into prezi and then I learned how to edit, rearrange etc

Go straight into prezi to create the presentation and find the materials/urls as I constructed the presentation

Table 8
Ranking of the amount of time spent on the processes in creating artefacts using specific technologies.

Technology (task)	Time spent of processes								
	Most time			Second most time			Least time		
	Learn tech	Prepare content	Create product	Learn tech	Prepare content	Create product	Learn tech	Prepare content	Create product
Prezi (create a presentation)	24%	48%	28%	34%	41%	24%	42%	10%	48%
Wikispaces (create a WebQuest)	17%	48%	34%	20%	41%	38%	62%	14%	24%
Inspiration (create concept maps)	14%	59%	28%	24%	24%	52%	62%	17%	21%
Hot Potatoes (create a quiz)	19%	62%	19%	19%	31%	50%	62%	8%	31%
Mahara (creating the ePortfolio)	24%	36%	40%	28%	32%	40%	48%	32%	20%

The grey shading indicates the largest percentage of students nominating the processes that they spent the most time and the least time on. It is meant to show visually the trend in the students' choices.

These findings show that using the technology was not of foremost concern for these students even though the vast majority of them were unfamiliar with them. They were able to embrace the technologies and integrate them into their learning with ease to produce meaningful products and develop their digital literacy skills further.

6.6.3. Resolving of technical issues encountered

In the open questions, the students were asked if they had encountered technical problems using the technologies and if they did, how they went about resolving them. As shown in Table 10, the majority of the students did not encounter technical issues. There were more students (44%) who found more issues with using Wikispaces than the Prezi (24%) software. Of the seven students who encountered technical difficulties with Prezi, one sought the tutor's help while the remaining six resolved their issues independently through the use of YouTube or from the Prezi online forum. Examples of comments were:

I used either the help tool or went on to forums which discussed my problem

Only at the beginning when I had to educate myself with the software, I searched YouTube to do this

Of the eleven students who encountered technical problems with Wikispaces, two indicated the use of human resources (peers, tutor) to help them solved their issues. The vast majority resolved their technical difficulties with their partner, through independent trial and error, by 'googling', from YouTube videos and using Wikispaces' 'Help' feature. Examples of comments in regards to technical issues are shown below:

We had some trouble using the navigation bar but fixed it by renaming all the pages in alphabetical order

Yes, accidentally removed the home page. Difficulty in formatting tables. We searched with Google and worked around other difficulties

Wikispaces is a very bad editing tool. We had many issues with things not staying in place after editing

I had technical problem of uploading pictures and videos in an organised manner, but I worked out to put them in tables

Our computers kept crashing. So, we had to turn off our laptops all the time. This was frustrating

Yes, after playing around for 1–2 hours, we ended up finding a solution

Many issues. We asked a friend

6.7. Students' self-evaluation of their own digital literacy

In the post-course questionnaire, the students were asked to rate their digital literacy on a scale of 1–10 at the start of the semester (before the course) and at the end of the semester (after the course has been completed). As shown below, the 34 students who responded to this question rated themselves with a mean of 6.2 at the start of the semester. This went up to 8.0 at the end of the semester. Table 11 shows the details of the change. Five of the students recorded no change at all, these students were confident digital technologies users and rated themselves very highly (9 or 10) for the start of the semester, leaving little room for change.

N = 34	Average
Start of semester	6.2
End of semester	8.0

Table 9
Qualitative data on the process of design and construction of products using unfamiliar technologies.

	Individual task (create a Prezi presentation)	Group task (create a WebQuest in Wikispaces)
Explore technology first	6%	–
Get content ready and transfer	17%	21%
Brief plan, straight into construction: concurrent design & content creation	43%	79%
No plan, straight into construction: concurrent design and content creation	33%	–

Table 10
Responses of students to the question 'did you encounter any technical problems?'

	Individual task (Prezi presentation) <i>N</i> = 29	Group task (WebQuest in Wikispaces) <i>N</i> = 25
Yes	24%	44%
No	76%	56%

The rest of the students indicated a change of at least 1 point with one student indicating a change of 6 points. The data shows that the majority of this group of undergraduate students thought that there was room to improve their digital literacy through the course.

6.8. Pre- and post-questionnaire data

The pre- and post-questionnaire questions sought to investigate the impact of the eLearning course on the students' attitudes and digital literacy. There were 17 statements in the questionnaire (see Table 1 above) measured on a 5-point scale. The pre-questionnaire was completed at the start of the semester by 51 students in a class of 53 students, hence there was a 96% return rate. However, only 34 students filled in the post-questionnaire at the end of the semester. Furthermore, only 28 of the 34 students could be matched with those who filled in the first questionnaire. There were a few issues with students writing in the wrong codes in the post-questionnaire, hence these could not be matched.

An attrition analysis was conducted to compare the possible differences between the 28 'matched' students to the 23 'dropouts' from the original pre-questionnaire sample of 51 students. The attrition analysis indicates that the 'dropout' group and the 'matched' groups were overall very similar because when all the scales (73 items) in the pre-questionnaire were compared, only two items as shown below, indicated significant differences:

- Responses to the question *Use the web to listen to sound recordings (e.g. via streaming audio or iTunes)*, $t(42.92) = 2.087$, $p = .043$ (Levene's test was significant, equal variances were not assumed). The 'drop outs' were on average listening to music more often (mean score = 4.48) than the 'matched' group (mean score = 3.86). The scales were daily = 5, weekly = 4, monthly = 3, more than monthly = 2 and not used = 1.
- Responses to the question *I have the technical skills I need to use ICT for learning and to create artefacts (e.g. presentations, digital stories, wikis, blogs) that demonstrate my understanding of what I have learnt*, $t(49) = -2.14$, $p = .038$. The 'drop outs' were on average less sure they have these skills (mean score = 3.13) while the 'matched' group was more confident (mean score = 3.68).

The pre- and post-questionnaire matched dataset of the 28 students were analysed to see if there were changes in their attitudes towards learning with ICT and their digital literacy. The internal consistency of the scale (Table 12) was high for both sets of responses of the questionnaire, with Cronbach's alpha values of .869 and .898 for the pre- and post-questionnaire respectively.

6.8.1. Attitudes towards ICT for learning

The *t*-test results of the matched data, shown in Table 12, indicate that there are no significant differences in the students' attitudes (items 1, 2, 3, 4, 6, and 14) towards the use of ICT for learning before and after the course. However, the mean values for all these statements were increased in the post-survey indicating more positive attitudes at the end of the course. The students were more positive about learning with ICT as they thought that ICT motivated them to learn, it made learning more interesting and they learnt better with ICT as it allowed them to learn more independently. They also thought that teachers and lecturers should use more ICT in their teaching.

For item 13 which gauged the students' perceptions of the potential of mobile devices for learning, there was a decrease in the post-survey mean value that is statistically significant, $t(27) = 3.03$, $p < .05$. The reason for the decrease could be due to the lack of exposure to learning with mobile devices in the course. While the theoretical aspects of learning with mobile devices were integrated into the lectures, there was no practical use of these devices for learning in the course since mobile learning was not a focus of the course. It is interesting to note the high mean value (4.18 out of a maximum of 5) in the pre-survey responses. This suggests that the undergraduates had very positive preconceptions of the usefulness of mobile devices for learning.

6.8.2. Students' pre- and post-course digital literacy

The mean values of the responses to the 10 statements that measured the technical, cognitive and social-emotional dimensions of the students' digital literacy are shown in Table 12, sections B, C and D respectively. Overall, the post-survey responses of these 10 statements show that the students were more positive at the end of the course with the mean scores increasing for all items except for item 12 (confidence with web-based search and evaluation skills) and item 17 (familiarity with issues related to web-based activities). These two statements are associated with the cognitive dimension of digital literacy and showed a decrease in the mean values in the post-survey responses, even though the decrease is not statistically significant. The less positive responses could be due to the high exposure to web-based resources in the course for both information consumption and content creation and an increased awareness by the students of

Table 11
Frequency and percentage of change in self-rating of being digitally literate over the semester.

Change in self-rating (difference between start and end)	Change in self-rating of being digitally literate from start of semester to end of semester							Total
	No change	1	2	3	4	5	6	
No. students	5	11	9	5	2	1	1	34
% of students	15%	32%	26%	15%	6%	3%	3%	100%

Table 12Means and standard deviations of matched students' pre- and post-questionnaire responses about attitudes and digital literacy. $N = 28$.

	Pre-survey mean (SD)	Post-survey mean (SD)
<i>A. Attitudes statements</i>		
1. I like using ICT for learning	4.11(.79)	4.32(.67)
2. I learn better with ICT	3.68(.77)	3.71(.85)
3. ICT makes learning more interesting	4.06(.69)	4.21(.74)
4. I am more motivated to learn with ICT	3.56(.85)	3.85(.86)
6. ICT enables me to be a self-directed and independent learner	3.82(.98)	3.96(.74)
13. There is a lot of potential in the use of mobile technologies (e.g. mobile phones, PDAs, iPods, smartphones etc) for learning	4.18(.82) ^a	3.79(.99) ^a
14. Teachers/lecturers should use more ICT in their teaching of my classes	3.86(.89)	3.96(.74)
<i>B. Digital literacy: technical dimension</i>		
7. I know how to solve my own technical problems	3.46(1.07) ^a	3.79(.99) ^a
8. I can learn new technologies easily	3.86(.97)	3.93(.81)
9. I keep up with important new technologies	3.36(1.06)	3.57(1.13)
10. I know about a lot of different technologies	3.26(1.13)	3.52(1.12)
11. I have the technical skills I need to use ICT for learning and to create artefacts (e.g. presentations, digital stories, wikis, blogs) that demonstrate my understanding of what I have learnt	3.68(.90) ^a	4.04(.69) ^a
16. I have good ICT skills	3.79(.83) ^a	4.00(.67) ^a
<i>C. Digital literacy: cognitive dimension</i>		
12. I am confident with my search and evaluate skills in regards to obtaining information from the Web	4.28(.76)	4.18(.72)
17. I am familiar with issues related to web-based activities e.g. cyber safety, search issues, plagiarism	4.41(.64)	4.25(.86)
<i>D. Digital literacy: social-emotional dimension</i>		
5. I frequently obtain help with my university work from my friends over the Internet e.g. through Skype, Facebook, Blogs	3.57(1.23)	3.79(1.29)
15. ICT enables me to collaborate better with my peers on project work and other learning activities	4.04(.81)	4.15(.82)

^a Marks significant differences between pre-/post- surveys, $p < .05$.

the complexity of researching and utilising web-based resources. The increased awareness could have led to a level of self-doubt of their own abilities in using web-based resources.

For the technical dimension of digital literacy, the results (Table 12, section B) show that mean responses for all the six items were higher in the post-survey in comparison to the pre-survey. There are three items (7, 11 and 16) that are significantly higher in the post-survey responses. The students:

- were significantly more able to solve their own technical problems (item 7), $t(27) = -2.78$, $p < .05$,
- were more positive of their technical skills that were needed to use ICT for learning and to create artefacts to demonstrate their understanding of what they have learnt (item 11), $t(27) = -2.71$, $p < .05$ and
- were more confident with their ICT skills (item 16), $t(27) = -2.71$, $p < .05$.

It is interesting to note that the attrition analysis (described in the previous section) highlighted that the matched group completing the post-survey was significantly more confident in having the technical skills needed to use ICT for learning (item 11) than the 'dropout' group. Thus, even this more confident group had room to improve their technical skills.

For the social-emotional dimension of digital literacy, the two statements (items 5 and 15) captured the more social aspects of this dimension of digital literacy asking the students about their involvement with peers and use of Web 2.0 technologies. The mean responses were more positive at the end of the semester, although not statistically significant, but indicated that they were positive about socialising online for learning's sake.

7. Conclusion and implications

This research sought to investigate the 'digital nativeness' and the digital literacy of a group of undergraduate pre-service teachers, largely in their second year of university. The 'digital nativeness' in the study assumes that digital natives in educational settings have a level of digital literacy that enables them to be comfortable with using digital technologies and to adopt new or unfamiliar technologies with ease. The study also sought to understand the level of digital literacy of the participating undergraduates and if it could increase through explicit teaching of the integration of technology into their learning. The framework of digital literacy for the study was premised on the three dimensions that are technical, cognitive and social-emotional.

The research findings indicate that all the students had largely unlimited access to desktops and/or laptops with more of them having more access to laptops than desktops, presumably through personal ownership of laptops as it is increasingly becoming more common to see more students bringing their laptops to campus these days. These students use online resources regularly to socialise, use online

services, the university's online management system, download music/multimedia files, receive/send emails, chat and seek information for both academic and personal purposes. Consistent with data shown elsewhere (e.g. Bennett & Maton, 2010; Jones, Ramanau, Cross, & Healing, 2010; Kennedy et al., 2008), these students do not engage as actively with content creation with Web 2.0 tools such as creating websites, keeping blogs or contributing to wikis. While the majority of the students in the study were familiar with these concepts, many have not used the tools for educational purposes to create artefacts online. A possible explanation for the lack of participation in online content creation is that there is a lack of purpose to do so. The majority (98% of the 51 students in this study) of the young people today have a social network account (*Facebook*) where they are able to exchange ideas, share photos/videos and links. They access online services and trade online frequently, regularly search for and use online information and resources for general and academic purposes, and communicate frequently via their mobile phones and selected online tools. In these respects, these students are living the digital natives' e-lives that are advocated by Prensky (2004). For these students, the frequent uses of these technologies are purposeful and would consume a significant part of their time. Unless taught explicitly to use other (educational) technologies, it is unlikely that digital natives would think about educational technologies or consider tinkering around creating a website or wiki unless for a purpose, for example to advertise for a product or for a graded academic assignment.

This research has shown that given the opportunity to engage with a purpose for adopting digital tools, the undergraduates were able to use them to create meaningful products with the minimum fuss. The meaningful products include creating artefacts in the students' discipline areas that could be shared with their peers and also be used for their future teaching when on placements or when they start teaching as graduate teachers. The results showed that the technical aspects of unfamiliar technologies were not of foremost concern to many of these students. It is the thinking about and preparation of content and its integration into the technologies that they spent more time on in the process of creating artefacts. The majority of the students also indicated that they concurrently explore the technologies and integrate the content, including finding for information and multimedia materials, when using new technologies to create learning artefacts. The little planning that many of these students undertook indicates the multi-tasking nature of digital natives, that is, there was no step-lock process demonstrated in their use of technologies and they were sufficiently comfortable with learning about the technology concurrently with assembling the product. Such behaviour is made possible by the editing capabilities of most digital technologies these days that allow individuals to literary 'dump' thoughts, information, images and videos in a disordered manner only to edit, delete and re-order them at a time that suits them. The undergraduates of this study would presumably have capitalised on these technological affordances.

The undergraduates' perceptions of their own digital literacy (in the post-questionnaire) at the start of the study showed a mean ($N = 10$) of 6.2 out of a maximum value of 10 which went up by a mean value of 1.8 to 8.0 at the end of the study. This indicates that they perceived having improved their digital literacy through the explicit teaching and learning in the course about new educational technologies and their integration into their learning. As new technologies that could be used in educational contexts seem to be appearing at a rather fast pace, the choice of technologies presented to the students in the study was not constraining as the skills and knowledge gained from interacting with the recommended technologies are transferable to other new technologies. For example, familiarity with having created a wiki online would mean that the students should be able to build a glog (online poster) without any issues. The underlying importance of educating young people in using technologies is to develop their digital literacy as the more the student builds up his/her digital literacy skills and knowledge, the more flexible and innovative (s)he would be with the use of technologies for learning or to demonstrate what has been learnt. The research findings showed that the course had the biggest (positive) impact on the students in the technical dimension of the digital literacy framework, in particular the improvement in the students' skills to create content with digital tools and their ability to solve technical issues. They were able to solve technical issues independently through trial and error or through the use of other available technologies, for example the 'Help' function, search online for solutions or post the problem on dedicated online sites where members of the communities might be able to offer a solution. The dependency on their lecturers or tutors to guide them through the use of the technologies appears to be minimal. It should be noted that the abilities to integrate content into the technologies and to solve technical issues are not strictly associated only with the technical dimension of digital literacy, but would also involve the cognitive aspect as well. Hence a limitation of the study is a lack of refined statements in the questionnaire that could explicitly capture the different dimensions of digital literacy independently. Furthermore, it was not within the scope of this paper to make explicit the multiple literacies in the digital literacy framework, for example critical, visual, multimodal and reproduction literacies. These literacies add to the complexity of developing digital literacy. It means that its development is an ongoing process for the students (Ng, 2012) and more research into young people's development of digital capabilities and literacy would need to be conducted.

An implication of the study is that educators need to have knowledge of the affordances the various technological tools offer that are beneficial for their own teaching and for their students' learning. They will also need to know how to use the tools and model their uses or explicitly teach their students about the technologies and their uses. Margaryan, Littlejohn, and Vojt (2011) asserted that students have a limited understanding of how technology could support their learning and that their expectations of learning with technologies are influenced by their lecturers' approaches to teaching. Hence the students will need to be guided. For many students, one of their sole aims at universities is to learn the content their lecturers require from them so that they can do the assignments and pass the exams. The 'limited understanding' of Margaryan et al. (2011) is not due to a lack of wanting to use technology as 96% of the students in this study access the web on a daily or weekly basis to seek general and/or referencing information. Unless there is a purpose to integrate technologies in their learning (e.g. as part of an assignment requirement, catching up with missed lectures by listening to recorded podcasts or use simulations and other learning resources as directed by the lecturers) it is unlikely that they will deliberately use educational technologies, apart from searching for information on the Internet, in their normal learning routine.

In concluding, the research has shown different perspectives of the undergraduates' 'digital nativeness'. It has focused on digital literacy development as the underlying principle for eLearning, that is, the equipping of students with a repertoire of tools and cognitive capabilities to help them live in a technologically oriented society that would inevitably require them to be able to adopt new technologies or adapt to changes to existing technologies. Digital literacy is also important for them to know about how the world operates where so many processes are being governed by technology. In applying Sweller's (1988, 2005) cognitive load theory for learning, a high level of digital literacy can help alleviate cognitive load that is often associated with the use of technology, hence freeing the working memory of the mind to focus on the tasks at hand and content to be learnt rather than on the technology.

It would be difficult to find homogeneity in any one student population as issues of equity, opportunities, abilities and interests invariably exist. Prensky (2004, online) has acknowledged, in describing digital natives' online activities:

This is not to say that every young person does every one of these things online – many still do only a few – but the possibilities for what Digital Natives can do online are growing exponentially, and are being adapted by more and more of them daily (and by some adults as well, although as we will see, there are differences.)

We need, however, to acknowledge that the students of today have had more opportunities to engage with technologies than their pre-1980s counterparts and are perhaps more comfortable and intuitive in handling technologies. This is not to say that pre-1980 individuals are not capable of using technology comfortably and intuitively since anyone willing to invest time and effort to explore technologies would be able to learn to use them effectively. For the current generation of students, a lot of their digital capabilities, in particular the use of mobile phones and social media have been gained informally where they explore these technologies themselves or with peers. There is a role for educators to expand their horizon in the use of digital technologies for educational purposes in formal settings.

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