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The Net Generation and Digital Natives

Implications for Higher Education

A literature review commissioned by the Higher Education Academy

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Executive Summary

Our students have changed radically. Today's students are no longer the people our educational system was designed to teach. (Prensky 2001 p1, emphasis in original)

1. There is no evidence that there is a single new generation of young students entering Higher Education and the terms Net Generation and Digital Native do not capture the processes of change that are taking place.
2. The complex changes that are taking place in the student body have an age related component that is most obvious with the newest waves of technology. Prominent amongst these are the uses made of social networking sites (e.g. Facebook), uploading and manipulation of multimedia (e.g. YouTube) and the use of handheld devices to access the mobile Internet.
3. Demographic factors interact with age to pattern students' responses to new technologies. The most important of these are gender, mode of study (distance or place-based) and the international or home status of the student.
4. The gap between students and their teachers is not fixed, nor is the gulf so large that it cannot be bridged. In many ways the relationship is determined by the requirements teachers place upon their students to make use of new technologies and the way teachers integrate new technologies in their courses. There is little evidence that students enter university with demands for new technologies that teachers and universities cannot meet.
5. Students persistently report that they prefer moderate use of Information and Communication Technologies (ICT) in their courses. Care should be taken with this finding because the interpretation of what is 'moderate' use of ICT may be changing as a range of new technologies take off and become embedded in social life and universities.
6. Universities should be confident in the provision of what might seem to be basic services. Students appreciate and make use of the foundational infrastructure for learning, even where this is often criticised as being an out of date and unimaginative use of new technology. Virtual Learning Environments (Learning or Course Management Systems) are used widely and seem to be well regarded. The provision by university libraries of online services, including the provision of online e-journals and e-books, are also positively received.
7. Students do not naturally make extensive use of many of the most discussed new technologies such as Blogs, Wikis and 3D Virtual Worlds. The use of 3D Virtual Worlds is notably low amongst students. The use of Wikis and Blogs is relatively low overall, but use does vary between different contexts, including national and regional contexts. Students who are required to use these technologies in their

courses are unlikely to reject them and low use does not imply that they are inappropriate for educational use. The key point being made is that there is not a natural demand amongst students that teaching staff and universities should feel obliged to satisfy.

8. There is no obvious or consistent demand from students for changes to pedagogy at university (e.g. demands for team and group working). There may be good reasons why teachers and universities wish to revise their approaches to teaching and learning, or may wish to introduce new ways of working. Students will respond positively to changes in teaching and learning strategies that are well conceived, well explained and properly embedded in courses and degree programmes. However there is no evidence of a pent-up demand amongst students for changes in pedagogy or of a demand for greater collaboration.
9. There is no evidence of a consistent demand from students for the provision of highly individualised or personal university services. The development of university infrastructures, such as new kinds of learning environments (for example Personal Learning Environments) should be choices about the kinds of provision that the university wishes to make and not a response to general statements about what a new generation of students are demanding.
10. Advice derived from generational arguments should not be used by government and government agencies to promote changes in university structure designed to accommodate a Net Generation of Digital Natives. The evidence indicates that young students do not form a generational cohort and they do not express consistent or generationally organised demands. A key finding of this review is that political choices should be made explicit and not disguised by arguments about generational change.

Contents

Contents.....	1
The origins of the idea	3
Millennials	4
Net Generation	4
Digital Natives/ Digital Immigrants.....	5
Generation Y	6
Implications for education	7
Collaborative learning	8
Institutional reform.....	9
Recent developments	10
Digital Wisdom.....	10
Born Digital	11
Digital Melting Pot.....	11
Digital visitors and residents	12
Recent empirical research.....	12
The United Kingdom	13
Other European countries.....	17
Germany	18
Austria.....	19
Netherlands	20
Scandinavia	20
Spain	21
North America.....	22
USA.....	22

Canada	27
Australia	28
South Africa	30
Chile	31
Mainland China	32
Hong Kong (China)	33
Conclusions from the empirical studies.....	34
Theoretical responses	35
Agency	36
Networked Individualism	37
Previous reviews	38
Implications for Higher Education	40
The New millennium student	41
Implications for teachers	42
Implications for policy makers.....	43
Universities	43
Government and government agencies	45
References	47

The Net Generation and Digital Natives

Implications for Higher Education

The origins of the idea

Authors such as Tapscott (1999, 2009), Howe and Strauss (1991, 2000), Prensky (2001a, 2001b, 2009, 2010), Oblinger and Oblinger (2005), Palfrey and Gasser (2008) and others have argued that because today's generation of young people have been immersed in a world infused with networked and digital technologies, they behave differently to previous generations. It is claimed that they think differently, they learn differently, they exhibit different social characteristics and have different expectations about life and learning. Some have even gone further claiming that the brains of students today are 'physically different' (Prensky, 2001b) from earlier generations of students because of the students' early immersion in technology. The new generation of students are said to prefer receiving information quickly, relying on communication technologies, often multitasking and having a low tolerance for lectures, preferring active rather than passive learning (see for example Tapscott 1999; Oblinger, 2003; Oblinger and Oblinger, 2005).

In education they [the Net generation] are forcing a change in the model of pedagogy, from a teacher-focused approach based on instruction to a student-focused model based on collaboration." (Tapscott 2009 p 11).

The key terms in this debate are the Net Generation and Digital Natives/ Digital Immigrants but there are a growing number of competing terms that claim to identify new generations of young people who have been brought up in a digitally rich environment. The most common terms in circulation are the 'Millennials' (Howe and Strauss, 1991, 2000, 2003), 'Net Generation' (Tapscott, 1998, 2009, Oblinger & Oblinger 2005), 'Digital Native/Digital Immigrants' (Prensky, 2001a, 2001b, 2009, 2010, Palfrey and Gasser 2008), and 'Generation Y' (Jorgensen, 2003; Weiler, 2005; McCrindle, 2006). The same population are also less commonly referred to as the 'IM Generation' referring to the Instant Message Generation (Lenhart, Rainie, and Lewis, 2001), the 'Gamer Generation' (Carstens and Beck, 2005) for the obvious reference to video games, and even 'Homo Zappiens' (Veen, 2003) for their ability to control information flows. Each definition is slightly different and differs in the way it is used by researchers, but in general the terms are used interchangeably. Currently there are a number of even newer terms that claim to identify a further generational step change, related to newer technological developments, using terms such as the Google Generation (Rowlands et al. 2008, JISC-Ciber 2008) or the i-Generation (Rosen 2010). We begin the review of terms used in this debate with the term Millennial because this term has a longer history and explains some of the generational aspects of the later debate and we follow this term with the two key terms, the Net generation and Digital Natives and conclude this introduction of key terms with a short consideration of the term Generation Y.

Millennials

In 1991, Howe and Strauss published their book *Generations*, describing the American history based on repeating generational stereotypes. In this book, Howe and Strauss (1991) first coined the term 'Millennial Generation' (defined as being born between 1982-2000), as successor to, but not wanting to be associated with the 'Generation X' (born between 1961-1981). Howe and Strauss later published *Millennials Rising: The Next Great Generation* (Howe and Strauss 2000). This book directly linked the generational hypothesis with the student population as in 2000 those born in 1982 or after began to leave schooling and enter higher education. The 'Millennials' were said to be distinctly different from the preceding Generation X, partly as a consequence of a broad historical cycle but also as a result of a combination of historical circumstances, and timing. According to Howe and Strauss the new generation of millennial students were 'optimistic, team-oriented, high-achieving rule-followers' (2003 p.1). Millennials, although described by their situation in terms of new technologies are also a part of a long term historical process rooted in biology and culture. The Millennials are just the most recent form of the recurring Civic generation, who are said to be heroic, collegial and rationalistic. Perhaps most interestingly the recurrent characteristics of this generational type are said to include the core values of community and technology.

Based on Howe and Strauss' concept of the 'Millennials', Oblinger (2003) went on to argue that these new characteristics had created an imbalance between students' expectations of the new learning environment and what they actually found in universities and colleges. As a result, universities and colleges needed to understand these new learners and to adapt to their approaches to learning when they were designing programs and courses. Oblinger took the precise date from Howe and Strauss for the emergence of the Millennial generation and suggested that they were born 'in or after 1982' (Oblinger 2003 p38). However Oblinger & Oblinger (2005 section 2 p9) argued that this generation ended in 1991, making new entrants to higher education in the academic year 2009-2010 the last intake of this generation. Oblinger and Oblinger (2005) clearly build on Howe and Strauss and while they are cautious in stating their claims they associate the civic generation, drawn directly from Howe and Strauss, with the Net Generation defined in terms of its exposure to technology. The generational argument suggests that the boundaries between one generation and the next are sharp, defined in single year turning points, implying that it takes just a few years to make a significant difference in young people's attitudes and behaviour. However Oblinger & Oblinger also acknowledged that while they described these trends in generational terms they were adding a strong interest in contextual factors, especially the technological environment, and they argued that for changes in the student population: 'age may be less important than exposure to technology' (2005 p.20).

Net Generation

In 1997 Don Tapscott, a consultant on the application of technology in business and society, published his book *Growing Up Digital: The Rise of the Net Generation*, which commented on the social and business impact of a new digital generation which was then coming of age. Tapscott coined the term 'Net Generation', which referred to young people who had grown up surrounded by digital media. According to Tapscott (1997), the reason he used the term 'Net Generation' was because the most significant change affecting that generation had been the rise of the computer, the Internet and other digital media. He argued that:

the New Generation is exceptionally curious, self-reliant, contrarian, smart, focused, able to adapt, high in self-esteem, and has a global orientation...there has been a change in the way children gather, accept and retain information. (Tapscott, 1997)

He noted that the generation of technologically advanced students would soon be arriving at university and posing radical questions about the transformation of traditional forms of teaching and learning.

In his later book (2009) Tapscott provided dates for the start and end of the Net Generation arguing that it encompassed those born in between January 1977 and December 1997. An important feature of Tapscott's argument was that he claimed to identify significant changes in attitudes and approaches to learning related to the generational shift. Indeed Tapscott suggested that because of changes in technology there have been some 'inevitable' consequences for learning. Tapscott identified the Internet as the ultimate interactive environment and argued that education needed to move from what he described as a teacher-centred approach to learning to a learner-centred approach. By teacher-centred Tapscott meant a transmission model of education in which the teacher or lecturer imparted knowledge to the student. Learner-centred in Tapscott's view placed the focus on the individual student's activity. The lead for this change was to come from the students:

But as we make this inevitable transition we may best turn to the generation raised on and immersed in new technologies. (Tapscott 1999 p11).

Tapscott argued that the Net Generation was an outcome of changes in technology but he went on to argue that the new generation of young people was an agent of radical change, change that had a particular relevance for education and especially for higher education.

Digital Natives/ Digital Immigrants

In 2001, another term to describe this generation was introduced by Marc Prensky (2001a, 2001b), who named them 'Digital Natives', because he found them to be 'native speakers' of the digital language of computers and the Internet. According to Prensky (2001a), Digital Natives were distinct from previous generations, who he described as Digital Immigrants, and they had developed new attitudes, aptitudes, and approaches to learning. Prensky argued that there had been a sharp generational step and that the emergence of Digital Natives led to significant changes:

A really big discontinuity has taken place. One might even call it a "singularity" – an event which changes things so fundamentally that there is absolutely no going back. (Prensky 2001 p 1)

Prensky identified the entire generation with the change and suggested that the new generation thought differently and that this generational change had been caused by a process of technological change. In his second article Prensky (2001b) also claimed that the brains of Digital Natives were 'physically different' to those of previous generations

because of the direct effects of digital technologies. This review does not cover this aspect of the debate but a current review of the way the brain might be affected by new technology can be found in Bavelier et al. (2010). In contrast to 'Digital Natives', those who were not born in the digital world and had adopted many of the new technologies later in life, were called the 'Digital Immigrants' (Prensky, 2001a). Unlike Digital Natives, Digital Immigrants had to learn and adapt to using emerging technologies rather than seeing them as natural tools as part of their given world. According to Prensky, no matter how well Digital Immigrants adapted to the new environment, they would retain their 'digital immigrant accent'.

Prensky also expressed a concern about the profound gap he had identified between Digital Native students and the technological literacy of their Digital Immigrant tutors, and he went on to claim that this generation gap was 'the biggest single problem facing education today' (2001 p.2). The characteristics and learning preferences of Digital Native students, he argued, were incompatible with the teaching practice of their teachers. As this generation of young people entered higher education, educators would need to change their teaching approaches in order to meet the needs of the new generation of learners (Prensky, 2001a). Students were once again the motor of change:

Our students have changed radically. Today's students are no longer the people our educational system was designed to teach (2001a p.1).

Both Tapscott and Prensky developed a determinist line of argument that suggested that technological change led automatically to a sharp change in generational characteristics and the new generation of students would then become an agent of further change. The change they both identified was centrally located in education and the institutions of higher education in particular.

Generation Y

The term 'Generation Y' has also had a wide use, mainly in relation to business and commerce, and it has currency in some contexts that have not adopted the terms Net Generation or Digital Natives. It is claimed that it first appeared in an *AdAge* magazine in 1993 (Zhao and Liu, 2008; Halse and Mallinson, 2009), as a term to identify the generational cohort following Generation X. Generation Y was a succession from Generation X and it was composed of the children of the 'Baby Boomers' a generation identified with those born in the years after the Second World War. There have been various dates suggested for the start and end points of this generation, but they generally ranging from the mid 1970s to the mid 1990s (Jorgensen, 2003; Noble *et al.*, 2008; Weiler, 2005). Once again the claim suggests that having grown up in a digital world at a time of economic expansion has led Generation Y to have developed unique generational characteristics (Wolburg and Pokrywczynski, 2001). These include aptitudes for collaboration and networking and a positive attitude towards change (Chen, 2008; Noble *et al.*, 2008; Tulgan and Martin, 2001). Digital devices including personal computers, mobile phones, iPods and game consoles were not only necessary as communication tools but they were also symbols of generational identity (Huntley, 2006). Generation Y has been used to identify young people in mainland China, although the generational discourse in China has some unique characteristics, and the use of the term Generation Y cannot be assumed to have the exactly the same meaning as it would in other contexts (Zhao & Liu 2008, Chen 2008).

Implications for education

An assertion associated with the idea of Digital Natives is that:

It is now clear that as a result of this ubiquitous environment and the sheer volume of their interaction with it, today's students *think and process information fundamentally differently* from their predecessors. (Prensky 2001a p1 emphasis as in original)

The changes that Prensky described as a consequence of technological change have a direct impact on ways of thinking. The kinds of changes that Prensky identified are these:

Digital Natives are used to receiving information really fast. They like to parallel process and multi-task. They prefer their graphics before their text rather than the opposite. They prefer random access (like hypertext). They function best when networked. They thrive on instant gratification and frequent rewards. They prefer games to "serious" work. (Prensky 2001a p2)

The outcome of this kind of argument is two-fold. Firstly it leads to a deficit model of professional development for teachers of a most peculiar kind. Digital Immigrant teachers must try to emulate their Digital Native students but they will forever retain a Digital Immigrant accent. A second feature of this discourse is that the nature of Digital Natives is already known. There is no call for empirical work to assess whether these claims are in fact born out by current populations of students. A good critical review of this approach can be found in Bennett et al. 2008 who not only review this literature but also call for empirical work to describe the student population and their relationships with new technologies and learning.

The Net Generation argument is couched in slightly different tones. Tapscott (1999) wrote that:

Needless to say, a whole generation of teachers needs to learn new tools, new approaches, new skills. This will be a challenge...

But as we make this inevitable transition, we may best turn to the generation raised on and immersed in new technologies. Give the students the tools and they will be the single most important source of guidance on how to make their schools relevant and effective places to learn (Tapscott 1999 p 11)

Not only does he describe a deficit model in which teachers have to change and learn new skills and approaches, but the roles in education are reversed and it is the students who will now be the source of guidance for their teachers. The Net Generation argument is also full of prescriptions for teaching and learning and it promotes a change from what is described as 'teacher-centered' learning to 'learner centered' in which the teacher creates and structures what happens in the classroom, tailoring an individualised experience for the student (Tapscott 1999 p10). These prescriptions were not novel in 1999, and they followed a broad line of arguments linked to the introduction of new technologies into education, however they were new in their focus on the student as the agent of change.

The discourse based on the Digital Native/Digital Immigrant distinction pervaded discussions about the kinds of challenges teachers might face in teaching the new

generation of students. Claims were made about students' changing learning preferences due to their exposure to technology and these were widely used to support proposals to radically change education. For example Oblinger and Oblinger (2005) claimed that,

Technology has changed the Net Generation, just as it is now changing higher education (p.27).

Similarly, Dede (2005a, 2005b) claimed that technology was reshaping the mindset of students of all ages and creating a 'neomillennial' learning style. As a consequence teachers were told that they had to modify their teaching practices to accommodate to a new technology-based educational trend and in order to meet the new learning needs of the technologically sophisticated students.

Prensky has recently written *Teaching Digital Natives* (Prensky 2010) a book in which he argues that because of the technological environment in the 21st century:

It is inevitable ... that change would finally come to our young peoples' education as well, and it has. But there is a huge paradox for educators: the place where the biggest educational changes have come is not our schools; it is everywhere else but our schools. (Prensky 2010 p 1)

Prensky is not alone in suggesting that institutional change has been slow and is likely to arise as an outcome of an inevitable process consequent on generational change. Tapscott (2009) views education as one of the central locations for the broad institutional changes he associates with the new generation, something he has develop further elsewhere (Tapscott and Williams 2010). Tapscott and Williams (2010) provide the following account of the necessity for radical change:

Change is required in two vast and interwoven domains that permeate the deep structures and operating model of the university: (1) the value created for the main customers of the university (the students); and (2) the model of production for how that value is created. First we need to toss out the old industrial model of pedagogy (how learning is accomplished) and replace it with a new model called collaborative learning. Second we need an entirely new modus operandi for how the subject matter, course materials, texts, written and spoken word, and other media (the content of higher education) are created. (Tapscott and Williams 2010 p10)

Palfrey and Gasser (2008) also devote a chapter to Learners in their book *Born Digital* and they also go on to promote the argument that: "The educational establishment is utterly confused about what to do about the impact of technology on learning." (2008 p 238). All these authors encourage the idea that education has to change because there has been a generational shift caused by a process of technological change. In this view technological change is seen as arising independently and then having an impact on other dependant domains in society.

Collaborative learning

The Net Generation and Digital Native arguments associate the rising generation with a desire to work together in teams or group (Jones and Ramanau 2009a). Tapscott argued that:

“In education they [the Net generation] are forcing a change in the model of pedagogy, from a teacher-focused approach based on instruction to a student-focused model based on collaboration.” (2009 p 11).

The argument for a Net Generation of Digital Natives has a strong educational component which suggests that the new generation of learners will be pre-conditioned by their use of technology to drive changes in pedagogy and that these changes will include aspects of collaboration, particularly team work and peer-to-peer learning (Oblinger and Oblinger 2005 Ch 2 p7).

Tapscott and Williams have continued to make similar claims and in their recent article, they suggest that the traditional model of education is a broadcast model and that:

‘A broadcast is, by definition, the transmission of information from transmitter to receiver in a one-way, linear fashion.’ (Tapscott and Williams 2010 p 20).

This claim ignores an entire literature concerning media consumption that emphasizes the active role of the audience in any broadcast medium (see Jones 2011). Tapscott and Williams have adopted a crude media effects position in which the student audience has a largely passive role. In general terms the audience is far from passive and they are involved in the co-construction of meaning with the resource transmitted and the sender of that resource. Leaving aside the active role of the student body as audience, the claim that there is a new generation of students predisposed to collaboration is entirely unsupported by a coherent body of peer reviewed evidence.

Institutional reform

The deterministic argument about the Net Generation has taken a further step with the argument that universities must change in a radical pro-market and neo-liberal fashion in order to meet the challenges posed by the new generation of students. The authors of some of these ideas have a more radical agenda, one that predicated deep institutional change on the speculative arguments about the character of this new generation (Margaryan et al. 2011). Tapscott and Williams propose the adoption of a free market approach in which private initiatives and the market replace existing models of the university. The role of government, in their view, is to building the digital infrastructure, such as broadband networks, which would allow private commercial providers to succeed. In the United Kingdom this kind of advice to policy makers is being received in the context of severe budget reductions, following the banking crisis. Calls for a reduced role for the state and an increase in marketisation and private provision fall on fertile ground and they may find support from the UK government’s response to the Browne Review (2010).

Following Bates (2010) we argue that the future of university provision is a choice and not in any simple way the result of a technologically determined process. Technological change can allow for or assist many kinds of changes in university teaching and learning and it may have an impact on the broader role of the university. However technological change does not require universities to change in one particular way rather than another. Nor can the changes that are required be read off from a set of generational stereotypes that are likely to lead to simplistic solutions. Decisions about the state’s role in higher education and non-market forms of organisation are political decisions and a move to a neo-liberal approach to markets and privatisation is not the inevitable outcome of

technological change or student pressure. A key issue that arises from the determinism inherent in Net Generation and Digital Natives arguments is that it obscures the role of political choice in deciding future directions for higher education.

Recent developments

Digital Wisdom

Recognizing that the Digital Native/ Digital Immigrant distinction might be less relevant as an increasing proportion of society would have grown up in a digital age or have been exposed to digital and networked technology, Prensky (2009) has proposed a new term 'digital wisdom'.

Although many have found the terms useful, as we move further into the 21st century when all will have grown up in the era of digital technology, the distinction between digital natives and digital immigrants will become less relevant. Clearly, as we work to create and improve the future, we need to imagine a new set of distinctions. I suggest we think in terms of digital wisdom. (Prensky 2009 p 1)

Unlike the strict Digital Native-Immigrant divide in which Digital Immigrants could not become Natives, they can now acquire digital wisdom through interaction with technology. Prensky defines wisdom, the key term in this new argument:

...as the ability to find practical, creative, contextually appropriate, and emotionally satisfying solutions to complicated human problems.' (Prensky 2009 p2).

Arguing that technology could make us 'not just smarter but truly wiser' Prensky retains the idea that the 'brains of those who interact with technology frequently will be restructured by that interaction' (p.1). The argument also suggests that digital technology will become an essential support for human development:

...in an unimaginably complex future, the digitally unenhanced person, however wise, will not be able to access the tools of wisdom that will be available to even the least wise digitally enhanced human.' (Prensky 2009 p1).

The significant shift that Prensky has made is that he now views everyone as being able to move towards digital enhancement and he has reduced the divide he previously identified between Natives and Immigrants. Prensky sums up this revised position in this way:

Homo sapiens digital, then, differs from today's human in two key aspects: He or she accepts digital enhancement as an integral fact of human existence, and he or she is digitally wise, both in the considered way he or she accesses the power of digital enhancements to complement innate abilities and in the way in which he or she uses enhancements to facilitate wiser decision making. Digital wisdom transcends the generational divide defined by the immigrant/native distinction. (Prensky 2009 p3)

Leaving aside the assumption that all will have grown up in an undifferentiated way in the era of digital technologies, Prensky retains many of his previous arguments. He retains a modified form of the claim that use of digital technologies changes the brain of the user and he continues to claim that the use of digital technologies is essential. Prensky's revised position remains deterministic suggesting that digital enhancement is essential, and that digital enhancement has to be accepted in order to succeed. Prensky has moved from a hard form of technological determinism, in which technology has created the divide between Natives and Immigrants, to a softer form of determinism in which digital enhancement is necessary for everyone if they are to succeed.

Born Digital

Arguably Palfrey and Gasser in their book *Born Digital* (2008) and subtitled "understanding the first generation of digital natives" mount the most sustained attempt to reclaim the term Digital Native as a useful academic label. Danah boyd in her *Aprophenia* blog commented in regard of academic use:

I know that many of you are very wary of pop books in this area. I also know how much y'all hate the term "digital natives" and I too feel my skin crawl when that term emerges. When I first learned about this book, I was very wary. I didn't know JP or Urs at the time and I didn't want to offend, but I reached out with a few of my concerns. To my astonishment, JP invited me to sit down with him and hash out my thoughts... From the beginning, JP acknowledged that the term "digital natives" is hugely problematic, but also pointed out that it's the kind of term that makes interventions possible... At first, I was very resistant to their approach, but the more time I spent with parents, teachers, and policy makers, the more that I realized how effective such a tactic is. (boyd 2008)

Palfrey and Gasser suggest that the term generation is an overstatement and prefer to call the new cohort a 'population' (2008 p14). While their intention is to reclaim the term Digital Native their arguments lead to some confusion. Firstly they identify the Digital Native population by their access to technology, so it ceases to be a universal condition, because access is differentiated between states and regions and between social classes within individual states. Palfrey and Gasser also argue that access to new technology is not a given and that it depends on a learned digital literacy. This argument clearly leaves a lot to be desired. From a generation who are born digital, because they grew up in a world infused with new technology, they have moved to a sub-group, a population who depend on access to technology which is itself conditioned by a digital literacy that can only be acquired through some form of informal or formal learning. The attempt to re-claim the term Digital Native has significant weaknesses and it is not clear what benefit remains in retaining the idea, because the term Digital Native is at best misleading, and the authors agree that the idea of a generational change needs to be abandoned.

Digital Melting Pot

An alternative to the Digital Native/ Digital Immigrant dichotomy was suggested by Stoerger (2009) who proposed a new metaphor, 'the Digital Melting Pot'. The aim was to redirect attention away from 'assigned' generational characteristics to the individual's diverse technological capabilities and to focus on the digital skills they might gain through experience. The Melting Pot metaphor emphasized the integration rather than the segregation of Digital Natives with the Digital Immigrants. According to Stoerger (2009), the Digital Melting Pot provided a bridge that spanned the Digital Native/Digital Immigrant

dichotomy. The melting pot metaphor suggested, by gaining technology experience, those with low levels of competency could be transformed. Educators, during this assimilation process, could play a significant role in guiding individuals and providing them with the opportunity to acquire and enhance their technological skills.

Digital visitors and residents

A further example from the United Kingdom of looking for a replacement metaphor has been the proposal to replace the terms Natives and Immigrants with 'visitors' and 'residents' (Tall Blog, 2008). In this revised metaphor the generational terms 'Immigrants' and 'Natives' are replaced by an experiential divide between 'Residents' and 'Visitors'. A resident is someone who spends a proportion of their life online whereas a visitor is someone who uses the Web as a tool to address their specific needs.

Recent empirical research

While there has been a considerable interest in outlining the characteristics of new generations of learners and their learning preferences, there has been little empirical support for many of the claims being made. Despite the widespread proposal that technology should play an increasingly prominent part in contemporary education to suit the needs of today's young people, there was a growing sense amongst researchers that this reform of higher education had been predicated on assumptions about the demand from students for the extensive use of new technologies in education. As Broad *et al.* (2004) observed in UK institutions, much of the initiative behind integration of the Internet into higher education had been driven by 'internal political pressure' rather than empirically sound evidence (p. 137). Others have argued that the discourse that surrounds the Digital Natives debate can be likened to 'an academic form of moral panic' (Bennett *et al.*, 2008). After a critical review of the literature, Bennett *et al.* (2008) concluded that:

There is no evidence of widespread and universal disaffection, or of a distinctly different learning style the like of which has never been seen before. (Bennett *et al.* 2008 p 783)

They went on to suggest that there was a need for critical enquiry and the collection of a sound body of evidence before proclaiming the need for widespread or radical change.

In an attempt to ground the Net Generation debate in evidence, the following sections review the empirical studies focusing on university students' use of technologies in a range of different countries and contexts. The review is largely restricted to research concerned with students in higher education and readers should be aware that there is an almost parallel literature dealing with younger children (Buckingham and Willett 2006, Luckin *et al.* 2009, Livingstone 2009). The review begins by reporting the research conducted within national educational systems, grouping them in geographical regions such as Europe and North America. An assumption that lies behind this structure is that it cannot be assumed that students in one educational context will either have access to the same suite of technologies or that they will react to available technologies in the same way. It then concludes by drawing out themes that run across the various national and regional contexts. Overall the global empirical evidence shows that today's young students repeatedly prove to be a mixture of groups with various interests, motives, and behaviours, and that they never cohere into a single group or generation of students with common characteristics.

The United Kingdom

Earlier work in the UK focusing on undergraduate students' use of technologies appeared in the first years of the 21st Century (Crook 2002, Goodyear et al 2001, Goodyear et al 2003, Goodyear et al. 2005). This research focused on new locations for study such as the student study bedroom (Crook 2002) and the relationship between students' general approaches to learning and their approaches to networked learning (Goodyear et al 2005). Some of this work also examined the relationship between students' practices and the design and teaching approach adopted in particular courses (Jones and Asensio 2001, Jones and Bloxham 2001). The findings from this research established that there were no strong links between students' judgments about their experience of networked learning and either their conceptions of learning or their approach to study. A practical implication of the research was that it was reasonable to expect *all* students to have positive experiences when studying on well-designed and well-managed networked learning courses, and these positive experiences were not likely to be restricted to those students with more sophisticated conceptions of learning or deep approaches to study (Goodyear et al. 2003). The literature largely pre-dates the direct concerns that arose with the discussion of generational differences but at this time there was no evidence from this research of an emerging generational divide.

Work by Kirkwood (2006, 2008) and Kirkwood and Price (2005) examined the relationship between new technologies and pedagogical approaches. Their work largely focused on distance learners who were generally older than a standard university intake. Kirkwood and Price (2005) concluded that, although ICTs could enable new forms of teaching and learning it was educational purposes and pedagogy that had to provide the lead. At this time they provided no reference to the literature about a generational divide. Kirkwood (2006) concluded that while a very large proportion of the students he studied had access to ICT and possessed skills at more than a basic level, only a small proportion had developed information literacy skills. Kirkwood suggested that there was a danger of erroneously assuming that students already possessed the necessary skills and experience. Kirkwood (2008) reported that learners were using the Internet to find information and resources for coursework, whether or not this was promoted or endorsed by their teachers. The findings suggested that it was a combination of contextual factors that determined students' use of Web resources for learning.

In 2008 the Joint Information Systems Committee (JISC/Ipsos MORI 2008) issued a report on first year students aged 17-19, which built on a report published one year earlier that had focused on school students aged 16-18 prior to their transition to university. The reports accepted the argument that:

Students are 'digital natives' – having grown up with ICT and expect to use their own equipment at university. (JISC 2008 p7)

The research was based on 1,111 online responses, 112 from a cohort group linked to the previous survey of school age students and 999 in a boost sample. It noted that students still saw face-to-face interaction as the best form of teaching although the use of ICT for teaching was perceived as a beneficial experience and commented that:

technology for technology's sake was not appealing to this group of students. However, the university's attitude to technology is important (p42)

They argued that the most common use of technology at university was to support students' social life, such as communication with friends and family, checking out administration, clubs and society activities etc (JISC/Ipsos MORI, 2008). The JISC/Ipsos MORI report endorsed large parts of the rhetoric concerning a new generation underpinned by empirical work in a UK context. Whilst this report preceded any fully developed academic empirical response it set a tone for the debate in the UK.

JISC also supported a series of studies of the student experience following a literature review that concluded that research had given little attention to the student voice and had given far more attention to the practitioner perspective and to course design (Sharpe 2005). The review led to the commissioning of two projects, Learner Experiences of e-Learning (LEX) and LXP Students' experiences of technologies. The LXP project reported that students were appropriating technologies to meet their own personal, individual needs and mixing the use of general ICT tools and resources with official course or institutional tools and resources. Their findings claimed that there was a shift in the way in which students were working and suggested that there was a rich and complex interrelationship between individual students and the tools and technologies that they were using (Conole et al. 2006, Conole et al 2008).

Selwyn (2008) surveyed 1222 undergraduate students in an attempt to understand their academic use of the Internet. Analysis of the data suggested that students' academic use of the Internet was strongly related with gender and discipline differences rather than simply differences in technology access or expertise. Students from medicine, social studies, law and business reported higher levels of educational Internet use than students in creative arts, architecture/planning and the humanities. In regard to gender difference, female students tended to be significantly more likely to seek academic information online than their male counterparts a feature that, as Selwyn pointed out, ran counter to much of the literature. Selwyn also found that academic-related information searching was a prominent but not predominant aspect of students' daily engagement with the Internet (Selwyn, 2008). Selwyn (2009) later conducted an in-depth qualitative analysis of 909 UK undergraduate students' Facebook posting activities and concluded that students' use of social networking sites such as Facebook had become important for students' social and cultural approach to 'being' a student rather than necessarily enhancing their formal studies.

Margaryan and Littlejohn (2008) studied undergraduate students' use of digital technologies in two UK universities and found no supporting evidence regarding the claims made by previous studies that students were adopting radically different learning patterns. The same study has recently been further elaborated in Margaryan et al. (2011). Far from demanding that lecturers change their practice, students in this research, appeared to conform to fairly traditional pedagogies and make minor use of technology tools for learning. They found low levels of use of virtual worlds, and social media including social networking sites. They also found that the younger 'Digital Native' students (born after 1980) and students from technical disciplines (engineering) used more technology tools compared with the older 'digital immigrant' students (born before 1980) and students from non-technical disciplines (social work). Students' approaches to learning appeared to be influenced by lecturers' teaching approaches. They found that

students possessed a relatively limited understanding of what tools they could adopt and how they might be used to support their learning. With regard to formal learning, the virtual learning environment (VLE) was used as the main support platform in both universities. The most popular tools amongst students for formal learning included general websites, Google, course websites and to a lesser extent, text messaging, while the tools they used for informal learning were largely the same, with the particular addition of mobile phones. There were a large number of students who never used virtual chat, MP3 players, handheld computers, podcasts, simulation games, MySpace, YouTube or blogs for learning.

Students made very limited use of more advanced technologies such as the media sharing, social networking, collaborative knowledge creation tools, and personal web publishing. Contrary to the image of net generation learners, they found that:

Our data does not support the suggestion that young students exhibit radically different learning styles. Instead, our findings suggest a deficit of learning literacies and a dependency on guidance from lecturers amongst students. Conventional forms of teaching appear to encourage students to passively consume information. (Margaryan et al. 2011 p.438).

Margaryan et al. (2011) argue that decisions about the use of technologies for learning should be based on an understanding of their educational value and how they could improve both the process and outcomes of learning. They go on to call for active experimentation with technologies and the full publication of evaluations of their effectiveness.

The ESRC funded *Net Generation encountering e-learning at university* project (<http://www.open.ac.uk/researchprojects/netgeneration/>) ran from January 2008 until March 2010. The research was conducted with students studying in 14 courses areas from five English universities, selected to represent the main types of English university. The aim of the research was to investigate students' use of technologies in the first year of their studies. Jones et al. (2010) concluded from the first phase of survey research that students were not homogeneous in their use of new technologies. Their research showed that even within the net generation age group, students' self-reported skill levels with technologies varied significantly. Despite the considerable amount of time students spent on the computers and Internet, they made limited use of blogs, wikis and virtual worlds (Jones and Cross, 2009). In general, students were active users of new technology. However, there were also some minorities who made very little use of them. There exist a significant minority who either did not use email or have no access to mobile phones (Jones and Cross, 2009).

Jones and Hosein (2010) using data gathered in the second year of the project, examined students' use of technology and categorized students into clusters based on whether they were using web 2.0 tools (web interactive), advanced use of mobile phones and use of audio and video editing tools (technical-oriented), instant messaging and social networking tools (social interactive), gaming consoles (game-oriented) and standard software such as online library access and word processing/presentation software tools (work-oriented). This research added to the argument that there wasn't a single Net Generation with common characteristics. Age only seemed to be one of several interrelated factors, rather than the sole factor, in students' use of web 2.0 and social networking sites which were connected to other demographic and social factors (Jones and Hosein, 2010). Gender, national origin

(local or international students) and mode of study (traditional place based or distance learning) all had a significant impact on students' use of technologies at the beginning of the academic year and they continued to be influential factors towards the end of the academic year (Hosein et al., 2010a). As part of the second phase of The Net Generation Encountering eLearning at University project, Ramanau et al. (2010) investigated how much time Net Generation age students (25 and below) spent using ICT for social life and leisure and for study purposes in comparison to older students. The survey results showed that while younger students tended to use ICT more for social life and leisure purposes, older students tended to use more ICT for study purposes. The research also showed that there was a significant difference in students' use of technology for social and leisure purposes and for academic use (Jones et al., 2010; Jones and Ramanau, 2009).

Overall the survey research conducted by this group concluded that digital and networked technologies infused most English students' lives and the material context claimed for a Net Generation existed in the UK with a widespread availability and access to computing devices of all kinds and good network connections. They found age related differences but no single identifiable generational set of changes. Age was often combined with other significant factors including, institutional mode (distance or place-based) and gender. Where differences were found with respect to age, they mostly concerned social networking and communication technologies. This evidence suggested that, rather than being homogeneous, the assumed Net Generation age group was itself divided internally by age. It was striking that students were often physically alone but usually digitally connected using SNS e.g. Facebook, voice over internet e.g. Skype and Mobile (Cell) phones. Often communication technologies using digital networks were used to help maintain distant links rather than increase the density of local contact (eg. Home from university/university friends from home).

Jones and Healing (2010b) reported the outcome of interviews with a sub-set of students who volunteered as part of the survey work for the project. They examined the case made for Net Generation learners in terms of agency with the aim to understand what kind of choices students were making in relation to the technologies they engaged with during their studies. Their results showed that students' choices were not direct responses to technologies that were universally available, rather they were responses to local infrastructure and specific requirements set out for the course. Most of the students commented on the distracting aspect of technology and almost all, across the full age range, recognised this as a feature and potential cost of using social networking sites (e.g. Facebook). The interviewees adopted several strategies to deal with this to help them focus on their work. Jones and Healing categorised them as:

- Removing the sources of distraction by switching them off
- Physically removing themselves from the distractions
- Interspersing study with breaks
- Working under pressure

They described distraction as a feature of the communication technologies available to students. Jones and Healing also noted that individual students were acting in settings that had increasing amounts of active technologies that replicated aspects of human agency.

Jones and Healing (2010a and 2010c) also reported the outcome of a cultural probe that was conducted with a small sub-sample of students selected from those interviewed. They discussed students' local habitations in place-based universities in relation to Crook's findings from almost a decade earlier (Crook 2002). Their findings suggested that although the technological landscape in the past 10 years had changed dramatically, students' practices didn't seem to have moved as quickly. Despite the increased mobility made available by new devices and relatively easy access to the Internet, students still largely inhabited their study bedrooms or dedicated work spaces in their permanent residence and when they made use of the new kinds of mobility it was often in university libraries or dedicated spaces within university. One way in which there had been considerable change was the way that technology had become much more integrated in mediating encounters between students in social and leisure activities. There was also an integration of activities on the computer screen with students working with multiple applications open at any one time, integrating their social and study lives in one space on screen.

Two recent studies have examined UK students in relation to library and information literacy. The JISC-Ciber study (2008) *The Google Generation Information Behaviour of the Researcher of the Future* focused on how researchers of the future, called by the researchers 'digital natives' and the Google Generation (those born after 1993), were likely to access and interact with digital resources in the near future. The research reported that the information literacy of young people had not improved with wider access to technology. To complement the findings of this a three year research study was commissioned by the British Library and JISC. The *Researchers of Tomorrow* study focuses on the information seeking and research behaviour of doctoral students born between 1982 and 1994. This study is unusual because it focuses on the Net Generation age group (which they call Generation Y) in relation to doctoral students. McKnight (McKnight, 2010) studied students at Nottingham Trent University and argued that although digital native students may feel comfortable in a digital immersed environment at home, they often lacked of information literacy skills or understanding of issues such as plagiarism and copyright. She called for a radical rethink of the role of librarians and proposed that future librarians would need to be able to adapt their professional skill sets to suit the needs of a multitude of new learners. Morris (2011) surveyed 513 students and conducted in-depth interviews with a further 20. They concluded that although higher education students made extensive use of computers and the internet, their wealth and occupational status had a greater influence on their proficiency with these technologies than their age.

Other European countries

One of the founding assumptions of claims for a generation of digital natives was that they had grown up with computers and the Internet, and were naturally proficient with new digital technologies. Research into university students' perceptions and use of technology in Europe offered a more diverse view of the role of technology in young people's lives. As Pedró (2009) put it:

'a far more complex picture than it is often presented in most of the well-known essays about this topic'.
(Pedró, 2009 p. 4)

Not all students fitted equally well into the image of the new millennium learner. Surveys of young people aged between 15 and 25 in four EU countries- France, Germany, Spain and

UK showed significant differences in terms of digital culture (Lusoli and Miltgen, 2009). For example;

Spain presents lower social network usage; France has a blogging culture; and youngsters are more skilled in Germany than elsewhere (Lusoli and Miltgen, 2009 p. 9).

Furthermore, the evidence showed that there were various factors that may influence students' perceptions and skill levels with technologies, such as gender, socio-economic background, year grade and disciplinary differences. Several studies served to illustrate this point including an Italian study that illustrated the lack of homogeneity amongst students (Ferri, et al., 2008). This study concluded that the evidence supported at least three different higher education student profiles. The profiles were derived from an analysis which combined two factors, firstly the intensity of Internet use and secondly content production, which was defined as uploading content to sites like My Space, Wikipedia, YouTube and general activity in social networks. The three profiles were characterised as:

- The digital mass - accounting for almost half of the students - heavy Internet users but not so keen on producing digital content.
- The neo-analogical - approximately 20% of the students, produce some content but connect to the Internet less than the average student.
- The inter-activated – approximately 30% of the students, close to the prevalent image of new millennium learners - heavy Internet users and quite frequent content producers.

Pedró (2009) also reports the results from a small research project funded by the European Union, eLene-TLC (Lam & Ritzen, 2008). The project covered six European countries (France, Germany, Italy, the Netherlands, Spain, Sweden). The research measured the disagreement between how students saw themselves and how teachers thought of students covering a range of learning characteristics associated with the new generation of students. Teachers appeared to slightly overestimate what students themselves claimed for their learning characteristics and the differences were high for a willingness to benefit from learning by doing, and a preference for visual learning (20% and 15%, respectively). Teachers underestimated, but less significantly, the students' preferences for social and interactive learning and for multi-tasking. There were also important differences between countries, with the Southern European countries (France, Italy, Spain) showing higher disparities in perception than Northern European countries (Germany, Netherlands, Sweden) where the disparities were marginal.

Germany

In Germany, the Institute for Media and Educational Technology at the University of Augsburg initiated the I-literacy project in 2007 in an aim to develop an infrastructure to support teaching information literacy skills to incoming students at universities as a main component of academic working skills (Heinze, 2008). Heinze reported that the self-evaluation of students in the area of information literacy was too positive. Just about half of the respondents could answer questions about Internet research correctly. Furthermore skills with regard to common Internet research tools were insufficient with the biggest deficits in relation to information research in library holdings and databases. Only half of

the respondents would take part in a class to learn about information literacy, even though almost all saw information literacy as an important competency (Heinze 2008). Overall the results showed that students were 'net savvy but not information literate' (Heinze, 2008; p.1). Although the net generation learners knew how to use technology for personal use, this did not mean that they were capable of using it for learning and working purposes in their future life (see also Lorenzo, Oblinger and Dzubian 2006). In order to achieve competency in effectively using technologies for learning, students needed special training which they hadn't acquired naturally through using digital technologies for leisure (Schulmeister 2008, Heinze, 2008; Klatt et al., 2001). Clearly the pervasive use of technologies did not necessarily transfer to the ability to use computers for learning (Schulmeister, 2008).

Schulmeister (2010) surveyed more than 2000 students in Germany via the Internet to investigate if students today are interested in the use of web 2.0 technologies for learning. The results showed that students had a very pragmatic and instrumental way of using technologies. The study presents what Schulmeister describes as a rather disappointing overview which contrasted with the 'myth' of the net generation. Schulmeister argues that students have a very realistic attitude to time management and a pragmatic way of using services when they need them. Only those applications which were especially helpful in communication and information searches enjoyed high numbers of users and frequencies of use (Schulmeister, 2008). He noted that gender differences and digital divides are still visible and concludes that it has become apparent that:

education is not the primary purpose of media use and that there is no transfer from extensive computer experience to learning (Schulmeister 2010 p.22).

Austria

In a more recent study conducted at Graz University of Technology in Austria, Nagler and Ebner (2009) surveyed 821 first-year undergraduate students (56% of all first year students). They examined technology use for both learning and socialising, focussing on patterns of Internet access, use of hardware devices and students' preferences for and experiences with tools ranging from Virtual Learning Environments (VLEs) to Web 2.0 tools. Nagler and Ebner found an almost ubiquitous use of Wikipedia, YouTube and social networking sites while social bookmarking, photo sharing and microblogging were much less popular. The study concluded that "the so-called Net Generation exists if we think in terms of basic communication tools like e-mail or instant messaging. Writing an email, participating in different chat rooms or contributing to a discussion forum is part of a student's everyday life" (p. 7). While the findings of this study are based on a more representative sample than in Kennedy et al. (2008), the age groups are not specified, making it impossible to determine what proportion of students were 'digital natives'. Similar to Kennedy et al. (2008), Nagler and Ebner (2009) focused on types of technologies used and the extent rather than the nature of use. In addition, their research design too did not include qualitative data, nor did it consider teachers' perspectives and other contextual factors. Finally, the results may have been biased since data were drawn from a technical university, where students may have had more technical know-how.

They found that the material basis of the Net Generation was present among Austrian students. Over 90% of the students had Internet access at their study-home. More than 80% had laptops and most of them have a desktop PC as well. One third of students had a mobile phone with Internet access. However they found that common Web 2.0 services

were used but they were associated with private activities. Web 2.0 features like social bookmarking, micro-blogging and media sharing communities had low use.

Netherlands

Van den Beemt et al. (2010a) studied the interactive media behaviour of a group of students in the Netherlands (N = 178, aged 10 to 25). Their study showed that the participants were using interactive media intensively, but not in a unified way. The results showed diversity in behaviour, which could be expressed in user patterns. The results also showed a relationship between interactive media use and educational level, and between use and gender. Because this study was limited in size it was followed by a larger study with a sample of 2138 Dutch students, in education levels ranging from primary education to higher professional education. Van den Beemt et al. (2010b) presented the findings and described the opinions and interactive media behaviour of young people. They distinguished four factors of interactive media activities and labelled them: interacting, performing, interchanging and authoring. They went on to distinguish four clusters of interactive media users describing them as different subcultures (Van den Beemt, et al., 2010b). These sub-cultures were labelled; 'Traditionalists', 'Gamers', 'Networkers' and 'Producers'. Each sub-culture was related to a specific factor: Traditionalists to interacting, Gamers to performing, Networkers to interchanging and Producers to authoring. The Producers were identified as a group making relatively intensive use of all kinds of interactive media but this was a small group whilst the Traditionalist group at the low end of use was relatively large. The group labelled Networkers had an emphasis on the use of social software.

Van den Beemt et al. (2010b) found no evidence to support claims regarding students adopting radically different patterns of knowledge creation and sharing. The patterns they found in both use of and opinions about interactive media show that young people give meaning to interactive media in divergent ways. This diversity related closely to both education level and gender. The small percentage of Producers among the respondents indicates that, although most of today's youngsters engage in traditional activities, not all of them are active in interactive media production. An important outcome was the complex relationship between behavioural dimensions. These dimensions clustered groups of activities, but they did not relate in a straightforward way to clusters of users. This outcome shows that young people have diverging ways of giving meaning to interactive media, rather than them behaving as a homogeneous group.

Scandinavia

Norway

In Norway, Rønning and Grepperud (2006) reported a comprehensive national survey on adult flexible students' daily usage of ICT. Based on survey data from 1477 students, with an average age of 39 years, it suggested that access to computers and the Internet was generally high in Norway, however there were variations according to employment status. Younger, unskilled, part time employees had the least access to the Internet at work. They argued that good access provided a better basis for increasing the use of ICT, however, they found no correlation between access to technology and increase in use. They also found that both the Internet and email played a less significant role than they expected for communication among students and between students and teachers outside plenary sessions. As Rønning and Grepperud (2006, p. 9) put it:

Digital communication has by no means replaced other media such as the telephone or physical meetings.

Nordkvelle (2010) reports that a major study was published in 2009 about how students in higher education use educational technologies in their everyday work (Norwegian Opening Universities). The survey involved 5686 students, but also administrators and higher education teachers were included in the study. The research is also reported in Wilhelmsen et al (2009), and Breivik (2010). The results showed that computers are not used extensively in teaching, and when they were used it was primarily for purposes such as composing text, handing in assignments and downloading teaching material on Learning Management Systems (or VLE).

Denmark

Ryberg et al. (2010) argued that the notion of 'digital natives' should be examined critically; instead of being assumed to have a different set of skills, young people may instead need to develop them. By presenting an experimental case study using a web 2.0 learning environment, Ryberg et al. (2010) argued that there was a gap between educators' intentions and students' actual outcomes. They argued that there was a need for a more concerted pedagogical effort to support students in developing digital literacy skills. They went on to suggest that educators should be wary of focusing narrowly on catering to the needs of an assumed generation of digital natives but that they should not dismiss the fact that many students are now heavy users of ICT with experience and skills in using social software that may be leveraged for formal learning purposes. The Net Generation might need support and guidance to develop their technical skills for use in an academic context. While many students might have extensive experience using social software as part of their everyday life, they may need support in translating these experiences into academically informed practices, including judging the validity of sources, pooling knowledge, and searching, synthesizing, and disseminating information as a collective.

Spain

The *Digital Learners in Higher Education* project is an international project aiming to develop further understanding of how post secondary students in different institutional and cultural contexts perceive and use technologies in their social and educational lives: a Canadian polytechnic teaching institution (BCIT), a Canadian research-intensive university (University of Regina) and a European online university (Open University of Catalonia). As part of the project, Romero et al., (2010) adapted a survey designed by their BCIT partners (Bullen et al., 2009) and administered it to students in the Open University of Catalonia, Spain. Consistent with findings from BCIT, data showed that there was very little difference between the net generation and non-net generation learners at UOC in terms of their learning and communication preferences with ICT. Romero et al. (2010) concluded that the notion of net generation as presented in the literature was more speculative than real.

North America

USA

Pew studies

In 2002 the Pew Internet and American Life Project (Jones, 2002; Lenhart et al, 2005; Jones and Fox, 2009, Jones et al 2009) began investigating the Internet's impact on college students' daily lives, as well as on their academic and social routines. It was one of the first projects to document the high proportion of U.S. college students who use Internet and computer technologies to access information, and communicate with friends and fellow students to assist with their studies. Data were collected using three main approaches, a large survey of students from year two to four in twenty seven U.S. colleges and universities; ethnographic observations of life in ten Chicago area institutions; and survey findings of American's use of the Internet conducted in 2001 and 2002 for the project. According to Jones (2002), the demographic features of college students in 2002 had not changed much from the previous decade but one character that set them apart was their familiarity with the Internet. One fifth of the 18-year-old college students surveyed began using a computer between age 5 and 8, and half of them had accessed the Internet before college. The online penetration among college students (86 percent) was much higher than among the general public (59 percent). College students led other Internet users in activities such as music downloading, file sharing, instant messaging and online chatting. He further argued that use of the Internet had become part of college students' daily life and was firmly embedded in their communication habits. By the early years of the 21st Century US college students had grown up with computers and networked technologies. Students used the Internet as much for social communication as they did for education. They used the Internet to communicate with friends and their professors, to do research and to access library materials. Nearly four-fifths of college students surveyed agreed that the Internet had a positive impact on their academic experience.

Lenhart et al., (2005) argued that teenagers in the U.S. used the Internet more often and in a greater variety of ways than they did in 2000. 87 percent of the U.S. teens age 12 to 17 used the Internet, and half of them used the Internet daily. Half of U.S. families with teenagers had broadband Internet access. Teenagers used instant messaging extensively and one third of all U.S. teenagers used Instant Messaging (IM) on a daily basis. Apart from using IM frequently, there was also an increase in other online activities, for example play online games (81 percent), watching news (76 percent), purchasing online (43 percent) and seeking health information (31 percent). Nevertheless, while teenagers showed some engagement with new technologies the traditional landline telephones remained the most popular choice for communication in their daily life. With regard to their preference for communicating with friends, half of the teenagers (51 percent) surveyed preferred using landlines, one fifth (24 percent) often used instant messaging, only one tenth (12 percent) preferred to call their friends on mobile phones, an even smaller proportion (5 percent) opted for email, and only a fraction (3 percent) used text messages. Despite the increased levels of access, there were also approximately three million teenagers in the U.S. who did not use the Internet. At that point the digital divide was still a serious issue in U.S. society. As Lenhart et al. (2005) put it, 'those teens who remain offline are clearly defined by lower levels of income and limited access to technology' (p. 2).

However, challenging the image of the Net Generation, Jones and Fox (2009) proposed that young people were not the only ones dedicated to technology and that 'Internet users

in their 20s do not dominate every aspect of online life' (p. 1). This conclusion was based on results from a series of telephone interviews conducted between August 2006 and August 2008 in the US. While younger generations continued to dominate the Internet, a larger percentage of older generations are doing more online activities than earlier years. Further survey work on college students in the US was undertaken in 2005 and followed up the 2002 Pew study (Jones et al 2009). This research also included a comparison of students with the general population in terms of Internet and computer use. The authors concluded that in some ways little had changed since the earlier research (Jones, 2002) and that Internet use was thoroughly woven into student life. They reported that even by 2005 students were at the forefront of the use of social networking sites. They also found that E-mail was still the tool that most students used most often. However there were more bloggers among students than among the general population and they were heavy users of Web 2.0 tools. They noted that while social communication remained a primary use of the Internet use for coursework had decreased and use for entertainment had greatly increased. They noted that one possible reason for this apparent change was that the categories they had used had become somewhat conflated over time and that social communication and entertainment had become more similar since 2002, due to the rise of social networking sites.

ECAR annual reports

Since 2004, the annual ECAR Study of Undergraduate Students and Information Technology have sought to shed light on how university students' use technology in and out of their academic world (Kvavik et al., 2004; Caruso and Kvavik, 2005; Salaway et al., 2006; Salaway and Caruso, 2007; Salaway and Caruso, 2008; Smith et al., 2009). The scale of the early surveys is shown by Kvavik (2005) who reported a survey of 4,374 college students from 13 US institutions. The 2010 study (Smith and Caruso 2010) is a longitudinal extension of this series. The current version is based on a quantitative survey of 36,950 students (285,000 email invitations were sent) from 100 U.S four-year institutions and 27 Canadian two-year institutions; focus groups with 84 students from 4 institutions; and an annual review extending the previous years' reviews. The ECAR reports began comparing longitudinal data in 2005, and further longitudinal analysis was conducted on repeated questions between 2006 and 2009. The comparisons were initially limited to those institutions that had participated in all years of the study but in 2010 the methodology changed because the subset had not proved to be divergent from the full samples. In 2010 the report is based on the full sample and it draws attention to statistically significant relationships and the changes the authors believe will be of interest.

The report suggests that undergraduates might well become prominent among the early users of cloud computing. This move may be assisted by the institutions which have already adopted cloud-based resources such as Google Apps Education Edition and Microsoft's Live@edu. Almost three-quarters of the respondents reported using at least one of the web-based tools listed in the survey during a course in the spring term of 2010. Much of the use involved collaboration with other students. A second trend identified in the 2010 report was the rapidly growing ownership and use of Internet-capable handheld devices. Thirdly the report noted the continuing near-universal use of social networking sites. The survey responses also shed light on how students used certain types of technology, including handheld devices, both in and out of the classroom.

Regardless of the specific technologies under investigation, the 2010 report (Smith and Caruso, 2010) on technology and college experience repeatedly reinforced the previous years' results concerning students' self-perceived technical skills and perceptions regarding the use of ICT. About half of the students identified themselves as mainstream

adopters. The ECAR reports map student responses into five categories: innovators, early adopters, mainstream adopters, late adopters and laggards. Student responses are reported to have been consistent over the years and the responses roughly form a bell curve distribution. There was a persistent gender gap and half of the male students identified themselves as innovators or early adopters whereas only a quarter of females identified themselves in this way. With regard to students' self-perceived skill levels, more than 80% considered themselves expert or very skilful in searching the Internet while more than half (57%) rated themselves as expert or very skilled in assessing the credibility and reliability of online information.

While the ownership of computers remained steady at around 98% between 2006 and 2009 there was change in the types of computer students owned. There was a fall in the ownership of desktop computers alongside a rapid rise in laptop ownership. However in recent years the level of desktop ownership appears to have stabilised. The report also notes that many students own relatively new computers with seven out of ten owning a computer less than 2 years old although a minority still report owning computers over 4 years old. Students continue to use standard institutional services and more than 94% reported using their institution's library website for school, work, or recreation, and more than a third of respondents used it at least several times a week, while more than 90% were using course or learning management systems.

Internet-capable handheld devices were reported to be growing in popularity with two-thirds in 2010 owning one of these devices and about half of the 2010 respondents used the Internet from their device daily, up from about a third in 2009. It was only in the 2006 survey that smartphones had made an appearance with 7.5% reporting ownership, up from just 1.1% the year before (Salaway et al., 2006). In 2009 (Smith et al., 2009) ECAR grouped student mobile Internet use into four emerging types:

- power users who own and use their devices to access the Internet weekly or more often;
- occasional users who own devices but use them to access the Internet monthly or less frequently;
- potential users who own but don't use their device or do not own a device but plan to purchase one in the next 12 months;
- nonusers who did not own a device or plan to purchase one in the next 12 months.

The report shows students are adopting the mobile Internet with an increase in power users and a decrease in nonusers from 2009 to 2010. Approximately one-half of respondents both own an Internet-capable handheld device and access the Internet with it. Of these, more than 8 in 10 said they check for information and about the same percentage also said they use their handheld device to send and receive e-mail.

The use of Web 2.0 services is still a minority activity but many contributed video to video websites (42%) and updated wikis (40%), while more than a third of respondents said they contribute to blogs (36%). The take-up of communication technologies dominates student use of IT, for example use of social networking sites (SNS) has increased significantly over recent years. However by 2010 the 95% of 18 and 19 year olds using SNS had stabilised, remaining almost consistent over the past four years, while the gap between younger and older students had shrunk. Those aged 25 and above had increased their

use steadily over the four year period. Usage of IM and SNS tended to be daily whereas Voice over Internet (VoIP) was used by 4 out of 10 with a monthly median.

The survey also found social networking to be a rapidly growing application for mobile access, as more than three-quarters of our respondents said they use social networking sites (SNSs) from their handheld device, up from two-thirds among last year's respondents. The report findings suggested that students were gradually integrating SNSs and other web-based tools into their academic experience. About 3 in 10 respondents reported they were using social networking websites in their courses, although half of those students were using them to collaborate with other students in a course. More than half of SNS-using respondents said they used SNSs to communicate with classmates about course-related topics, but only 8% said they use them to communicate with instructors about course-related topics. When students were asked if they would like to see greater use of social networking websites in their courses slightly more than a quarter said they would.

In addition to students' use of technology for work, social and entertainment purposes, the survey also asked respondents about the use of technology as part of their courses. Results showed that the majority of respondents frequently used their university library website, presentation software, course website or university's learning management system. For the first time the survey asked about the use of e-books and found about 25% were using them but only 4% owned a dedicated reader. In 2010 the report also distinguished between the older core technologies and the newer web-based cloud computing. They asked students if they were using several web-based tools for any of their courses and if they were collaborating or working with other students using similar tools. None of the tools were being used in courses by a majority of students but six of the tools were used by 25% of student respondents.

Students appeared to be relying on Course Management Systems (CMS, more usually Virtual Learning Environment or VLE in the UK), more than a third of all respondents used a CMS daily, and more than 24% used them several times a week. More than half said that their overall experience with a CMS was positive or very positive, but this fell from 77% in 2007 to 51% in 2010. The respondents who use a CMS more frequently report more positive experiences using a CMS and the respondents' positive perceptions about institutional IT service levels were related to their CMS experience. These rates of CMS use had increased since 2008 but it appeared that not all staff (faculty) were putting courses on CMSs. The ECAR surveys have found that respondents are lukewarm about their instructors' use of IT. ECAR began asking questions about students' views on instructors' use of IT in courses in 2007, and the responses to these questions have been consistent from year. The report authors were surprised that the desire for moderate IT in courses had been highly consistent over the years when students' use of technology in their personal lives had increased. They speculate that it would be possible that what respondents in 2004 considered a "moderate amount of IT" might be quite different from what respondents in 2010 consider moderate. In conclusion the report authors reflect back on the launch of Gmail on April 1, 2004 when an offer of one gigabyte of free e-mail storage for life seemed a joke. Six years later cloud-based applications and resources are reported to be catching on among undergraduates. The report concluded that in relation to technology there are no stereotypical students.

Other studies

Ramney (2008) investigated undergraduate students in an attempt to provide insight into students' perceptions of the seven characteristics assigned to the millennial generation by

Howe and Strauss (2003). The characteristics surveyed were: 'special, sheltered, confident, team-oriented, conventional, pressured, and achieving' (p.6). Results from the survey showed that students' agreement with the seven characteristics was relatively high for all of the characteristics except for team-oriented and sheltered. Variations in perceptions in characteristics noted in different groups include gender, ethnicity, socioeconomic status, family history of education, and geographical area of primary and secondary education. There were also significant differences between self and peer perception for all the seven characteristics except for sheltered. In general, the study supported the seven characteristics assigned to the Millennial generation students.

Nevertheless, there was little evidence that students desired more technologically-driven approaches to teaching and learning (McWilliam 2002). In fact, empirical evidence showed that students' high levels of use and skill did not necessarily translate into preferences for increased use of technology in the classroom. Students held conventional attitudes towards teaching and learning (Garcia and Qin, 2007; Lohnes and Kinzer, 2007) and preferred moderate amounts of technology in the classroom (Salaway and Caruso, 2007, Smith and Caruso 2010).

Vaidhyathan (2008) criticized the claims about the digital generational shift and argued that the assertion of a group of 'digital generation' is over-generalizing. Instead, the college students' technological skills varied, even among elite universities, and were influenced by socio-economic factors that are independent of generational demographics. Talking about youth as digital natives ignored the different ways young people use technologies. Similar findings have been obtained from (Hargittai & Walejko, 2008) who found that students' habit of creating and sharing digital content correlated with their identity traits.

In recent study, Hargittai (2010a, 2010b) showed the complexity and variation in people's use of Internet and argued for a more nuanced approach to study in this area. She surveyed more than a thousand American first year university students about their Internet uses, skills and participation as well as demographic characteristics. Results showed that there was considerable variation in students' online skills and these were largely related to students' socioeconomic backgrounds. Students from lower socioeconomic backgrounds (women, African, Americans and Hispanic students) were less confident and took part in less activities than those from more privileged backgrounds (men, White, and Asian American). Findings suggested that even among a group of highly wired young people, there was considerable variation in how they are embracing the Internet in their lives. This raised questions of whether only a segment of the population is taking advantage of the Internet is decreasing or potentially increasing social inequality. Hargittai's work shows clearly that issues surrounding the idea may have changed but the issue of a digital divide remains significant in the US context.

Hargittai et al (2010) investigated how first year students at a US university look for and evaluate online content. They found that the students displayed a high level of trust in search engine brand as a measure of credibility:

Over a quarter of the respondents mentioned that they chose a Web site because the search engine had returned that site as the first result suggesting considerable trust in these services. In some cases, the respondent regarded the search engine as the relevant entity for which to evaluate trustworthiness, rather than the Web site that contained the information. (Hargittai et al. 2010 p 479)

Only 10% of the students commented on the site author or that author's credentials. The authors commented that this suggested that students had a level of faith in the search engine that they chose that they did not feel the need to verify content independently. The research suggested that students also had a strong reliance on brands, such as Google or Microsoft and a discrimination based on domains with higher credibility being given to educational and governmental domains (i.e dot edu or dot gov).

how users get to a Web site is often as much a part of their evaluation of the destination site as any particular features of the pages they visit. Accordingly, looking at Web site credibility without the entire search context ignores an important part of the puzzle. (Hargittai et al. 2010 p 486)

The article ends by suggesting that initiatives are required to educate people in how to evaluate the credibility of online content and a contrast is drawn with the Net Generation and Digital Native literature that suggests young people come equipped with these skills naturally.

Canada

In Canada the Net Gen Skeptic blog keeps a running commentary on the debate around the Net Generation and Digital Natives and it is a valuable source for current literature, providing brief reviews of new research (<http://www.netgenskeptic.com>). The blog is associated with the Digital Learner in Higher Education project which has produced a number of the publications which follow in this review. Bullen et al. (2008) studied students' social and educational use of technology and the extent to which they could be characterized as 'Millennials'. The results showed that students' use of technologies were not generation related. Despite the vast availability of tools freely available on the Internet and provided by institutions, students only use a very limited range of tools. Within the limited range, the selection of tools was driven by three characteristics: their familiarity with the tools, cost and immediacy the tools can provide. From interviews with the students, Bullen et al., (2008) also found that students have a good understanding of what technology can and can not do for them in specific contexts. Their data also showed that there was a considerable variation in students' perceptions of whether their technology needs have been met across the disciplines. For example students in an Automotive programme felt their needs were being met very well, whereas students in the Architecture program reported a lack of essential tools. They also argued that with regard to technological proficiency, age might not be the only factor to consider. This group of researchers (i.e. Bullen et al., 2008; Bullen, Morgan, Belfer and Qayyum, 2009; Bullen et al., 2011) have argued that students' communication preferences were not simply age or generation related. Net generation students were only as comfortable in using computers, Internet and other technologies for a variety of purposes as non-net generation students. They report that there was not a generational divide in the student population they studied:

When compared according to the most commonly-cited net generation characteristics, students born before and after 1982 are not significantly different. (Bullen et al., 2011[Online], p. 17).

Bullen, Morgan, Qayyum, Belfer and Fuller (2009) repeated their previous finding that there was no empirically sound basis for most of the claims been made about the net generation. Based on 69 interviews with students, Bullen et al. (2009) developed the survey consisting of psychological and behavioural items to determine the extent to which students fitted the typical Net Generation profile. 849 students from 14 courses completed the survey and results showed there was no generational divide. Although some of the

descriptors of Net Generation learners were evident in these learners, a generational approach did not help to explain the difference in students' learning approaches or the use of technology. There was no meaningful difference between the net generation and non-net-generation students in terms of their use of technology and learning preferences. Furthermore, there was:

little evidence to support a claim that digital literacy, connectedness, a need for immediacy, and a preference for experiential learner were characteristics of a particular generation of learners (p. 10).

Bullen, Morgan, Belfer and Qayyum (2009) challenged the grand claims made about the Millennial or Net Generation learners and their difference to the previous generations, and they concluded that there was no meaningful difference between the Net Generation's and non-Net Generation's use of technology, behavioural characteristics or learning preferences.

Similarly, Salajan et al. (2010) discussed the digital native-immigrant dichotomy through a small scale study conducted with students and faculty members at University of Toronto, on their attitudes towards the implementation of digital technologies into the curriculum. Survey results showed that a definitive distinction can not be drawn between the digital native students and digital immigrant faculty members surveyed. They argued that the digital native-immigrant dichotomy was a complex phenomenon and could not be described in extreme terms. These confirmed conclusions from Australia (Bennett et al., 2008) who asserted that the net generation claims 'have been subjected to little critical scrutiny, are undertheorised, and lack a sound empirical basis' (p. 776).

Gabriel and MacDonald (2009) in Canada studied the expectations of new learners entering the first year at a small Canadian university regarding the use of digital technologies for learning. Their data from a web survey and interviews show that while technologically savvy, net generation learners still anticipated using technology in fairly traditional ways.

A joint project by the Working Group on Library Instruction of the Subcommittee on Libraries of the Conference of Rectors and Principals of Quebec Universities (CREPUQ) was conducted to study the information literacy skills of undergraduate students entering Quebec universities (Mittermyer and Quirion, 2003). A questionnaire including 5 themes was compiled based on standards published by the Association of College and Research Libraries, in an effort to study students' 'concept identification', 'search strategy', 'document types', 'search tools', and 'use of results'. 3003 questionnaires were returned and analyzed. Results showed that the Internet was widely used as a source of information, however a significant number of students had limited knowledge of the information research process. The poor information research skills has resulted in few or no relevant documents being found, time wasted due to inefficient search strategies, and too many or too few documents being found. Mittermyer and Quirion (2003) also argued that there was a need to promote awareness at the institutional level that students should develop the ability to recognise when and how to locate, evaluate the use the information needed and promote the integration of information literacy instruction in higher education institutions.

Australia

The largest and most sustained research effort in Australia has come from the Educating the Net Generation project (<http://netgen.unimelb.edu.au/>). The Australian Learning and Teaching Council funded project began in June 2006. Many of the authors of journal

articles cited below were involved in this project. Kennedy *et al.* (2006; 2008) studied 2000 first year students at the University of Melbourne in 2006. Survey results showed that though many first year students were technologically knowledgeable, their patterns of use of technologies varied considerably when they moved beyond the basic and entrenched technologies (i.e. computers, mobiles and email). They argued that there was no universal student experience with regard to the use of technology among incoming first year students. There was a diverse range in students' access to, use of, skill levels with, and preferences for a range of technology based tools. Factors contributing to this variance include gender, background and discipline area.

In a recent study, Kennedy *et al.* (2010) again provided empirical-based evidence that contradicted the claims made about Digital Natives being a homogenous and highly skilled group of young people with respect to information and communication technology. They found that there was a widespread diversity in students' access to, skill levels and use of technologies. They surveyed 2096 students about their frequency of technological tool use at three universities and found that there was a widespread diversity in students' access to technology, skill levels with technology and in their use of technologies. Through cluster analysis, they found that within the population of young students there were disparities in how students used technologies. They identified four types of student users:

- power users,
- ordinary users,
- irregular users and
- basic users.

They indicated that power users made use of a wide range of technologies whilst ordinary users used mainly web and mobile technologies. Irregular users were similar to ordinary users but their frequency of using web and mobile technologies were lower and were less likely to use emerging technologies except for Web 2.0 publishing. Basic users were irregular users of new and emerging technologies but were regular users of standard mobile phones. The distribution of the four types of technology users was as follows: power users (14%), ordinary (27%), irregular (14%) and basic (45%). Advanced technology users (power users) were in a minority, and the largest group of students were basic technology users (basic) whose uses of new technologies were characterised by extremely infrequent use of new and emerging technologies and less frequent use of standard web-based applications. The diversity of the student cohort suggested that a 'one size fits all' approach would be inappropriate when integrating ICT into university curricula. They went on suggest that pedagogy and curriculum changes that have been proposed to accommodate the needs of the new generation of learners should be both evidence-based and empirically informed, rather than making predictions based on a generation assumption that students coming to university have a universal digital upbringing.

Adding to Kennedy *et al.* (2010), Corrin *et al.* (2010) conducted a survey on a group of first year university students' technology access and practice in both everyday life and for academic study. Results showed that not all young participants fitted neatly into the stereotype of the 'digital native' in terms of access and use of technologies. There was not a homogenous group in relation to access, skills and experience with technology. While access to and use of certain technologies was quite high, others remained significantly low. Furthermore, there was also a 'mismatch' between students' use of technologies in their everyday lives and for their academic studies. Implementing technology as part of academic study was generally lower than everyday technology usage.

Judd & Kennedy (2010) reported on a large scale study of Australian biomedical students' on campus use of Internet over a five year period. While most of the research evidence to date comprised of self-reported snapshots of technology use, Judd & Kennedy (2010) monitored students' actual technology use and variation in use over time. The most frequently used technologies included the university's learning management system, Google, email and Facebook. Results showed that students were heavy users of Google, with the use of both tools increased over the study period. Email was the most popular though its use declined substantially between 2005 and 2009, when social networking sites – such as Facebook first entered the market in 2005. There was then a rapid uptake of Facebook between 2006 and 2007. With the exception of Facebook, all other 'web 2.0' technologies (i.e. blogs, twitter, social bookmarking, and photo-sharing) remained at low levels of use.

Using part of the Australian biomedical study data, Judd and Kennedy (in press) reported on a group of undergraduate students' computer-based task switching and multitasking behaviour. Based on detailed analysis of over 6000 individual sessions, they conclude that while a majority of students engaged in task switching and multitasking, their intensity was less frequent than the prominent net generation advocates would lead us to believe. Students' incidence and intensity of task switching and multitasking varied significantly, though low-level users greatly outnumbered inveterate users. Male students and international students were more likely to task switch and multitask than their female and local counterparts. Also, students who had entered university directly from secondary schools were more likely to multitask than graduate students.

Waycott *et al.* (2009) reported qualitative research that ran counter to assumptions made about the 'digital divide' between the more technological adept 'digital native' students and their less savvy 'digital immigrant' teachers. 46 first year students and 31 teaching staff took part in interviews about their perceptions and use of technologies both in their daily lives and in teaching and learning. The results showed that students and teachers used many of the same technologies in their everyday lives. There was also a significant overlap in their use of technologies for personal and entertainment purposes. As Waycott *et al.* (2009) put it:

the 'differences in the way students and staff perceive and use technologies in higher education might be better understood in terms of their different roles as students or staff, rather than age-related differences (p.17).

South Africa

The most sustained research effort in South Africa has been conducted by researchers in the Access and Use project (<http://www.cet.uct.ac.za/virtualmobius>) at the University of Cape Town (Brown and Czerniewicz, 2008; Brown and Czerniewicz, 2010, Czerniewicz *et al.* 2009). Brown and Czerniewicz (2008) surveyed 3533 students regarding their ICT use in six higher education institutions in five South African provinces. Despite the growing emergence of new technologies the findings suggested that students' use of computers for teaching and learning was still quite narrow. There was no evidence that ICTs were ubiquitous in students' everyday lives, nor could they be described as being entrenched in higher education courses. Even though there was a growth in use of more familiar technologies such as web searching and instant messaging, there was 'a surprisingly low use of social software tools' (p. 2). The results also confirmed findings from other studies on ICT use for teaching and learning in South Africa higher education (Czerniewicz and

Brown 2005; Hodgkinson-Williams and Mostert 2006) who noted that the most frequent web activities were information seeking and word processing.

The use of ICT remained main stream though students from different disciplines report different frequencies of use of more specialized e-learning activities. More students from the science discipline report above average use whilst students with below-average use were predominantly from the humanities (Brown and Czerniewicz, 2008). This finding runs counter to their 2004 study where the sciences and humanities were the least frequent users of ICTs (Brown and Czerniewicz, 2008). Moreover, students' use of ICT was found to be related to institutional approach to e-learning. Students reported more frequent use at institutions that had adopted structured approaches to e-learning.

Drawing on research project on South Africa university students' access to and use of ICT, Brown and Czerniewicz (2010) concluded that age was not a determining factor in students' digital lives; rather, their experience with ICT was more important. Instead of a new generation of young people entering higher education, there was deepening digital divide in South Africa characterized by access to ICT rather than age. They argued that the notion of 'digital natives' was problematic, both conceptually and empirically. As a concept, it is problematic because there is an implied superiority of those with particular skills and dispositions; moreover, the idea that people are born into a category they cannot change is problematic. Empirically, there was also insufficient evidence to support the concept.

Thinyane (2010) reports on another study conducted with students at South African universities. Again, contrary to Prensky's digital natives claim (2001a, 2001b, 2010), results of the study portrayed a heterogeneous student population, with varied levels of access to most of the technologies. Furthermore, students' use of web 2.0 technologies, which Prensky claimed to be a key feature of digital natives, didn't appear to be actively used by students in their daily lives nor in their studies. Confirming previous South African studies (Czerniewicz & Brown, in press; Czerniewicz & Brown, 2010; Brown & Czerniewicz, 2010; Brown & Czerniewicz, 2008), survey results showed that mobile phones, outnumbered the others, was the most accessible (98.1%) tools among students. Tasks involving the use of mobile phones ranked the top in both students' daily activities with technologies and use of technology particularly for their studies.

Chile

Sánchez et al. (2010) interviewed students and teachers from four cities in Chile to explore the current generation of students and their relationship to technology. As a developing country, where access to ICTs is far from the developed countries, Sánchez et al. (2010) took a qualitative perspective, in an aim to provide some empirical evidence to the discussion of 'digital natives' in Chile. Interview results showed that students' skills and abilities with technology did not represent a precise description of the 'digital natives' described in the literature. There was not a generation with common traits with regard to their use of ICTs; some students made highly sophisticated uses and others made little. There was no evidence to show that students' skill levels with ICTs was distinct from the previous generations as Prensky (2001a, 2001b) claimed. Though some of the students use several applications at the same time when using computers, there was no evidence to show that they were multitaskers or have any special abilities to process parallel information. Though students in general had wide access to ICTs and heavily integrated ICTs into their everyday lives, there was no case that students' traditional social activities such as getting together with friends in and out of school, was replaced by any use of ICTs.

Face to face communication was still highly evaluated among the students. Furthermore, it was found that the students' experience with ICT in the Chilean context was not distributed according to socio-economic status as expected. However, it was related to gender in some specific activities such as video games.

Mainland China

One of the few empirical studies contributed to this generation of students were Shao's (2010) report on Chinese university students' use of technologies. Shao (2010) surveyed 2920 university students across seven disciplines in Jinan, Shandong province on their experience with technologies. The aim was to understand how university students in China use technologies in their daily lives and to explore the ways in which the technologies could be harnessed for educational purposes. Their results indicated that there was diversity in university students' use of technology in China. The use of Web 2.0 technologies that are often associated with this generation were relatively low. There existed a large number of students whose computer skills levels were far from what one might expect of digital natives.

Similarly, Li & Ranieri (2010) investigated the characteristics of a group of Chinese teenagers (ninth grade students) in Ningbo, Zhejiang province in an aim to provide a 'piece of evidence' on the digital competence of the 'digital natives'. An Instant Digital Competence Assessment (iDAC) tool was adopted as the measurement tool for the study. Results showed that teenagers' digital competence was just 'pass' rather than 'good' or 'excellent', and there were big disparities among participants in their digital competences.

Wang (2003) surveyed 92 students' use of technology at China's Northeast Normal University in Shenyang Province, focusing on three aspects: students' technology awareness (whether they understood the information system), information ethics and technology literacy. The results showed that the students had a low awareness of the source of information. Only 32 students understood where information came from compared with the other 60 students who were not aware of the source. Although these students were said to have been brought up in a digital world, contradictory results were obtained when they were asked what their daily source of information was. Unlike what we might expect of digital natives, students got the majority of their information from printed materials rather than from digital sources. Almost 50% of the student participants said the best source of information was the newspaper. The information they got from digital resources (i.e Internet, CD, and media databases) was less than 30%. Furthermore, students showed a lack of understanding of intellectual property rights. Only 30% of the students were aware of individual privacy infringement and Internet crime. Their understanding of information ethics was at a low level and there was a need for education in relation to these issues.

Wang, Lin and Mao (2003) also investigated students' computer skills and information literacy at university. Questionnaires were administered to 167 undergraduate students and 150 graduate students pursuing a master's or PhD degree at Beijing Normal University. The results showed that there was a gap between undergraduates and graduates in their computer skills. Graduate students had a lower level of computer proficiency compared with undergraduate students. In particular, graduate students who came from other universities or rural areas were less familiar with computers and had not received enough training during their undergraduate studies. Although the government endeavoured to promote students' information literacy, there was still a lack of implementation at the institutional or departmental level for various practical reasons. A number of universities still had not yet offered information searching courses to their

students. Without systematic and thorough training, students showed a lack of information searching skills, which resulted in a gap between their information needs and the digital resources. In other words, students could not make good use of the available digital resources due to their poor information literacy, and hence the digital resources freely available online cannot help the students to meet their needs.

Following Wang, Lin and Mao's (2003) study, Wang (2007) surveyed 300 students in three universities in southern China: Fudan University, Tongji University and Shanghai Financial University and found that a number of students had not received any training on information searching or attended any relevant courses at university. Due to a lack of computer training, students were not clear about the sources of information available to them in their field. Although there was a vast amount of information available on the Internet, students lacked the skills to find, search, and organize the information. Some of them had never used advanced search, the majority of the students only possessed basic skills using search engines (i.e. Google and Baidu). The four most popular online activities were watching news, watching movies, using forums, and playing games. Most of their online activities were for personal and entertainment purposes. Although English was a compulsory subject at school and university, students still had problems with browsing English websites. Only 22% could understand any content from English websites, which undoubtedly limited the scope of their information sources.

Hong Kong (China)

In research related to Australian studies (Kennedy et al, 2006; 2008), McNaught et al. (2009) investigated 689 year one students and 56 of their teachers in Hong Kong using the same survey instrument in an aim to explore the digital divide between teachers and students. Results showed that although students were 'digital ready' in general, there was variation in both their level of ownership and perceived skills levels with the digital device. The digital divide between students and teachers was not straightforward and:

the so-called digital natives (students) were not always more digitally-oriented than the so-called immigrants (teachers) (p. 10).

Both teachers and students were competent with basic computer and web technologies. The digital divide between students and teachers appeared to relate to preferences and prior experiences with technologies and the divide was less apparent regarding access to technology. In general more students had access to digital technologies (i.e. desktop computers, mobile phones, MP3/4 player, video game console and broadband Internet) than their teachers, apart from two items: laptops and Personal Digital Assistants (PDAs).

McNaught et al. (2009) also found that gender and discipline were related to the diversity of students' digital experience. For instance, men were found to be more able to use advanced web or mobile features and games, while women are more able to use technology for socializing and entertainment. In terms of discipline, students in Education, Law and Science disciplines had better access to technology and were able to use a wider range of technology-based strategies than students in either Medicine or Arts.

Conclusions from the empirical studies

Findings from the published empirical research investigating the claims of the Net Generation and Digital Natives in relation to students in Higher Education show that, while the material basis for these arguments (i.e. access to and use of computers and high speed networks) is present in most advanced and emerging industrial economies, the technological context does not translate in any simple way to a generational change in attitudes and skill levels related to the technology. Rather than showing that there is a Net Generation of digital natives who are naturally proficient with technology, empirical evidence from a variety of countries shows that students' experiences with technologies are far from universal. Not all students were equally competent with technologies and their patterns of use varied considerably when they moved beyond basic and entrenched technologies to newer emerging or recently introduced technologies (Jones et al., 2010, Kennedy et al., 2008). There were variations among students within the Net generation age band and studies of larger samples using differential statistical methods (factor and cluster analysis) demonstrate that young people break-up into different user groups with different interests, preferences, and lifestyles (Bullen et al., 2008, Jones et al 2010, Jones and Hosein 2010, Kennedy et al. 2010, Schulmeister 2010). Students selection of tools were related to other characteristics, including age, gender, socio-economic background, academic preference (major) and year of study (grade) (Brown and Czerniewicz, 2008 Caruso and Kvavik, 2005, Hosein, Ramanau, Jones 2010a, Kvavik, 2005, Krause 2007, McNaught et al., 2009, Selwyn, 2008, Smith et al 2009, Smith and Caruso 2010).

Although there was a considerable growth in university students' access to a range of computing technologies and online technological tools, in some contexts their use of technologies was mainly for social and entertainment purposes, but not for learning (Oliver and Goerke, 2007; Selwyn, 2009). Overall there were differences in students' use of technology for social and leisure purposes and for academic use (Corrin et al 2010, Jones et al., 2010; Jones and Ramanau, 2009a, Ramanau, Hosein and Jones 2010, Hosein, Ramanau and Jones 2010b). Furthermore, contrary to Prensky's (2001a, 2001b) claim about students' changing learning preferences due to technology exposure and his call for radical change in educational practice, empirical studies showed that students' high levels of use and skill did not necessarily translate into preferences for increased use of technology in educational contexts. A large number of students still held conventional attitudes towards teaching (Kennedy et al. 2009, Gabriel and MacDonald, 2009; Garcia and Qin, 2007; Lohnes and Kinzer, 2007; Margaryan et al. 2011) and there is now a consistent and long-standing finding that students would prefer moderate use of technology in the classroom (Jones, 2002, Kennedy et al. 2009, Kvavik, 2005, Salaway and Caruso, 2007, Smith and Caruso 2010). A caveat to this finding is that what was meant by 'moderate use of ICT' in 2004 prior to many of the new Web based services and applications might be something quite different to what is meant by moderate use of ICT in 2010 (Smith and Caruso 2010).

There is evidence is that students are not great users of Web 2.0 nor the most recent or most advanced technologies. However, the evidence also suggests that students will make use of technologies that are course or programme requirements (Jones et al 2010, Smith and Caruso 2010, Kennedy et al 2007). This evidence contrasts with the rhetoric fuelled by the idea of the Net Generation and digital native students who are promoted as advanced users of technologies. It also sounds a note of caution against those who suggest that standard technologies such as Virtual Learning Environments (Learning Management Systems) are out of date and run counter to the demands of students. The evidence is that most students are largely content with such systems and that student use tends to emphasise good communications and the ability to access resources (Jones et al

2010, Smith and Caruso 2010). This of course reflects the current provision of Higher Education and it should not put off educators who wish to experiment with new technology because the evidence also suggests that students will use the technologies required by courses and respond positively to well designed and implemented courses using Web 2.0 and other advanced technologies.

The Net Generation and Digital Native arguments suggest a number of digital divides. They suggest that there is a divide between a generation that begins around 1980 and preceding generations. They claim that this generational divide is found in education in a divide between teachers and their students. Most depressingly this divide can be ameliorated but never fully bridged because digital immigrants will always retain their analogue 'accent'. However, as noted above there is now good evidence to suggest that there is no simple generational divide. Moreover there is evidence that the divide between students and teachers has also been overdrawn (Kennedy et al. 2008, McNaught et al 2009). Yet while these digital divides dissolve under empirical scrutiny other digital divides have shown persistence (Schulmeister 2008, Hargittai 2010). Access to technology is still unevenly spread both between and within different countries; it also relies on digital literacies (in German, digital kompetenz) not simply the availability of new technology (Schulmeister 2010, Palfrey and Gasser 2008). Broad demographic groupings still affect students' interaction with technology, with gender, ethnicity and social class still having an effect (Hargittai 2010, Jones et al 2010, Smith and Caruso 2010, Kennedy et al. 2010, Selwyn 2008). The problem with the arguments deployed to support the Net Generation and Digital Native ideas is that they direct attention towards divides that are not found in empirical work, and away from those divides that persist in Higher Education.

Much of the early work researching the technology engagement of students took the form of large and medium scale surveys. Recently there has begun to develop an interest in expanding the range of methods used in this area of research in order to answer questions that were not appropriate for survey methods of research. Judd and Kennedy (in press) used logs from computers in a large open-access computer laboratory to study a group of undergraduate medical students and their computer-based task switching and multitasking behaviour. Hargittai et al (2010) report a study that used interviews with stratified samples of students and observation of students' searching behaviour. Jones and Healing (2010a and 2010c) report on the use of a cultural probe in which students were issued with small video cameras and notebooks and responded to set questions when they received SMS text messages on their mobile phone over a 24 hour period. All these methodological approaches attempt to take our understanding beyond the surface that has now been covered by a number of large scale surveys in a number of different countries. Given the distributed nature of mobile and networked technologies traditional forms of observation are limited in scope. New and innovative approaches to collecting in vivo data from students going about their normal activities will be important to gain a fuller understanding of students' uses of new technologies.

Theoretical responses

Bennett et al. (2008) have noted that the discourse surrounding technology and generational change resembles an academic 'moral panic', in that it restricts critical and rational debate and because the new generation is identified as a positive but threatening presence in relation to the existing academic order. The Net Generation and Digital Native discourse is one that provides a series of binary distinctions: new generation or old generations; technically capable and inclined or technically challenged; and finally between students and their teachers. These authors do not dismiss the potential for

change related to developments in digital and networked technology, rather they argue for the collection of evidence and the adoption of a cautious attitude when advocating technologies as a vehicle for educational reform.

Furthermore, Bennett & Maton (2010) suggested that, rather than simply regarding all young people as 'digital natives', research was required that was able to explain what young people chose to do with technology and why they chose to do it, taking into account the context in which they engaged with it. They argued for new ways of conceptualizing key ideas to advance understanding of the debate, using Castells', Bourdieu's and Bernstein's theoretical constructs. These concepts as a theoretical lens suggested a means by which they can build a more sophisticated understanding of young people's technology experience.

Several authors (Buckingham 2006, Bayne and Ross 2007, Herring 2008) have pointed to the importance of commercial and market interests in perpetuating the idea of a new generation and we noted earlier the strong anecdotal appeal of a generational argument for parents and educators. However such arguments lead to some highly negative consequences. Bayne and Ross (2007), for example, note that Digital Native arguments lead to a paradoxical one-way determinism in which institutions and teachers are forced to change but each person is said to be fixed in their own generational position. This provides a contradictory account in which older people are expected to change, though they are generationally fixed, and become more like the new generation. In education this can lead to a deficit model of professional development in which academic staff who are outside the net generation, composed of digital natives, can only ever be 'immigrants', never able to fully bridge the gap with 'natives' arising from their generational position (Bennett et al. 2008, Bayne and Ross 2007).

Agency

The arguments used to support the idea of a significant generational change related to technology rely on a form of technological determinism (Jones and Healing 2010b). The argument that young people are radically different from preceding generations rest on the idea that because young people have been exposed to a range of digital and networked technologies as they grew up, there has been a consequent change in their attitudes and skill levels. In this account technology behaves as an independent and external structural factor acting on social forms but not being conditioned by them. A point that often gets neglected when talking in this way about the technological environments is that digital natives use and inhabit technologies that were designed and developed by previous generations. As Stoerger put it:

Someone had to design, build, and upgrade the technologies that have evolved into the electronic spaces that the natives now inhabit. Interestingly, very few educational technology advocates mention that the digital immigrants were the creators of these devices and environments." (Stoerger 2009 Online).

Alternative accounts understand young people as active agents in the process of engagement with technology (Czerniewicz, Williams & Brown 2009). The notion of agency has been widely discussed as a contrasting framework to structure in the social sciences. Structure describes the factors enabling and constraining what human agents do. Agency, in contrast, is concerned with the shaping of processes by the intentions and projects of humans.

Research conducted by Jones and Healing (2010b) illustrates the way in which the structural conditions that students face at university are, at least in part, the outcomes of collective agency. The research showed how staff members designed and re-designed courses and how the availability of technologies was an outcome of decisions and actions taken elsewhere in the university. They suggest expanding the notion of the agent to include persons acting not on their own behalf, but enacting roles in collective organizations such as courses, departments, schools and universities. Furthermore they argue that individual students are working in settings that have increasing amounts of active technologies that replicate aspects of human agency. They point to the way the digital networks through which education is mediated are increasingly able to become interactive. They also reported that distraction, caused by the intervention of automated processes such as notifications from social networking sites, is commonly reported by students. They conclude that there is an increasing likelihood that students will interact with humans and machines in similar ways.

Networked Individualism

Manuel Castells (2000) building on work by Wellman (see Wellman et al., 2003), has used the term 'networked individualism' to describe the form of sociality in network societies. Networked individualism describes the ways that social relations are realized in interaction between on-line and off-line social networks and the move from physical communities to personalized or privatized virtual networks. This social trend raises fundamental questions about the relationships between the emerging network society and the organization of learning environments in both formal education and training. Networked individualism might suggest that we need to take a more critical approach to the theories of education and learning that are based on community and collaboration (Jones 2011, Jones 2004). The term also suggests that we can do this without ruling out the central place of communication and dialogue in education and learning (Jones and Dirckinck-Holmfeld 2009). The term networked individualism suggests a move away from place-to-place interaction towards interactions that are person-to-person in character. The pattern of social life enabled by networked digital technologies is one that allows for a sociability based on the person rather than classic notions of community and collaboration. The new networks rely as much on weak ties as they do on the strong ties of traditional groups and communities (Jones 2008).

The emphasis on the person and choice in networked individualism contrasts with the deterministic arguments that support the Net Generation and Digital Natives. Bennett and Maton (2010) suggest that networked individualism places the focus on the individual who navigates through their own personal networks. This focus on choice is welcome but it may be insufficient as the choices people make are in conditions that they themselves are not able to control. In a related article Jones and Healing (2010b) argue that choice cannot be confined to the individual and that choices are made at various levels of social scale, including in universities departments and whole institutions. Decisions about what kind of infrastructure to provide for students has an impact on the range of choices which students are then faced with.

Educational designers and university policy makers could respond to any growth of a trend towards networked individualism by individualizing networked learning, in Personal Learning Environments (PLE) for example. If they do so they will not only be responding to a social pressure they will be adding to it by making a choice and helping to constitute a privatised context within which students make educational and technological choices. The more radical arguments for PLEs suggest an extremely individualized and learner-centric

view of learning. This radical view ignores the political and institutional requirements built into educational systems for social cohesion (Dirckinck-Holmfeld and Jones 2009). Seen from a social cognitive or a social pedagogical perspective such a radical version of PLEs may be counterproductive. Networked learning offers an alternative vision of a learning environment that allows for individualization but emphasizes connections rather than the privatization involved in PLEs. Whilst networked learning doesn't necessarily privilege the strong ties involved in collaboration or community it still involves a connectedness of some kind, whether reliant on strong or weak links ties. The argument for personalising learning environments is closely related to the arguments for de-institutionalisation (Downes 2010) and the neo-liberal privatisation of universities that Tapscott and Williams (2010) support using arguments derived from the idea of the Net Generation.

Previous reviews

Selwyn (2009) provides a review of the recent published literatures on young people and digital technology with a particular focus on information sciences, education and media/communication studies. The focus of Selwyn's review is young people; as such, it complements this review, which is focused on Higher Education. As with students in H.E., Selwyn shows that young people's engagements with digital technologies are varied and often unspectacular. He also highlights the misplaced determinism that underpins many current portrayals of young people and digital technology. He concludes that while there is a need to keep in mind the changing lifeworlds of young people it would be helpful to steer clear of the excesses of the Digital Native debate.

Selwyn argues that while digital technologies are associated with significant changes in the lives of young people there is no evidence of a serious break between young people and the rest of society. Selwyn also points to the wider political and ideological agendas that maintain the digital native discourse. He comments that:

there is a very real danger that if these rhetorical stories continue to be taken at face value and conflated with the realities of young people's technology use, then they can only provide an ill-informed and unrealistic basis for the formation of effective policymaking and practice. (Selwyn 2009 p 376)

Selwyn argues that educationalists should approach the digital native literature with caution and that adults should not feel threatened by younger generations' engagements with digital technologies. He suggests that academic communities should promote more empirically grounded and socially aware portrayals of the complex lives that young people engage in using digital and networked technologies.

Pedró (2009) carried out a meta-analysis of studies from OECD countries (that is Organisation for Economic Co-operation and Development, current members include: Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States, Japan, Finland, Australia, New Zealand, Mexico, Czech Republic, South Korea, Hungary, Poland, Slovakia). He concluded that not all students fitted equally well into the new millennium learner image. There were differences in students' technology adoption and use and digital divides clearly still existed. Furthermore, there was not sufficient empirical evidence to support the claim that students'

use of digital media has transformed the way in which they learn or their preferences and perceptions concerning teaching and learning in higher education. Neither was there enough empirical evidence to support claims about the effects of technology on cognitive development.

Schulmeister (2008) provided a critical analysis of the speculation surrounding the 'Net Generation' from five perspectives: generation, the use of media, the motivation for the use of media, socialization, and student responses and university didactics. He concluded that many of the claims were overstated or unsupported.

Generation. The users repeatedly prove to be a mixture of groups with various interests, motives, and behaviours, and never to be a group of students with common characteristics.

The Use of Media. After examining more than fifty international studies of media use, he found that studies examining the use of computers did not always distinguish between the types, contents or functions of the media activities or include anything about the motives of the users (e.g. active information creation /passive information consumption).

The motivation for the use of media. The age distribution of young people's preferences suggest that their actual interests are influenced by socialisation. Young people who have grown up with the new media regard them as no more remarkable in relation to their normal daily lives than earlier generations regarded print and analogue media previously.

Socialization. The behaviour of today's youth in relation to media is related to the all too human questions that occupied young people before the advent of contemporary media. The young take up the new media in the ways they require them to satisfy their needs.

Student Responses and University Didactics. Despite the high uptake of media, today's students prefer a moderate use of media for teaching and they still value 'live teaching' highly. The active self-determined participation associated with Web 2.0 is only engaged in by a minority of students.

Jones (2011) argues that there are two different kinds of argument that link students and young people with changes in technology.

The first argument and the one, that is most associated with the idea of the Net Generation and Digital Natives, is that:

the ubiquitous nature of certain technologies, specifically gaming and the Web, **has affected the outlook of an entire age cohort in advanced economies.**

A second related but distinct argument is that:

The new technologies emerging with this generation have particular characteristics that **afford certain types of social engagement.** (Jones 2011)

Jones suggests that it is the first of these arguments we may need to abandon in the face of the empirical evidence. The argument that new technologies allow for or afford new types of social engagement should be an encouragement for educators to experiment and develop new ways of working.

Implications for Higher Education

Over all there is no evidence that there is a single new generation of young students entering Higher Education and the terms Net Generation and Digital Native do not capture the processes of change that are taking place. The empirical evidence shows that technology related changes in the student population are complex and there is no single explanation for them. The complex changes that are taking place in the student body have an age related component that is most obvious with the newest waves of technology. Prominent amongst these are the use made of social networking sites (e.g. Facebook), uploading and manipulation of multimedia (e.g. YouTube) and the use of handheld devices to access the mobile Internet. These changes are not slowing down and we can expect a tipping point soon with regard to access to the Internet using a variety of handheld and tablet like mobile devices. Each wave of technological change leaves a residue of age related effects, such that younger and older students differentiate in terms of their use of new technologies and Web-based services but not in any step-change or generational singularity. The demographic factors identified by researchers interact with age to pattern students' responses to new technologies. The most important of these other demographic factors are gender, mode of study (distance or place-based) and the international or home status of the student. Further research is needed to identify the full range of additional factors and the ways they interact with age in different national and regional contexts. There is a developing body of evidence which shows how important the context in which students interact with technology is for defining their responses.

The gap between students and their teachers is neither fixed nor is the gulf so large that it cannot be bridged. The Net Generation and Digital Native argument has been used to justify a rather odd deficit model of teacher development. Teachers are urged to change in order to accommodate the new generation of students but they are told that no matter how hard they try they will not be fully successful and they will retain their Digital immigrant accent. The evidence suggest that the relationship between students, teachers and technology use is at least partially determined by the requirements teachers make of their students to make use of new technologies and the way teachers integrate new technologies in their courses. Teachers who are prepared to develop their skills with the new technologies and to integrate them carefully into their courses are unlikely to be held back by their membership of a preceding generation. There is also little evidence that students enter university with demands for new technologies that teachers (faculty) and universities cannot meet. Students persistently report that they prefer moderate use of Information and Communication Technologies (ICT) in their courses. Care should be taken with this finding however as the interpretation of what is 'moderate' use of ICT may be changing as a range of new technologies take off and become embedded in social life and universities.

Universities should be confident that the current provision of what might seem to be basic services is filling most if not all students' needs. The evidence shows that students appreciate and make use of the foundational infrastructure for learning that is often criticised as being an out of date and unimaginative use of new technology. Virtual Learning Environments (Learning or Course Management Systems) are used widely and seem to be generally well regarded. The provision by university libraries of online services, including the provision of online e-journals and e-books are also positively received. Students uses of technology, given the current dominant pedagogy applied in universities, is focused on communication technologies and obtaining good access to those resources required for their studies. In relation to the newer Web 2.0 technologies students do not naturally make extensive use of many of the most discussed new

technologies such as Blogs, Wikis and 3D Virtual Worlds. The use of 3D Virtual Worlds is notably low amongst students and the use of Wikis and Blogs is relatively low but use does vary between different contexts including national and regional contexts. Students who are required to use these technologies in their courses are unlikely to reject them and a low spontaneous take-up does not imply that they are inappropriate for educational use. The key point being made is that there is not a natural demand amongst students that teaching staff and universities should feel obliged to satisfy.

The Net Generation and Digital Native discourse has included demands for educational reform. Students are said to be a force for change, demanding kinds of teaching and learning (e.g. collaborative and learner centred) and systems of delivery and organisation that are not found in the current provision (Personal Learning Environments or neo-liberal privatised institutions). The evidence shows that on the contrary there is no obvious or consistent demand from students for changes to pedagogy (e.g. demands for team and group working). There may be good reasons why teachers and universities wish to revise their approaches to teaching and learning and to introduce new ways of working but students are not forcing these changes. Students will respond positively to changes in teaching and learning strategies that are well conceived, well explained and properly embedded in courses and degree programmes. However there is no evidence of a pent-up demand amongst students for changes in pedagogy or of a demand for greater collaboration. There is also no evidence of a consistent demand from students for the provision of highly individualised or personal university services. The development of university infrastructures, such as new kinds of learning environments (for example Personal Learning Environments) should be choices about the kinds of provision that the university wishes to make and not a response to general statements about what a new generation of students are demanding. Advice derived from generational arguments should not be used by government and government agencies to promote changes in university structure designed to accommodate a Net Generation of Digital Natives. The evidence indicates that young students do not form a generational cohort and they do not express consistent or generationally organised demands. A key implication of this review is that political choice should be made explicit and not disguised by arguments about generational change.

The New millennium student

Perhaps the term new millennium student (Pedró 2009) is the best term currently in circulation to summarize the position we are in. The authors of this review do not believe that the currently popular terms Net Generation and Digital Natives can be reclaimed despite the valiant efforts of some researchers (Palfrey and Gasser 2008). There are changes taking place amongst the student population and there are some features of these changes that relate to the students' age. As new technologies are introduced they role out through a population at particular periods of time, for example a technology like social networking only came of age with the launch of the Harvard focused The facebook in 2004 and the public version, Facebook, in 2006. A student entering university in 2010 has been in a world with social networking sites as an available resource, and in a context of media hype concerning the effects on children and young people, since they were 13 years of age. Social networking sites were barely on the horizon when the Net Generation and Digital Native literature became popular and this points to a regular temporal feature of technology innovation and one that affects digital and network technologies in particular. It is hard to predict what the next big innovation will be and the speed of change following an innovation can be prodigious. The complex picture that emerges from empirical studies of the new millennium student shows differences between students within the age range of students thought to form a single generation. These differences are most marked in

relation to the newer technologies, social networking sites and more recently the uploading and manipulation of video to various sites including YouTube. Digital and networked technologies do not present themselves to young people as one single entity. Students actively engage with a variety of different applications and services simultaneously and their features are far from uniform.

The single most important message from this review is that young students are diverse and do not form a single generationally defined cohort. Perhaps just as importantly their characteristics, especially their educational characteristics, cannot be read off from the Net Generation and Digital Native literature that purports to describe an entire generation that consists of both students at university and those of a similar age who are not. Recent attempts to characterise the groupings of students that arise in relation to technology have focused on several groupings. Kennedy et al. (2010) identified four distinct types of technology users within the net generation age group: power users (14%), ordinary users (27%), irregular users (14%) and basic users (27%). Advanced technology users (power users) were in a minority, and the largest group of students were the basic technology users who were characterized by extremely infrequent use of new and emerging technologies and a lower frequency of use of standard web-based applications. In the UK Jones and Hosein (2010) grouped students into clusters based on several factors; whether they were using web 2.0 tools (web interactive), audio and video editing tools (technical-oriented), social networking tools (social interactive), gaming consoles (game-oriented) and online resources or word processing/presentation software tools (work-oriented). Results suggested that while age was the most significant factor, other variables such as gender, mode of study (traditional or distance learning), national origin (local or international students) all played an important role in defining students' engagement with technologies.

Implications for teachers

The Net Generation and Digitally Native students were supposed to be forcing teachers to change their curricula and pedagogical models to cater for the needs of the new population of students entering university.

If you are an experienced teacher, you almost certainly have students filling up your classes who are, in many ways, different from those in the past. You probably feel a need, or some pressure, (and may have even started) to do something different for them." (Prensky 2010 p5)

The literature about Digital Natives positions older people, and teachers in particular, as Digital Immigrants, unable to completely shake off the 'accent' of having grown up prior to the emergence of digital and networked technologies. However analysis of the empirical evidence suggested that today's young students' don't fit neatly into the stereotype of the 'Digital Native' and conversely age does not seem to be a barrier to gaining technological aptitudes and skills. Students do not form a homogeneous generational group in relation to access, competence levels and experiences with technologies and they vary considerably according to specific local contexts and socio-economic factors. While general ownership and competence levels of some technologies have increased slightly in recent years, there are still a significant number of students who are not participating in activities that are typically associated with the generational argument. University teachers and educational practitioners of all types should pay greater attention to the variety within the student body and not focus on the claims of a systematic generational gap between teachers and the student body. Given the diversity of the new generation of students a

'one size fit all' approach can no longer be adopted. University teachers may be better advised to design teaching solutions to meet the needs of the diversity of learners described in the literature.

Furthermore, we argue from the evidence we have available that decision making around the use of technologies for teaching and learning should not be based solely on students' preferences and their current practices. Teachers have a clear role to play in selecting appropriate technologies for the teaching approach and subject area that they teach. They also have a role in developing a deeper level of skill than can be found spontaneously amongst students entering university. These skills might be in particular tools, such as spreadsheets, but they may encompass wider skills such as information and digital literacies. What's more, educators need to develop a deeper understanding of the educational affordances of these new technologies and how they could be used to facilitate a range of teaching and learning practices and improve the process and outcomes of students' learning. Achieving this requires an engagement with the educational rationale for the deployment of particular technologies, an active participation in experimentation with different tools and technologies, and evaluation of the effectiveness of the technological tools in practice.

Implications for policy makers

The Net Generation and Digital Native proponents claim that the current educational system is no longer equipped to accommodate the changing needs of this new generation of learners entering university. Universities are urged to act in response to this challenge by making radical changes to their technical infrastructure, professional development systems, pedagogy and curriculum design, and finally to the structure of the university itself.

A powerful force to change the university is the students. And sparks are flying today. A huge generational clash is emerging in our institutions. (Tapscott and Williams 2010 p 29).

However, with regard to educational practice and policy making, we agree with Kennedy et al. (2008) who suggested that:

educators and administrators should look to the evidence about what technologies students have access to and what their preferences are to inform both policy and practice (p. 10).

To develop appropriate policies towards students who been brought up in a culture infused with digital technologies, we need to improve our understanding of the characteristics of new millennium students and to encourage further research that will provide up to date empirical evidence on the actual status of students' access to, competence levels and preferences with the varies technologies and tools that are available to them.

Universities

The review of currently available literature suggests that young people's access to and use of different technologies for different purposes varies considerably.

Educational providers and policy makers need to take this variability into account when making changes at programme or institutional level. More in-depth investigation of students' technology practices and research into how these technologies are capable of transforming students' social and academic lives is essential in substantiating and underpinning the design of educational systems and the policy-making process in university. While there are students who use technology in a wide range of ways, we cannot assume that being a member of the Net Generation or being a Digital Native is synonymous with a natural capacity and confidence in the use of either technology generally or the use of particular tools or Web-based services. It would be even more misleading to assume that being a member of the Net Generation or Digital Native was synonymous with knowing how to use and adapt new technologies and tools to help with their learning in university. It should also not be forgotten that many students are older:

in a number of OECD countries, an important part of the student body is constituted largely by people older than assumed. This accounts for as high as 40% of any student cohort, who might be older than 25 and certainly not responding to the stereotype of a new millennium learner, as this percentage certainly includes people with full or part-time jobs and sometimes family obligations. (Pedró 2009 p 16)

Some of the literature addresses the growing numbers of older students with work and family pressures beyond the academy alongside the Net Generation (Oblinger and Oblinger 2005). Work in England has pointed to the differences in distance students and those who are place-based. Much of this may be a contextual response by students selecting distance education to accommodate other commitments of this type. Universities will need to calibrate their responses to new technology by considering the particular kinds of intake of students they have. This will vary of course both by institution and by programme with some vocational programmes recruiting a significantly older group of students

The empirical evidence suggests many students need more support than is often assumed and a spontaneous engagement with new technology and a university learning environment is insufficient to provide the kinds of support they require. Educational use of new technologies and tools needs to be fully supported by university learning infrastructures and educational design. Because the university is itself a service provider, they will need to develop plans to support the current and future technology needs of their students. They will also need to pay more attention to aspects of the educational design of courses and programmes in addition to the design of teaching materials and resources. To help teaching and support staff to engage successfully with new technologies universities will need to provide both professional development and opportunities to engage in new ways of working with technology. Teaching staff and other support staff in positions with a responsibility for developing students' technological skills will need good systems to help them develop and provide training in information and digital literacy.

The university has a role in providing learning infrastructures that both meet current needs and anticipate as much as possible near future developments. Timing in this regard is crucial and poor intelligence can lead to a misuse of financial and human resources. The current development of Web 2.0 technologies has generated a debate about the use of institutional VLEs/LMSs and the potential to provide a decentralised and more individualised or personalised system, sometimes referred to as a Personalised Learning Environment (PLE) (Weller 2010). We argue that the evidence is that there is no

strong pressure or demand for this kind of provision from students and indeed some evidence that certain kinds of use of new technologies are against student wishes (Jones, Blackey et al. 2010). A choice to move towards a full personalisation is not one that is simply determined by the technological possibilities nor can such a choice be narrowly focused on technological issues. Instead the choices are ones that affect the core functions of the university and an important restriction on the full development of the technical possibilities of personalisation will be the institutional requirement that universities have to retain a degree of centralized control to ensure the quality of the credentials they issue to students. A second near future trend affecting university infrastructure is towards cloud computing and how the storing and sharing of data entailed with this development could conflict with university requirements. Cloud computing also has implications for accessibility and the need for universities to allow access to students with a range of disabilities. The issue of cloud computing like the discussion of more personalized systems for learning touches on core aspects of a universities mission. Choice in these circumstances involves consideration of technological issues and the technologies can in some ways define the parameters for the range of alternatives, however choice remains a highly political question, touching as it does on the diversity of the student body and the central role of the university in society (Sclater 2010). A final consideration for universities in the current climate might be the growth in ownership of handheld and tablet devices and the availability of the mobile Internet. Whilst there is little evidence this is currently an issue the ECAR surveys in the USA show that ownership and use of these kinds of devices and networks is approaching a tipping point (Smith and Caruso 2010). Earlier waves of innovation and the way students have responded to them shows that the take up of these devices by students is unlikely to translate automatically into demand or pressure on universities to adopt these technologies, but it will open up a range of new possibilities that universities may wish to explore.

Government and government agencies

The Net Generation and Digital Native literature has a consistent line of argument that suggests that education will have to change because of the impact of a rising cohort of students that form part of a new generation having an impact on society more generally.

It is inevitable ... that change would finally come to our young peoples' education as well, and it has. But there is a huge paradox for educators: the place where the biggest educational changes have come is not our schools; it is everywhere else but our schools. (Prensky 2010 p 1)

The review shows that it would be a mistake for government and government agencies to take the claims of the Net Generation and Digital Natives at face value. The diversity of the student body has been demonstrated in relation to the intake of new millennium students, but as noted above it should also not be forgotten that the student body in Higher Education spans more than one age cohort.

Governments can set the conditions that affect both the technological environment in universities and in society more generally. The development of broadband in those areas of the UK that currently have little or no provision is an example of the way government policy affects the general provision of infrastructure relevant to education. At the time of writing this review the current conditions in UK Higher education are uncertain following the Browne report and the Comprehensive Spending Review which followed it (Browne 2010). It is clear however that the current coalition government is intent on reducing the role of state agencies in supporting the introduction of new technologies and technological

innovation in education more broadly (the abolition of Becta and the review of JISC signals this) and at the same time and in an unrelated way it is introducing a regulated market into Higher Education. Government will retain a role in setting a range of conditions in which the market will grow but money will be withdrawn from direct state grants and replaced, in whole or in part, by fees which will be loaned to the student. Technology will not have a causal role in the introduction of this neo-liberal system of funding in the UK but the technological infrastructure will be affected by the consequences of this political and ideologically driven decision.

Finally government or one of the agencies responsible for Higher Education may decide to sponsor regular longitudinal research in the United Kingdom that keeps track of the changing relationship between students in Higher Education and the new technologies that are available to them. The model for this could be the annual ECAR surveys, but they could be less regular and include research methods that go beyond the simple survey. Some of this is necessary to provide timely intelligence to universities so that they can plan for the near future. Evidence of this kind can also inform teachers and those responsible for professional development. It can also provide some empirical grounding for policy formation in government and those agencies responsible for Higher Education.

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