Digital Natives and Digital Immigrants

Towards a Model of Digital Fluency

Digital natives are the new generation of young people born into the digital age, while "digital immigrants" are those who learnt to use computers at some stage during their adult life. Whereas digital natives are assumed to be inherently technology-savvy, digital immigrants are usually assumed to have some difficulty with information technology. The authors suggest that there is a continuum rather than a rigid dichotomy between digital natives and digital immigrants, and this continuum is best conceptualized as digital fluency. They propose a tentative conceptual model of digital fluency that outlines factors that have a direct and indirect impact on digital fluency.

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1 Introduction

It has been suggested that there is a significant difference between "digital natives" and "digital immigrants". Digital natives, a generation of young people born into the digital age, are assumed to be inherently technology-savvy (Prensky 2001a; Tapscott 1998). Digital immigrants, by contrast, are those who learnt to use computers at some stage during their adult life. Digital immigrants are assumed to resist new technology or at least have some difficulty accepting it (Vodanovich et al. 2010). Since IS researchers have traditionally conducted empirical research on "digital immigrants" – and some of the theories such as the Theory of Planned Behavior (Ajzen 1991) and the Technology Acceptance Model (Davis 1986) are based on the assumption that users tend to resist or at least have some difficulty accepting new technologies and systems – the rise of a new generation of digital natives has profound implications for IS research (as well as research in other disciplines). If the new generation of young people has no problem accepting new information technology, then some of the assumptions of these theories used in IS research are thrown into question.

However, rather than seeing the difference between digital natives and digital immigrants as a rigid dichotomy, we suggest that this difference might be best conceptualized as a continuum. Some people are more technologically adept than others (Nedbal et al. 2012). Hence, the research problem that we seek to address in this paper is: How can we best conceptualize technology adeptness?

We propose that the best way to conceptualize this continuum of technology adeptness is in terms of digital fluency. Digital fluency is the ability to reformulate knowledge and produce information to express oneself creatively and appropriately in a digital environment. Therefore our research question is: what are the factors that have a direct and indirect impact on digital fluency? The purpose of this paper is to propose a tentative conceptual model that captures the most important factors affecting digital fluency.

The contribution of this paper is that it moves the debate forward about the supposed differences between digital natives and digital immigrants. Based on a review of the state-of-the-art research on this topic from multiple disciplines, we identify the relevant factors that might influence digital fluency.

This paper is organized as follows. The next section describes the research background. Section 3 discusses the methodology used for the systematic review. This

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is then followed by a discussion of the evidence base and the main themes that emerged from our analysis of the literature. In Sect. 6, we propose a tentative conceptual model of digital fluency. The final two sections are the discussion and conclusions.

2 Research Background

In this section we discuss some of the previous research on digital natives and digital immigrants and propose the concept of digital fluency.

2.1 Digital Natives and Digital Immigrants

Most of the previous research on digital natives and digital immigrants tends to assume that these groups are mutually exclusive cohorts. A sharp generational boundary is assumed in much of the literature (Jones and Czerniewicz 2010, p. 317). There are two characteristics commonly used to define the difference between the two: age and accessibility. Although the exact cut-off year of birth varies, most suggest the cut-off date is somewhere between the end of 1970s to the end of 1990s.

However, this binary view has attracted criticism (Brown and Czerniewicz 2010; Jones and Czerniewicz 2010). One problem with this view is that there are many young people in some parts of the world with no access to technology and hence they can hardly be described as digital natives. Another problem is that accessibility to technology does not guarantee better technology usage (Ching et al. 2005, p. 394; Li and Ranieri 2010, p. 1041). Hence, some have suggested that it might be better to think of digital nativity as a continuum (Vodanovich et al. 2010, p. 711). Following this line of thought, we propose that the concept of digital fluency might be a better way to conceptualize this continuum.

2.2 Digital Fluency

Various terms have been used to describe one's capability, competence or skill in using information technology such as digital literacy (Gilster 1997), computer literacy (Ktoridou and Eteokleous-Grigoriou 2011), Information Technology (IT) literacy (Ferro et al. 2011), digital competence (Calvani et al. 2009; Li and Ranieri 2010), computer self-efficacy (Compeau and Higgins 1995) or Information and Communication Technology (ICT) competency (Guo et al. 2008). While these terms are sometimes used interchangeably, we suggest that the concept of "digital fluency" might be the best way to conceptualize the difference between digital natives and digital immigrants (Wang et al. 2012).

Digital fluency can be defined as "the ability to reformulate knowledge to express oneself creatively and appropriately, and to produce and generate information rather than simply to comprehend it" (National Research Council 1999, p. viii). This goes beyond the notion of digital literacy, which focuses on teaching learners to make syntactically correct expressions (National Research Council 1999). It implies that being digitally fluent not only involves knowing how to engage with technology, but also be able to produce things of significance with technology (Papert and Resnick 1995). This paper proposes a tentative conceptual model that outlines factors that can have a direct and indirect impact on digital fluency. Our focus on digital fluency is with respect to technology usage in general, rather than on any specific technology (e.g. Facebook).

3 Methodology

The purpose of a systematic literature review is to explore and understand the existing research in a field of study (Huff 2008). The initial phase of our systematic review was limited to digital natives, digital immigrants and their digital fluency. Furthermore, we focused on the domains of education, IS and computer assistant learning, and extended it to technology and computer science in general. Keyword searches were made on databases related to the selected subjects including Infomit, ProQuest, EBSCO, Ovid, SAGE publications and Reed Elsevier databases.

We followed the paper selection guidelines from Pittaway et al. (2004, pp. 138–143). The steps are outlined below:

1. The keywords were generated based on our research topic. For the digital natives related keywords, we included *digital natives, digital immigrants, net generation* (Oblinger and Oblinger 2005; Tapscott 1998), *millennial* (Strauss and Howe 1992) and *generation Y* (Perillo 2007). Similarly, *digital literacy, competence* and *fluency* are used as keywords for digital fluency.
2. The keywords were constructed with operators into search strings and tested for accuracy in the search engine.
3. The search string was used to search in the databases mentioned earlier.
4. The search string was altered to include "generation-Y", which is frequently used as a variation of "generation Y". Similarly, asterisks were added to cater for singular and plural forms. "Tech*" was added to avoid confusion with language or other domains' fluency, competence and literacy. Instead of using "digital" as a keyword, we found that "technology" and its variations are more frequently used in abstracts and titles. The enhanced search string was formulated as below:
   [(digital native* OR digital immigrant* OR net generation OR millennial* OR generation Y OR "generation-Y") AND tech* AND (competen* OR literacy OR fluen*)].
5. Where supported by the search engine, the result was filtered by peer reviewed articles. We added the search criterion to be 1999 and onwards to reflect the research around the digital natives area because (1) the term "digital natives" was first used in 2001 (along with the term "digital immigrant"), and hence we captured all the articles using these terms and those immediately preceding their introduction, (2) this was immediately after the term "net generation" was coined but before the term "digital natives" was introduced, and (3) "millennial" and "generation Y" are often used to describe the generation after generation X, and the focus of these two terms were not necessarily related to technology in previous research; hence, we did not opt to use the years these two terms were coined. Our search was applied on citations and abstracts where available.
6. All search results were exported to reference management software for further analysis.
7. Duplicates and citations without an author were removed manually from the software input dataset.
8. The citations were then reviewed according to our inclusion and exclusion criteria (Appendices I and II; online available at http://link.springer.com). The main criterion for including a journal paper is that the paper describes both digital natives/digital immigrants and digital fluency. Two

Table 1 Number of citations at each review stage

Step	Description	Included	Excluded
5	Database search	526	
6	Export to reference management software	526	
7	Remove duplicates and articles without authors or proper title	430	96
8a	Title analysis	222	208
8b	Abstract analysis	109	113
8c	A list (37), B list (40), C list (31)	37	

stages were undertaken to reduce the number of citations. We first analyzed the titles of articles according to the exclusion criteria. Following a further abstract analysis, we applied both inclusion and exclusion criteria and, according to their relevance, papers were separated into three lists; A (37), B (40), and C (31). List A contained articles that are most relevant for the review, followed by lists B and C. However, in using this approach, there exists a risk that articles may be miscategorized if their abstracts are poorly written.

9. In order to provide a structured review process, two further article analysis steps were taken. First, the article keywords and abstracts were examined; this allowed key themes to come to the fore, and provided a holistic view of the evidence base. Secondly, all articles were reviewed to ensure papers were categorized into the most relevant theme.

4 The Evidence Base

In this section we discuss the evidence base that was used in our literature review. **Table 1** highlights the number of entries relevant to the subject at each stage of the review. The result shows that studies involving digital natives and digital fluency are primarily in the education field. The top two journals contributing to the review are *Computers & Education* (24 %) and *Information, Communication & Society* (11 %). Out of all 37 papers, one paper is a literature review and has no empirical data. Consequently, it was excluded from our subsequent analyses.

4.1 Participant Type Analysis

Table 2 highlights the breakdown of participant types involved in the studies. As can be seen, most of the papers focus on student participants of different ages. Hence caution is needed when seeking to generalize the conclusions from this study to older generations. For example, the largest proportion of participants, university students, tend to be of a higher socio-economic background, hence they may not be representative of the broader population (Bradley et al. 2008).

Table 2 Empirical findings by participant type

Participant type	No. of papers
University student	14
Senior school student	9
Primary school student	4
Preservice teacher	3
High school student	3
Senior (55+)	2
General population	1
Unemployed (21–55)	1
Parents of 6th grader	1
University staff	1

Note: preservice teachers are enrolled students, however their ages vary significantly

*3 studies include two types of participants

The lack of research in the private sector may be due to the fact that the majority of digital natives were in schools at the time. However, as they have started to join the workforce in recent years, a future opportunity will be to investigate their behavior and compare them with digital immigrants.

4.2 Trend Analysis

Table 3 shows the articles by year of publication. It is clear that this subject of study and the evidence base is very recent, with more than 80 % of the papers published between 2010 and 2011. Moreover, there is one special issue on "Learning, the Net Generation and digital natives" in *Learning, Media and Technology* in 2010 and a special section on the net generation in the *Journal of Computer Assisted Learning* in 2010. We also notice that this topic started to appear in the IS literature from 2010 with two articles in *Information Systems Research*.

Table 3 Articles per year

Year	No. of papers	% of sample
2003	1	2.78 %
2005	2	5.56 %
2008	2	5.56 %
2009	1	2.78 %
2010	17	47.22 %
2011	13	36.11 %

5 Thematic Review

After carefully selecting the evidence base, we then performed a keyword analysis on these papers. A keyword analysis illustrates the nature of the papers reviewed for this study. After consolidation, the top categories of keywords are *education level, participant type, digital divide, IS type, gender, IT literacy/fluency, digital natives/net generation, ethnicity, Internet, self-efficacy, digital immigrants* and *diffusion and adoption*. Several themes emerged from the keyword analysis as shown in **Table 4**.

An investigation of the search keywords in the A list shows that terms such as "millennial", "generation Y" or "generation-Y" are used less frequently in these papers compared with "digital natives", "digital immigrants" and "net generation". Furthermore, they are rarely used in the abstract or title. This may be because the latter terms are tightly linked with technology whereas the former are more generic, generational terms.

Several themes emerged from our keyword analysis. Most papers focus on the study of digital divide, specifically exploring the determining factors and impact of digital divide. Another large proportion of papers examine the individual's behavior when using IS, or pattern of using IS. For example, many IS applications such as computer mediated communication, social network software, Wikipedia, Twitter, and user generated content (UGC) are found in the keyword analysis. A smaller proportion specifically targets IS use for educational purposes. The remaining papers belong to IS adoption and diffusion research.

Table 4 Thematic analysis of papers reviewed

Coding	Theme	Description	No. of articles	% of sample
1	Digital divide	Research on the gaps between individuals, household or societies with regard to their technology accessibility, use and competence for a wide range of activities.	14	37.8 %
1. 2	Digital competence	Studies that focus on technological competence, especially related to cognitive perspective, processing and verifying credibility of information.	4	10.8 %
2	Pattern and preference of IS use	These papers look at individuals' IS use and behavior related to IS use, especially based on different types of IS and users' preference and patterns of use.	8	21.6 %
3	IS use in education	Studies that investigate students' use of information and communication technology (ICT) in education.	4	10.8 %
3.2	ICT integration	Studies that focus on issues and changes required in order for ICT to properly integrate in education for interactive teaching and learning activities.	3	8.1 %
4	IS adoption and diffusion	Research which focuses on the adoption and diffusion of IS.	4	10.8 %

5.1 Digital Divide and Digital Competence

The concept of "digital divide" is a frequently discussed topic in both political and academic fields. Digital divide is sometimes referred to as digital inequality, but inequality of what? Initially it was defined with respect to computer ownership or basic access to the Internet (Barron et al. 2010, p. 178), but now has a wider scope. Although there is no agreement as to its definition, extent, or impact (Dewan and Riggins 2005, p. 299), we briefly outline the evolution of the digital divide debate below and illustrate how it is related to our research.

5.1.1 Digital Access Divide

As the popularity of the Internet grew rapidly during the mid-1990s, policy makers and social scientists worried about the distribution of Internet access (Dimaggio and Hargittai 2001, p. 141). At this stage, digital divide was seen dichotomously as a simple distinction between "haves" and "have nots". Since the National Telecommunications Information Administration published its first report "Falling Through the Net: A Survey of the Have Nots in Rural and Urban America" in 1995, many analyses have been written on the inequalities of accessibility (Hargittai 2002).

The meaning of "access" varies from study to study, but generally refers to whether one has the means to connect to the Internet (Dimaggio and Hargittai 2001, p. 2). This level of divide includes both hardware access as well as use of software (Wei et al. 2011, p. 171). This view tends to neglect the influence of digital fluency (Ferro et al. 2011). Digital access is obviously a prerequisite for gaining digital fluency, but is not in itself sufficient to determine one's digital fluency (Fischer 2005).

5.1.2 Digital Skill and Use Divide

The binary view of the digital divide was perhaps to be expected at the beginning of the technology diffusion process. However, the declining cost of ICT made it more accessible. Therefore, researchers shifted their emphasis to the skills and use of digital technology (Goode 2010, p. 499). This divide refers to the inequality of IS capability or "the ability to use technology" and is considered as a second-level digital divide (Kvasny and Keil 2006). Van Dijk and van Deursen (2008, p. 279) explain four types of digital skills, namely instrumental skills, formal digital skills, informational skills and strategic skills. Although the physical access divide seems to be closing in most developed countries, the digital use and skills divide seems to have widened (van Dijk 2006, p. 225). Digital fluency is both a determinant of the digital divide and a divide in itself (Ferro et al. 2011, p. 4). It is often included as a dimension in digital divide models (van Dijk and van Deursen 2008; Ferro et al. 2011). Studies have covered its definition (Huffaker 2005), its measurement (Li and Ranieri 2010), its correlated factors (Jones et al. 2010; Kennedy et al. 2010) and its impact (Goode 2010). This concept of a divide related to skills is closely related to our research project into how digital fluency differs between digital natives and digital immigrants.

5.1.3 Digital Outcome Divide

Extending the digital divide framework from Dewan and Riggins (2005), Wei et al. (2011) add a third level of digital outcome divide based on studies that show that students with lower computer self-efficacy have poorer learning outcomes. Zhao et al. (2010) echo similar sentiments, where students with high levels of Internet self-efficacy exhibit more exploratory behaviors. Using the Internet at school and home results in better academic performance than those with lower self-efficacy.

5.2 Patterns and Preference of IS Use

Many researchers investigated users' preferences and behaviors based on technology-based activities. These papers show that one's digital fluency varies significantly from one activity to another and digital natives are not a homogeneous group (Grimley and Allan 2010; Hosein et al. 2010; Malliari et al. 2011). However, there are commonalities amongst digital natives in activities such as text messaging, instant messaging and social networking (Kaare et al. 2007; Valtonen et al. 2010). This may be due to the fact that social networking tools gained their popularity mainly over the past decade. It is also worth noting that resistance towards new technology is not universal among digital immigrants; the data show that some of them also "love" new technology (Waycott et al. 2010).

5.3 Education

There has been growing interest in the role that ICT can play within education (Grimley and Allan 2010; Hosein et al. 2010; Malliari et al. 2011). This not only concerns hardware and software but also the teachers' ability to use and transfer knowledge with ICT. Other researchers focused their studies on the relationship between technology skills and academic performance (Luu and Freeman 2011; Papastergiou et al. 2011; Selwyn 2008). Based on a hypothesized ICT-scientific literacy relationship, Luu and Freeman (2011) suggest that students with prior ICT knowledge, more Internet surfing experience and basic ICT self-efficacy earn higher scientific literacy scores. This suggests there is some benefit in promoting the integration of ICT in education.

5.4 IS Adoption and Diffusion

Adoption and diffusion is an important topic in the IS field. The Technology Acceptance Model (Davis 1989) is widely used in the IS acceptance literature and has been tested under many contexts (Davis 1989; Koufaris 2002; Moore and Benbasat 1991). The TAM model suggests that the perceived usefulness and perceived ease of use influence one's decision on adoption of a new technology. For example, Hargittai and Litt (2011) look at the adoption of Twitter. They find that the acceptance of Twitter is not randomly distributed, but rather, an interest in celebrities and entertainment news is an important predicator of Twitter use. In addition, Twitter's service is offered through many channels such as the web, mobile phone or text message; hence, its ease of use has enhanced its adoption rate.

In summary, our thematic review regarding this topic has shown that four key themes have emerged in the academic literature: digital divide and digital competence; patterns and preference of IS use; education; and adoption and diffusion.

6 A Conceptual Model of Digital Fluency

Following our thematic review of the relevant literature, we are now in a position to propose a tentative conceptual model of digital fluency. This model outlines factors that have a direct and indirect impact on digital fluency and hence indicates how someone's digital fluency can be improved. The model is based on an analysis of those factors that have been found to be important in our state-of-art literature review on this topic from multiple disciplines. If one or more studies mentioned a factor as being a significant or insignificant contributor to digital fluency, then that factor was included or not included in our model as the case may be.

Our model incorporates seven factors: *demographic characteristics, psychological factors, social influences, educational factors, behavioral intention, opportunity* and *actual use of technology*. We acknowledge that conflicting results for many of these factors have been observed in the literature. In addition, the literature indicates that some factors are correlated, that is, they may have influences on each other as well as direct impact on digital fluency. This further complicates the research area. **Table 5** summarizes the results of the characteristics analysis. The "Not significant" and "Significant" columns include references to the papers where their authors or research result shows that the related characteristic has or has no significant impact on one's digital fluency, competence and/or literacy.

6.1 Demographic characteristics

Age is one of the determinants used to differentiate between digital natives and digital immigrants. Some studies show that age is significantly and inversely related to digital fluency (Li and Ranieri 2010; Salajan et al. 2010). Yet, when including participants with wider age group ranges, the results suggest otherwise (Guo et al. 2008; Hosein et al. 2010). Keyword analysis shows that *gender*, *gender studies* and *gender differences* appear as keywords in 9 papers. Studies show some level of gender difference within the digital natives group (Hosein et al. 2010; Tømte and Hatlevik 2011). Gender differences also exist in the intention towards technology use and self-confidence in technology use (Volman et al. 2005). In many ways, people in society communicate and reinforce gender-based stereotypes (Martin et al. 1995). For example, females are found to use ICT for educational purpose more often (Selwyn 2008, p. 18) and are more interested in design oriented activities (Selwyn 2008). On the other hand, males are more likely to play computer games (Nasah et al. 2010, pp. 542–543), sharpen programming language expertise (Nasah et al. 2010, p. 540), or use technologies in general (Hosein et al. 2010, p. 404). Traditionally, demographic and *socioeconomic status* factors are considered as the main determinants of the digital divide (Ferro et al. 2011, p. 8). The socioeconomic status is predictive of technology use (Ching et al. 2005), sophistication of usage (Ferro et al. 2011), and activities (Hargittai 2010). For example, people from more privileged backgrounds use the Internet in more informed ways for a greater number of activities (Hargittai 2010, p. 92). However, a New Zealand study shows that low socioeconomic pre-teens choose to perform technology related activities equally if not more than high socioeconomic counterparts (Grimley and Allan 2010). *Ethnicity* and *nationality* are also found to be important influences, but the differences seem to be more related to socioeconomic status (Volman et al. 2005), opportunities of technology usage (Hargittai 2010; Ferro et al. 2011), and ability to speak English (Ferro et al. 2011, pp. 5–6; Gudmundsdottir 2010, pp. 175–177).

6.2 Educational Factors (Organizational Factors)

Some studies show that students' digital fluency differs according to educational factors, for example, *school* (Li and Ranieri 2010), *university mode of study* (Hosein et al. 2010), and *support of computer learning* at school (Goode 2010, p. 508). Some schools provide better technology activities to promote the technology skills building than others (Li and Ranieri 2010). From a social networking perspective, students that have more technology skilled classmates are at an advantage as interest and expertise might be shared informally (Barron et al. 2010, p. 185). The educational factors provide insights into how the external environmental factors might affect one's digital fluency.

6.3 Psychological Factors

Psychological factors such as *computer anxiety, computer self-efficacy* and *aging anxiety* are barriers that can stop seniors from using technology (Jung et al. 2010). On the other hand, intrinsic personal interest is a motivation for people to improve their technological knowledge. In more generic technology-based activities

Table 5 Characteristics analysis

Characteristics	Not significant	Significant
Demographic characteristics		
Age	Guo et al. (2008), Hosein et al. (2010)	Li and Ranieri (2010), Salajan et al. (2010)
Gender	Barron et al. (2010), Volman et al. (2005)	Ching et al. (2005), Ferro et al. (2011), Hargittai (2010), Hosein et al. (2010), Li and Ranieri (2010), Tømte and Hatlevik (2011), Volman et al. (2005)
Socio-economic status	Yavuz et al. (2011), Grimley and Allan (2010)	Ching et al. (2005), Ferro et al. (2011), Hargittai (2010), Hargittai and Litt (2011)
Ethnicity/Nationality/Country		Hargittai (2010), Hargittai and Litt (2011), Hosein et al. (2010), Tømte and Hatlevik (2011), Volman et al. (2005)
Geography (i.e. urban/rural)		Ferro et al. (2011)
Language (barrier or ability to speak a foreign language)		Ferro et al. (2011), Gudmundsdottir (2010)
Size of household		Ferro et al. (2011)
Educational factors		
University/school		Li and Ranieri (2010), Barron et al. (2010)
Discipline/Subject/Faculty	Malliari et al. (2011)	Yavuz et al. (2011)
University mode of study		Hosein et al. (2010)
Computer supported learning		Goode (2010)
Behavioral intention to use technology		
Behavior intention to use		Sykes et al. (2009)
Attitude towards technology		Ktoridou and Eteokleous-Grigoriou (2011), Ferro et al. (2011)
Psychological factors		
Interest		Hargittai and Litt (2011)
Personality	Malliari et al. (2011)	
Computer anxiety		Jung et al. (2010)
Aging anxiety		Jung et al. (2010)
Perceived ability to use technology		Malliari et al. (2011)
Social influences		
Family and peer influence		Goode (2010), Kaare et al. (2007), Thornham and McFarlane (2011), Zhao et al. (2010)
Teachers' use, ability, influence		Cotten et al. (2011), Gudmundsdottir (2010)
Opportunity		
Accessibility	Ching et al. (2005), Li and Ranieri (2010)	Goode (2010)
Home access	Ching et al. (2005)	Barron et al. (2010), Wei et al. (2011)
Location of access		Zhao et al. (2010)
Years of computer ownership		Ching et al. (2005)
Use of technology		
Generic technology experience	Li and Ranieri (2010)	Hosein et al. (2010), Malliari et al. (2011), Papastergiou et al. (2011), Volman et al. 2005)
Specific technology experience		Barron et al. (2010), Cotten et al. (2011), Yavuz et al. (2011)
Training (application specific)	Malliari et al. (2011)	Ktoridou and Eteokleous-Grigoriou (2011)
Type of technology		
Type of technology used		Hosein et al. (2010), Luu and Freeman (2011)
User profiles/groups		Tømte and Hatlevik (2011), Valtonen et al. (2010), Grimley and Allan (2010)

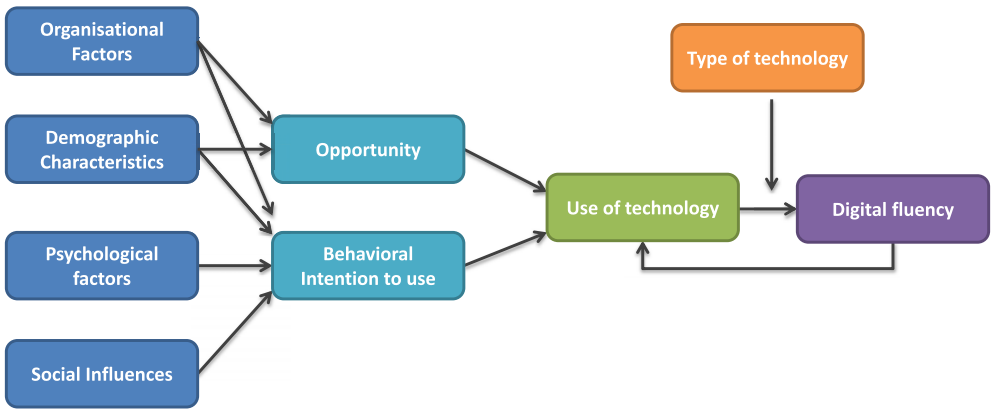

Fig. 1 Conceptual model of digital fluency

such as information seeking tasks, personal characteristics are less influential (Malliari et al. 2011).

6.4 Social Influences

Social influences of peers and others on one's proficiency of technology use are important (Eckhardt et al. 2009; Laumer et al. 2010). Social influences can be from *family* (Goode 2010; van den Beemt et al. 2010; Zhao et al. 2010), *peers* (Kaare et al. 2007), *superiors* (Zhao et al. 2010) and *teachers* (Bennett and Maton 2010). Among these influences, social support from school has a greater effect on teenagers than other forms of social influence (Zhao et al. 2010).

6.5 Opportunity

The opportunity factor includes both accessibility and the opportunity to use technologies to perform daily activities. *Accessibility* relates to the level of access to technology. Other opportunities such as faster Internet connections, infrastructure (Stern et al. 2009) and technological support from others (Goode 2010) are also important. Differences in opportunities to participate in creative fluency-building activities were tied to *home access* to tools, size of the non-home access network and use of broader resources (Barron et al. 2010). The analysis of *organizational factors* and *demographic characteristics* in the previous sections indicate their impact on one's opportunity to use technology. Studies show that owning a computer, or having access to a computer or the Internet at home does not affect one's fluency in using technology (Li and Ranieri 2010; Ching et al. 2005). On the other hand, Brown and Czerniewicz (2010, pp. 363–364) label young people that have no opportunity or accessibility to use technology as "digital strangers". Likewise, Goode (2010) discovers that the student participants with limited home, school computer access and support from others would continue to suffer from low digital fluency throughout high school and university. Students with home Internet or computer access have the highest self-efficacy (Zhao et al. 2010; Wei et al. 2011) and are able to conduct more sophisticated tasks (Barron et al. 2010).

6.6 Behavioral Intention to Use

There is a substantial body of empirical support for the relationship between behavioral intention and actual behavior (Davis 1986, 1989; Koufaris 2002; Lu et al. 2003). It is also confirmed in the context of technology (Ferro et al. 2011; Ktoridou and Eteokleous-Grigoriou 2011; Sykes et al. 2009). The behavioral intention to use technology is influenced by many variables, such as *demographic characteristics* (Li and Ranieri 2010; Ching et al. 2005; Ferro et al. 2011; Hargittai 2010; Hosein et al. 2010; Tømte and Hatlevik 2011; Volman et al. 2005; Hargittai and Litt 2011; Gudmundsdottir 2010), *organizational factors* (Li and Ranieri 2010; Barron et al. 2010; Hosein et al. 2010; Goode 2010), *psychological factors* (Hargittai and Litt 2011; Jung et al. 2010; Malliari et al. 2011), and *social influences* (Cotten et al. 2011; Goode 2010; Gudmundsdottir 2010; Kaare et al. 2007; Thornham and McFarlane 2011; Zhao et al. 2010).

6.7 Use of Technology

The research literature shows that *experience* and frequency of technology use are significantly related to one's digital fluency for overall technology use (Li and Ranieri 2010), generic use (Malliari et al. 2011), and specific technology-based activities (Cotten et al. 2011; Papastergiou et al. 2011). The positive relationship between frequency and fluency remains until the user reaches optimum efficiency (Hosein et al. 2010, p. 415).

6.8 Type of Technology

Researchers have tried to move the focus towards types of activities instead of particular technologies (Kennedy et al. 2009; Malliari et al. 2011). Many large-scale studies show that except for social networking, web 2.0 related activities are less understood and less engaged in by digital natives (Kennedy et al. 2007, 2008; Menchen-Trevino and Hargittai 2011). The technology-based activities studies, rather than the accessibility ones, highlight the significant variances across different demographic groups (Bennett and Maton 2010). They show that some common activities are indeed engaged in frequently by young people (Bennett and Maton 2010; Jones and Healing 2010). Hence, type of activity is considered a mediating factor for digital fluency. Many studies use frequency and type of technology to create a typology. This allows the generation of distinct types of user profiles and user groups (Tømte and Hatlevik 2011; Valtonen et al. 2010; Grimley and Allan 2010). In summary, the use of technology is positively associated with digital fluency with technology-based activity as the mediating factor.

6.9 Conceptual Model

Our analysis of the literature illustrates a complicated picture. However, we think it allows us to suggest a tentative conceptual model for digital fluency as shown in **Fig. 1**. An additional relationship is

postulated to indicate that digital fluency influences technology use. This produces a reciprocal relationship between technology use and digital fluency. This dynamism distinguishes digital fluency from general IT traits such as computer self-efficacy and personal innovativeness with IT (PIIT) (Agarwal and Prasad 1998). Several studies suggest that improvement in digital fluency increases self-efficacy (Ktoridou and Eteokleous-Grigoriou 2011) and Internet use (Ferro et al. 2011). Therefore, the use of technology is influenced by: (1) opportunity – contextual constraints relating to a behavior; (2) intention – the willingness or need to perform an action; and (3) ability (which means digital fluency in our context) – to have the skills and capabilities required to complete the task (Hughes 2007). Digital natives and digital immigrants are different in their age and accessibility by definition, hence the age and accessibility contribute to part of the demographic and opportunity factors in this model. The mixed results of existing research on digital fluency can be accounted for by other variables derived from the literature. One variation to the proposed model is to have opportunity as a moderator of the intention to use – use of technology linkage rather than as a direct antecedent of use of technology. In summary, the differences in opportunity or behavioral intention to use IT between digital natives and digital immigrants are the major factors that lead to the differences in digital fluency.

7 Discussion

Given the recent interest in digital natives and digital immigrants in information systems (Vodanovich et al. 2010) and other disciplines, this paper has suggested that there is a continuum rather than a rigid dichotomy between digital natives and digital immigrants, and this continuum is best conceptualized as digital fluency. Based on a review of the state-of-art literature on the topic from multiple disciplines, we have proposed a tentative conceptual model of digital fluency that outlines factors that have a direct and indirect impact on digital fluency.

7.1 Research Contributions

Our review of the literature has shown that the underlying assumption that there is a big disparity between digital natives (who are assumed to be inherently fluent in IT) and digital immigrants in their use of technology (Prensky 2001b) is false. Rather, there is a continuum between the two groups and this continuum is best conceptualized as "digital fluency". Also, it is too simplistic to reduce 'digital nativity' or digital fluency solely to age and accessibility factors; besides these factors there are psychological, organizational and social factors that influence digital fluency.

The model of digital fluency that we have proposed thus contributes to IS research in the following ways. First, it suggests that IS researchers who are conducting research on technology adoption, diffusion, information systems implementation and resistance need to be aware of the differences between digital natives and digital immigrants. Given that all our previous empirical data in the past has been obtained from digital immigrants, our models of technology adoption and resistance will need to be changed to take account of the new generation of digital natives and their digital fluency. This could be done by including digital fluency as a control variable in technology adoption studies.

Second, the model suggests that all IS studies that are in some way concerned with users and/or stakeholders need to take account of digital fluency. Not all users are the same with regard to their digital fluency.

Third, the model shows that digital fluency is dynamic and can change over time. The reciprocal relationship between actual use and digital fluency implies there is a potential virtuous circle to improve one's digital fluency. Alternatively, this could also imply a vicious circle, which deepens the digital divide. A vicious circle was found in the 2004 Freshman Survey, where the digital divide was actually widening for African American students in the USA (Farrell 2005).

7.2 Practical Implications

Two leading international companies have approached us expressing their interest in understanding this new generation of employees. Management wished to uncover if changes should be made to the workplace to accommodate digital natives. This has now become a common question in the industry.

There are three important practical implications of our study. First, companies should be aware of their policy on using new technologies, especially social networking tools. A report from software security company Clearswift (2011) found that 19 % of companies are blocking employee access to social media sites at work. However, regardless of their preferences over social networking, employees highly value freedom and flexibility in their work. Moreover, our systematic review of the literature shows that digital natives use networking tools more frequently. Therefore, companies may need to rethink their policies about technology use at work if they want to hire and retain digital natives.

Second, companies might benefit from digital natives' technology skills. Research shows that digital natives are more proficient at incorporating new technology in their personal and professional lives than previous generations, and they bring new ways of working to the workplace (Johnson Controls Research 2011). Additionally, the younger generation are said to favor community building and friendly rituals over personal spirituality (Howe and Strauss 2007). Hence, the way to motivate the current generation may be different from the previous one. For example, team building, collaboration and frequent feedback may be their preferred ways for accomplishing tasks, for both work and study. In addition, to improve employees' digital fluency, management could look at the factors described in our conceptual model, such as providing training, giving home access to computer or the Internet, and/or coaching by peers etc.

Third, our conceptual model might help organizations to consider how best to improve the digital literacy of their employees. Our model identifies the most important factors that should be considered in any digital literacy improvement effort.

7.3 Limitations

Several limitations are associated with our paper. First, the topic is relatively new and hence there is a limited amount of literature on this topic. Second, we limited our literature search to peer reviewed articles only, which means that we may have missed relevant articles in practitioner magazines and other outlets. Third, the process of paper selection could have been influenced by the quality of the abstract, title and keywords quality in the databases. If the key words

we used do not appear in these sections of the articles, then they would not have been included as part of our evidence base. Although we believe our model is fairly comprehensive, there is a possibility that we missed some articles which emphasized some factors more than others. In addition, including both digital natives and digital fluency in the search criteria narrows our search result.

7.4 Future Directions

Our research highlights a number of areas for future research.

First, a significant amount of IS literature has focused on users' resistance to new technology. As mentioned, the TAM model is widely used in empirical studies (Davis 1986; Koufaris 2002; Venkatesh 2000; Venkatesh and Davis 2000). However, the subjects of these earlier studies have been digital immigrants. Whether the same findings will hold when the subjects are digital natives is open to question.

Second, as digital natives start to join the workforce, we now have an opportunity to compare their digital fluency with their digital immigrant counterparts.

Third, organizational policies with respect to digital natives' use of IT need to be better formulated. Some companies have banned social networks for reasons such as loss of productivity, exposure of company's network to viruses, or corporate information leaks. However, reports show that digital natives have different expectations on how to learn, work and pursue careers (Rainie 2006). How firms can help their employees to increase their digital fluency, and what policies they should have regarding it, are examples of questions that still need to be answered.

8 Conclusion

In this paper we have suggested that there is a continuum rather than a rigid dichotomy between digital natives and digital immigrants. Based on a systematic review of the literature from multiple disciplines, we have proposed a conceptual model that outlines factors that have a direct and indirect impact on digital fluency, namely demographic characteristics, organizational factors, psychological factors, social influence, opportunity, behavioral intention, and actual use of digital technologies.

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Abstract

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Digital Natives and Digital Immigrants

Towards a Model of Digital Fluency

The article looks at the differences between "digital natives" and "digital immigrants." Digital natives are the new generation of young people born into the digital age, while "digital immigrants" are those who learnt to use computers at some stage during their adult life. Whereas digital natives are assumed to be inherently technology-savvy, digital immigrants are usually assumed to have some difficulty with information technology.

The paper suggests that there is a continuum rather than a rigid dichotomy between digital natives and digital immigrants, and this continuum is best conceptualized as digital fluency. Digital fluency is the ability to reformulate knowledge and produce information to express oneself creatively and appropriately in a digital environment. The authors propose a tentative conceptual model of digital fluency that outlines factors that have a direct and indirect impact on digital fluency namely, demographic characteristics, organizational factors, psychological factors, social influence, opportunity, behavioral intention and actual use of digital technologies.

Keywords: Digital natives, Digital immigrants, Digital fluency, Net generation

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