Education Tech Research Dev (2010) 58:531–555
DOI 10.1007/s11423-010-9151-8

RESEARCH

The digital literacy debate: an investigation of digital propensity and information and communication technology

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Published online: 4 February 2010

Abstract Research suggests students' use of information and communication technology (ICT) may be more a matter of digital literacy and access rather than a generational trait. We sought to identify ICT preferences of post-secondary students ($N = 580$) through a Digital Propensity Index (DPI), investigating communication methods, Internet practices and the creation of online content. Age, gender and socioeconomic status were examined as factors which might explain why students use ICT. Results suggest age is a factor in ICT use but that it is not the most important consideration; the gender gap and gaps between socioeconomic groups in terms of ICT use may be closing. The findings raise a variety of implications for institutions training pre-service teachers, curriculum developers designing instructional materials and educational leaders developing ICT policy for schools.

Keywords Digital literacy · Digital natives · Digital propensity · ICT · Age · Gender · Socioeconomic status

Introduction

The broadly painted and common-sense notion that students' use of information and communication technology (ICT) is defining a generation of learners who are radically different from those of past generations has been permeating itself into the public, political and academic landscape (Selwyn 2009) throughout the early part of the twenty-first

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century. Commonly referred to as *Digital Natives* (Prensky 2001a), the *Net Generation* (Tapscott 1998), the *Millennial Generation* (Howe and Strauss 2000) and *Generation M* (Roberts et al. 2005), these individuals are said to have been "born digital" (Palfrey and Gasser 2008) into the late twentieth and early twenty-first centuries. They are native speakers of the digital age. These students don't have to translate or learn ICT, but merely experience it.

These individuals have spent their entire lives immersed in a digital culture, to the extent that it has fundamentally changed the way in which they process information (Prensky 2001a, b); so much so, they possess distinct learning styles and preferences never before seen. In fact, students are so drastically different from past generations that education is not keeping pace (Oblinger and Oblinger 2005; Prensky 2001a; Tapscott 1998). As Prensky (2001a) has argued, "Our students have changed radically. Today's students are no longer the people our educational system was designed to teach" (p. 1). This is due in part to the fact that educational systems are comprised of instructors born during the analog age (Jones et al. 2005), who will never be as fluent with ICT as their students because they will always retain, to some degree, a foothold or "accents" to their past (Prensky 2001a).

These blanket claims of disparity have not been accepted without scrutiny. Many researchers have disagreed with what has been called an overly simplified characterization of an entire generation. They have further contended that our understanding of students' use of ICT is far from clear (Bennett et al. 2008). In fact, there is mounting evidence that the actual uses of ICT by students are much more limited in scope than the rhetoric implies (Selwyn 2009). According to Lohnes and Kinzer (2007), recent studies suggest that students do not expect or want to use ICT in educational settings in the same way they do at home or in the community. Actually, there is little evidence that students want more ICT integration in the classroom (McWilliam 2002). According to Keen (2007), students are much more interested in using ICT for social-networking purposes than for learning.

Finally, empirical findings show that students' use of ICT is driven by factors such as age, socioeconomic status, living arrangement and locale (Kennedy et al. 2008). Thus, their use of ICT may be more a matter of digital literacy and digital access than a generational trait.

Regardless of the arguments, researchers continue to stress that educating today's technologically confident youth remains a major concern for education (Bennett et al. 2008). While some are suspicious of the strong claims favoring a generation of radically different learners from that of past generations, there are obviously those who believe that these individuals have been exposed to technological advancements never before seen. This balance between unreserved accord and skepticism is best summed up by Selwyn (2009) who asserted:

> Whilst there is a clear need to remain mindful of the changing information and technological needs of children and young people it is clear that we do well to avoid the excesses of the digital native debate and instead concentrate on enhancing our understandings of the realities of technology use in contemporary society. (p. 12)

Purpose of the study

To help promote a better understanding of technology use by our students, the present study was designed to identify the ICT preferences and perceptions of post-secondary students through the use of a Digital Propensity Index (DPI) questionnaire that targeted the frequency with which individuals use ICT in their daily lives and the level of importance they place on these technologies. Specifically, we investigated: (a) ICT use preferences, (b) Internet use preferences, (c) gaming, (d) online media activities, (e) digital communications, (f) ICT facilitated learning activities and (g) ICT facilitated social/economic activities. We also examined whether age, gender and socioeconomic status are contributing factors to ICT use, as prior research has suggested they may play a significant role in explaining why people use ICT to varying degrees (Kennedy et al. 2008; Kvavik et al. 2004; Livingstone and Bober 2004; see Selwyn 2009).

The findings will be of assistance to educators, educational policy-makers and researchers in separating reality from conjecture and lead to a better understanding of students' digital propensity and the role ICT play in their education.

Literature review

Until recently, little empirical evidence has been available to examine the claims made about today's students. While examples of contradictory findings can be found, there is a growing body of emerging research demonstrating the need to be more cautious in our views of students and ICT use (Bennett et al. 2008).

For example, a study conducted by Conole et al. (2006), surveying UK undergraduate students ($N = 427$), found that students were using technologies in "pervasive," "integrated," "personalized," "social," and "interactive" ways (p. 6). All students made extensive use of personally owned technologies (e.g., mobile phones, laptops and PDAs) and standard software packages (e.g., Word, PowerPoint, Excel and statistical software) in creating, manipulating and presenting information. Students were primarily using technologies for their own needs, intermingling general ICT tools and resources with official institutional or course tools and resources. Based on these findings, the authors suggested that "there is a shift in the nature of the basic skills with a shift from lower to higher levels of Bloom's taxonomy, necessary to make sense of their complex technologically enriched learning environment" (p. 6).

Other studies seem to refute claims that students are shifting their way of thinking. For example, Bullen et al. (2008) found in interviewing a group of Canadian students ($N = 69$) that individuals had a good understanding of what ICT can and cannot do for them, but lacked a deep knowledge of the technologies themselves.

Kvavik's (2005) survey of 4,374 undergraduate students led to similar results, "students are skilled with basic office suite applications but tend to know just enough technology functionality to accomplish their work; they have less in-depth application knowledge or problem solving skills" (p. 7.6). Furthermore, Kvavik found that students had a moderate preference for technology and that "students appear to be slower developing adequate skills in using information technology in support of their academic activities, which limits technology's current value to the institution" (p. 7.17).

Further, in investigating students' ability to find information, use technology and think critically with regard to the Internet, Lorenzo and Dziuban (2006) noted that "students aren't as net savvy as we might have assumed" (p. 2) with regard to their safety on the Internet. While finally, Margaryan and Littlejohn (2008), in surveying undergraduate Social Work and Engineering students in two UK universities ($N = 160$), did not find evidence to support the claims that students are using a wide range of ICT for both learning and socialization. In fact, students in their study made limited, recreational use of social networking sites and their findings pointed to little knowledge and use of authoring tools, virtual worlds, web publishing and other emergent social technologies.

In addition to these findings, there is research suggesting that students' use of ICT may be influenced by a number of factors. For example, the 2005 Kaiser Family Foundation Study (Roberts et al. 2005) showed that use of technology had dramatically increased since a prior 1999 study. Among other findings, the study reported that, typically, 8- to 18-year-olds are exposed to 8.5 h of recreational media per day. While alarming, the authors warned that these numbers vary in relation to demographic characteristics, such as parents' level of education, family income level and ethnic background. Similarly, Downes (2002), for example, indicated that the nature of students' home computer use is influenced by family dynamics and domestic affluence. Further, both Kennedy et al. (2008) and Kvavik et al. (2004) found differences in ICT use related to socioeconomic status, cultural/ethnic background, gender and discipline specialization. Finally, Livingstone and Bober (2004) noted that the nature and frequency of students' Internet use differ based on age and socioeconomic status. This is in line with Salaway et al. (2008), who found similar results with age, in that it was the single most important factor with regard to the usage and perception of social networking activities.

Although a more in-depth review of the literature would be required to adequately identify trends and formulate conclusions, the aforementioned findings shed doubt on the notion that students use ICT in radically different ways, posses distinct learning styles and preferences never before seen, or learn so fundamentally differently that our educational system may not be able to cope with the disparity. While premature, our findings appear to be in line with others who have carried out similar reviews (e.g., Bennett et al. 2008; Selwyn 2009).

Method

Participants

The present study was conducted in 2006 at a large, metropolitan, public university in the southeastern portion of the U.S. From a body of 38,045 undergraduate and 6,608 graduate students, 1,890 undergraduate and 1,980 graduate students were randomly selected for participation. Of this, 580 students responded to the questionnaire (Graduate Students, $n = 395$; Undergraduate Students, $n = 185$), whereas the remaining 3,290 students, could not be reached, explicitly chose not to participate, or never responded to the request for participation. The number of graduate student responses was considered more than adequate with the sample estimate returning a figure of 363. However, the undergraduate response rate was not representative of the total sample where the estimate returned a figure of 380.

The reader will note that for the total number of students at the university, the response rate was considered more than adequate with the sample size estimate returning a figure of 381. The confidence level set for these estimates was 95% with the bound set at 5. Participants were all over the age of 18 and were not paid for their participation. All participants were treated in accordance with the American Psychological Association's (APA) Ethics in Research with Human Participants (APA 2002).

Materials

The DPI measured how often individuals use various forms of communication technology in their everyday lives (Henderson and Hirumi 2005, as cited in Norman 2008). Based on

Prensky's (2001a, b) propositions, the 50-item DPI provided a rating on a continuum from 34 to 170 as a numerical representation of the likelihood an individual had a high propensity towards technology. Of the 50 items on the instrument, 6 were demographic in nature and not included in the scoring.

Participants were asked to rate their agreement to each item on the questionnaire. Each item had 5 possible responses ranging from 1 to 5. The responses for each item were specific to the question asked. For example, participants chose from the responses, "at no time during the week," "weekly," "2–3 days per week," "daily," or "more than 3 times daily" when asked the questions, "I communicate with others using email," "I communicate with others using instant messaging (IM)," and "I communicate with others using chat rooms;" whereas participants chose from the responses, "not at all," "1–5 times per day," "6–10 times per day," "11–15 times per day," or "more than 15 times per day," when asked the question, "I use a cell phone to send and receive calls."

The DPI rated digital propensity based on the following categories: (a) ICT use preferences, (b) Internet use preferences, (c) gaming, (d) online media activities, (e) digital communications, (f) ICT facilitated learning activities and (g) ICT facilitated social/economic activities. Examples of ICT incorporated in the DPI consisted of cell phones; email; two-way instant messaging; chat rooms; blogs; personal web pages; single- and multi-player video games and game modifications (i.e., mods); online shopping rating systems; and the download of images, audio and video. Individuals who scored high on the DPI were likely to be classified as having the characteristics of digital natives as described by Prensky (2001a, b).

The DPI also collected demographic information about each participant to include socioeconomic status (measured as family annual income), age, gender and the number of computers found in the home. For example, participants chose from the responses, "less than $9,999," "$10,000–19,999," "$20,000–39,999," "$40,000–59,999," or "$60,000 or more" when answering the question, "my family's annual gross income is;" participants chose from the responses, "male," "female," or "transgender" when answering the question "my gender is;" and participants chose from the responses, "none at all," "1," "2," "3," or "4 or more" when answering the question, "I have the following number of computers in my home." All demographic information was self-reported by participants.

Factor analysis

The present study extends the work of Norman (2008) in that a factor analysis was conducted to determine if various items on the instrument were tied together conceptually. The analysis confirmed that certain items lined up in predictable ways according to concepts related to the study of ICT use and digital literacy among the sample. The maximum likelihood estimation procedure was used to extract the seven factors referred to throughout the present study which together explain 46% of all variable variances as illustrated in Table 1.

The solutions illustrated in Table 1 converged in 12 iterations where the Promax with Kaiser normalization rotation method was engaged. The factor categories which emerged along with associated variables and coefficients are listed in Table 2.

Reliability and validity

According to Norman (2008), the reliability of the DPI scoring was evaluated during two pilot studies. In the first, the DPI was mailed to Instructional Technology students at a large, metropolitan, public university in the southeastern portion of the U.S. Negatively

Table 1 Total variance explained

Factor	Initial eigenvalues		
	Total	% of variance	Cumulative%
1	5.643	13.437	13.437
2	5.113	12.174	25.610
3	2.247	5.349	30.906
4	1.938	4.615	35.574
5	1.627	3.874	39.448
6	1.421	3.382	42.831
7	1.376	3.276	46.107
8	1.320	3.142	49.249
9	1.181	2.812	52.061
10	1.135	2.703	54.764
11	1.077	2.565	57.330
12	1.002	2.385	59.714
13	.944	2.248	61.962
14	.911	2.168	64.130
15	.876	2.086	66.216
16	.821	1.955	68.171
17	.801	1.906	70.077
18	.789	1.880	71.957
19	.734	1.748	73.704
20	.705	1.678	75.382
21	.686	1.633	77.015
22	.678	1.613	78.628
23	.656	1.563	80.191
24	.631	1.503	81.694
25	.601	1.431	83.125
26	.586	1.395	84.520
27	.542	1.290	85.810
28	.534	1.272	87.082
29	.517	1.231	88.313
30	.507	1.206	89.519
31	.484	1.153	90.672
32	.442	1.053	91.725
33	.439	1.045	92.770
34	.432	1.028	93.797
35	.404	.963	94.761
36	.381	.908	95.669
37	.373	.888	96.557
38	.336	.801	97.358
39	.318	.757	98.115
40	.284	.676	98.791
41	.270	.643	99.435
42	.238	.565	100.000

Table 1 continued

Extraction sum of squares loadings			Rotation
Total	% of variance	Cumulative%	Total
5.062	12.053	12.053	4.438
4.524	10.772	22.825	3.845
1.666	3.966	26.791	3.124
1.216	3.895	29.686	2.755
.940	2.238	31.924	2.684
.698	1.661	33.585	2.423
.695	1.655	35.240	1.803

Note: Extraction method: maximum likelihood

Table 2 Factors with associated variables and coefficients

Factor	Variables	Coefficient
ICT use preferences	Download music from the Internet	.582
	Communicate using chat utilities	.564
	Programming language expertise	.537
	Download movies from the Internet	.532
	Download images from the Internet	.456
	Read/contribute to web blogs	.427
Internet use preferences	Use search engines	.714
	Use Internet resources for work/school	.655
	Use Internet resources for general interest	.613
	Use search engines for entertainment	.477
	Review online evaluations before purchasing online	.431
	Use a computer at work	.382
Gaming	Play video games	.752
	Play 2 + player video games	.658
	Use handheld gaming console	.504
	Customize video game characters	.382
	Play group games	.372
Online media activities	Download MP3 files from the Internet	.565
	Update personal web space/site	.512
	Share pictures online	.452
Digital communications	Manage online conversations	.674
	Communicate using instant messaging (2-way)	.614
	Socialize online	.508
ICT facilitated learning activities	Conduct group work using the Internet	.587
	Use the Internet to communicate with instructors/classmates	.556
	Share ideas and knowledge online	.295
	Use advanced search engine features	.329
ICT facilitated social/ economic activities	Arrange to meet new people online	.524
	Meet people online	.461
	Use PDA	.307
	Make online purchases	.289

Table 3 Reliability coefficients for each factor (scale)

Factor (scale)	Number of items	Reliability coefficient
ICT use preferences	6	.635
Internet use preferences	6	.639
Gaming	5	.744
Online media activities	3	.525
Digital communications	3	.770
ICT facilitated learning activities	4	.549
ICT facilitated social/economic activities	4	.524

correlated items and items with low correlations were removed. The scores from the DPI were determined to be reliable, with a Cronbach alpha of .858.

In the second pilot study (of which the present study findings are based) the DPI was distributed through the Internet using a random sampling of 1,980 undergraduate and 1,890 graduate students. Negatively correlated items and items with low correlations were removed. Again, the scores from the DPI were determined to be reliable, with a Cronbach alpha of .851 ($N = 580$). Unlike the first pilot study, a reliability analysis was conducted on the responses. In accordance with Norman (2008), responses for the various aspects of the DPI were determined to be reliable, with a reliability coefficient of .882 ($N = 284$). A further analysis of the corrected item-total correlation resulted in the removal of two questions related to the use of email and other communication devices. The removal of these items resulted in a reliability coefficient of .885. The negatively correlated and low correlation items removed during the two pilot studies are not included as part of the present study findings. Furthermore, the present study extends the Norman (2008) reliability data by presenting Cronbach's alpha coefficients for each of the seven constructs that emerged during the factor analysis. These are shown in Table 3.

Regarding validity, Norman (2008) noted that the DPI followed Prensky's (2001a, b) theory whereby the overall slope of the DPI score decreases as age increases. Thus, in the two pilot studies, those under the age of 30 scored, on average, 7.24 points higher on the DPI than those over 30.

Procedure

Participation was solicited by means of email. The email invitation included all pertinent information. Those deciding to participate completed the DPI on a website specializing in survey research and questionnaire dissemination. Upon accessing the DPI, participants were instructed to "Give the answer that *truly* applies to you and not what you would like to be true, or what you think others want to hear." Furthermore, participants were asked to "Think about each statement *by itself* and indicate how true it is. Do not be influenced by your answers to other statements." Participants were not required to answer all questions and could withdraw at any time.

Results

To examine the notion of how age, gender and socioeconomic status influence the use of ICT and digital literacy among the population accessed for the present study, a data analysis strategy using a series of correlations paired with determining the predictive capability of the DPI through multiple linear regression analysis was adopted. Variables associated with the constructs extracted during the factor analysis procedure were correlated with the age and family annual income demographic variables to determine the extent to which relationships existed between ICT use and those demographics. In addition, rank biserial correlations were computed to examine the extent to which gender influenced how individuals utilized ICT. Understanding the ability of the DPI to predict one's propensity toward using ICT will be helpful for further research and, therefore, a multiple regression analysis included two models (age + gender and age + gender + socioeconomic status) was conducted to determine how predictive of ICT use the DPI is in terms of age, gender and socioeconomic status demographics.

Demographics

Of the 580 participants, 68% reported being graduate students ($n = 395$) while 32% reported being undergraduate students ($n = 185$). A 52% majority of the participants reported an age in the range of 20–29 ($n = 279$); 37% of the participants were male ($n = 212$) while 45% of the participants were female ($n = 262$). In addition, 41% of participants reported family annual income at $60,000 or more ($n = 212$). Moreover, 30% of the participants reported having at least two computers in the home ($n = 157$) with approximately 36% of participants reporting at least two people living in the home ($n = 192$). Table 4 details the participants' demographics.

A series of Spearman's rho correlation coefficients were computed to evaluate whether significant relationships existed among variables associated with the various aspects of digital literacy and ICT use. Spearman's Rho was selected to conduct this analysis because it is appropriate to use with ordinal data such as that which was collected from the DPI. Variables from the questionnaire representing each aspect of digital literacy and ICT use under examination were paired with two of the demographic variables: Age and socioeconomic status (measured as family annual income). The gender demographic was examined with the same variables using the rank biserial correlation procedure because of its status as a nominal variable; its results are presented immediately following the age and socioeconomic status data in each sub-section. In addition to reviewing these correlations, the DPI's ability to predict propensity toward using ICT was examined through a multiple linear regression analysis. The alpha level was set to .05 for evaluation purposes. That is, p levels below .05 were considered significant enough to suggest a linear relationship between the comparison variables as well as the predictive capability of the DPI.

ICT use preferences

To examine any significant relationships among participants' ICT use preferences with age and family annual income, a series of Spearman's Rho correlation coefficients were computed. The variables under examination were: (a) Communicate using chat utilities, (b) Read/contribute to web blogs, (c) Download music from the Internet, (d) Download movies from the Internet, (e) Download images from the Internet and (f) Programming language expertise. In terms of age, only two of the variables in the ICT use preferences construct produced significant relationships: Download music from the Internet ($\rho = .115$) and download movies from the Internet ($\rho = .087$) suggesting that a participant's age relates to his or her propensity toward downloading media from the Internet. However, the effect sizes for the aforementioned correlations are small. In terms of family annual income, significant

Table 4 Participant demographics

Demographic	Number	Levels	Frequency	Percent	Median response
Family annual income	523	$0–$9,999	76	14.5	$40,000–$59,999
		$10,000–$19,999	53	10.1	
		$20,000–$39,999	93	17.8	
		$40,000–$59,999	89	17.0	
		$60,000 or more	212	40.5	
		Missing response/%total	57	100.0	
Number of computers in home	531	None at all	10	1.7	3
		1	132	24.9	
		2	157	29.6	
		3	113	21.3	
		4 or more	119	22.4	
		Missing response/%total	49	100.0	
Number of people in home	535	1	81	15.1	2
		2	192	35.9	
		3	121	22.6	
		4	89	16.6	
		5 or more	52	9.7	
		Missing response/%total	45	100.0	
Respondent age	538	50 and over	60	11.2	20–29
		40–49	49	9.1	
		30–39	90	16.7	
		20–29	279	51.9	
		0–20	60	11.2	
		Missing response/%total	42	100.0	
Respondent gender	476	Male	212	36.6	Female
		Female	262	45.2	
		Transgender	2	3.0	
		Missing response	104	14.3	
		%Total		100.0	
Graduate or undergraduate	580	Graduate	395	68.1	Graduate
		Undergraduate	185	31.9	
		Missing response/%total	0	100.0	

negative relationships were detected suggesting income level does not correlate to participants' ICT use preferences. Table 5 lists the correlation coefficients with effect sizes for each of the variables in this construct.

Gender had a small to moderate impact on ICT use preferences among the participants. Note that the data in Table 6 show female participants have an advantage in terms of number in the sample; however, the male participants' ranked means were higher than the female participants' ranked means on all variables in the construct. Gender explained approximately 36% of the variance in scores for programming language expertise ($\rho_{rb} = .367$) and download images from the Internet ($\rho_{rb} = .364$). However, gender differences were very small for the download music from the Internet ($\rho_{rb} = .098$),

Table 5 Correlations coefficients among the ICT use preferences and age/family annual income demographics

	Communicate using chat utilities	Read/ contribute to web blogs	Download music from the Internet	Download movies from the Internet	Download images from the Internet	Programming language expertise
Respondent age	−.026	.079	.115**	.087*	.068	−.036
Effect size	−.052	.159	.232	.175	.136	−.072
Family annual income	−.349**	−.248**	−.345**	−.261**	.051	−.242**
Effect size	−.745	−.534	−.735	−.541	.102	−.499

* Significant at the .01 level; ** significant at the .05 level

Table 6 Correlation coefficients among the ICT use preferences and gender demographic

	Mean ranks	*N*
Communicate using chat utilities (ρ_{rb})	.105	
Male	250	212
Female	225	261
Read/contribute to web blogs (ρ_{rb})	.126	
Male	253	210
Female	223	262
Download music from the Internet (ρ_{rb})	.098	
Male	250	212
Female	227	261
Download movies from the Internet (ρ_{rb})	.158	
Male	258	212
Female	220	261
Download images from the Internet (ρ_{rb})	.364	
Male	284	212
Female	198	260
Programming language expertise (ρ_{rb})	.367	
Male	283	210
Female	196	259

communicate using chat utilities ($\rho_{rb} = .105$), download movies from the Internet ($\rho_{rb} = .158$) and read/contribute to web blogs ($\rho_{rb} = .126$) variables. These small correlation coefficients indicate that gender does not have a practical impact on participants' ICT use preferences.

Internet use preferences

Correlation coefficients were computed to examine variables associated with the Internet use preferences factor and the respondent age and family annual income demographics. The variables examined in this construct were: (a) Review online evaluations before purchasing online, (b) Use Internet resources for work/school, (c) Use Internet resources

Table 7 Correlation coefficients among the Internet use preferences and age/family annual income demographics

	Review online evaluations before purchasing online	Use Internet resources for work/school	Use Internet resources for general interest	Use search engines	Use a computer at work	Use search engines for entertainment
Respondent age	.148**	.007	−.092*	.106*	−.149**	.144**
Effect size	.014	.014	−.185	.213	−.301	.291
Family annual income	.256**	.372**	.068	.319**	.134**	.100*
Effect size	.529	.801	.136	.673	.270	.201

* Significant at the .01 level; ** significant at the .05 level

for general interest, (d) Use search engines, (e) Use a computer at work and (f) Use search engines for entertainment. The correlation coefficients presented in Table 7 show that family annual income has more of an impact on the variables in this construct than does the respondent age variable.

Though statistical significance for the age demographic is shown in Table 7, the data also suggest that age does not have a practically significant impact on participants' Internet use preferences as evidenced by the low effect sizes reported. With regard to family annual income, there is a strong effect on Internet use in general; however, the impact is particularly strong for the review online evaluations before purchasing online ($\rho_{rb} = .256$), use Internet resources for work/school ($\rho_{rb} = .372$) and use search engines variables ($\rho_{rb} = .319$).

Participants' Internet use preferences were minimally impacted by gender as is shown by the data presented in Table 8.

The correlation coefficients produced for the variables included in the Internet use preferences construct were low, with the only appreciable figures emerging with the use search engines ($\rho_{rb} = .165$), review online evaluations before purchasing online ($\rho_{rb} = .166$) and use Internet resources for general interest ($\rho_{rb} = .152$) variables. Essentially, gender did not show any practical impact on Internet use preferences.

Gaming

Five variables associated with the gaming factor were correlated with the age, gender and family annual income demographics: (a) Play video games, (b) Play 2 + player video games, (c) Use handheld gaming console, (d) Customize video game characters and (e) Play group games. Though some statistically significant relationships were detected among these variables in both demographics, most did not show any appreciable effect size. Table 9 shows the correlations where the respondent age demographic produces a stronger impact than does the family annual income on the gaming variables.

The reader will note that data in Table 9 show that respondent age accounts for a relatively low percentage of DPI scores for the play video games ($\rho = .104$) and play 2 + player video games ($\rho = .123$) suggesting that for these participants, age does not have any practical significance in terms of digital gaming practices. In addition, the family annual income demographic produced negative correlations with the gaming variables suggesting no linear relationship between income and gaming practices.

Table 8 Correlation coefficients among the Internet use preferences and gender demographic

	Mean ranks	N
Review online evaluations before purchasing online (ρ_{rb})	.166	
Male	257	209
Female	218	261
Use Internet resources for work/school (ρ_{rb})	−.001	
Male	234	211
Female	238	261
Use Internet resources for general interest (ρ_{rb})	.152	
Male	257	211
Female	221	262
Use search engines (ρ_{rb})	.165	
Male	258	210
Female	219	262
Use a computer at work (ρ_{rb})	.070	
Male	243	209
Female	227	258
Use search engines for entertainment (ρ_{rb})	.110	
Male	251	211
Female	225	261

Table 9 Correlation coefficients among the gaming variables and age/family annual income demographics

	Play video games	Play 2 + player video games	Use handheld game console	Customize video game characters	Play group games
Respondent age	.104*	.123**	.057	.070	−.026
Effect size	.209	.248	.114	.140	−.052
Family annual income	−.071	−.128**	−.085	−.275**	−.395**
Effect size	−.142	−.258	−.171	−.572	−.859

* Significant at the .01 level; ** significant at the .05 level

Gender explains approximately 35% of the variance in scores on the play video game ($\rho_{rb} = .349$) and 30% of the variance in scores for the customize video game characters ($\rho_{rb} = .301$). In addition, approximately 21% of the variance in scores is explained by gender for the play 2 + player video games variable ($\rho_{rb} = .207$). However, the correlations between gender and the use handheld gaming console ($\rho_{rb} = .105$) and the play group games ($\rho_{rb} = .104$) variables are weak suggesting that gender does not have a strong impact on these aspects of the gaming factor. Table 10 displays the rank biserial correlation data for the gaming construct.

Online media activities

The online media activities factor included three variables: (a) Download MP3 files from the Internet, (b) Update personal web space/site and (c) Share pictures online. Both the respondent age and family annual income demographics produced significant correlations

Table 10 Correlation coefficients among the gaming variables and gender demographic

	Mean ranks	N
Play video games (ρ_{rb})	.349	
Male	280	208
Female	198	260
Play 2 + player video games (ρ_{rb})	.207	
Male	261	208
Female	212	259
Use handheld gaming console (ρ_{rb})	.105	
Male	247	209
Female	223	257
Customize video game characters (ρ_{rb})	.301	
Male	274	212
Female	204	259
Play group games (ρ_{rb})	.104	
Male	251	212
Female	226	262

Table 11 Correlation coefficients among the online media activities and age/family annual income demographics

	Download MP3 files from the Internet	Update personal web space/site	Share pictures online
Respondent age	.248**	.362**	.086*
Effect size	.512	.777	.173
Family annual income	.082	.055	.124**
Effect size	.165	.110	.249

* Significant at the .01 level; ** significant at the .05 level

among the variables for this factor. However, the respondent age demographic produced stronger relationships with the download MP3 files from the Internet ($\rho = .248$) and update personal web space/site ($\rho = .362$) variables than did the family annual income demographic. Table 11 details the correlation coefficients and effect sizes for variables included with this factor.

The reader will note that for the share pictures online variable, family annual income ($\rho = .124$) is more impactful than is respondent age ($\rho = .086$), but essentially, age is more closely associated with online media activities than is family annual income.

Gender did not have a strong impact on the variables in the online media activity factor, although gender did explain 22% of the variance in score for the download MP3 files from the Internet variable ($\rho_{rb} = .221$). The data in Table 12 shows that gender did not impact the update personal web space/site ($\rho_{rb} = -.037$) and share pictures online ($\rho_{rb} = -.063$) variables.

Digital communications

There were three variables included with the digital communications factor of the DPI: (a) Manage online conversations, (b) Communicate using instant messaging (2-way) and

Table 12 Correlation coefficients among the online media activities variables and gender demographic

	Mean ranks	N
Download MP3 files from the Internet (ρ_{rb})	.221	
Male	263	211
Female	211	257
Update personal web space/site (ρ_{rb})	−.037	
Male	227	212
Female	245	261
Share pictures online (ρ_{rb})	−.063	
Male	220	212
Female	250	260

Table 13 Correlation coefficients among the digital communications variables and age/family annual income

	Manage online conversations	Communicate using instant messaging (2-way)	Socialize online
Respondent age	.337**	.272**	.299**
Effect size	.716	.565	.627
Family annual income	−.018	−.145**	.016*
Effect size	−.036	−.293	.213

* Significant at the .01 level; ** significant at the .05 level

(c) Socialize online. Respondent age produced significant, positive correlations with the variables under examination with very strong effect sizes as shown in Table 13.

Respondent age and digital communications variables show strong correlations with very strong effect sizes which indicates that age impacted the participants' level of digital communications activities. Though statistically significant relationships were detected in terms of the family annual income variable, they were weak and not practically important. For example, there was a statistically significant relationship between family annual income and communicate using instant messaging (2-way). However, the relationship is negative indicating that the income and 2-way messaging variables move in opposite directions during the correlation procedure.

Gender did not have a strong impact on the digital communications factor explaining approximately 11% of the variance in scores for the communicate using instant messaging (2-way) variable ($\rho_{rb} = .105$). Table 14 displays the correlations between gender and the variables for the digital communications factor.

ICT facilitated learning activities

There were four variables included with the facilitate learning activities factor of the DPI: (a) Conduct group work using the Internet, (b) Use the Internet to communicate with instructor/classmates and (c) Share ideas and knowledge online and (d) Use advanced search engine features. Though statistically significant correlations were detected among these variables and the respondent age and family annual income demographics, they were

Table 14 Correlation coefficients among the digital communications variables and gender demographic

	Mean ranks	N
Manage online conversations (ρ_{rb})	.040	
Male	240	210
Female	230	258
Socialize online (ρ_{rb})	.013	
Male	238	211
Female	235	260
Communicate using instant messaging (2-way) (ρ_{rb})	.105	
Male	249	209
Female	224	261

Table 15 Correlation coefficients among the ICT facilitated learning activities and age/family annual income demographics

	Conduct group work using the Internet	Use the Internet to communicate with instructor/classmates	Share ideas and knowledge online	Use advanced search engine features
Respondent age	.058	−.124**	−.070	−.108*
Effect size	.116	−.249	−.140	−.217
Family annual income	−.005	−.234**	.112*	−.017
Effect size	−.010	−.481	.225	−.034

* Significant at the .01 level; ** significant at the .05 level

mostly negative and limited in terms of effect size. Table 15 displays the correlations for this construct.

The reader will note that there was a positive correlation detected between the family annual income and share ideas and knowledge online variables ($\rho = .112$), but the effect size was small. Gender was also negligible in terms of impact on the variables associated with the ICT facilitated learning activities factor. Though the female mean rank is higher than the male mean ranks for each variable in this factor, the correlation coefficients suggest that this difference does not have a strong impact on the variance in scores for each variable represented. Table 16 displays the correlation coefficients for the gender demographic with the variables from this construct.

ICT facilitated social/economic activities

The four variables associated with the social/economic activities factor were: (a) Arrange to meet new people online, (b) Meet people online, (c) Use PDA and (d) Make online purchases. Age did not have any practical impact on variables associated with the social/economic activities factor. The family annual income correlations with the use PDA and make online purchases variables produced significant correlations with moderate effect sizes indicating that income is impactful in terms of these activities. Table 17 displays the correlation coefficients along with effect sizes for this factor.

Table 16 Correlation coefficients among the ICT facilitated learning activities variables and the gender demographic

	Mean ranks	*N*
Conduct group work using the Internet (ρ_{rb})	−.029	
Male	228	210
Female	242	260
Use the Internet to communicate with instructor/classmates (ρ_{rb})	−.105	
Male	208	207
Female	257	262
Share ideas and knowledge online (ρ_{rb})	−.041	
Male	226	211
Female	245	261
Use advanced search engine features	.103	
Male	247	209
Female	224	258

Table 17 Correlation coefficients among the ICT facilitated social/economic activities variables and age/family annual income demographics

	Arrange to meet new people online	Meet people online	Use PDA	Make online purchases
Respondent age	.040	.016	−.162**	−.059
Effect size	.080	.032	−.328	−.118
Family annual income	−.097	.032	.157**	.204**
Effect size	−.195	.064	.318	.417

** Significant at the .05 level

Gender was negligible in terms of explaining variance in score for the ICT facilitated social/economic activities factor though gender did explain 16% of the variance in score for the meet people online ($\rho_{rb} = .162$) and 10% of the make online purchases ($\rho_{rb} = .102$) variables. Table 18 displays correlation data for these variables.

Predicting digital propensity

A multiple linear regression (MLR) analysis with two unordered sets of predictors was conducted to evaluate the capability of the DPI to predict propensity toward ICT use. The random effects model approach to MLR was used since the present study is non-experimental, survey research. Two models were tested during the analysis. One model in the MLR analysis examined two demographic characteristics as predictors of digital propensity: age and gender. A second model in the MLR examined socioeconomic status as predictor of digital propensity using the family annual income and number of computers in home variables in concert with the age and gender variables. The mean DPI score for survey respondents was 94.4 with a standard deviation of 15.64 ($N = 512$). The DPI score was the dependent variable and the data met the normality assumption where the data were skewed left (skewness = −1.23); scores were concentrated between 70 and 120. The data were slightly leptokurtic (kurtosis = 2.78) but still reflected a normal variance in terms of deviation from the mean per score. In addition, the data represented randomly sampled cases from

Table 18 Correlation coefficients among the ICT facilitated social/economic activities variables and gender demographic

	Mean ranks	*N*
Arrange to meet new people online (ρ_{rb})	.088	
Male	248	212
Female	227	260
Meet people online (ρ_{rb})	.162	
Male	257	210
Female	219	261
Use PDA (ρ_{rb})	.082	
Male	244	209
Female	226	258
Make online purchases (ρ_{rb})	.102	
Male	250	212
Female	226	261

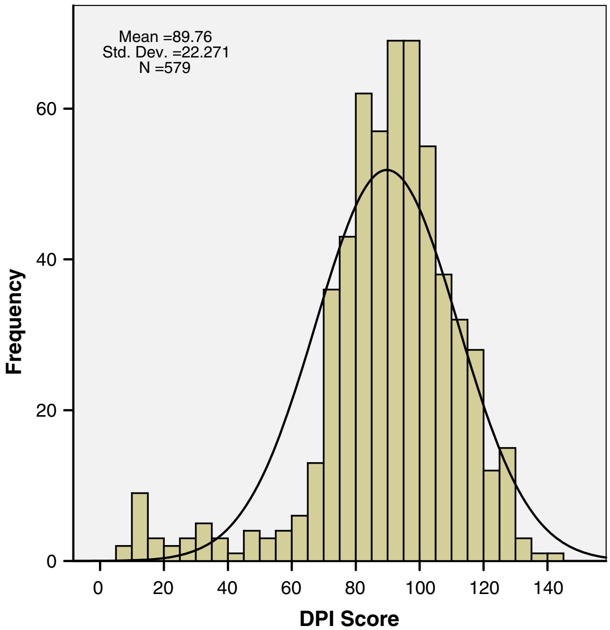

Fig. 1 Normal distribution of DPI scores

the population where the scores on variables were independent of other scores on the same variables. Figure 1 illustrates the distribution of DPI scores.

The regression analysis examining the age and gender variables was significant, $R^2 = .16$, adjusted $R^2 = .15$, $F(6, 445) = 14.2$, $p < .01$. In addition, the regression analysis examining the socioeconomic status with age and gender variables was also significant, $R^2 = .31$, adjusted $R^2 = .29$, $F(14, 437) = 14.1$, $p < .01$. These results suggest that age, gender and socioeconomic status demographics all make a statistically significant contribution to an individual's propensity toward ICT utilization. The variables accounted for 15% (age and gender) and 29% (age, gender and socioeconomic status) of the variance in DPI score, respectively. The R^2 change for each model was .16, $F(6, 445) = 14.2$, $p < .01$ (age and gender model) and .15, $F(8, 437)$ 11.96, $p < .01$ (age, gender and

Table 19 Correlations and partial correlations of digital propensity predictors with *t*-statistic

Predictors	Correlation between each predictor and DPI score	Correlation between each predictor and DPI score controlling for all other predictors	*t*-Statistic	*p*-Value
New age 1	−.18	−.23	−4.22	<.01
New age 2	−.12	−.14	−3.24	<.01
New age 3	−.12	−.10	−3.24	<.01
New age 4	.24	.03	−3.30	<.01
New gender 1	.25	.02	−.447	>.05
New gender 2	.25	−.02	.351	>.05
New annual income 1	.004	−.001	−.015	>.05
New annual income 2	−.02	−.05	−1.062	>.05
New annual income 3	.03	−.004	−.094	>.05
New annual income 4	−.05	−.07	−1.41	>.05
New num of computers 1	−.02	−.13	−2.63	<.01
New num of computers 2	−.29	−.40	−9.19	<.01
New num of computers 3	−.03	−.28	−6.04	<.01
New num of computers 4	.06	−.19	−4.12	<.01

socioeconomic status model). The R^2 change statistics indicated that each of the predictor variables makes a similar contribution to the variance in DPI score, suggesting that digital propensity is impacted by multiple demographic factors.

Examining the correlations in Table 19 of each predictor with DPI score and against other predictor in each model reveals age and number of computers in the home to be most predictive of digital propensity. The *p*-values for the age and number of computers in the home variables are <.01 whereas the *p*-values for the gender and family annual income variables are >.05.

The statistics in Table 19 suggest that one aspect of the participants' socioeconomic status impacted digital propensity (i.e., number of computers in the home) over and above the other socioeconomic status variable (i.e., family annual income) as evidenced by the *p*-values. Likewise, age impacted participants' digital propensity over and above gender again, as evidenced by the *p*-values. The regression model considering each of the demographic predictors was also significant, $R^2 = .31$, adjusted $R^2 = .29$, $F(14, 437) = 14.13$.

Figure 2 illustrates the DPI scores in terms of the multiple-regression analysis where all predictors were included and shows the standardized predicted value and standardized residuals. The multiple-regression analysis results suggest that age and number of computers in the home contributed significantly to predicting digital propensity over and above gender and family annual income but that the MLR did not provide a practically reliable model for predicting digital propensity.

Discussion

The results presented here extend the work of Kennedy et al. (2008), Kvavik et al. (2004) and others by identifying factors contributing to ICT use by students. Indeed, the survey analysis results confirm that a combination of factors explains an individual's propensity

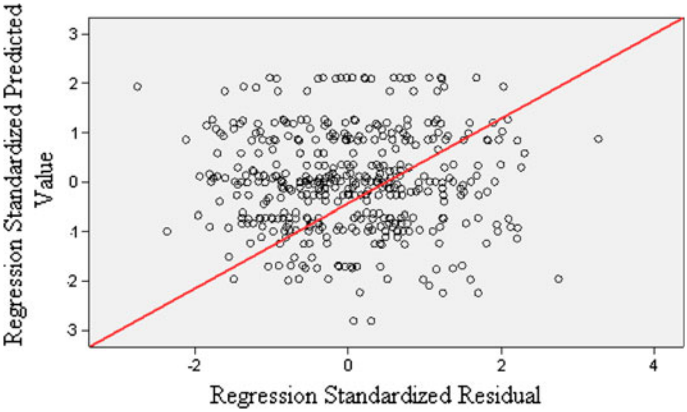

Fig. 2 Scatterplot: DPI scores by standardized predicted value and standardized residual

toward ICT use as evidenced by the MLR indicating that age, gender and socioeconomic status together account for approximately 30% of DPI scores.

We agree with those such as Selwyn (2009) who have adopted a healthy balance between unreserved accord and skepticism with regard to today's technology confident youth. While we are suspicious of the strong claims favoring a generation of radically different learners from that of past generations, we concede that today's youth have been exposed to technologies never before seen. Educational policy-makers must, therefore, consider data-driven evidence showing who these students are in total when developing ICT policy. The criticisms of the claim made that students are much more adept at all things digital are borne out by the findings presented here. Although significant correlations were detected among age and variables related to survey respondents' digital communications and online media activities, age did not make a strong contribution to the other factors identified in the present study. Moreover, the MLR analysis determined that age and gender together accounted for only 15% of the total number of DPI scores, suggesting that age accounted for less than 15% of those scores.

The data reported herein raise a range of implications for institutions training preservice teachers, curriculum developers designing instructional materials and educational leaders developing ICT policy for schools. We review these implications in terms of digital propensity through the prisms of age, gender and socioeconomic status.

Digital propensity

The results suggest that age, gender and socioeconomic status together make a significant contribution toward one's digital propensity. Thus, the MLR showed that, when combined, these demographics account for about 30% of DPI scores. It is important, therefore, that educators, curriculum developers and educational policy-makers consider these demographics carefully when planning ICT use for today's students. Moreover, there are important implications to consider about each demographic examined here.

Age

Age is an important factor in an individual's propensity toward ICT use. The results showed that age shared statistically significant correlations with 18 variables included in the factors extracted for this analysis, but there was no statistically significant relationship with 13 variables from the analysis. This balance suggests that age is a factor in ICT use but that it is not the most important predictor of one's digital propensity.

Clearly, those developing ICT-rich curricula should not focus solely upon age when determining an approach to development efforts, but age should be considered when efforts to include digital gaming and communications as well as online media activity are part of courseware design. For example, virtual societies (i.e., SecondLife, etc.), should be seriously explored as a part of curriculum development because of their potential to appeal those in the 20–29 age demographic. Bear in mind that Salaway et al. (2008) found that age is the single most important factor with regard to usage and perception of social networking activities, but not a significant factor for other uses. Close examination of various correlations support the MLR showing that age accounts for less than 15% of DPI scores. That is, more robust and meaningful uses of ICT are not explained by relationships to age.

Essentially, age as the sole determinant of digital literacy is not supported. In fact, many of the characteristics identified as age-dependent in terms of ICT use do not share significant relationships with age. Therefore, we contend that although age should be considered when designing instructional materials that incorporate ICT and developing educational policy regarding ICT use, age should not account for the major share of the decision-making paradigm.

Gender

Like the age variable, the gender variable explained less than 15% of DPI scores. Once again, when the rank biserial correlation tables are examined, variables producing strong coefficients appear across the ICT use preferences and gaming constructs. Aside from strong correlations among a few variables within those two constructs, gender does not show a strong relationship with the other factors.

Results of data analyzed through the gender lens are hint that the gender gap in terms of ICT use may be closing. That is, it is possible that on either end of the gender spectrum, ICT use may be improving or decaying. It is entirely possible that female's ICT use skills may be improving or that male's ICT use skills may be decaying. However, more research is needed to substantiate such claims.

Researchers and educators alike should take into consideration the very low percentage of scores explained by the gender demographic on most of the variables in each factor examined. These results support findings from Salaway et al. (2008) who found few gender differences, reporting that males and females had similar skill levels across most applications. The results of the present study show that though gender is important, it is not a factor that makes a strong contribution to an individual's digital propensity.

Socioeconomic status

The MLR showed that age and gender explains 16% of the variance in DPI scores for participants while all predictors explained approximately 30% of the variance in DPI scores. However, upon examining the correlation tables, 20 statistically significant correlations emerged between the family annual income and the comparison variables whereas 11 variables showed no relationship. As with the age comparisons, this balance suggests that socioeconomic status is not the most important predictor of one's digital propensity. Moreover, the coefficients table from the MLR analysis showed that age and number of the computers in the home contribute to digital propensity over and above the other predictors. In practical terms, these findings support the assertion of the researchers referenced in the literature review of the present study. That is, the participants had access to ICT but use them in limited ways. For example, the correlation data showed that participants used ICT for entertainment over and above facilitating learning activities. Of the 20 significant relationships detected with the family annual income variable, 10 are negative correlations. Some of these negative correlations suggest that as family annual income increases, interest in things like reading/contributing to web blogs, using the Internet to communicate with instructors/classmates and customize video game characters does not increase as well. Clearly, access to ICT equipment alone does not suggest proficiency with ICT utilities or rate of ICT use. It is possible that as income increases among the participants, the novelty of ICT access is less impactful on use habits. This finding is a potential indicator that gaps between socioeconomic groups may be closing in terms of ICT use. However, more research is needed to substantiate such claims.

It is clear that although family annual income impacts one's ability to select from and use a variety of digital media, it does not appear to be a determining factor in the activities in which one engages using ICT. That is, there was no relationship between the family annual income variable and the variables meet people online, download MP3 files and download images among others. These relationships suggest that schools offering consumer economics and similar courses should consider including content in curricula which addresses the robust and complex nature of the online economy. The idea here is that schools should seek to provide online economy experiences to students in low socioeconomic categories because student of this status are less likely to have access to such experiences though they have experience using ICT for other purposes. Indeed, because socioeconomic status impacts the rate at which students access various forms of ICT, schools and educational policy-makers should provide more opportunities for students in low socioeconomic categories to practice digital literacy skills with a variety of ICT across the curriculum.

As ICT-like personal digital assistants (e.g., PDAs), Internet-capable cell phones and Internet-connected gaming consoles blur the lines between uses of ICT devices, students from low socioeconomic categories will need the advantage of ICT use in school to be competitive with their wealthier counterparts later in college and in the job market. The results of the present study show that as family annual income increases, access to information via ICT increases as well.

Limitations

There are a number of methodological limitations. First and foremost, although the DPI has undergone two pilot studies to examine its reliability as an index, it may not truly reflect an individual's skill and knowledge regarding use of ICT. Therefore, additional study investigating its reliability and validity is necessary. The DPI was conceived in 2005; consequently, the DPI does not capture technologies which may have gained popularity in recent years. This means that more work is needed to improve the instrument which may increase its ability to predict digital propensity. Moreover, an improved DPI may improve how the factors identified through this analysis are measured. Further, the population sampled was restricted to post-secondary students from one, public university and the undergraduate response rate was not representative of the total sample. Generalizations outside of this population are, therefore, difficult. In addition, the DPI was administered online as opposed to using pencil and paper. The online venue may have discouraged those with low digital propensity from completing the 50-item questionnaire. At the same time, the internal validity of the DPI may have been threatened by the email-based recruitment strategy. Students who did not use email would not have participated and, therefore, were likely to be excluded from the population sampled for the present study. Also, since the DPI was accessed over the Internet, it is unknown if outside influences may have affected participant responses. Individual participant environments could not be controlled.

There is also the problematic issue of using a survey to solicit responses. Although the DPI clearly states that participants should give answers that truly apply to them and not what they might like to be true or what others might want to hear, there is the concern that participants still provided responses they felt were socially desirable. Additionally, many of the correlations presented in the results section were small with small effect sizes; this is an overarching issue in the present study. Finally, there is the problematic matter of the demographic variables. For example, what does family annual income mean? It may be different for a young college freshman who has parental financial support as opposed to an older graduate student who does not. The questionnaire did not account for such variations.

Future directions

The results of the present study along with the limitations noted combine to call for additional research on many fronts regarding digital literacy and propensity toward ICT use. Firstly, the DPI should undergo additional reliability study with a more diverse sample of the population under consideration as previously mentioned. Clearly, the factor and MLR analyses indicate that further research is necessary to determine the other factors contributing toward digital propensity in students. Indeed, because the factor analysis produced constructs explaining less than 50% of the variance in DPI scores and the MLR produced an explanation of approximately 30% of the variance in DPI scores, additional research on and development of the DPI is warranted. However, other interesting subjects emerged as a result of this analysis.

Because correlations show that survey respondents engage in social uses of ICT over and above academic uses of ICT, additional research is needed to determine how to increase students' proficiency with ICT use in educational contexts for pedagogical goals. Related to this is the need for additional research into digital literacy with school aged and undergraduate populations. The digital literacy domain also presents an opportunity to explore how low rates of digital literacy impact employability. In addition, researchers, educators and educational policy-makers need research which helps them to understand what actually motivates people to use various ICT devices and services. It is also important for researchers to examine the similarities and differences between traditional literacy rates and digital literacy rates and how they each compete with and complement each other.

The findings also opened a discussion of how the gender gap may be impacted in terms of ICT use practices. That the frequency of and reason for ICT use among males and females may be coming closer together has broad implications for educational and workplace settings. In addition to the potential impact on the gender gap paradigm where ICT use is concerned, the data has shown that the socioeconomic gap may also be impacted. That is, correlations between family's annual income and certain ICT use indicators do not show a positive or statistically significant relationship. Results indicate that family's annual income does not, practically speaking, impact one's interest in and abilities with various ICT-related activities. Therefore, investigating the impact of high access to ICT equipment over time is warranted and would be useful for those developing ICT policy for young people. In terms of the literature reviewed which led to the present study, these results support the notion that those developing ICT use policy in schools should address concrete skills associated with critical thinking and digital literacy. Moreover, those developing ICT policy and curriculum should endeavor to provide ICT experiences related to the multiple factors associated with ICT use among young people.

Scholars, policy-makers and educators are just beginning to crystallize the impacts of ICT use on literacy among young people. Specifically, digital literacy involves, among others, the topics engaged during the present study: ICT use preferences, Internet use preferences, gaming, online media activities, digital communications, ICT facilitated learning activities and ICT facilitated social/economic activities. It is essential for those working with young people to continue evolving ICT implementation paradigms that incorporate all of the factors contributing to how individuals use ICT.

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