COMPUTER LITERACY SKILLS OF NET GENERATION LEARNERS

A Dissertation

by

CHRISTOPHER MICHAEL DUKE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2011

Major Subject: Educational Psychology

Computer Literacy Skills of Net Generation Learners

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Approved by:

Co-Chairs of Committee, Lauren Cifuentes
Ernest Goetz
Committee Members, Ronald Zellner
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ABSTRACT

Computer Literacy Skills of Net Generation Learners. (May 2011)

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Dr. Ernest Goetz

Younger learners are widely considered to be technologically savvy and computer literate because of their lifelong exposure to ubiquitous technology. Educators often rely on that assumption to justify changes to institutional curricula, technology initiatives, new classroom strategies, and calls for educators to meet the educational demands of the younger generation. This study examines the computer literacy skills of Net Generation Learners (NGLs).

This dissertation is composed of a systematic literature review, an examination of learner computer literacy skills prior to completing a college level course, and an investigation of the effects of different types of instruction on learner computer literacy skills. In the systematic literature review, identified studies focused primarily on learner familiarity with emerging technologies and relied heavily on self-reported data. Few studies directly measured learner computer literacy skills, and none compared the skills of NGLs and non-NGLs.

A causal-comparative examination of learner computer literacy skills prior to a college level computer literacy course found that both NGLs and non-NGLs exhibited inadequate computer literacy skill. A 1-way ANOVA indicated NGLs performed significantly better than non-NGLs on a computer literacy skills assessment; however, examining learner age as a continuous variable via regression yielded different results. There may be validity to claims regarding the comparative computer proficiency of NGLs to non-NGLs, but the level of skill exhibited by learners does not warrant calls for radical educational changes, and the imprecision of arbitrarily defining age as a dichotomous variable produces potentially erroneous results.

The effect of type of instruction on learner computer literacy skills was explored. Based on the results in this study, direct instruction focused on a comprehensive scope of computer literacy skills better supports learner acquisition of skills than does informal instruction or instruction focused on a limited range of skills. Future research should use statistical methods that analyze age as a continuous variable while continuing to examine directly the comparative computer literacy skills of NGLs and non-NGLs at all levels of education. Further inquiry into the effectiveness of different types of instruction to support learner acquisition of computer literacy skills should also be conducted.

DEDICATION

This dissertation is dedicated to . . .

MY WIFE and BEST FRIEND, Misty. Thank you for supporting my pursuit of this degree. There were many times you had to "hold down the fort" at home while I attended classes, studied, or worked on research projects. You patiently listened to far too many rants and gracefully provided a sense of balance and perspective. Words cannot express my appreciation for your unconditional love, support, and patience. This would not have been possible or worthwhile without you. We're done! ILUX4.

MY DAUGHTERS, Kaylee, Abigayle, and Madalynn. First, Daddy's DONE! You will never again hear the words, "Daddy needs to work on his dissertation." It's play time! Second, you motivate, inspire and make me prouder than you may ever imagine. The pride I have in this accomplishment pales in comparison to the opportunity to watch you each learn and grow into strong, intelligent young women. I hope you will always remember to ask yourself, "What did I learn today?"

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I also want to thank colleagues and friends at San Jacinto College that inspired, encouraged, and supported my efforts. You routinely expressed a sincere interest in my progress and success, and you directly supported my research by allowing me into your classrooms and by facilitating data collection sessions. I owe some measure of my success to the San Jac family.

Finally, I sincerely appreciate the everlasting support of family, friends, teachers, colleagues and mentors that provided inspiration and support as I have worked toward this goal. I am extremely aware of how fortunate I have been to be surrounded by brilliant, caring individuals at every step of my education and career. Thank you.

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CHAPTER I

INTRODUCTION

A great deal of rhetoric scattered throughout contemporary educational literature, publications, and news stories describes today's younger learners as inherently computer literate, with fundamentally different attitudes toward and habits when using computer technology than the previous generation. The younger generation (often defined as those who were born after 1980) has been categorized and labeled, at various times, as the Net Generation, millennials, and digital natives (Howe & Strauss, 2000; Prensky, 2001b, 2001b; Tapscott, 2008). According to proponents, Net Generation Learners (NGLs) have grown up with access to computer technology, and they "all have the skills to use those technologies" (Palfrey & Gasser, 2008, p. 1). NGLs' exposure to and ability to use technology has shaped their minds differently from preceding generations; this younger generation possesses a distinctly different learning style from their predecessors (Brown, 2005; Frand, 2000; Prensky, 2001a; Tapscott, 2008). They are "not the people our system was designed to teach" (Prensky, 2001a, para. 2).

Despite a general lack of empirical evidence justifying claims regarding Net Generation Learners, the rhetoric surrounding the argument may be contributing to policy decisions at all levels of education. The technologically adept and computer literate "digital native" exists independently within mainstream consciousness and is often cited as a reason to implement a new technology or to advocate sweeping changes

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This dissertation follows the style of *Journal of Information Technology Education*.

in curriculum and teaching methods. For example, Sheryl Abshire, chief technology officer for a school system in Lake Charles, Louisiana, commented as justification for a digital textbook initiative, “Kids are wired differently these days. They’re digitally nimble. They multitask, transpose and extrapolate” (Lewin, 2009, p. 5). Further, instances exist of computer literacy skills courses being removed from higher education curriculum given that incoming college freshmen, and Net Generation Learners, already possess the requisite computer literacy skills (Baugh, 2004). Ultimately, claims are regularly made that education must “evolve to meet the needs” of inherently computer literate Net Generation Learners who “are redefining the landscape in higher education” (Hartman, Moskal, & Dziuban, 2005; Khalid, 2008).

In addition to policy decisions, the rhetoric may be reinforcing assumptions learners and faculty make regarding learners’ actual computer literacy skill levels. A number of studies suggest learners and/or faculty overestimate the actual computer literacy skills possessed by learners (Ballantine, McCourt Larres, & Oyelere, 2007; Hilberg & Meiselwitz, 2008; Kvavik, Caruso, & Morgan, 2004; McCourt Larres, Ballantine, & Whittington, 2003; Stone, Hoffman, Madigan, & Vance, 2006); the mismatch between learners’ expectations with their actual skill levels may put learners behind the expected learning curve regarding the technology used for a course. Hilberg and Meiselwitz (2008) found significant discrepancies between learner perceptions and learner actual skill level; most students (73%) overestimated their computer literacy skill. It is important for academia and learners to better understand learners’ actual computer literacy skill level.

This dissertation was comprised of three different studies focused on examining the validity of claims regarding the computer literacy skills of Net Generation Learners. The three studies are presented in Chapters II, III and IV, and are followed by a synthesis of the research with further conclusions in Chapter V.

A critical, systematic review of the literature on computer literacy skills of Net Generation Learners is presented in Chapter II. The review focused on synthesizing current research, evaluating the body of literature, and offering recommendations for future research focused on NGLs' technology skills (Creswell, 2008). Prior literature reviews in the field have summarized quantitative studies regarding NGLs (Horwath & Williamson, 2009; Pedro, 2009) or taken a critical view of the rhetoric used by NGL proponents (Stoerger, 2009). Bennett, Maton and Kervin (2008) challenged the rhetoric of NGL proponents as "moral panic" and emphasized the lack of empirical evidence to support NGL claims. The review here expands and updates their work. In addition to synthesizing and summarizing current NGL research, the review will identify and examine the constructs and the designs and methods used to measure them. The literature review will provide educators greater clarity of what it means to argue that "NGLs are tech-savvy" or "computer literate" and suggests future research to contribute to understanding the technology skills of NGLs.

Chapter III presents a mixed-method, causal-comparative study examining the effect of learner age on learner computer literacy skill and the relationship between learner self-assessment of computer literacy skill and learner actual computer literacy skills. Two research questions were investigated.

1. What is the relationship between learners' actual performance on the Internet and Core Computing Certification Fast Track exam prior to beginning a college level computer literacy course and learner self-assessment of their computer literacy skills as measured by the Learner Computer Literacy Self-Assessment?

2. What is the relationship between learner age and learner computer literacy skills prior to beginning a college level computer literacy course?

   a. What is the relationship between learner age, as a continuous variable, and learners' score on the IC^3FT exam?

   b. What is the difference between Net Generation Learners' (born after 1980) and non-Net Generation Learners' (born prior to 1981) scores on the IC^3FT exam?

The study directly measured and compared NGL and non-NGL community college students' performance on a validated computer literacy skills assessment and their self-assessment of computer literacy skill on a researcher-developed instrument aligned to IC^3 objectives. Learner age was analyzed as both a categorical and as a continuous variable, and learner explanations of skills they did or did not possess were qualitatively examined.

Chapter IV presents a causal comparative study that directly measured and compared, in a community college environment, NGL and non-NGL performance on a pretest to posttest administration of a validated computer literacy skills assessment. Three research questions were examined.

1. What is the relationship between learner age and learner computer literacy skills after completing a college level computer literacy course?

    a. What is the relationship between learner age, as a continuous variable, and learner's score on the IC3FT exam after completing a college level computer literacy course?

    b. What is the difference between Net Generation Learners' and Non-Net Generation Learners' scores on the IC3FT exam after completing a college level computer literacy course?

2. What is the difference between learners completing courses that employ comprehensive-formal computer literacy instruction, limited-formal computer literacy instruction, and informal computer literacy instruction on scores on the IC3FT exam?

3. What is the differential effect of the three types of instruction in computer literacy courses for Net Generation Learners and non-Net Generation Learners as measured by the IC3FT?

The study first addressed the effect of learner age, as a categorical and as a continuous variable, on learner computer literacy skill and then focused on the manner and efficiency by which learners acquire computer literacy skills in formal and informal learning environments.

Chapter V summarizes the findings of the three studies conducted and synthesizes the results. The implications of the combined effect and limitations of the three studies are discussed and suggestions regarding the direction of future research are made.

The purpose of this dissertation is to address identified gaps in the literature. First, learner computer literacy skills were examined using an established operational definition of computer literacy relevant to academic and workplace environments. Second, a valid and reliable computer literacy skills assessment instrument was used to evaluate learner computer literacy skills. Third, a pretest/posttest design was employed to allow inferences regarding actual learner computer literacy skills and how learners may acquire those skills. Finally, this study was conducted in a community college environment, a setting largely underserved within existing literature.

By addressing the noted gaps in existing literature, educators will know more about how prepared community college learners are to use computing technology typically used in academic and workplace environments. This focus and the results will be more relevant to faculty and institutions than current literature that focuses more on learner use of emerging technologies and learner self assessment. Also, community colleges and faculty may be able to draw inferences regarding the computer skills of students in their institutions depending upon the similarity of their student population to the study's sample. The study provides methods and procedures by which the study may be replicated by other community colleges needing to assess the readiness of local students.

The researcher hopes to make two unique contributions to the literature. Learner age will be examined both as a categorical and as a continuous variable to determine if the relationship between learner age and computer literacy skills may be better described; this contrasts with current Net Generation Learner literature that focuses on learner age as a dichotomous categorical variable. Further, this study compares the effects of three approaches by which learners may acquire computer literacy skills; the results may suggest a particular, curricular approach not currently used by some institutions.

CHAPTER II

REVIEW OF LITERATURE ON NET GENERATION LEARNERS

A great deal of rhetoric scattered throughout contemporary educational literature, publications, and news stories describes today's younger learners, born after 1980, as inherently tech-savvy. Because of their purported fundamentally different attitudes toward and habits when using computer technology, they have been categorized and labeled, at various times, as Net Generation Learners (Howe & Strauss, 2000), millennials (Tapscott, 2008), new millennium learners (Pedro, 2006), and digital natives (Prensky, 2001a). According to proponents, Net Generation Learners (NGLs), the term used in this report, have grown up with access to computer technology, and they "all have the skills to use those technologies" (Palfrey & Gasser, 2008, p. 1). NGLs' exposure to and ability to use technology has shaped their minds differently from preceding generations; this younger generation possesses a distinctly different learning style from their predecessors (Brown, 2005; Frand, 2000; Prensky, 2001b; Tapscott, 2008). They are "not the people our system was designed to teach" (Prensky, 2001b, p. para 2).

The rhetoric surrounding the argument may be contributing to policy decisions at all levels of education. The technologically adept and computer literate "digital native" exists independently within mainstream consciousness and is often cited as a reason to implement a new technology or to advocate sweeping changes in curriculum and teaching methods. For example, Sheryl Abshire, chief technology officer for a school system in Lake Charles, Louisiana, commented as justification for a digital textbook initiative, “Kids are wired differently these days. They’re digitally nimble. They multitask, transpose and extrapolate” (Lewin, 2009, para. 5). Further, computer literacy skills courses are being removed from higher education curriculum based on the assumption that incoming college freshmen, and NGLs, already possess the requisite computer literacy skills (Baugh, 2004). Ultimately, claims are regularly made that education must “evolve to meet the needs” of inherently computer literate NGLs who “are redefining the landscape in higher education” (Hartman et al., 2005; Khalid, 2008).

The discourse surrounding the NGL has been described as “an academic form of moral panic” (Bennett et al., 2008, p. 782). According to Bennett et al., the generalizations about the NGLs focus on the technically adept members of the cohort to emphasize and reify differences between this and previous generational groups while a number of factors have yet to be meaningfully investigated. The discourse focuses on the portrayal of the younger generation as having different values, norms or tendencies than the generations before it yet little or no empirical data supports those claims. Critical inquiry and evaluation is necessary to make progress within the literature and discussion.

Purpose and Contributions of This Review

The purpose of this article is to critically and systematically review current research focused on the technology skills of NGLs. The current review focuses on synthesizing current research, evaluating the body of literature, and offering recommendations for future research focused on NGLs’ technology skills (Creswell, 2008). This review of literature is significant in three ways. First, this review synthesizes and summarizes current NGL research; it offers educators an understanding of NGL technology skills given current empirical research. Second, the review addresses the literature from a new perspective, identifying and examining the constructs and the manner in which they were measured by research offers educators greater clarity of what it means to argue that "NGLs are tech-savvy" or "computer literate." Third, the critical analysis of research designs and methods used by researchers who conducted such studies raises issues and suggests the need for future studies which may contribute to the body of knowledge regarding the technology skills of NGLs.

Method

To identify potentially relevant literature, a range of search strategies were employed. First, an initial, broad keyword search was conducted via Google Scholar for articles spanning 2000 to 2009 including keywords *computer literacy education*. Second, phrasal keyword searches were conducted in education related databases for the phrases *digital natives*, *net generation*, *millennial,* and *computer literacy*; databases searched included Academic Search Complete (EBSCO), Education Full Text (Wilson), Proquest Dissertations and Theses, and PsycINFO (CSA). Second, informal notes and comments published by other, noted researchers in the field were often consulted to identify additional and more recently published studies; for example, Mark Bullen's blog *Net Gen Skeptic* provides a "balanced exploration of research and commentary on generational differences, particularly the Net Generation discourse and impacts on learning, teaching and the use of technology" (2010). Third, during the review of identified literature, the "snowball" method was used in which articles cited by those reviewed were collected for review and consideration for inclusion in this analysis. Fourth, after reviewing much of the resulting literature, an update search was conducted within Google Scholar social sciences resources using Boolean search operators: *native or millennial or generation AND ("information literacy" OR "computer literacy" OR literacy)* and a broader search for articles published *in 2010* containing the phrase *"digital native*." The full search process yielded in excess of 3,200 possible articles for which abstracts or summaries were at least briefly evaluated for inclusion in the review.

Given a widely acknowledged need for empirically-based research regarding the technological skill of NGLs (Bennett et al., 2008; Hilberg, 2008; Kennedy et al., 2007, 2006; Kennedy, Gray, & Tse, 2008a; Margaryan & Littlejohn, 2008; Pedro, 2009; Reeves & Oh, 2007; Selwyn, 2009; Tesch, Murphy, & Crable, 2006; Thinyane, 2010) this review focuses on reports of original, empirical research regarding the technology skills of learners. The selection criterion resulted in 279 articles that were submitted for more in-depth evaluation. Upon further inspection, 227 articles were removed from the review because they presented secondary reports, literature reviews, theoretical frameworks, or policy and practice opinions; some were retained as theoretical reference and background to inform this review and subsequent research. The final review included 52 articles that reported results of empirical research focused on the technological skill of NGLs.

The unit of analysis was an individual article or report. To analyze current literature, the constant comparative method described by Lincoln and Guba (1985) was used in concert with a semi-open coding process similar to the process employed and described by Hew (2009). With an emphasis on the manner in which the NGL phenomenon has been investigated, the review began with a focus on the construct being measured, the design of inquiry, the instruments for data collection, and the context in which research was conducted. Within each element of the study, coding themes were not predetermined prior to beginning the review of selected literature; instead, specific codes emerged based upon the data. The first article reviewed was assigned a theme for each aspect of the study: construct, design, instrument, and context. For example, Kennedy et al. (2007) was noted as focusing on the technology use patterns of students using a descriptive design that relied on focus groups, interviews, and surveys to collect data from students in an Australian four year institution. Subsequent articles were examined, compared to previous articles, and assigned existing themes if applicable; instances in which an article diverged in some respect to previously reviewed articles, new themes were created.

Results

The literature review was framed around the constructs measured by research, the research designs, the instruments, and the contexts in which the research was conducted. The analysis discovered varied operational definitions of what differentiates NGLs from non-NGLs, including: learner technology ownership and access, technology use patterns and habits, computer and information literacy skills, learner self-assessment of computer literacy skills, and technology influenced learning styles. Researchers pursuing the same evaluation regarding the “tech-savvyness” of NGLs used five different constructs to define that concept. The review also revealed significant concerns regarding the research designs, the assessment instruments, and the contexts in which research was conducted.

The analysis yielded 44 themes including, within the four areas that defined the framework of the review: the construct being measured, the design of inquiry, the instrument of data collection, and the context in which research was conducted. The themes regarding the construct being measured by research included, for example, technology use patterns, learner confidence in and self assessment of skills, information literacy skills, academic computing skills and computer literacy skills. The themes that emerged regarding the designs of inquiry included, for example, quasi-experimental, literature review, ethnographic and simple descriptive studies. The instruments used included focus groups, interviews, narratives, surveys and skills assessments. Finally, the themes identified regarding the contexts in which research was conducted included but was not limited to the different countries or locales, the type of institution (K-12, 2 year institution, 4 year institution), and the type of groups (different majors and age group classrooms). In this section, the results within each of the four frameworks will be presented with discussion of the themes and issues for each.

Constructs Measured

Prior research exploring the validity of claims regarding NGLs has examined a range of distinct constructs to determine if they are “tech-savvy” and computer literate. Constructs identified within the literature include learner technology ownership and access, technology use patterns and habits, computer and information literacy skills, learner self-assessment of computer literacy skills, and technology influenced learning styles.

Learner technology ownership and access. College learners' ownership of and access to computing technology has been analyzed frequently by researchers evaluating the validity of claims regarding NGLs (Arafeh, Levin, Rainie, & Lenhart, 2002; Jones & Cross, 2009; Kennedy, Judd, Churchward, Gray, & Krause, 2008b; Kirkwood & Price, 2005; Kvavik, 2005; Margaryan & Littlejohn, 2008; Oliver & Goerke, 2007; Pedro, 2009; Salaway & Caruso, 2008; Selwyn, Potter, & Cranmer, 2009; Smith & Mills, 2009; Smith, Salaway, & Caruso, 2009; Thinyane, 2010). Pedro (2009) and the EDUCAUSE Center for Applied Research (ECAR, (Caruso & Salaway, 2007; Kvavik et al., 2004; Salaway & Caruso, 2008; Smith et al., 2009) have conducted extensive evaluations of learner ownership of and access to computing technology relevant to the NGL debate.

In a report for the Organisation for Economic Co-Operation and Development (OECD), Pedro (2009) surveyed international data reports regarding individual user access to and use of technology to evaluate whether learners had become NGLs. The first half of the report focused on learner access to technology. Pedro used 2003 data regarding home access to computers by secondary school students, for which direct comparative data exists across all 24 OECD countries, as an analogue for current levels of access by higher education students. Across all OECD countries, 85% of all 15 year olds had access to a computer within the home, and 13 of the 24 countries exceeded 90%. As Pedro noted, the 2003 data suggested the "universalisation of home access to computers" with "a matching development in broadband access" (p. 9). Further, the data actually may have underestimated higher education students' access to technology. While admitting that simple access to and use of computers does "not automatically transform higher education students into new millennium learners," (p. 11) Pedro concluded that higher education students "almost universally" have access to an internet-connected computer and are "most likely to be new millennium learners, growing steadily and already having a universal character in some OECD countries" (p. 17).

The EDUCAUSE Center for Applied Research (ECAR) has conducted an annual survey of U.S. higher education learners beginning with the 2004 "Study of Undergraduate Students and Information Technology." Over the last three years of the study, the most recent of which surveyed 30,616 college freshmen and seniors at 115 institutions (Smith et al., 2009), learner ownership of computers has held steady at over 98%. The strong trend toward a preference for laptop computers over desktop computers has continued with ownership of laptops increasing steadily from 46.8% in 2004 to 87.8% in 2009. Smith et al. (2009) also observed an increase in learner use of broadband internet, up to 98.1% in 2009 from 81.5% in 2004. Smith et al.'s survey indicated that 89.8% of the thirty thousand plus students reported owning a mobile phone; according to Smith et al. a "mobile revolution" is occurring in undergraduate education in the United States. However, unlike Pedro (2009), Smith et al. (2009) did not conclude learner ownership of and access to computer technology suggests a generation of technically-skilled learners have entered higher education; simple access to technology and applications does not necessarily translate to meaningful, sophisticated use (Kirkwood & Price, 2005).

Other recent studies have found similar rates of student ownership of and access to computers. Jones and Cross (2009), Kennedy et al. (2008b), Nagler and Ebner (2009), Selwyn et al. (2009), Smith and Mills (2009), and Thinyane (2010) each found high rates of ownership and access to computers; more than 80% of students in those studies owned a computer. The high rate of ownership supported Nagler and Ebner's (2009) conclusion that "the so-called Net-Generation has arrived [given] the equipment they bring" to higher education (p. 7). Similarly, Oliver and Goerke (2007) averred that a gap exists between higher education curricula and student use of technology: that higher education courses use limited technology while learners use technology broadly; their data do not clearly support that conclusion. Learners reported access to and use of technology may present opportunities for innovative use of technology within higher (Kennedy et al., 2008b), but college learners are not influenced by their exposure to technology in a way that suggests they are a single, coherent cohort (Jones & Cross, 2009). Ultimately, learners may have technology at hand in their everyday lives, but that does not suggest their use of it is anything other than "perfunctory and unspectacular" (Selwyn et al., 2009).

Technology use patterns and habit. Of the 52 included in this review studies examining the NGL phenomenon, 30 investigated the technology use patterns and habits of participants, particularly in regard to the use of new or emerging technologies. Conclusions regarding NGLs' patterns of technology use in comparison to those of older generations have been mixed at best, and the vast majority of studies have suggested the Net Generation is "not homogenous nor is it articulating a single clear set of demands" for presence of technology in learning environments (Jones, Ramanau, Cross, & Healing, 2010, p. 731).

Overall, NGLs' familiarity with, let alone use of, new or emerging technologies appears "patchy" (Cox, Tapril, Stordy, & Whittaker, 2008). Learners use established technologies like search engines, email, and text messaging (Kennedy et al., 2007), but they do not recognize differences or capabilities of internet websites and applications that support information sharing, user-generated content, and collaboration (Burhanna, Seeholzer, & Salem, 2009). Whether within or outside of academic settings (Selwyn, 2009), NGLs generally are not significant users of Web 2.0 technology; a small percentage of learners use new or emerging technologies, and their use is limited in breadth and depth (Bullen, Morgan, Belfer, & Qayyum, 2009; Burhanna et al., 2009; Jones & Cross, 2009; Kennedy et al., 2007; Kennedy et al., 2008b; Margaryan & Littlejohn, 2008; Thinyane, 2010). Quite simply, NGLs are "nowhere near as frequent users of new technologies as some commentators have been suggesting" (Kennedy et al., 2007, p. 522).

NGLs frequently use newer, mainstream technologies like text messaging tools and social networking sites, but they do not use other emerging technologies with any regularity. Consistent with Smith et al.'s (Smith et al., 2009) earlier conclusion that a "mobile revolution" is occurring in undergraduate education in the United States, researchers have found high rates of learner use of and confidence with text messaging via mobile devices for personal and academic uses (Jones & Cross, 2009; Kennedy et al., 2007; Kennedy et al., 2008b; Thinyane, 2010). Further, researchers have documented well NGLs' extensive use of social networks (Jones & Cross, 2009; Judd & Kennedy, 2010; Luckin et al., 2009; Sandars, Homer, Pell, & Croker, 2008; Smith & Mills, 2009); however, social networks have been the only newer technology learners have reported using frequently. Even popular Web 2.0-type websites like photo-sharing site Flickr.com and social bookmarking site Digg are little known among NGLs (Burhanna et al., 2009), and other applications and tools at the root of emerging internet-based technologies – blogs, podcasts, really simple syndication (RSS), and wikis – are rarely engaged by more than a small proportion of learners (Burhanna et al., 2009; Kennedy et al., 2007; Kennedy et al., 2008b; Luckin et al., 2009). In short, NGLs "are avid users of social networking tools (for personal, social or recreational use) but infrequent users of other so-called 'Web 2.0' technologies" (Judd & Kennedy, 2010, p. 8).

Even within the group of learners using emerging technologies considered characteristic of NGLs, prior research has found most users to engage technology at a simplistic level. Learners exhibit a lack of "critical enquiry or analytical awareness" (Luckin et al., 2009) regarding technology and have been found to conduct only unsophisticated internet searches (Judd & Kennedy, 2010). Rather than leveraging the capabilities of Web 2.0 technologies to produce, contribute, and share content, very few NGLs reported posting personally created content to the internet (Burhanna et al., 2009). When NGLs do use emerging, web-based social and collaborative technologies, they engage primarily as consumers, not producers, of content (Cox et al., 2008; Judd & Kennedy, 2010; Selwyn et al., 2009). Further, systematic variances in learner integration of technologies attributable to factors other than age have been found (Hargittai, 2010).

Extending from assumptions regarding learner use of technology, a common argument by proponents of the Net Generation is that ". . . today's kids are challenging us, their educators, to engage them at their level . . . More and more, they just don't tolerate the old ways — and they are enraged we are not doing better" (Prensky, 2005, p. 64). The general assumption within education is that NGLs require and demand more use of technology within the classroom, but few efforts have been made by academia to understand how NGLs would like to use technology in learning spaces (Roberts, 2005). Kennedy et al. (2008b) discovered a relationship between learner use of technology and the learner's desire that it be used in academia, and Oliver and Goerke (2007) concluded a gap exists between faculty use and curriculum and the extent to which students use technology. Further, Arafeh et al. (2002, p. 25) argued that younger learners may force schools to adapt to technologically savvy students shaped by day-to-day access to technology. At the very least, Kennedy et al. (2008b) suggested that the degree to which learners are using some emerging technologies and tools points to distinct opportunities for integrating innovative technologies into higher education curricula.

However, empirical findings clearly indicate that NGLs do not demand greater use of technology in academia; they prefer balanced, moderate use of technology in the classroom (Kvavik, 2005; Margaryan & Littlejohn, 2008; Roberts, 2005; Smith et al., 2009). Learners typically describe themselves as being mainstream adopters of technology rather than being early adopters as some have suggested (Smith et al., 2009);

so, learners exhibit less enthusiasm about technology in learning environments than popularly believed (Selwyn, 2009). Learner use of and need for technology is driven more by their discipline needs rather than their age (Bullen et al., 2009), and researchers have found that learners prefer educators "stick to [academic] tools" rather than leveraging Web 2.0 technologies, particularly those students may use frequently like social networking sites (Burhanna et al., 2009; Ismail, 2010). Learners have been observed to openly resist the use of technology in some learning environments (Lohnes & Kinzer, 2007). Thus it is "unlikely that young people will force any 'bottom-up' change" in institutional use and integration of technology into learning spaces (Selwyn, 2009).

Summarizing NGLs' patterns of technology use, most students do not fit the Net Generation stereotype, particularly within the context of Web 2.0-type applications and tools (Judd & Kennedy, 2010; Nagler & Ebner, 2009). Younger learners do not fit neatly into a single, homogenous cohort of early adopters and technophiles, and they are not articulating demands for curricular and instructional changes (Bullen et al., 2009; Jones et al., 2010; Kennedy et al., 2007; Kennedy et al., 2008a; Kennedy et al., 2008b). While holding learner age and access to technology constant, Hargittai (2010) found significant within-group variation in learner skills regarding various aspects of internet use among a group of college learners; thus, researchers "must be wary of overgeneralising [*sic*] the distinctive features of this generation . . . based on assumptions about technology use or preferences" (Kennedy et al., 2007, p. 522).

Computer and information literacy skills. The literature generally acknowledges a difference between "computer literacy" and "information literacy." Computer literacy emphasizes technical skill with specific hardware and software applications; the technical skills necessary to use computing technology are requisite for and support information literacy which is considered a higher order skill. Information literacy is "a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information" (Association of College and Research Libraries, 2000, p. 2). To analyze how "tech-savvy" NGL's may be, researchers have examined computer or information literacy skills of learners, but only five studies identified for the review directly measured technology skills of learners. Within those five reports, researchers found a great deal of variance in learner performance, but all found results that suggest learners do not possess adequate computer literacy skills.

Focusing on computer literacy skills, the technical aspects of using technology, prior research indicates learners are not computer literate. Hardy, Heeler, and Brooks (2006) reported that 73.8% of 164 learners answered less than 60% of questions correctly on a comprehensive computer literacy exam; only 1.2% of learners scored 80% or better, which was considered "mastery level" for the purposes of the study. Sieber (2009) administered an assessment consistent with the ECDL curriculum to 400 first year, medical sciences division students, found "considerable variation in individual proficiency with very few students scoring well across all topics, and concluded that many students may lack competence in basic technology processes.

While studies have used different instruments with differently scaled scores, a general pattern of learner performance appears. Learners exhibit greater proficiency with word processing and presentation skills in comparison to spreadsheets and databases, but their level of proficiency with each application and basic computer concepts does not support conclusions that learners are computer literate or "tech-savvy" (Baugh, 2004; Grant, Malloy, & Murphy, 2009; Guo, Dobson, & Petrina, 2008; Hardy et al., 2006; Tesch et al., 2006). In Hardy et al.'s (2006) study for example, 20.7% and 28% of students scored 80% or higher on word processing and presentation skills, respectively, but only 16.5% scored 60% or higher on basic computer concepts; 30.5% scored 60% or higher on spreadsheets, and 18.9% scored 60% or higher on database tasks. Generally, few students have been found to have sophisticated levels of competence across a range of technology applications (Baugh, 2004; Kirkwood & Price, 2005).

Turning to information literacy skills, two studies identified by the review directly measured information literacy skills of learners (Higntte, Margavio, & Margavio, 2009; Hilberg, 2008; Hilberg & Meiselwitz, 2008). Higntte et al. (2009) administered 15 tasks designed to address learners' critical thinking skills to 600 first or second semester students in a general education computer literacy course at a university. Both studies concluded that there is considerable deficiency in learner information literacy skills and that there is significant room for improvement. While learners are heavy users of technology, they do not fully leverage technology skills (Hilberg, 2008), and the skill level exhibited by learners may not justify or leverage much of the investment typically occurring in technology within higher education (Kvavik, 2005).

Learner self-assessment of computer literacy skills. Researchers have examined learner self-assessment of computer literacy skill and assessed the accuracy of learner self-assessment in comparison to learner actual skill level observed via skill exams. One researcher observed no relationship between learner self-assessed skill level and learner score on a diagnostic exam (Sieber, 2009), but the balance of studies included in this review concluded that learners overestimate personal computer literacy skill (Ballantine, McCourt Larres, & Oyelere, 2007; Grant et al., 2009; Hilberg & Meiselwitz, 2008; McCourt Larres, Ballantine, & Whittington, 2003; McEuen, 2001; Salajan, Schönwetter, & Cleghorn, 2010).

Learner self-assessment scores are relatively high, particularly when juxtaposed with actual computer literacy skill demonstrated on a skills assessment. Higher skill levels indicated by learner self-reports are not supported by learner actual performance on a skills assessment; learners frequently overestimate their skill level (Ballantine et al., 2007; Grant et al., 2009; Hilberg & Meiselwitz, 2008; McCourt Larres et al., 2003; McEuen, 2001; Sieber, 2009). Hilberg and Meiselwitz (2008) observed 73% of participants overestimating their computer literacy skill; some overestimated by as much as 20 percentile points. Only one in four students underestimated their skill level. Further, differences between learner perceived and actual skill levels have been found to be statistically significant (Ballantine et al., 2007; Hilberg & Meiselwitz, 2008; McCourt Larres et al., 2003). Thus, reports that use learner self-assessments as the basis for concluding that students have adequate to superior skill levels, such as Hoffmann and Vance (2005) and Grant et al.(2009) regarding learners' word processing, presentation and spreadsheet skills, should be taken with caution.

Learner self-assessment of computer literacy skill has been examined specifically within the context of the NGL debate. Salajan et al. (2010) considered learner and faculty confidence levels regarding increased use of technology and found that learners appeared more confident in and proficient with technology use, and Jones et al. (2010) found younger students to be more confident in self-assessment than older counterparts. In contrast, Guo et al. (2008) reported no statistical difference in the self-assessment of computer literacy skills exhibited by Net Generation pre-service teachers and non-Net Generation pre-service teachers. Ultimately, Ballantine et al.'s (2007) caution appears to be valid: high self-assessments of computer skills do not necessarily reflect high levels of competence in those skills.

Learning styles and preferences. The premise that NGLs' learning styles and preferences have shifted dramatically given the ubiquity of technology presents significant implications for educational institutions. Whether a whole-sale shift in educational theory and practice is occurring or must occur underpins the entire body of literature. Thus, empirical research regarding the learning styles of NGLs should be of particular importance.

Of the key proponents of NGL demographic shift noted earlier, Tapscott (2008) provides the only empirical research regarding NGLs. Tapscott's *Growing Up Digital* presents qualitative research "written in collaboration with over 300 N-Geners who provided their opinions, experiences, and insights over a one-year period." From discussions and interviews with 6,000 NGLs in online forums, Tapscott concludes that technology and game play has and is changing brain processing capabilities of younger learners; they are able to rapidly switch between tasks with greater efficiency than older counterparts and, generally, can think more quickly. Tapscott makes a range of claims that may be summarized that NGLs' "brains have indeed developed differently than those of their parents" (2008, pp. 1-2).

Tapscott's research has been questioned by researchers within the field with a focus on the sampling methods producing a significant selection bias, the generalizability of the research given a lack of information regarding demographics and methods, and the use of online discussion forums which potentially skew the results (Bullen, 2008, 2009). Additional concerns should be noted as well. In the chapter regarding brain research, Tapscott spends a significant amount of time citing research that game playing changes brain processing capabilities. However, he then slips into a discussion of how using interactive hypertext improves memory recall; while arguably related, "changing brain processing capabilities" and "improving recall" are on different orders of magnitude when considered as substantial, systematic changes to a demographic. Tapscott concludes, "As we've seen in this chapter, growing up digital has equipped these Net Geners with the mental skills, such as scanning and quick mental switching, that they'll need to deal with today's overflow of information" (p. 118). However, Tapscott jumps to the conclusion that the younger generation will develop scanning skills without presenting any empirical evidence.

While Tapscott concludes that NGLs learn differently, the only research report that addressed learning styles of NGLs using a research-based framework of learning styles found no style to be prevalent among students (Cox et al., 2008). Cox et al. (2008) administered Kolb's Learning Style Inventory (LSI) to 25 NGLs in a University environment. While a small sample, the LSI results indicated no dominant learning style within the group. The results do not suggest a convergence of learning style within the group as suggested by the generational change proponents, like Tapscott. At the very least, the results undercut the overgeneralizations about how student knowledge, attitudes and learning styles are changing.

Research Design

Many of the studies identified for this review, 23 of 52, relied upon surveys, interviews, or focus groups to collect and report only descriptive data regarding NGL interactions with technology. Typically focusing on the technology use patterns and preferences of NGLs, the survey and qualitative research designs produced only descriptive data regarding NGLs with no comparisons drawn with other cohorts (Arafeh et al., 2002; Bullen et al., 2009; Burhanna et al., 2009; Cox et al., 2008; Hargittai, 2010; Hoffmann & Vance, 2005; Jones & Cross, 2009; Kennedy et al., 2007; Kennedy et al., 2008b; Kirkwood & Price, 2005; Luckin et al., 2009; Margaryan & Littlejohn, 2008; Nagler & Ebner, 2009; Oliver & Goerke, 2007; Roberts, 2005; Sandars et al., 2008; Smith & Mills, 2009; Smith et al., 2009; Tapscott, 2008; Thinyane, 2010).

A small number of studies, however, used survey and qualitative data to draw comparisons between different cohorts included in the study. Smith et al.'s (2009) extensive survey data allowed comparison of various groups within the study: community college students, university students, males, females etc. Hartman et al. (2005) compared NGLs to older learners regarding preferences for technology use, and Waycott, Bennett, Kennedy, Dalgarno, and Gray (2010) and Salajan et al. (2010) compared students to faculty regarding technology use and assessment of learner skill, respectively. While their constructs and instruments varied, Hartman et al., Waycott et al., and Salajan et al. both concluded that NGLs could not confidently distinguished from non-NGLs regarding technology preferences, proficiency or confidence; the differences between the two were as likely a function of "different 'life stages' of individuals rather than . . . historical generational differences" (Waycott et al., 2010, p. 1209).

Only two reports identified presented a quasi-experimental research design including pretest and posttest learner assessment (Bartholomew, 2004; Guo et al., 2008). Guo et al. conducted a survey of pre-service at the beginning and end of a one year post-baccalaureate teacher education program; the research claimed to address pre-service teachers' ICT literacy across different age groups; however, the instrument included only learner self-assessment and not a direct assessment of learner skill. Bartholomew administered a self-assessment survey to business school students on four different occasions through the course of the four year program; learner self-assessments decreased over the course of their career, and business stakeholders surveyed indicated that graduating students did not meet expectations regarding proficiency with relevant technologies like word processing, spreadsheet and database applications.

Instruments

A portion of the Net Generation Literature used skills assessments to directly measure learner technology skills; however, the instruments used vary across the body of research. Researchers have developed custom developed and delivered skills assessments focused on a limited scope of skills (Baugh, 2004; van Braak, 2004; McCourt Larres et al., 2003); Grant et al. (2009) and Tesch et al. (2006) developed a custom skills assessment based on the SAM 2003 platform made available by Thompson Publishing Co. Three studies used more comprehensive skills assessments consistent with the European Computer Driver's License curriculum (Ballantine et al., 2007; Hardy et al., 2006; Sieber, 2009), and Hilberg (2008; Hilberg & Meiselwitz, 2008) and Higntte et al. (2009) employed *iCrit*, an information literacy exam developed by the Educational Testing Service.

The majority of studies using skills assessments only reported descriptive results (Baugh, 2004; Grant et al., 2009; Hardy et al., 2006; Hilberg, 2008; Tesch et al., 2006). However, Higntte et al.'s (2009) findings of learner performance on the *iCrit* assessment included comparison across various participant cohorts. A number of researchers administering skills assessments compared learner scores to learner self assessed skill level to evaluate the accuracy of learner self assessment (Ballantine et al., 2007; van Braak, 2004; Hilberg, 2008; McCourt Larres et al., 2003; Sieber, 2009). In contrast, several studies identified evaluated learner self-assessment of computer literacy skills, but in that effort, relied entirely on learner self-reported skill levels via surveys or interviews (Kennedy et al., 2008b; Kvavik, 2005; McEuen, 2001).

Contexts

Only four studies identified by this review were conducted outside of university learning environments. Tapscott (2008) conducted research within the general online public, and Arafeh et al. (2002), Judson (2010), and Luckin et al. (2009) conducted studies within K-12 environments. The literature has addressed global university settings with inquiries into the NGL issue having been conducted in the United States, South Africa, Australia, the United Kingdom and Canada; further studies are likely forthcoming which replicate the effort in additional locales. Only the ECAR series of study addressed community college learners, but that cohort represented a very small minority of study participants.

In summary, much of the NGL literature focused on learner ownership and access to technology as well as their technology use patterns and habits and reported only descriptive results based on survey research. NGLs were found to use social networking tools at a simplistic level; many do not fit the stereotypical NGL established by previous literature. Research that focused on actual skill levels revealed a general pattern in which learners lacked fundamental computer and information literacy skills; Hardy, Heeler and Brooks (2006) found only 1.2% of 164 learners exhibited "mastery level" computer literacy skills, and Hligntte et al.(2009) and Hilberg (2008) both concluded that there is considerable deficiency in learner information literacy skills. Despite that, learners typically self-report higher levels of proficiency; the body of research suggests self assessment instruments should be considered with caution, but the only two studies identified that conducted quasi-experimental research both relied on self-assessment data. Only three studies used instruments which addressed more comprehensive computer or information literacy skills, and only descriptive results were reported. NGLs are not technologically proficient to the extent that learning styles are changing (Cox et al., 2008), and studies that reported differences between NGLs and non-NGLs concluded differences were likely a function of "different 'life stages' . . . rather than historical generational differences" (Waycott et al., 2010, p. 1209). Finally, the vast majority of all NGL research identified by the review was conducted in four year, university institutions; the range of contexts in which research has been conducted is extremely limited.

Discussion

The constructs, designs, instruments and contexts within the current body of literature give rise to several critical concerns. Generally, much of the current literature uses descriptive research designs relying heavily on survey responses by learners in university settings, and though generally labeled "technology skills," the construct being measured varies greatly. Future research using causal comparative or experimental designs to directly observe and compare the computer literacy skills of NGLs and non-NGLs in a variety of educational settings would contribute to the body of knowledge regarding the claims of generational differences in technology skill levels between older and younger learners. Following the results of the literature review, the discussion first addresses issues related to the constructs measured by the literature and then turns attention to the designs, instruments and contexts used by the current body of NGL literature.

Constructs Measured

Existing research has examined the claim that NGLs are different from their older counterparts from a number of different perspectives. Five different constructs were identified through this review of the literature: technology ownership and access, technology use patterns and habits, computer and information literacy skills, learner self-assessment of computer literacy skills and learning styles. The difficulty is that distinctions between the various constructs have been blurred; the notion of the NGL has been repeated so often that a general understanding has developed in higher education that younger learners are inherently computer literate (Bayne & Ross, 2007). Despite the differences, each construct has been addressed within the literature to draw conclusions regarding the validity of claims regarding NGLs; a de facto equivalence between the constructs has been established by the body of literature. Thus, the literature further obfuscates the issue by offering multiple operational definitions of what it means to be technically capable, as NGLs reportedly are. Clarity is needed; rather than pursuing one of a variety of constructs established in the current body of literature, future research should critically identify appropriate and meaningful constructs to be measured.

Examining learners' technology ownership or technology use patterns and habits dominates current literature with almost half of the reviewed literature focusing on those two constructs to define technical proficiency. Neither of the two constructs may be appropriate for examining the technology skills of NGLs. Regarding technology ownership and access, previous research has shown that simple access to technology does not guarantee the ability to use the technology (van Braak, 2004). NGLs may be comfortable with technology, but it does not ensure that they possess any particular skill level (Salajan et al., 2010; Stone et al., 2006). Second, familiarity with or use of new or emerging technologies does not equate with being computer or information literate; the specific, formal skills defined by computer and information literacy have much greater implications for learners than do emerging technologies. Thus, studies which investigate learner familiarity or comfort with or use of specific computing technologies only superficially address the issue. At the very least, future studies focused on NGLs' patterns of use regarding emerging technologies should examine NGL proficiency with the technologies, not just their familiarity of them.

Previous researchers have also examined the validity of NGL claims based on learner self-assessment of skills or familiarity with specific technologies. Current literature suggested that learners often overestimate personal computer literacy skill that self-assessment instruments should be used with caution. Unfortunately, results from studies using learner self-assessment of computer literacy skill as the construct of technology proficiency may be generalized to suggest learners are computer literate, based on the self-assessment results. One study by Guo et al. (2008) even claimed to address pre-service teachers' ICT literacy across different age groups even though the instrument included only learner self-assessment and not direct observation of learner computer literacy skill. If NGL proficiency with technology related skills is to be reliably measured, learner self-assessed skill levels should not be used to define "learner computer literacy skill level" as some current research has done.

A more appropriate focus for studies examining generational differences of NGLs and non-NGLs would be on a construct that more definitively addresses relevant computer skills. Even if learners proved to be proficient with emerging technologies, the use of those technologies is not essential to computer or information literacy. Computer competence is a crucial factor to learners for expanding opportunities both in personal life and at the workplace (van Braak, 2004); however, the skills needed within academia and the workplace are distinct and separate from emerging technologies. Bartholomew (2004) conducted a survey of 23 prospective employers of four year graduates from a business school. Computer literacy within the workplace focuses on computer and information literacy rather than emerging technologies; specifically, all productivity applications were found to be important with an emphasis on word processors, spreadsheets, and databases, not the use of technologies like blogs, wikis, podcasts, RSS feeds, and social networks which are at the foundation of assumptions regarding NGL rhetoric and research. The skills identified by employers are more in line with technical skills assessments being used by researchers rather than learner self-reported technology use habits. Research literature focused on computer and information literacy skills potentially make a greater contribution to understanding the NGL question for which many educators assume the answer: Are NGLs computer literate?

Research Design

A significant limitation of the current body of NGL literature lies in the research designs used. More than half of the research reports included in this review considered NGLs' skills based upon only descriptive outcomes. Only two studies in the review collected data from participants on more than one occasion, but neither of the two studies directly observed NGL computer literacy skills. Instead, both studies relied on self-assessment or survey data (Bartholomew, 2004; Guo et al., 2008).

On balance, much of the existing research examined the habits or skills of NGLs within a vacuum; there was an absence of studies that compare NGLs to non-Net Generation Learners (non-NGLs). Only four of the studies identified observed both cohorts which enabled comparisons between the two (Guo et al., 2008; Hartman et al., 2005; Salajan et al., 2010; Waycott et al., 2010). However, no identified studies compared NGL and non-NGL performance on a computer or information literacy skills assessment; they relied on other constructs.

Salajan et al. (2010) noted and addressed the importance of addressing the proposed dichotomous relationship between NGLs and non-NGLs rather than simply examining the skills of younger learners. Future research should employ causal-comparative to experimental designs to examine the skill levels of different learners, to evaluate technology curriculum, or to understand how learners of different ages acquire technology related skills.

Instruments

Narrowing the review of literature to only those studies that directly observed learner computer or information literacy skills, researchers have used a number of different instruments addressing different scopes of technology related skills that make it difficult to generalize or synthesize results. The operational definition of computer or information literacy has become more indeterminate, in practice, than the theoretical literature regarding the two constructs would suggest.

Of studies directly observing learner skills, a majority employed instruments addressing specific tasks or skills which create a more limited operational definition of computer literacy; that stands in contrast to studies using instruments specifically designed to address a more comprehensive scope of computer literacy related skills. For example, Baugh (2004) utilized an instrument that assessed learner skill regarding only spreadsheet and database concepts and applications; in contrast, Sieber (2009) explicitly describes following the European Computer Drivers License curriculum, which includes seven modules covering basic computer concepts, file management and operating system functions, word processing, spreadsheets, databases, presentations, and communications (Axelson, 2005).

Additional research is needed that uses skills assessments focused on computer literacy and information literacy to extend the findings of studies employing skills assessments (Ballantine et al., 2007; Baugh, 2004; van Braak, 2004; Grant et al., 2009; Hardy et al., 2006; Hilberg, 2008; McCourt Larres et al., 2003; Sieber, 2009; Tesch et al., 2006). Future research would benefit from applying technology to directly observe learner behavior (Judd & Kennedy, 2010) or using established, standardized skills assessments to allow meaningful comparisons across samples. The body of NGL research examining technology use patterns would benefit from studies applying skills assessments to observe learner proficiency with new and emerging technologies.

Contexts

The vast majority of NGL research has been conducted in university settings without significant consideration for other environments. Only four studies identified by this review were conducted outside of university learning environments. Tapscott (2008) conducted research within the general online public, and Arafeh et al. (2002), Judson (2010), and Luckin et al. (2009) conducted studies within K-12 environments. Notably absent from the literature was research conducted in two year institutions. Only the ECAR series of study addressed community college learners, but that cohort represented a very small minority of study participants. Two year institutions possibly provide the greatest opportunity for direct comparisons of younger and older learners given that they serve a wider age demographic than K-12 or University institutions.

Conclusion

The current body of literature focused on NGLs has investigated a number of varied constructs relevant to the technology preferences and skills typically associated with the younger generation. On balance, empirical data undermines many claims made regarding the technical proficiency of NGLs.

Future studies may contribute to the NGL body of knowledge by relying less on learner reported data and self-assessment, focusing instead on direct observation of learner behavior and direct measures of learner skills regarding emerging technologies, computer literacy or information literacy. Given academic and workplace demands, learner computer literacy and information literacy skills should be of particular interest to researchers, and examining learner performance of those skills in community college environments may permit meaningful comparison of NGL and non-NGLs.

CHAPTER III

COMPUTER LITERACY SKILLS OF NET GENERATION LEARNERS IN COMMUNITY COLLEGE

A great deal of rhetoric scattered throughout contemporary educational literature and news stories describes today's younger learners, born after 1980, as inherently tech-savvy and computer literate. Because of their reportedly different attitudes toward and habits when using computer technology, they have been categorized and labeled, at various times, as the Net Generation (Howe & Strauss, 2000), millennials (Tapscott, 2008), new millennium learners (Pedro, 2006), and digital natives (Prensky, 2001b). According to proponents of the more tech-savvy younger generation, Net Generation Learners (NGLs), the term used in this report, have grown up with access to computer technology, and they "all have the skills to use those technologies" (Palfrey & Gasser, 2008, p. 1). NGLs exposure to and use of technology has shaped their minds differently from preceding generations; this younger generation possesses a distinctly different learning style from their predecessors (Brown, 2005; Frand, 2000; Prensky, 2001b; Tapscott, 2008). They are "not the people our system was designed to teach" (Prensky, 2001b, para 2).

Adapting to tech savvy NGLs has become a mantra within education. Faculty frequently discuss "struggling to discover ways to adapt and develop curriculum to meet the needs of [their] twenty first century N-Gen students" (Adams, 2008, p. 96). The need to adapt to learners who readily and willingly use a range of technologies pervades educational literature as a reason to modify, change, or adapt curriculum or some aspect of institutional teaching and learning, including for example: library services (Fuller, Achtermann, & McLeod, 2009; Click & Petit, 2010); general education and instructional design (Manuel, 2002; Conole, 2010; Philip, 2007; Wilson & Gerber, 2008; Wilson, 2008); language learning (Durán-Cerda, 2010); science education (Campbell, Wang, Hsu, Duffy, & Wolf, 2010); nursing education (Chambers, 2010; Paterson, 2010); medical education (Collier, 2010); student services (Hornak, Akweks, & Jeffs, 2010; Lippincott, 2010); faculty development (Hummer, Sims, Wooditch, & Salley, 2010; Read, 2006); and facility management (McVay, 2008).

The concept of the special abilities and characteristics of NGLs has been repeated so often that a general understanding has developed in higher education that younger learners are inherently computer literate (Bayne & Ross, 2007), which in turn, has had an impact in shaping decisions at all levels of education. For example, Sheryl Abshire, chief technology officer for a school system in Lake Charles, LA, declared that “Kids are wired differently these days. They’re digitally nimble. They multitask, transpose and extrapolate” (Lewin, 2009, para. 5). Further, this view has caught on in the mainstream media and is often cited as a reason to implement a new technology or to advocate sweeping changes in curriculum and teaching methods. Further, computer literacy skills courses are being removed from higher education curriculum as a result of the assumption that NGLs, incoming college freshmen, already possess the requisite computer literacy skills (Baugh, 2004). Ultimately, claims are regularly made that education must “evolve to meet the needs” of inherently computer literate Net

Generation Learners who "are redefining the landscape in higher education" (Hartman et al., 2005; Khalid, 2008). The purpose of this study is to address the validity of claims made regarding the technology skills of NGLs by examining the differences between NGLs and non-NGLs regarding their self-assessment of computer literacy skills and their actual computer literacy skills as assessed directly by a validated, comprehensive computer literacy skills exam.

A significant body of empirical research questions the claims regarding the inherently computer literate and tech-savvy NGL. Contrary to popular opinion, NGLs have been found to not be significant users of emerging technologies; their use is limited in scope and sophistication (Bullen et al., 2009; Burhanna et al., 2009; Cox et al., 2008; Jones & Cross, 2009; Judd & Kennedy, 2010; Kennedy et al., 2007; Kennedy et al., 2008a; Margaryan & Littlejohn, 2008; Selwyn, 2009; Thinyane, 2010). Quite simply, most students do not fit the Net Generation stereotype (Judd & Kennedy, 2010; Nagler & Ebner, 2009). Thus, researchers "must be wary of overgeneralising [*sic*] the distinctive features of this generation . . . based on assumptions about technology use or preferences" (Kennedy et al., 2007, p. 522).

Several gaps exist within the current body of literature. First, the majority of available NGL research focused on learners' simple familiarity with new or emerging technologies. Representative of 44 of 52 studies identified by the critical review of the literature, Kennedy et al. (2008b) investigated NGLs' personal use of and desire for classroom use of blogs, instant messages, social networks, text messages and audio files. However, even heavy users of technology may not fully leverage technology skills

(Hilberg, 2008), and familiarity with and access to technology does not equate to any particular level of skill (Salajan et al., 2010; Stone et al., 2006). Further, skills at using emerging technologies are distinctly different than the skills needed within academia and the workplace; those skills focus on computer and information literacy, including use of common productivity applications like word processors, spreadsheets, and databases (Bartholomew, 2004). Additional research is needed which directly assesses NGL computer literacy skills (Baugh, 2004; Grant et al., 2009; Hardy et al., 2006; Hilberg, 2008; Sieber, 2009; Tesch et al., 2006).

Second, much of the current literature also relied heavily on self-reported data, yielding only descriptive analyses and reports with few direct comparisons between NGLs and non-NGLs. Many of the studies identified, 23 of 45, relied on surveys, interviews, or focus groups to collect data regarding NGLs technology use and skills; the studies produced only descriptive data regarding NGLs with no comparisons drawn with other cohorts (Bullen et al., 2009; Hargittai, 2010; Jones & Cross, 2009; Kennedy et al., 2008b; Margaryan & Littlejohn, 2008). Salajan et al. (2010) noted and addressed the importance of addressing the proposed dichotomous relationship between NGLs and non-NGLs rather than simply describing the skills of younger learners.

Third, the aforementioned studies and others have depended greatly on learner self-assessment of computer literacy skills and self-reported levels of confidence. Salajan et al. (2010), Jones et al. (2010), and Guo et al. (2008) found that younger learners were more confident in their technology skills than older learners were of theirs. However, learner self-assessments of computer related skills are not reliable. While one researcher observed no relationship between learner self-assessed skill level and learner score on a diagnostic exam (Sieber, 2009), on balance, studies have concluded learners overestimate personal computer literacy skill (Ballantine et al., 2007; Grant et al., 2009; Hilberg & Meiselwitz, 2008; McCourt Larres et al., 2003; Salajan et al., 2010). Further, differences between learner perceived and actual skill levels have been found to be statistically significant (Ballantine et al., 2007; Hilberg & Meiselwitz, 2008; McCourt Larres et al., 2003). Thus, Ballantine et al.'s (2007) caution appears to be valid: self assessment instruments should be considered with extreme caution.

Fourth, a small niche of literature identified by a critical review, 10 of 52, directly measured NGL computer literacy skills. Learners' levels of proficiency did not support conclusions that learners are computer literate or "tech-savvy" (Baugh, 2004; Grant, Malloy, & Murphy, 2009; Guo, Dobson, & Petrina, 2008; Hardy et al., 2006; Tesch et al., 2006). Few studies have found students to have competence in basic, let alone sophisticated, tasks across a range of technology applications (Baugh, 2004; Kirkwood & Price, 2005; Sieber, 2009), and studies have concluded that there is considerable deficiency in learner information literacy skills (Higntte et al., 2009; Hilberg, 2008).

The small body of literature directly observing NGL computer literacy skills was found to have further limitations. Researchers developed and delivered skills assessment focused on a limited scope of skills (Baugh, 2004; van Braak, 2004; Grant et al., 2009; McCourt Larres et al., 2003; Tesch et al., 2006) in contrast to fewer studies which used more comprehensive computer literacy (Ballantine et al., 2007; Hardy et al., 2006;

Sieber, 2009) or information literacy skills assessments (Hightte et al., 2009; Hilberg, 2008; Hilberg & Meiselwitz, 2008). Significantly, no studies were identified by the literature review which compared NGL and non-NGL performance on a computer literacy skills assessment. Additional research is needed which directly skills assessments comprehensive in nature and aligned to a validated standard and definition of skill level; such studies would extend the findings of studies employing skills assessments (Ballantine et al., 2007; Baugh, 2004; van Braak, 2004; Grant et al., 2009; Hardy et al., 2006; Hilberg, 2008; McCourt Larres et al., 2003; Sieber, 2009; Tesch et al., 2006)

Fifth, only five studies identified by the literature review were conducted outside of university learning environments (Arafeh et al., 2002; Judson, 2010; Luckin et al., 2009; Tapscott, 2008). Other than the EDUCAUSE Center of Applied Research's annual undergraduate students and information technology study (Smith et al., 2009), research conducted in community colleges or two year institutions was absent from the literature. Given the wider age demographic they serve in comparison to K-12 or university institutions, two year institutions possibly provide the greatest opportunity for direct comparisons of younger and older learners, and the NGL versus non-NGL question may be more relevant to educators in those institutions for the same reason.

Purpose and Research Questions

This study addressed the identified gaps in the literature by directly measuring and comparing NGL and non-NGL community college students' performance on a validated computer literacy skills assessment and their self-assessment of computer literacy skill. Throughout the Net Generation Learner literature, researchers have consistently acknowledged a continuing need for empirically based research regarding the technological skill of NGLs (Bennett et al., 2008; Hilberg, 2008; Kennedy et al., 2006, 2007; Kennedy et al., 2008a; Margaryan & Littlejohn, 2008; Pedro, 2009; Reeves & Oh, 2007; Selwyn, 2009; Tesch et al., 2006; Thinyane, 2010). The purpose of this study was to contribute to the body of knowledge regarding computer literacy skills of Net Generation Learners.

This study employed a causal-comparative design, relying on a researcher developed survey and a computer literacy skills assessment to examine learner computer literacy skills. The Internet and Computing Core Certification Fast Track (IC^3FT) was used to measure learner computer literacy skills; the IC^3FT is a one hour, computer-based exam assessing learner competency regarding (a) knowledge of hardware and software necessary for basic use of computing technology, (b) production of documents using word processing, spreadsheet and presentation software, and (c) safe and productive use of communication networks to access, evaluate, create and share information. Two research questions were investigated:

1. What is the relationship between learners' actual performance on the Internet and Core Computing Certification Fast Track exam prior to beginning a college level computer literacy course and learner self-assessment of their computer literacy skills as measured by the Learner Computer Literacy Self-Assessment?

2. What is the relationship between learner age and learner computer literacy skills prior to beginning a college level computer literacy course?

a. What is the relationship between learner age, as a continuous variable, and learners' score on the IC^{3}FT exam?

b. What is the difference between Net Generation Learners' (born after 1980) and non-Net Generation Learners' (born prior to 1981) scores on the IC^{3}FT exam?

It was hypothesized that learners would overestimate their knowledge of and skills with computer technology, learners and that age would not be a predicative factor of learner computer literacy skill as measured by the IC^{3}FT exam.

Method

The study was conducted during the Spring 2010 semester across three different campuses of a comprehensive community college that serves approximately 30,000 students in a large metropolitan-to-suburban area. The study was conducted to better understand college learners' computer literacy skills and ability to self assess computer literacy skills.

Participants

The study included 428 learners with an overall response rate of 86%. Data collected from 20 students were removed from the study because the students were enrolled in more than one course section selected for the study; 39 students were removed because they failed to complete either the skills assessment or the self-assessment survey. The remaining 369 students offered valid responses on the entire skills assessment and self assessment survey.

The 369 participants proved to be representative of institutional demographics, except for the gender distribution, based on data for the study in Spring 2010 and available institutional reports for Fall 2009. Of participants in the study, 54.5% were male (compared to 44.1% institution-wide), and 45.5% were female (55.9%, institution-wide). Participants' self-reported ethnicity indicated 38.8% Hispanic (38.5%), 38.6% Caucasian (41.1%), 12.2% African American (11%), and 10.4% distributed among other ethnicities (9.4%). Further, 53.4% of participants were enrolled full time at the time of the study, compared to 46.6% who were enrolled part time. Forty-two percent of participants indicated enrollment in an academic program; 34.4% were enrolled in technical programs, and the remaining 23.3% were undecided or were not certain.

Given the focus of the study, the distribution of participant ages was of significant concern. Study participants ranged in age from 18 to 58 years of age with an average age of 24.04 years old. NGLs comprised 79.9% of participants in the study with an average age of 21.13 years; the remaining 21.1% of participants were non-NGLs and averaged 35.62 years of age. The age demographic of the sample was similar to institutional demographics. In Fall 2009, 82.4% of college learners were 29 years or younger (Gonzalez et al., 2009); the sample for this study included 84.8% of participants in that age group. The study's sample was statistically representative of the student population of the college in which the study was conducted in terms of gender, ethnicity, and age.

Sampling

The sampling method focused on intact class sections of students taking one of 21 courses which satisfied the institution's curricular computer literacy requirement. Thirty individual class sections were selected for inclusion in the study in a stratified random sample with several constraints. First, the college in which the study was conducted wanted to include in the study students from all three campuses where possible; though the selection of course sections was random, this required three different sections of Composition I to be included, one from each campus. Second, not all courses offered multiple sections available during the semester in which the study was conducted; thus, in some instances, random sampling was not possible; the only section offered of a course was included by default.

Participants blindly self-selected enrollment in course sections selected for inclusion in the study; students were not aware of the study or the sampling process when they elected to enroll in a particular course or section. A minimum of 10 and a maximum of 30 students were expected to be enrolled in each of the 30 course sections selected for the study; the original sampling of the intact course groups anticipated approximately 600 potential participants.

Procedure

During the third week of the Spring 2010 semester, all participants in selected course sections were invited to complete the Internet and Computing Core Certification Fast Track (IC^3FT) exam and the researcher developed Learner Computer Literacy Self Assessment (LCLSA) survey. Prior to beginning either instrument, students were given a hard copy of the informed consent document noting their rights and protections as voluntary participants in the study. All sessions were administered by a trained facilitator in a computer lab during regularly scheduled class time. Participants received step-by-step instructions to access and complete each instrument online.

Instruments

Learner Computer Literacy Self Assessment survey. Participants first completed the Learner Computer Literacy Self Assessment (LCLSA) survey to measure self assessment of computer literacy skills, an independent variable. The LCLSA was based significantly on the Information and Communication Technology (ICT) Fluency Questionnaire developed by Hilberg (2008) for a similar study; some questions from the original instrument were omitted for a lack of relevance. Any questions included from the original instrument were replicated exactly. The LCLSA included 4 sections and 49 questions completed confidentially by participants. The first section elicited from participants general information regarding college experience and current academic standing. The second section, questions 4 through 17, focused on learner technology use, habits and experience; learners were asked how much time they typically spend each week using a computer, the internet, and communications and other computer based technologies. Possible responses included *none, under 5, 5 to 10, 11 to 20,* and *21 or more.* The third section, questions 18 through 24, collected information about learners' educational background in and experience with computing technology. Learners were asked to indicate their overall assessment of their computer literacy skill as well as the number and type of technology related courses and training they completed prior to this study.

The primary change to the LCLSA, compared to the survey used by Hilberg (2008), focused on the self assessment component. Questions 25 to 48 asked learners to rate their proficiency completing computer related tasks; each task corresponded to one of the 24 IC^3 objectives and replicated the definition and wording of each objective per IC^3 Global Standard specifications (Certiport, Inc, 2008a, 2008b, 2008c). The items included tasks related to hardware, software, operating systems, common program functions, word processing functions, spreadsheet functions, presentation software, networks, electronic mail, using the internet and the impact of computing and the internet on society (Certiport, Inc, 2008a, 2008b, 2008c; Certiport, Inc., 2004). Participants indicated their level of skill regarding each objective on a five point scale: *(1) poor*, (2) *below average*, *(3) average*, *(4) above average*, or *(5) excellent*. Learner total self assessment scores were calculated as the sum of responses to the individual tasks (items 25-48) and the overall computer literacy rating (item 18); this yielded a self assessment minimum score of 25 and a maximum score of 125 representing the learner's total assessment of all skills across all IC^3FT exam objectives.

Internet and Computing Core Certification Fast Track (IC^3FT). To directly measure learners' computer literacy skills, the dependent variable, participants completed the Internet and Computing Core Certification Fast Track (IC^3FT) exam: a 75 question, one-hour version of the complete Internet and Computing Core Certification Exams (IC^3, Certiport, Inc, 2008a, 2008b, 2008c; Certiport, Inc., 2004). The IC^3FT

included 25 questions focused on the objectives covered by each of the three IC^3 component certification exams: Computing Fundamentals, Key Applications, and Living Online. Each set of 25 component exam questions were randomly drawn from a larger pool of 90 practice exam questions; all questions were presented in randomized order on the IC^3FT. The pool of practice exam questions consisted of items constructed using the same methods and principles used to develop the IC^3 certification exams. The IC^3FT was scored and reported in the same manner as the certification exams; the score was calculated as a simple percentage of correct questions and expressed on a scale of 0 to 1000. The passing score on the IC^3FT was similar to the certification cut score of 650 to 750 across the three exams. For the purpose of this study, the total exam score on the IC^3FT operationally defined learners' actual computer literacy skills; learners' subscale scores on computing fundamentals, key applications and living online were also used. The total exam score was the most appropriate score to examine learner actual computer literacy skill.

The IC^3FT exam leveraged the item construction and selection methods designed, developed and validated for the IC^3 certification exams. Each of the three IC^3 component exams was defined by 3 to 4 knowledge domains that were further operationalized via specific objectives and tasks (Certiport, Inc., 2004). The IC^3 was validated by empirical, theoretical, statistical and conceptual evidence to ensure it measures an individual's computer literacy skills Donath Group (Certiport, Inc., 2003). Initially, industry and academic research was conducted to identify core competencies including focus groups with subject matter experts. A job task analysis defined critical skills required of an IC3 certified professional and served as the basis of content validity for the exams. Given the research and job task analysis, an exam blueprint was developed for each IC3 component exam; the blueprints were revised and validated via a survey of over 270 subject matter experts regarding each exam objective. Subject matter experts then wrote test items which were reviewed by colleagues and researchers, pilot tested at more than 40 different testing locations, analyzed for item difficulty and discrimination, and selected for inclusion in the final version of the exam. All exam questions used one of two formats: performance-based items or traditional linear items. When testing a learner's ability to complete specific tasks within an application, performance-based test items using an interactive simulation of the application required learners to perform actual tasks. General skills and knowledge not tied to the use of a specific application used traditional linear item formats such as but not limited to multiple-choice or multiple-response questions (Certiport, Inc, 2008a, 2008b, 2008c). All items had equal weight in the calculation of the exam score; the score was calculated as a simple percentage of correct questions and expressed on a scale of 0 to 1000. Finally, researchers determined a cut score based on level of mastery, standard deviation, test score means, and decision error (Certiport, Inc., 2003).

Learner age was an independent variable in the design and was considered as both a continuous variable and as a categorical variable for the purposes of the study. Given the existing literature's claims regarding the ability of learners as categorized by age, learners 28 years of age and younger in January 2010, born in 1981 or later, were designated as Net Generation Learners (NGLs), and learners older than 28 years of age were considered non-Net Generation Learners (non-NGLs); the categorical analysis of learner age was necessary to evaluate the validity of claims made by existing literature. To further consider the relationship between learner age and computer literacy skills, analyses including learner age also examined learner age as a continuous variable; this considered age at the highest scale of data possible which is typically preferable (Stevens, 1951).

Results

Prior to addressing the research questions, descriptive data were reviewed to understand learners' overall performance on the IC^3FT and cumulative self-assessment scores. Table 1 summarizes the descriptive statistics for learner results on the IC^3FT. As a group, learners did not exhibit adequate computer literacy skills as indicated by the mean score for the group being 117.21 points below a cut score of 650. Learners also self assessed slightly below average with a mean self assessment score of 2.88 on the five point Likert scales used by the LCLSA.

Table 1: LCLSA and IC^3FT Descriptive Statistics

Scale	N	Mean	Min.	Max.	SE	SD
LCLSA	369	2.88	0.2	5.0	.043	.82
IC^3FT	369	532.79	160	907	8.05	154.56

To better understand the distribution of scores, Table 2 displays the frequency of IC^3FT scores segmented by 100 point increments below the cut score of 650 and by 50 point increments at or above that cut score. The table revealed that 78.3% of all participants, 289 learners, failed to achieve a cut score of 650 or greater; only 21.7% of all participants demonstrated a basic level of computer literacy skill, and only 5.1% of participants scored an 800 or above. A two-way chi square test was calculated to examine the distribution of NGLs versus non-NGLs that achieved a passing score on the IC3FT; there was not a statistically significant difference in the number of NGLs and non-NGLs that scored a 650 or higher ($\chi^2 = 3.64$, $p = .06$).

Table 2: IC3FT Scores Segmented by Score Range

IC3FT Score	NGL			non-NGL		
	n	Percent	Cumulative Percent	*n*	Percent	Cumulative Percent
0-99	0	0%	0%	0	0%	0%
100-199	3	1.0%	1.0%	2	2.7%	2.7%
200-299	13	4.4%	5.4%	4	5.4%	8.1%
300-399	33	11.2%	16.6%	12	16.2%	24.3%
400-499	62	21.1%	37.6%	21	28.4%	52.7%
500-599	78	26.5%	64.1%	17	23.0%	75.7%
600-649	36	12.3%	76.3%	8	10.8%	86.5%
650-699	25	8.5%	84.7%	3	4.1%	90.5%
700-749	16	5.5%	90.2%	2	2.7%	93.2%
750-799	12	4.1%	94.2%	3	4.1%	97.3%
800-849	10	3.4%	97.6%	2	2.7%	100.0%
850-899	6	2.0%	99.7%	0	0%	100.0%
900-949	1	0.3%	100.0%	0	0%	100.0%
950-1000	0	0%	100.0%	0	0%	100.0%

Prior to principal analysis, we explored the data to ensure assumptions were met for the statistical tests used in the analysis. Homogeneity of variance was assumed since Levene's Test for Equity of Variances indicated no significant difference between variability of scores within the two groups, $F(1, 369) = .02$, $p = .88$. Further, exploration of data suggested a normal distribution of scores, and the Kolmogorov-Smirnov test was used to confirm normality, $F(1,369) = .04$, $p = .20$. The underlying assumptions necessary for the analyses held.

Research Question 1

Research question one dealt with the relationship between learners' actual performance on the Internet and Core Computing Certification Fast Track exam prior to beginning a college level computer literacy course and learner self-assessment of their computer literacy skills as measured by the Learner Computer Literacy Self-Assessment. To address this question, a regression analysis was used to understand the correlation between learners' actual skill level and learners' self assessed skill level and to examine the variance in learner computer literacy scores accounted for by learner self assessment. We applied the same analysis separately to NGLs and non-NGLs to observe potential differences between the two groups regarding self-assessment of computer literacy skill.

The correlation between learners' actual performance on the IC^3FT exam and learner self-assessment score on the LCLSA proved to be statistically significant and suggested a moderate level of learner proficiency regarding self assessment, $r(367) = 0.45$, $p < .01$. Learners exhibited some ability to assess individual levels of computer literacy skill, but the extent to which learner's self assessed rating predicted the learner's actual computer literacy skill was limited, $R^2 = .20$.

NGLs and non-NGLs differed in their ability to accurately self-assess their computer literacy skill. The correlation of NGL IC3FT exam and self-assessment score was lower than the group of all learners; the correlation was significant and showed some ability to accurately self assess computer literacy skill, but the extent to which NGLs self assessment rating predicated their actual computer literacy skill was limited, $r(294) = 0.41$, $p < .01$, $R^2 = .16$. Non-NGL self assessment scores correlated to actual skill to a greater extent than did NGLs and than did the group of all learners; non-NGLs appeared to more accurately self-assess, $r(73) = 0.54$, $p < .01$, $R^2 = .29$. Ultimately, the regression analysis indicates the extent to which learners accurately self assessed computer literacy skill, but it did not explain the degree to which learners may overestimate or underestimate their computer literacy skill.

Extending the analysis further, we examined the extent to which learners overestimated or underestimated computer literacy skill and compared the accuracy of NGLs and non-NGLs in self assessing computer literacy skill. A Wilcoxon matched-pairs signed-ranks test was applied to examine potential learner overestimation or underestimation of actual computer literacy skill when reporting self assessed skill level. With the self assessed data being an ordinal scale of measurement, a nonparametric statistical test was deemed most appropriate (Siegel & Castellan, 1988), and previous researchers have applied the Wilcoxon matched-pairs signed-ranks test to compare ordinal scaled self assessment data to interval scaled computer literacy skill scores

(Ballantine et al., 2007; McCourt Larres et al., 2003; van Vliet, Kletke, & Chakraborty, 1994). That method was replicated by this study.

The Wilcoxon analysis required paired data to be on the same scale. The learner IC^3FT scores were in interval scale, so learner self assessment scores were expressed as a percentage of the total maximum score possible. Individual learner actual computer literacy skill score was paired with their self assessment score expressed as a percentage, and the differences were analyzed using the Wilcoxon matched-pairs signed-ranks test. The analysis was repeated for all learners, NGLs, and non-NGLs. The results of the test are summarized in Table 3.

Table 3: Wilcoxon Matched-pairs Signed-ranks of Self-assessed and Actual Computer Literacy Skill Level for All Learners, NGLs and non-NGLs

	Mean Ranks						
Participants	IC^3FT[d]	LCLSA[e]	IC^3FT[d] > LCLSA[e]	IC^3FT[d] < LCLSA[e]	Ties	Z	*p*
All Learners [a]	53.28	57.75	150	219	0	-4.87	0.00[f]
NGLs[b]	54.34	60.62	105	190	0	-6.29	0.00[f]
non-NGLS [c]	49.06	46.27	45	29	0	-1.67	0.10

[a] $n = 369$
[b] $n = 295$
[c] $n = 74$
[d] Relative score achieved on IC3FT
[e] Relative score achieved on LCLSA items
[f] $p < .01$

Considering all learners in the study, the results indicated that learners overestimated their computer literacy skill level. The extent to which learners' self assessed score was more frequently higher than their actual skill level (IC^3FT < LCLSA) was statistically significant ($p < .01$). The significant overestimation held true for NGLs; that group also more frequently self assessed at a higher level than their actual skill level. In contrast, non-NGLs more accurately self assessed their computer literacy skill. There was not a significant difference in the frequencies of overestimation and underestimation by non-NGLs.

Research Question 2

Research question two focused on the relationship between learner age and learner computer literacy skills; we addressed the question in two ways. First, a one-way ANOVA addressed the relationship with age as a categorical variable: NGLs who were born in 1981 or later and non-NGLs who were born before 1981. That was followed by a regression analysis that examined the relationship with age as a continuous variable.

A one-way ANOVA was calculated with learner $IC3^FT$ score as the dependent variable to compare the two generations. The difference between NGL and non-NGL scores on the IC^3FT was statistically significant when analyzed as a categorical variable; NGLs scored higher on the IC^3FT than did their older counterparts (see Table 4).

Table 4: Differences Between NGLs and non-NGLs Scores on the IC^{3}FT

Variable	Sum of Squares	*df*	Mean Square	*F*	Sig.
Between Groups	164497.32	1	164498.32	6.99	.009
Within Groups	8627251.61	367	23507.50		
Total	8791748.93	368			

However, the regression analysis used to examine age as a continuous variable indicated that learner age was not a statistically significant predictor of learner score on the IC^{3}FT, $R^2 = .004$, $F(2, 367) = 1.51$, $p = .22$. Further, learner age was inversely related to learner score on the IC^{3}FT; as learner age decreased, learner score on the IC^{3}FT increased. Younger learners outperformed older learners, but the magnitude of the relationship was minimal, $\beta = -0.64$.

Discussion

The descriptive results of learner performance present a critical finding of the study. The 369 students participating in the study, a sample that was demographically representative of the student population of a large, urban community college, only answered correctly 53% of the 75 questions on an assessment aligned to an internationally developed standard of fundamental computer literacy skill. NGLs only achieved a mean score of 54% as a group; and, non-NGLs answered an average of 49% questions correct. In an era of near-ubiquitous computing technology, 78% of students failed to exhibit adequate computer literacy skills. This contradicts the assumption that students are generally computer literate given prior experience.

For producers and consumers of educational researchers, the results suggest the critical importance of identifying exactly what the constructs “tech-savvy” or “computer literate” mean when designing or reading research. For the general public and many educators, the two terms have become equivalent, accurate descriptors of an entire generation. Demographic researchers initiated the blurring of the two constructs by characterizing NGLs as a uniquely “tech-savvy” generation whose skill required radical, digital changes in the educational system. Educational researchers further contributed to the problem by drawing conclusions regarding NGLs’ generic “technology skills and abilities” based on research designs and instruments that focused on skills other than those to be considered at the core of computer literacy, a term of art within the industry. The result has been that mainstream media and many educators consider NGLs to be tech-savvy, which has come to be equivalent to being computer literate. The results of this study clearly illustrate that NGLs are not computer literate.

For faculty at all levels of education, this study highlights the difference between being tech-savvy and computer literate. The argument that NGLs possess computer literacy skills through years of osmosis living in a world of ubiquitous technology is false. Any differences in technology skill between NGLs and non-NGLs become irrelevant to an educator responsible for a classroom of students when NGLs do not exhibit adequate computer literacy skills. Those are the skills that have an impact on a learners’ ability to function in a classroom or a workplace: to use productivity applications, to access and evaluate online resources, and to understand how a computer functions. As faculty preparing students for future success, it is important to understand that tech savvy students are not necessarily computer literate; all students may need additional support to complete class assignments that require the use of technology.

For educational institutions, the results here contradict a wide-ranging discourse within educational literature. Bayne and Ross (2007) described the importance of becoming "more critical of a discourse which otherwise promises to over-determine our future understanding of the complex relationships between teacher, learner, technology and higher education" (para. 25). Research relying on the assumption that NGLs possess particular technology skills should be questioned; the implications for institutions are not minor. As noted earlier, sweeping changes to a range of instructional and student services have been proposed based on the technological skill and preferences of NGLs, including: library services, general education and instructional design, language learning, science education, nursing education, medical education, general student services, faculty development and facility management. From a curricular perspective, computer literacy courses should remain at all levels of education, and quite likely, a renewed effort should be made to align curricula with workplace and academic standards for computer literacy. The results of this study call into question the wisdom of calls for curricular changes or technology implementation based on the need to adapt to an entire generation of learners who are tech-savvy.

The first line of inquiry examined the accuracy of learner self assessment of computer literacy skills. Specifically, what was the relationship between learners' actual performance on the IC^3 Fast Track exam prior to beginning a college level computer literacy course and learner self-assessment of their computer literacy skills, as measured by the Learner Computer Literacy Self-Assessment? We hypothesized that learners would generally overestimate their computer literacy skills, following previous research (Ballantine et al., 2007; Grant et al., 2009; McCourt Larres et al., 2003). While learners' actual skill and self assessed skill were moderately correlated, the effect size was relatively small and there was a significant overestimation of computer literacy skill level when considering all learners in the study. This was consistent with prior research. It was notable that non-NGLs, older learners, did not significantly overestimate or underestimate their actual skill level. While they slightly underestimated their skill level, it was not significant; they exhibited a greater capacity to more accurately self assess their actual computer literacy skill level.

To address popular claims made regarding NGL computer literacy skills, which inherently establish learner age as a categorical variable, we considered learner age as both a categorical and a continuous variable. Thus, two research questions were evaluated. First, is there a difference between NGL (born after 1980) and non-NGL (born prior to 1981) scores on the IC^3FT exam prior to beginning a college level computer literacy course? Second, is there a relationship between learner age, as a continuous variable, and learners' score on the IC^3FT exam prior to beginning a college level computer literacy course? We anticipated no significant difference in learner computer literacy skills by learner age, as a dichotomous, categorical variable, and we expected learner age to be statistically and practically insignificant as a continuous variable predicting learner computer literacy skills.

The results, in comparison to our expectations, were mixed. Contrary to our expectation, the difference between NGL and non-NGL scores on the IC^{3}FT was statistically significant; when learner age was examined as a categorical variable, as it is in all existing NGL literature, younger learners systematically outperformed their older counterparts. The finding was inconsistent with prior research which assessed NGL computer literacy skill using comprehensive computer literacy skill assessments comparable to the one used in this study; Hardy et al. (2006) and Hilberg (2008) found NGLs' significantly lacking computer literacy skills. As a continuous variable, however, our expectation was accurate; learner age was not a statistically significant predictor of learner score on the IC^{3}FT and the relationship was minimal.

The initial result suggests there may be statistical validity to claims that NGLs are more computer literate than non-NGLs. Contrary to expectations and prior research, NGLs exhibited statistically better computer literacy skills than non-NGLs. However, given the results, that claim may have only theoretical significance, relevant to researchers for the sake of argument. Even while NGLs demonstrated greater computer literacy than non-NGLs, their mean score on the IC^{3}FT was 53%. As discussed previously, that level of proficiency does not warrant calls for radical changes in educational environments to meet the needs and demands of NGLs. Further, any statistical validity of the claim that NGLs are more computer literate than non-NGLs is undermined by the analysis of learner age as a continuous variable. When learner age is considered much more precisely as a continuous variable, there is no statistically or practically significant effect on learner computer literacy scores. Learner age has a negligible effect ($\beta = -0.64$). The result of the categorical analysis appears to be influenced by the arbitrary definition of learner age groups.

The most critical implication of the results lies in the juxtaposition of the two findings; this study demonstrates the possibility of achieving different results regarding statistical significance when using different analytical methods. Within an educational context, the differentiation of learners by generational membership is arbitrary, and analyzing learner differences by age group rather than learner age sacrifices statistical fidelity by scaling the data down from ratio data to ordinal data. The imprecision created in that methodological choice creates imprecision in the results. Thus, the conclusions, policy decisions, curricular changes and technology implementations advocated based upon assumptions regarding generational differences in technology skill are called into question by these results.

Conclusion

The study addressed a number of gaps identified within the body of literature focused on the technology skills of Net Generation Learners by using a validated construct of and assessment instrument to directly measure and compare the computer literacy skills of NGLs and non-NGLs in a community college environment. Contrary to assumptions made by mainstream media and many educators, NGLs are not computer literate; younger learners were only able to answer correctly, on average, 53% of questions on the Internet and Computing Core Certification Fast Track (IC^3FT) exam. Overall, only 1 out of 5 of all study participants demonstrated adequate computer literacy skills.

The results extend prior research by differentiating non-NGLs' and NGLs' ability to self-asses computer literacy skill. NGLs significantly overestimated their computer literacy skill; in contrast, non-NGLs were relatively accurate in their ability to accurately self assess. They did not exhibit estimated skills that were significantly different from their actual skill level. This may be significant within the context of popular beliefs about the skill of NGLs and non-NGLs.

The study made a unique contribution to the NGL literature by analyzing the effect of learner age on computer literacy skill with age both as a categorical and as a continuous variable; all reviewed existing literature evaluated learner age as a continuous variable. The results of this study challenge the results of previous studies which analyzed age as a dichotomous variable by demonstrating that different statistical results may be achieved depending upon the analytical method. The methodological choice to scale data down from a ratio to an ordinal scale creates imprecision that can result in conflicting results regarding statistical significance. Future inquiry regarding technological skills and preferences of NGLs would benefit by including analysis of age as a continuous variable.

The results call into question the generalization that Net Generation Learners are "technologically" savvy, or at least, this study reframes the debate within a definition of computer literacy relevant to academic and workplace environments. Just because younger learners have been using computing technology informally for a number of years, educators at all levels should not ascribe any particular level of computer literacy skill to groups of learners.

CHAPTER IV

ACQUISITION OF COMPUTER LITERACY SKILLS BY NET GENERATION LEARNERS IN COMMUNITY COLLEGE

As a result of having "grown up digital" (Tapscott, 2008), today's younger learners have often been described as inherently tech-savvy and computer literate. They reportedly have different attitudes toward and habits when using computer technology. Proponents of generational differences regarding the use of technology have categorized and labeled the current young adult generation as the Net Generation (Howe & Strauss, 2000), millennials (Tapscott, 2008), new millennium learners (Pedro, 2006), and digital natives (Prensky, 2001b). According to proponents, Net Generation Learners (NGLs), the term used in this report, "all have the skills to use those technologies" (Palfrey & Gasser, 2008, p. 1). Ubiquitous technology has shaped their minds differently to the extent that they possess a distinctly different learning style from their predecessors (Brown, 2005; Frand, 2000; Prensky, 2001b; Tapscott, 2008). Adapting to tech savvy digital natives has become a mantra within education because they are "not the people our system was designed to teach" (Prensky, 2001b, para 2).

The rhetoric surrounding the argument may be shaping decisions at all levels of education; the concept of the tech savvy digital native has been repeated so often that a general understanding has developed in higher education that younger learners are inherently computer literate (Bayne & Ross, 2007). The need to adapt to learners who readily and willingly use a range of technologies pervades educational literature as a reason to modify, change, or adapt curriculum or some aspect of institutional teaching and learning, including for example: library services (Click & Petit, 2010); general education and instructional design (Collier, 2010; Conole, 2010; Philip, 2007; Wilson, 2008); student services (Lippincott, 2010); and facility management (McVay, 2008).

A significant body of empirical research questions the claims regarding the inherently computer literate and tech-savvy NGL. Contrary to popular opinion, NGLs have been found to not be significant users of emerging technologies; their use is limited in scope and sophistication (Bullen et al., 2009; Burhanna et al., 2009; Jones & Cross, 2009; Judd & Kennedy, 2010; Selwyn, 2009). Quite simply, most students do not fit the Net Generation stereotype (Nagler & Ebner, 2009). Thus, researchers “must be wary of overgeneralising [*sic*] the distinctive features of this generation . . . based on assumptions about technology use or preferences" (Kennedy et al., 2007, p. 522).

The systematic literature review documented critical gaps in the evidence regarding the existence of generational differences in the level of computer skill and the extent to which NGL students arrive in post-secondary settings with the technology skills they need. The majority of available NGL research focused on learners’ simple familiarity with new or emerging technologies. Only 8 of the 52 studies included in the review directly measured learner computer literacy skills; instead, researchers have relied heavily on self-reported and self-assessment data yielding only descriptive analyses or reported only descriptive data with few direct comparisons between NGLs and non-NGLs. The relatively few studies that directly measured participant computer literacy skills were limited by skills assessment instruments that were limited in scope or too varied in the constructs they measured, and none of those studies compared NGL and non-NGL performance on a computer literacy skills assessment. Finally, current literature has been conducted primarily in university settings; research conducted in community colleges was absent from the literature.

More specifically, studies that have examined methods by which learners acquire computer literacy skills have been limited. Researchers have suggested the need for introductory level computer literacy courses and the benefit of direct instruction to learners, but the studies addressed a limited scope of computer literacy skills (Johnson, Bartholomew, & Miller, 2006; Tesch et al., 2006; Wallace & Clariana, 2005), relied on student surveys or self assessments (Keengwe, 2007), or did not compare the computer literacy skills of NGLs and non-NGLs.

Purpose and Research Questions

This study addressed the identified gaps in the literature by using a causal-comparative research design to examine the effectiveness of different types of instruction in supporting student acquisition of computer literacy skills. Examining instructional methods attends to underlying assumptions that NGLs have become technology savvy by learning informally through simple access to and use of ubiquitous computer technology and to potential differences in the instructional needs between NGL and non-NGL students. To measure student computer literacy skills, the study relied on the Internet and Computing Core Certification Fast Track (IC^3FT), which assesses (a) knowledge of hardware and software necessary for basic use of computing technology; (b) production of documents using word processing, spreadsheet, and presentation software; and (c) safe and productive use of communication networks to access, evaluate, create and share information. The three research questions for the study were:

1. What is the relationship between learner age and learner computer literacy skills after completing a college level computer literacy course?

    a. What is the difference between Net Generation Learners' and Non-Net Generation Learners' scores on the IC^3FT after completing a college level computer literacy course?

    b. What is the relationship between learner age, as a continuous variable, and learner's score on the IC^3FT after completing a college level computer literacy course?

2. What is the difference between learners completing courses that employ comprehensive-formal computer literacy instruction, limited-formal computer literacy instruction, and informal computer literacy instruction on scores on the IC^3FT?

3. What is the differential effect of the three types of instruction in computer literacy courses for Net Generation Learners and non-Net Generation Learners as measured by the IC^3FT?

Prior to the study, it was hypothesized that learners would exhibit insufficient computer literacy skills and age would not be a predictive factor as a categorical or as a continuous variable. Further, we expected a significant main effect of type of instruction on computer literacy skill but did not expect learner age to interact with type of instruction to influence computer literacy skill. The results were expected to contribute to the debate surrounding NGLs and their assumed skill with computing technology.

Method

The study was conducted during the Spring 2010 semester across three different campuses of a comprehensive community college that serves approximately 30,000 students in a large metropolitan-to-suburban area. The study was conducted to better understand the computer literacy skills and needs of college learners and the learning experiences through which they acquire those skills. The results of the pretest were reported previously with an emphasis on the differences between NGLs and non-NGLs and the accuracy of learner self-assessment. This report focuses on the effectiveness of different types of instruction for facilitating learner acquisition of computer literacy skills of NGLs and non-NGLs.

Participants

The study initially included 428 learners with an overall posttest response rate of 49.3%. For the pretest, 369 students provided valid responses. Data collected from 20 students were removed from the study since the students were enrolled in more than one course section selected for the study; 39 students who failed to complete either the skills assessment or the self assessment survey or a portion of one and were removed. During the posttest, 156 students did not complete the IC^{3}FT, and two students' scores were removed from the analysis: one only completed a portion of the IC^{3}FT, and one submitted a completed test without answering any questions.

Of the 369 who completed the pretest, 211 participants fully completed the posttest administration of the IC^3FT. The overall 51.7% rate of attrition occurred primarily due to absences on the day of a test administration and withdrawals from the course prior to the posttest administration; the specific reason a student did not attend class for the posttest could not be ascertained given available data. Two students chose to opt out of the study prior to the posttest. Given the extent of learner attrition from pretest to posttest, we compared the demographic characteristics and pretest scores of the 158 learners who dropped from the study prior to the posttest to those who completed the study; results are reported and discussed below.

The study sample of 211 students proved to be representative of institutional demographics based on data for the study in Spring 2010 and available institutional reports for Fall 2009; the only exception was participant gender. This sample was a subset of a larger sample of students that completed only a pretest; as noted previously, the pretest results were reported in a prior manuscript. Of participants in this portion of the study, 56.9% were male (compared to 44.1% institution-wide) and 43.1% were female (55.9% institution-wide). Students' reported ethnicity indicated 39.3% Hispanic (38.5%), 38.4% Caucasian (41.1%), 9.5% African American (11.0%), and 13.3% distributed among other ethnicities (9.4%). Further, 56.4% of the students were enrolled full time at the time of the study. Overall, 40.3% indicated enrollment in an academic program, 34.6% were enrolled in technical programs, and the remaining 25.1% were undecided or were not certain.

Given the focus of the study, the distribution of participant ages was of significant concern. Study participants ranged in age from 18 to 53 years of age, with an average age of 24.31 years old. NGLs comprised 77.3% of participants in the study, with an average age of 21.2 years; the remaining 22.6% of participants were non-NGLs and averaged 34.9 years of age. The age demographic of the sample was similar to institutional demographics. In Fall 2009, 82.4% of college learners were 29 years or younger (Gonzalez et al., 2009); the sample for this study included 81.6% of participants in the same age group. The study's sample was statistically representative of the student population of the college in which the study was conducted.

Procedure

The sampling method focused on intact class sections. Courses that had previously met the institutional computer literacy requirement were classified into three categories based on how the course objectives related to computer literacy skills: *comprehensive formal instruction*, *limited formal instruction*, and *informal instruction*. The distinctions drawn among types of instructional experiences was based on definitions of formal and informal learning offered by Trinder, Guiller, Margaryan, Littlejohn, and Nicol (2008). Formal instruction and learning is structured in terms of objectives, time, and support and undertaken intentionally by the learner; in contrast, informal learning occurs beyond the scope of the form course and may not be structured. The notion of comprehensive versus limited instructional experiences focused on the scope of learning objectives covered by the course in comparison to those addressed by the IC^3 construct.

Comprehensive formal instruction courses focused on a broad range of computer literacy skills and included those skills as explicit outcomes of the course in the institutional syllabi. In courses like *Introduction to Computers* and *Integrated Software Applications*, learners engaged course objectives, materials, and content related directly to the objectives identified by the IC^{3}FT, which was used to operationalize computer literacy. Limited formal instruction courses focused on computer skills and included those skills as explicit outcomes of the course in the institutional syllabi; however, the range of skills covered by these courses was intentionally limited to focus on specific software or hardware. In courses like *Basic Computer Aided Drafting*, *Introduction to Computer Graphics, Advanced Spreadsheets*, *Introduction to PC Operating Systems,* and *Introduction to Programming,* learners engaged more narrowly defined objectives, materials and content that failed to address one or more skill or knowledge domains identified by the IC^{3}FT. Informal instruction courses did not focus on computer skills as outcomes of the course as defined by the institutional syllabi; learner use of computers was incidental to the course objectives. In courses like *Composition I, Argumentation & Debate,* and *Journalism*, learners and faculty may have elected to use computer technology to complete course activities; thus, learner acquisition of computer literacy skills through these courses was not an intentional outcome of the course and may only have occurred through informal, learner-directed learning experiences. Courses were independently categorized by the researcher and an instructional administrator; 95% inter-rater agreement, 21 of 22 courses, was achieved initially, and the classification of the remaining course was resolved in conference.

Ten individual course sections of each instructional type were selected for inclusion in the study in a stratified random sample. Students blindly self-selected enrollment in sections of the courses selected for inclusion in the study; students were not aware of the study or the sampling process when they elected to enroll in a particular course or section. A minimum of 10 and a maximum of 30 students were expected to be enrolled in each of the 30 course sections selected for the study; the original sampling of the in-tact course groups anticipated approximately 600 potential participants.

Instruments

Students twice completed the Internet and Computing Core Certification Fast Track (IC^3FT) and an accompanying survey. During the third week of the Spring 2010 semester, all participants in selected course sections were invited to complete the IC^3FT and the researcher developed Learner Computer Literacy Self Assessment (LCLSA) survey. The posttest was conducted during the fourteenth week of the Spring 2010 semester; all participants were invited to retest on the IC^3FT exam and to complete the researcher developed Learner Course Evaluation (LCE) survey. Prior to both test administrations, participants were given a hard copy of the informed consent document noting their rights and protections as voluntary participants in the study. All sessions were administered by a trained facilitator in a computer lab during regularly scheduled class time. Participants received step-by-step instructions to access and complete each instrument online.

During the pretest battery, participants first completed the Learner Computer Literacy Self Assessment (LCLSA) survey to measure self assessment of computer literacy skills, and during the posttest battery, participants complete the Learner Course Evaluation (LCE) survey to again measure learner self assessment of computer literacy skills and to solicit participant feedback regarding the relevance of instruction to computer literacy. Both instruments were based on the Information and Communication Technology (ICT) Fluency Questionnaire developed by Hilberg (2008) for a similar study. The data from the LCLSA and the LCE were not used for this portion of the research agenda; a more complete description of the LCSLA and results of learner self-assessment of computer literacy were reported previously, and LCE data will be reported in future reports of study results.

Internet and Computing Core Certification Fast Track (IC^{3}FT). To directly measure learners' computer literacy skills, participants completed the Internet and Computing Core Certification Fast Track (IC^{3}FT, Certiport, Inc, 2008a, 2008b, 2008c) on two occasions: during the third week as a pretest and during the fourteenth week as a posttest. A 75-question, one-hour version of the complete Internet and Computing Core Certification Exams (IC^3, Certiport, Inc, 2008a, 2008b, 2008c; Certiport, Inc., 2004)**,** the IC^{3}FT included 25 questions focused on the objectives covered by each of the three IC^3 component certification exams: Computing Fundamentals, Key Applications, and Living Online. Each set of 25 component exam questions was randomly drawn from a larger pool of 90 practice exam questions; all questions were presented in randomized order on the IC^{3}FT. The pool of practice exam questions consisted of items constructed using the same methods and principles used to develop the IC^3 certification exams. The IC^{3}FT was scored and reported in the same manner as the certification exams; the score was calculated as a simple percentage of correct questions and expressed on a scale of 0 to 1000. The passing score on the IC^{3}FT was similar to the certification cut score of 650. For the purpose of this study, the total exam score on the IC^{3}FT operationally defined learners' actual computer literacy skills; the total exam score was the most appropriate score to examine learner actual computer literacy skill.

The IC^{3}FT leveraged the item construction and selection methods designed, developed, and validated for the IC^3 certification exams (Haber & Stoddard, n.d.). Each of the three IC^3 component exams was defined by 3 to 4 knowledge domains that were further operationalized via specific objectives and tasks (Certiport, Inc., 2004). The IC3 was validated by empirical, theoretical, statistical, and conceptual evidence to ensure it measures an individual's computer literacy skills Donath Group (Certiport, Inc., 2003). Initially, industry and academic research was conducted to identify core competencies including focus groups with subject matter experts. A job task analysis defined critical skills required of an IC^3 certified professional and served as the basis of content validity for the exams. Given the research and job task analysis, an exam blueprint was developed for each IC^3 component exam; the blueprints were revised and validated via a survey of over 270 subject matter experts regarding each exam objective. Subject matter experts then wrote test items that were reviewed by colleagues and researchers, pilot tested at more than 40 different testing locations, analyzed for item difficulty and discrimination, and selected for inclusion in the final version of the exam. All exam questions used one of two formats: performance-based items or traditional linear items. When testing a learner's ability to complete specific tasks within an application, performance-based test items using an interactive simulation of the application required learners to perform actual tasks. General skills and knowledge not tied to the use of a specific application used traditional linear item formats such as but not limited to multiple-choice or multiple-response questions (Certiport, Inc, 2008a, 2008b, 2008c). All items had equal weight in the calculation of the exam score; the score was calculated as a simple percentage of correct questions and expressed on a scale of 0 to 1000. Finally, researchers determined a cut score based on level of mastery, standard deviation, test score means, and decision error (Certiport, Inc., 2003).

With computer literacy skills measured by the IC^{3}FT as the dependent variable in the study, type of instruction and learner age were independent variables in the design. Types of instruction, described earlier, included comprehensive formal instruction, limited formal instruction and informal instruction. Learner age was considered as both a continuous variable and as a categorical variable for the purposes of the study. Given the existing literature's claims regarding the ability of learners as categorized by age, students born after 1980 were designated as Net Generation Learners (NGLs); older students were considered non-Net Generation Learners (non-NGLs). To further consider the relationship between learner age and computer literacy skills, analyses including learner age also examined learner age as a continuous variable; this considered age at the highest scale of data possible, which is typically preferable (Stevens, 1951).

Results

Prior to principal analysis, we explored the data to ensure assumptions were met for the statistical tests used in the analysis. Homogeneity of variance was assumed since

Levene's Test for Equity of Variances indicated no significant difference between the error variance across groups, F (5, 211) = 1.262, p = .28.

Learner actual computer literacy skill was calculated as the total exam score on the IC^3FT pretest and posttest, respectively; the score was expressed on a scale of 0 to 1000 representing a simple percentage of questions answered correctly. Table 5 displays the descriptive statistics across all combinations of variables for both administrations of the IC^3FT.

Table 5: IC^3FT Scores Before and After Three Types of Courses for NGL and non-NGL Students

		Pretest		PostTest	
Type of Instruction	*n*	*M*	*SD*	*M*	*SD*
Informal					
NGL	48	522.48	147.92	497.73	163.82
non-NGL	13	467.62	149.96	512.77	194.97
Total	61	510.79	148.83	500.93	169.31
Limited Formal					
NGL	48	640.85	142.27	647.52	178.85
non-NGL	13	572.23	113.48	602.00	129.03
Total	61	626.23	138.69	637.82	169.53
Comprehensive Formal					
NGL	67	518.03	121.72	552.45	158.97
non-NGL	22	496.41	142.01	606.64	146.90
Total	89	512.70	126.54	565.84	157.02

For the primary analysis, a 2 x 3x2 ANOVA was conducted to examine the main and interaction effects of learner age group (Net Generation Learners, non-Net Generation Learners), type of instruction (comprehensive-formal, limited-formal, informal), and test time (pretest, posttest) on the IC^3FT. Table 6 displays the summary of results for the ANOVA analysis. Learner age did not have a statistically significant main effect on learner computer literacy skill ($p = 0.40$). Type of instruction had a statistically significant effect on learner skill level ($p = .001$), but the effect size was very limited ($\eta^2 = .063$). The interaction effect of age group and type of instruction was not significant ($p = .427$). Table 7 displays the within subjects contrasts for the three variables in the ANOVA.

Table 6: Difference Between Groups on IC^3FT Posttest Scores

Variable	Sum of Squares	*df*	Mean Square	*F*	Sig.	η^2
Age Group	28797.19	1	28797.19	0.71	.400	.003
Type of Instruction	561322.35	2	280661.17	6.94	.001	.063
Age Group x Type of Instruction	69048.92	2	34524.46	.85	.427	.008
Error	8292153.11	205	40449.53			

Table 7: Difference Within Groups on IC^{3}FT Pretest to Posttest Scores

Variable	Sum of Squares	*df*	Mean Square	*F*	Sig.	η^2
Time of Test	79322.64	1	79322.64	15.412	.000	.070
Time of Test x Age Group	55684.98	1	55684.98	10.820	.001	.050
Time of Test x Type of Instruction	62475.71	2	31237.85	6.07	.003	.056
Time of Test x Age Group x Type of Instruction	9531.95	2	4765.98	.93	.398	.009
Error	1055076.91	205	5146.72			

Considering the interaction effects further highlights the statistically significant difference between learner pretest and posttest scores and the significant effect of age group on learner scores from pretest to posttest. Figure 2 illustrates the change from pretest to posttest among the different types of instruction.

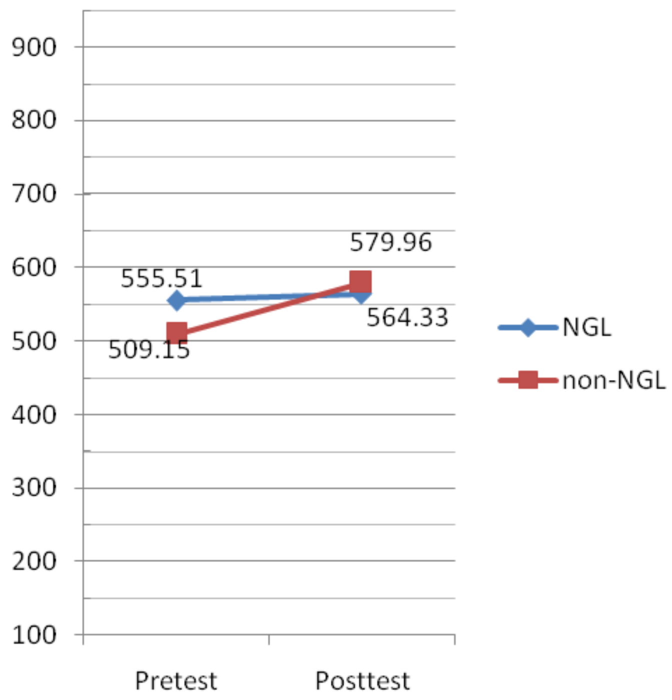

Figure 1: Pretest to Posttest Score by Age Group

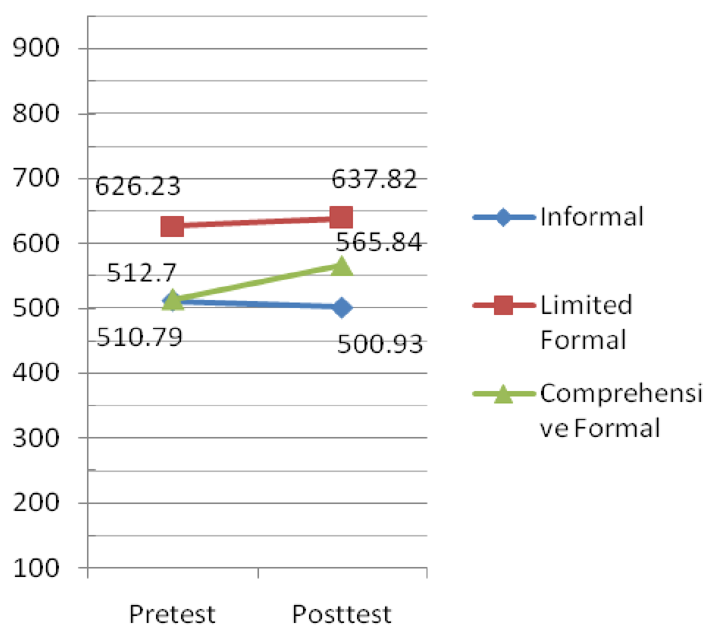

Figure 2: Pretest to Posttest Score by Type of Instruction

To consider age as a continuous variable, a multiple regression analysis was conducted with IC^{3}FT posttest scores as the dependent variable and learner age and type of instruction as independent variables. The regression revealed learner age, as a continuous variable, and type of instruction were not statistically significant predictors of learner score on the IC^{3}FT posttest (see Table 8, Table 9).

Table 8: Predictors of IC^{3}FT Posttest Score

Variable	B	β	*p*	95% CI
Constant	475.67		.000	[377.35, 573.98]
Learner Age	1.59	0.06	.353	[-1.79, 4.97]
Type of Instruction	25.08	0.12	.079	[-2.94, 53.10]
R^2	.02			
F	2.2*			

Note. N = 211. CI = confidence interval. * p = .11

Table 9: Correlation of Predictors of IC^{3}FT Posttest Score

Variable	1	2	3
1. IC^{3}FT Posttest	--		
2. Learner Age	.079	--	
3. Type of Instruction	.130	0.121	--

To address research questions two and three, similar analyses were conducted with the addition of learner pretest scores on the IC^{3}FT as a covariate to statistically control for pre-study differences between learners. First, a 2 x 3 ANCOVA considered the main and interaction effects of learner age group and type of instruction. Second, a multiple regression analysis was conducted to examine the effect of learner age as a continuous variable.

First, a 2 x 3 ANCOVA was calculated to examine further the main and interaction effects of learner age group (Net Generation Learners/non-Net Generation Learners) and type of instruction (comprehensive-formal/limited-formal/informal) on learner scores on the posttest administration of the IC^3FT (see Table 10). Learner IC^3FT pretest score was used as a covariate to statistically control the influence of pre-study differences among participants regarding computer literacy skills. Planned contrasts were calculated, with a Bonferroni correction for multiple contrasts, to examine differences among Types of Instruction and Learner Age Group.

Table 10: Effect of Age Group and Type of Instruction on Computer Literacy Skill with Pretest Score as a Covariate

Source	Sum of Squares	*df*	Mean Square	*F*	Sig.	η^2
IC^3FT Pretest Score	3440865.86	1	3440865.86	334.10	.000	.621
Age Group	100005.13	1	100005.13	9.71	.002	.045
Type of Instruction	117594.33	2	58797.16	5.71	.004	.053
Age Group x Type of Instruction	20424.53	2	10212.26	.99	.373	.010
Corrected Model	4085147.71	6	680857.95	66.11	.000	.660
Error	2100979.56	204	10298.92			

There was a statistically significant effect of Age Group on posttest IC^3FT scores after controlling for the effects of learner pretest IC^3FT scores, p=.002. The effect size of age group was limited, η^2=.045. A planned contrast revealed an estimated, covariate-controlled mean non-NGL posttest score of 605.07, CI95% [575.10, 635.03], *SE*=15.20. Once controlled for influence of pretest scores, NGLs estimated IC^3FT posttest score was 551.17, CI95% [535.22, 567.11], *SE*=8.08.

Type of Instruction had a statistically significant effect on learner posttest IC^3FT score, but the effect size was minimal, p = .004, η^2=.053. For participants in comprehensive formal courses, a planned contrast revealed an estimated, covariate-controlled mean posttest score of 615.43, CI95% [590.45, 540.32], *SE*=12.62. Participants in informal learning (552.71, CI95% [521.02, 584.10], *SE*=16.08) and limited formal learning experiences (566.20, CI95% [534.30, 598.12], *SE*=16.19) scored lower on the IC^3FT. A Bonferroni post hoc comparison of types of instruction showed that learners in comprehensive formal instructional courses performed significantly better than learners in courses relying on informal and limited formal instruction of computer literacy skills (see Table 11). The remaining pair-wise comparison (informal vs. limited formal) was not statistically significant.

Table 11: Bonferroni Comparison for Type of Instruction

Comparison	Mean IC³FT Posttest Difference	Std. Error	95% CI Lower Bound	95% CI Upper Bound
Informal Learning vs. Comprehensive Formal	-62.2*	20.19	-102.52	-22.91
Limited Formal vs. Comprehensive Formal	-49.23*	20.83	-90.30	-8.16
Informal Learning vs. Limited Formal	-13.49	23.17	-69.43	42.45

* $p < 0.05$

The interaction effect of age group by type of instruction was statistically insignificant with little practical explanatory value, $p = .37$, η^2=.01. The interaction effect was significantly less predictive than the two factors considered independently. Group means adjusted for pre-study differences yielded results in which learners in comprehensive formal learning courses outperformed other groups (see Table 12).

Table 12: Pretest Adjusted IC^{3}FT Posttest Score for Age Group x Type of Instruction Interaction

Type of Instruction	*n*	*M*	*SE*	95% CI	
				LL	UL
Informal					
NGL	48	519.11	14.69	490.14	548.08
non-NGL	13	586.32	28.43	530.26	642.38
Limited Formal					
NGL	48	556.34	15.47	525.83	586.85
non-NGL	13	576.07	28.18	520.50	631.64
Comprehensive Formal					
NGL	67	578.06	12.48	553.46	602.66
non-NGL	22	652.81	21.79	609.86	695.76

Second, a multiple regression analysis was conducted with IC^{3}FT posttest scores as the dependent variable and learner age, type of instruction, and IC^{3}FT pretest scores as independent variables. Entering the IC^{3}FT pretest scores as an independent variable within the model controlled for pre-study differences among participants and groups. The regression revealed both learner age, as a continuous variable, and type of instruction as statistically significant predictors of learner score on the IC^{3}FT posttest; Table 13 summarizes the results of the regression, and Table 14 provides the correlation between factors. While the strength of the relationships were limited, age was positively related to learner scores on the posttest, β=.13, as was type of instruction, β = .14.

Table 13: Predictors of IC^{3}FT Posttest Score with IC^{3}FT Pretest Score as Covariant

Variable	B	β	*p*	95% CI
Constant	-86.43		.038	[-167.99, -4.87]
IC^{3}FT Pretest Score	0.94	0.80	< .000	[0.85, 1.04]
Age	3.31	0.13	.001	[1.29, 5.33]
Type of Instruction	28.43	0.14	.001	[11.75, 45.11]
R^2	.65			
F	130.97*			

Note. N = 211. CI = confidence interval. * $p < .001$

Table 14: Correlation of Predictors of IC^{3}FT Posttest Score with IC^{3}FT Pretest Score as Covariant

Variable	1	2	3	4
1. IC^{3}FT Posttest	--			
2. Learner Age	.079	--		
3. Type of Instruction	.130	.121	--	
4. IC^{3}FT Pretest	.783	- .089	-.031	--

Given the high rate of attrition from pretest to posttest, we compared the demographic characteristics and pretest scores of the 158 learners who dropped from the study prior to the posttest to the characteristics and scores of learners completing the study. A 2 x 2 x 3 ANOVA was used to compare the mean scores on the pretest of learners based on study completion (not complete/complete), age group (NGL/non-NGL), and type of instruction (comprehensive formal/limited formal/informal). The learner ages of the two groups was examined by a t-test, and χ^2 analyses were used to examine differences between the two groups regarding age group, gender, ethnicity and the type of instruction to which they were assigned.

First, learners completing only the pretest had significantly lower scores on the pretest than learners who completed the study, and that difference held across all groups analyzed within the study; Table 15 summarizes the results. NGLs and non-NGLs completing the study performed significantly better on the pretest than students of the same age who did not complete the study, and learners completing the study in informal, limited formal and comprehensive formal learning environments performed better than students in the same group that did not complete the study.

Table 15 Comparison of IC^{3}FT Pretest Scores for Students Completing and Not Completing the Study

Source	Sum of Squares	*df*	Mean Square	*F*	Sig.	η^2
Study Completion x Age Group	166499.90	2	83249.95	3.84	.022	.021
Study Completion x Type of Instruction	694477.98	4	173619.50	8.00	.000	.081
Corrected Model	959500.93	7	137071.56	6.32	.000	.109
Error	7832248.05	361	21695.98			

Second, between the group that completed the study and those that did not, there was not a significant difference in the distribution of learners across age group, gender, ethnicity or the type of instruction to which they were assigned. The age of students that completed the study did not differ significantly from those dropped from the study. The mean age of learners completing the study was 24.31 years old compared to 23.67 for learners only completing the pretest, $t(1) = .775$, $p < .379$, and there was not a significant difference between the number of NGLs and non-NGLs completing the study and not, $\chi^2(1) = 2.23$, $p = .14$. Also, the proportion of students completing the study did not differ by gender, $\chi^2(1) = 1.15$, $p = .29$, by ethnicity, $\chi^2(6) = 6.26$, $p = .40$, or by the type of instruction to which they were assigned, $\chi^2(2) = 1.93$, $p = .38$. The only significant difference between the pretest and posttest participants was the differences in their pretest results described above.

Discussion

The most basic, descriptive result has significant implications; the idea that younger learners “all have the skills to use” computer technology (Palfrey & Gasser, 2008, p. 1) appears to be a myth. Further, the results here validate claims by previous researchers that direct instruction benefits learners and is necessary to support effective acquisition of computer literacy skills; examining learner acquisition of a full scope of computer literacy skills aligned to an established definition of computer literacy and comparing the skills of NGLs and non-NGLs, this study contributes to and extends the current body of knowledge.

Learner Age Effect on Computer Literacy Skill

The first research question addressed the relationship between learner age and learner computer literacy skills after learners completed a college level computer literacy course. The analyses considered age as both a categorical and as a continuous variable; neither found learner age to be a statistically significant predictor of learner computer literacy skill as exhibited on two different administrations of the computer literacy skills assessment: one at the beginning of the semester and one at the end. The results are different from findings in a previous analysis of the pretest results in which learner age was statistically significant. Figure 1 highlights an explanation for the differing results. Non-NGLs improved their computer literacy skills from the beginning to the end of the semester; the statistically significant gains experienced by that group surpassed the posttest performance of NGLs and overwhelmed the statistically significant advantage held by NGLs at the beginning of the semester. The within subjects analysis supported that explanation. There was a statistically significant difference in computer literacy from pretest to posttest; that suggested learner scores potentially improved significantly from pretest to posttest. Further, The ANCOVA and regression analysis using pretest scores as a covariate also supported that explanation. Both found learner age to be statistically significant when pre-study differences were controlled, and learner age was positively related to learner computer literacy skill. The results suggested non-NGLs were more successful in learning and improving computer literacy skills than their younger counterparts and emphasized the importance of the subsequent research questions focused on the efficiency of instructional methods to support learner acquisition of computer literacy skills.

Type of Instruction Effect on Computer Literacy Skill

Research question two asked, "Is there a difference between learners completing courses that employ comprehensive-formal computer literacy instruction, limited-formal computer literacy instruction, and informal computer literacy instruction on scores on the IC3FT exam?" We expected a main effect of Type of Instruction on IC^3FT; we believed the results would reveal a statistically significant effect with a moderate effect size indicating participants in the comprehensive formal instructional treatment outperformed participants in the limited formal and informal instruction groups. The findings validate prior research claims that direct instruction focused specifically on computer literacy skills was needed to ensure learner success in subsequent courses requiring the use of information technology (Johnson et al., 2006; Keengwe, 2007; Tesch et al., 2006; Wallace & Clariana, 2005), .

Descriptively, there appeared to be mixed results for the three types of instruction. Figure 2 indicated that learners in informal instruction courses experienced degraded computer literacy skill from the beginning to the end of the study; learners in limited formal courses experienced slight gains, and in contrast, comprehensive formal instruction produced noticeable gains. At first glance, the graphic clearly distinguishes the comprehensive formal instruction courses from the other two.

The initial 2 x 3 x 2 ANOVA indicated type of instruction was a statistically significant factor of learner computer literacy skill, and the within subjects contrast indicated a statistically significant difference in computer literacy from pretest to posttest for the different types of instruction. However, the effect size was quite limited, and the multiple regression analysis suggested differently. The reason for the difference in the two analyses likely was the different treatment of age by the two analytical methods. The gain in fidelity of data by treating learner age as a continuous variable rather than a categorical one allowed learner age to explain more of the variance not accounted for by learner age as a categorical variable; that suppressed the statistical significance of the type of instruction. The results appeared consistent with the mixed results for type of instruction observed in Figure 2.

The use of covariates to address the type of instruction appeared critical. Table 5 exposed a potential bias in student self-selection into course sections. The pretest score for learners in limited formal courses was higher than the other two types of instruction. It was reasonable to expect that learners with greater proficiency in computer literacy would enroll in courses focused on more narrow, specialized computer skills, like Advanced Spreadsheets or Computer Aided Drafting.

When controlling for pre-study differences in computer literacy skills between learners, type of instruction had a statistically significant effect on learner computer literacy skill given two administrations of the skills assessment. The multiple regression and ANCOVA analyses, which both used pretest scores as a covariate, indicated type of instruction was statistically significant although the effect size was small. Controlling for pre-study differences the statistical significance of learner age and type of instruction indicated that older learners exhibited greater computer literacy skill through the course of the semester. Further, the planned contrast revealed a statistically significant difference between learners in the comprehensive formal courses and both the limited formal and informal courses. However, there was not a significant difference between informal learning and limited formal instruction. Participants receiving more direct instruction regarding computer literacy skills outperformed those participants expected to learn the same skills in more informal situations.

The implication of the results is that more direct instruction is needed for learners to acquire computer literacy skills effectively. For faculty, instructional activities requiring the use of computer technology will require more direct treatment of computer technology skills rather than assuming learners already possess the requisite skills or that they will be able to learn the skills informally. For institutions, if a student cannot demonstrate adequate computer literacy skill on a comprehensive skills assessment, she should be required to complete a course that directly addresses a comprehensive scope of computer literacy skills. That is the most effective instructional approach to support learner acquisition of computer literacy skills. Institutions should not be relying on other types of courses to satisfy computer literacy requirements, and they should not remove the requirements from the curriculum. Finally, educational policymakers should reconsider excluding computer literacy skills from general education outcomes or core objectives, given the importance of technology skills to future academic and workplace success.

Learner Age and Type of Instruction Interaction Effect

The final research question focused on the differential effect of the three types of instruction in computer literacy courses for Net Generation Learners and non-Net Generation Learners? We did not expect the interaction effect of learner age and type of instruction to have a statistically significant effect on learner computer literacy skill. Proponents of NGLs have argued that younger learners have learned skills as they have "grown up digital" within the ubiquity of technology; the argument implies younger learners have the capacity to learn technology informally more efficiently than non-NGLs.

The interaction effect of learner age by type of instruction was not statistically significant. However, the estimated results, adjusted for pre-study differences, of the different groups indicated that NGLs in informal learning environments performed less well than all other groups, that non-NGLs in informal learning environments outperformed NGLs across all instructional treatments, and that non-NGLs in comprehensive formal courses performed better than all other groups. The results should be interpreted carefully in this instance given the lack of statistical significance.

The results begin to challenge assumptions regarding the influence informal computer use has on NGL proficiency with computer technology. A key premise of the NGL argument is that younger learners have grown up with access to computer technology and that access and use of computer technology in informal learning environments translates to meaningful skill or ability to use a broader range of technology. If that were true, NGLs in the informal learning type of instruction should have performed as well or better than the other groups; more specifically and at least, participants within the NGL by Informal group should have outperformed the non-NGL by Informal group. The results indicated that is not the case. This is consistent with previous findings that simple access to and use of computers does not "automatically transform education students into new millennium learners" (Pedro, 2009) and does not translate to meaningful, sophisticated use (Kirkwood & Price, 2005). NGL proponents may overestimate the value of informal learning experiences within the context of computer literacy skills relevant to academic and workplace environments.

Participant Attrition

Given the extent of learner attrition from pretest to posttest, we analyzed the demographic characteristics and pretest differences in computer literacy skill of the 158 learners that dropped from the study prior to the posttest to the 211 participants that completed the study. The two groups exhibited significantly different levels of computer literacy skill on the pretest; learners completing the study outperformed those that did not. That difference, however, held across all subgroups examined by the study; learners completing the study outperformed those that did not when examining the computer literacy skills of learner by age group, by gender, by ethnicity and by type of instruction to which learners were assigned. The pre-study differences appeared to be distributed evenly across the posttest sample. Further, there were no statistical differences between the distributions of learners within the various groups: age group, gender, ethnicity, or type of instruction. The inclusion of only the 211 students that completed the study in the Chapter IV study and the use computer literacy skills exhibited at the beginning of the study as a controlling variable limited the influence of pre-study differences, but the difference in computer literacy skills of learners completing and not completing the study must be observed before generalizing the results to other students.

Limitations

The study has several limitations to be considered before generalizing the results to local populations. First, students in the study were a sample of convenience using intact groups of class sections, and local institutional needs for the study required a stratified sample. The intact groups and the lack of a purely random sample could have introduced systematic sampling bias. Second, the results only apply to students who completed the study and must be viewed within the context of the high number of students who failed to take the posttest. Students not completing the study typically had withdrawn from the course or were absent for the posttest, but the specific reason could not be determined given available data. Third, the sample size within individual groups was limited. While the overall sample size was adequate, the statistical methods used generalized results based on relatively small groups of participants, particularly within the non-NGL and type of instruction interactions. Fourth, using a repeated measures design introduces test-retest maturation risk to validity into the study design. Learners had two opportunities to take the IC^3FT; repeated exposure to the same assessment instrument may have confounded the results. Finally, the research was conducted in an applied environment with a causal-comparative design; different, unidentified confounding variables could account for some of the differences found in the results. The results found in this study may not generalize to other academic environments.

Conclusion

The results of this study validates the need in community colleges for courses that provide direct instruction to learners regarding a comprehensive scope of computer literacy skills; the results also directly challenge the characterization of Net Generation Learners as being inherently technologically savvy. When framing the discussion within the context of computer literacy skills relevant to academic and workplace environments, college learners generally are not proficient and require direct instruction to efficiently acquire necessary skills.

Learners participating in the study acquired computer literacy skills more efficiently through direct instruction. The results have implications for the level of support provided to learners by faculty, institutions and policymakers regarding the acquisition of computer literacy skills. More direct instructional experiences through courses, curriculum and general education requirements better support learner acquisition of computer literacy skills relevant to academic and workplace environments. Prior analysis suggests NGLs have slight statistically significant advantage over non-NGLs regarding computer literacy skills. However, that is an advantage that was reversed through a single semester of computer literacy instruction for non-NGLs. The results here suggest that non-NGLs learn computer literacy skills more efficiently than younger learners and that, contrary to popular opinion, NGLs do not effectively acquire computer literacy skills through informal learning experiences.

CHAPTER V

SUMMARY

The research reported in this dissertation was undertaken to evaluate the validity of the claim that Net Generation Learners (NGLs) are inherently more computer literate than non-Net Generation Learners (non-NGLs) in regard to proficiency of computer technology use. This section will summarize the three studies conducted, describe contributions the studies make to the body of knowledge regarding NGLs, and focus on the implications of the studies for theory and practice before concluding with limitations of this study and recommendations for future research.

Literature Review

The systematic, critical literature review examined the body of literature focused on the computer and technology skills of Net Generation Learners (NGLs): students born after 1980. The review focused on reports of original, empirical research regarding the technology skills of learners; the review examined the constructs and the manner in which they were measured by research and provided insight regarding how current literature approaches the NGL question. The literature review considered research reports from 2000 to 2010 which included various combinations of keywords relevant to the body of literature: *computer literacy, education, digital native*, *net generation*, and *millennial*. The full scope of searches yielded in excess of 3,200 articles for which abstracts were at least briefly evaluated for inclusion in the review. The researcher identified an initial sample of 279 articles and narrowed that selection to 52 articles focused on reports of original, empirical research regarding the technology skills of NGLs. Learners' simple familiarity with new or emerging technologies was the focus of 30 of 52 articles. Only 8 directly measured NGLs computer literacy skills; instead, researchers have relied heavily on self-reported and self-assessment data yielding only descriptive analyses or reported only descriptive data with few direct comparisons between NGLs and non-NGLs. The relatively few studies that directly measured participant computer literacy skills were limited by skills assessment instruments which were limited in scope or too varied in the constructs they measured, and none of those studies compared NGL and non-NGL performance on a computer literacy skills assessment. Finally, current research has been conducted primarily in university settings; research conducted in community colleges was absent from the literature. The literature review provided educators greater clarity of what it means to argue that "NGLs are tech-savvy" or "computer literate" and suggested future research to contribute to understanding the technology skills of NGLs.

Computer Literacy Skills of Net Generation Learners in Community College

This study addressed previously identified gaps in the literature by directly measuring and comparing NGL and non-NGL community college students' performance on a validated computer literacy skills assessment and their self-assessment of computer literacy skill. The study used a 1-way ANOVA and a multiple regression to analyze the effect of learner age on computer literacy skill as both a categorical and as a continuous variable; further, learner actual computer literacy skill was compared to learner self assessment. Two research questions were examined

1. What is the relationship between learners' actual performance on the Internet and Core Computing Certification Fast Track exam prior to beginning a college level computer literacy course and learner self-assessment of their computer literacy skills as measured by the Learner Computer Literacy Self-Assessment?

2. What is the relationship between learner age and learner computer literacy skills prior to beginning a college level computer literacy course?

    a. What is the relationship between learner age, as a continuous variable, and learners' score on the IC^3FT exam?

    b. What is the difference between Net Generation Learners' (born after 1980) and non-Net Generation Learners' (born prior to 1981) scores on the IC^3FT exam?

A critical finding of the study was that NGLs and non-NGLs were not computer literate; neither group demonstrated adequate computer literacy skill. Addressing the first research question, the study found that learners generally overestimated actual computer literacy skill. Considering the second research question, NGLs statistically outperformed non-NGLs by exhibiting greater computer literacy skills; the results of the categorical analysis supported claims within the literature regarding the technology skill of NGLs. In contrast to significant differences between NGLs and non-NGLs, learner age, as a continuous variable, did not have a significant effect on learner computer literacy skill.

Acquisition of Computer Literacy Skills by Net Generation Learners

The third study directly observed learner computer literacy skill to better understand the computer literacy skills of NGLs and non-NGLs and focused on the instructional methods by which they learn those skills. Three research questions were addressed by the study.

1. What is the relationship between learner age and learner computer literacy skills after completing a college level computer literacy course?
    a. What is the difference between Net Generation Learners' and Non-Net Generation Learners' scores on the IC3FT exam after completing a college level computer literacy course?
    b. What is the relationship between learner age, as a continuous variable, and learner's score on the IC3FT exam after completing a college level computer literacy course?
2. What is the difference between learners completing courses that employ comprehensive-formal computer literacy instruction, limited-formal computer literacy instruction, and informal computer literacy instruction on scores on the IC3FT exam?
3. What is the differential effect of the three types of instruction in computer literacy courses for Net Generation Learners and non-Net Generation Learners as measured by the IC3FT?

The study used a 2 x 3x2 ANOVA and a regression analysis to examine the main and interaction effects of learner age, as a categorical and as a continuous variable, and instructional method on learner computer literacy skill. Extending the analysis by controlling for pre-study differences, a 2 x 3 ANCOVA and a regression with learner pre-test score as a covariate were used to better isolate the effect of learner age and instructional method on learner skill from the beginning to the end of the study.

Examining the instructional methods used to facilitate learner acquisition of computer literacy skills, two findings were of particular interest. First, taken in context of the second study, non-NGLs learned computer literacy skills better than non-NGLs. On the pretest, the difference between the computer literacy skills of NGLs and non-NGLs was statistically significant, and NGLs performed better. By the end of the study, non-NGLs improved their skills enough to overcome the statistical difference and enough to outperform NGLs on the posttest. Second, direct instruction addressing a comprehensive scope of computer literacy skills was statistically better than less comprehensive and more informal approaches to teaching computer literacy skills. The interaction effect of learner age and type of instruction was not statistically significant across all groups; that finding suggests that NGLs did not outperform non-NGLs in informal learning environments as proponents of NGLs have assumed.

Contributions

This dissertation addressed the identified gaps in the current literature by directly measuring and comparing the computer literacy skills of NGLs and non-NGLs in a community college environment using an established computer literacy skills assessment instrument aligned to an internationally recognized framework of computer literacy. This is in contrast to the current body of literature that more frequently relied heavily on self-assessment data yielding only descriptive analyses of university NGL skill levels and often only addressed learner familiarity with new or emerging technologies rather than computer literacy skills. In addressing those gaps, the studies here make several significant contributions to current knowledge regarding NGL technology skills.

First, community college learners are not computer literate. The two empirical studies consistently discovered that NGLs and non-NGLs did not possess adequate computer literacy skills, as defined by the IC^3FT skills assessment. Contrary to trends within higher education suggesting NGLs possess computer literacy skills, for example institutions removing computer literacy courses from required curriculum (Baugh, 2004) and state regulatory bodies removing computer literacy from core objectives (Texas Higher Education Coordinating Board, 1999, 2010), and widespread rhetoric regarding the inherent computer literacy skills of NGLs (Bayne & Ross, 2007), the studies in Chapters III and IV revealed that neither group exhibited adequate skills.

Second, being computer literate is distinct from being tech-savvy. The literature review identified a number of constructs used to consider technological proficiency of NGLs. While being tech-savvy could have a range of different meanings including access to technology or use of emerging technologies, researchers have defined computer literacy much more precisely. Further, the rhetoric of NGL proponents suggests learners are tech-savvy because they have grown up in a world of ubiquitous technology, and because of that, they are able to adapt to and use new technology seamlessly. However, the results here clearly indicate that does not equate to computer literacy; learners failed to exhibit fundamental computer literacy skills, and they performed less well in learning environments in which technology skills were learned more informally. Even if learners are tech-savvy, as popularly defined, they are not computer literate.

Third, instruction which directly teaches computer literacy skills is more effective than informal instructional experiences for supporting learner acquisition of skills. Results in Chapter IV indicated a significant difference between instruction that directly teaches computer literacy skills and instruction that teaches a limited scope of skills or that informally supports learner acquisition of the same skills. Learners, across both age groups, exhibited greater success in the acquisition of computer literacy skills from direct instruction. There was a noticeable difference between teaching a comprehensive scope of computer literacy skills versus teaching a more narrow range of skills; learners performed better as a group following the comprehensive instructional experience.

Finally, the treatment of data regarding learner age can have a significant impact on research results. Treating learner age as a categorical and as a continuous variable renders different results, and findings from both treatments are of interest. The study in Chapter III found a statistically significant difference in the computer literacy skills of NGLs and non-NGLs with NGLs outperforming their older counterparts; these initial results suggested there may be statistical validity to claims regarding the greater computer literacy skills of NGLs. However, the analysis of age as a continuous variable contradicted those results; learner age as a continuous variable did not have a statistically significant effect on learner computer literacy skill. The 2 x 3 x 2 ANOVA indicated that type of instruction had a statistically significant effect on learner computer literacy skill; however, the multiple regression did not indicate the effect was statistically significant. The differentiation of learners by generational membership appears arbitrary, and analyzing learner differences by age group rather than learner age sacrifices statistical fidelity by scaling the data down from ratio data to ordinal data and produces statistically different results.

Implications

For faculty, institutions and researchers, the widespread calls for changes based upon the assumption that NGLs are tech-savvy, along with the assumption itself, must be reconsidered, challenged and corrected. Net Generation Learner rhetoric has been critiqued previously as equivalent to "moral panic" without empirical justification (Bennett et al., 2008) and challenged as a "divisive understanding of student/teacher relationships" (Bayne & Ross, 2007, para. 25). The results here further erode the foundation of assumptions regarding the technology skills of NGLs. They did not exhibit fundamental computer literacy skills on an established assessment instrument, and they do not exhibit the ability to learn those skills informally. Educators must reconsider the previously accepted, false reality of the technologically literate Net Generational Learner.

For faculty, as proponents of NGLs suggest, faculty should consider the technological proficiency of NGLs when designing and development course assignments; however, rather than trying to appeal to tech-savvy NGLs, faculty should consider adding technology support content and limiting the potential impact of new technology on learners that do not possess fundamental computer literacy skills. Even assignments that have long been a part of a class, like research papers, may require more computer related support for learners than previously thought; the studies in Chapters III and IV showed that learners are not computer literate and that includes basic word processing, spreadsheet and presentation applications. Further, the computer illiterate NGL radically impacts considerations to increase the use of technology in a course; the basic assumptions used to justify the implementation of new or emerging technologies in courses simply are not true. Technology should be used judiciously with careful consideration for the potential learning curve it may create for learners.

For institutions, curricular trends and demands to expand the use of technology within student services should be reconsidered; the skill level and preferences of learners should be evaluated empirically before decisions are made. Institutions have previously removed computer literacy courses from curriculum (Baugh, 2004), and at least one state higher education regulatory body, the Texas Higher Education Coordinating Board, has recently excluded computer literacy skills from core objectives for all higher education institutions in the state (Texas Higher Education Coordinating Board, 1999, 2010), The argument may be made from the results here that computer literacy courses should remain at all levels of education: direct instruction focused on comprehensive scope of computer literacy skills more effectively support learner acquisition of computer literacy skills. Further, institutions should not race to add technology to student services for the simple sake of adding technology that appeals to NGLs. Modifications, as has been demanded in the literature, to library services, general education, instructional design, language learning, science education, nursing education, medical education, general student services, faculty development and facility management should not be made based on assumptions that younger learners are tech-savvy and computer literate. Generally, educational practice and decisions shaped by assumptions regarding technology skills of NGLs should be evaluated with greater scrutiny.

For consumers and producers of research, the results found in this study have three implications that challenge the validity and practical importance of assumptions regarding differences between the technology skills of NGLs and non-NGLs. First, the question of differences between older and younger learners may not be practically relevant. Differences between the inadequate computer literacy skills of NGLs and the inadequate computer literacy skills of non-NGLs only serve to identify which group exhibits less inadequate skills. That difference has little practical utility for faculty and institutions at all levels of education making decisions on how to support learners who do not have necessary skills to be successful. Second, it is important to critically understand the construct being measured when discussing the technology skills of NGLs. The literature review delineated the range of constructs measured by research regarding the technology skills of NGLs and contrasted the operational definitions of tech-savvy and computer literate within current literature, and the results in Chapter IV further distinguish the two constructs given that learners do not acquire computer literacy skills very well through informal learning environments. Third, learner age should not be treated as a categorical variable. Studies in Chapter III and IV both showed that analyzing age as a categorical variable yields different results than analyzing age as a continuous variable even though both results have statistical interest.

Differences among NGLs and non-NGLs may be an artifact of the arbitrary assignment of learners to generational groups.

Limitations

The impact of this dissertation is limited by several factors. First, students in the study were a sample of convenience using intact groups of class sections, so the results of the studies in Chapters III and IV may not generalize to other community college students. Students primarily dropped from the study as a result of having withdrawn from the course in which the study was conducted or were absent from class on the day of the pretest; however, the specific reason could not be determined given available data. Further, the results of the study in Chapter IV only apply to students who completed the course and must be viewed in the context of the high number of students who failed to take the posttest as a result of dropping the class or other factors.

Second, learner maturation beyond the control of the research design also presented a potential limitation. The research was conducted in an applied environment with a causal-comparative design; different, unidentified confounding variables could account for some of the differences found in the results. Changes in learner computer literacy skill from the beginning to the end of the semester could have resulted from learning experiences other than the curriculum by courses included in the study; learners participating in the study often were enrolled in other courses which may have influenced their outcome. Learner maturation may have impacted the results and conclusions of the study.

Third, the applied nature of the research limited the sampling procedure. Students' self-selected enrollment into intact course sections which were later chosen for inclusion in the study; that permitted only stratified random sampling of course sections, and there were further institutional limitations. Further, the sample size within individual groups was limited. While the overall sample size was adequate, the statistical methods reported results based on relatively small groups of participants, particularly within the non-NGL and type of instruction interactions. While the sample for the study mirrored the student population from which it was drawn, caution should be taken when generalizing the results to other students and learning environments.

Finally, using a repeated measures design introduced a risk of test-retest maturation into the study design. Learners had two opportunities to take the IC^3FT; repeated exposure to the same assessment instrument may have confounded the results. The results found in this study may not generalize to other academic environments.

Recommendations for Future Research

Future research regarding the technology skills of Net Generation Learners is recommended. First, studies replicating the inquiry in Chapter IV using an established framework to assess computer literacy skills in a pretest-posttest design would provide a broader understanding of community college learners' technology proficiency and address NGL rhetoric at local levels. Additional inquiry regarding the comparative effectiveness of instructional methods in supporting learner acquisition of computer literacy skills will further inform institutional curricular and faculty instructional decisions. Second, this research examined computer literacy skills holistically; future studies focusing on learner skill within specific domains and examining learner performance at the component level, for example general computing versus online technologies versus productivity applications, would further inform theory and practice. Finally, future research regarding NGLs and new or emerging technologies could contribute to the body of knowledge by considering age as a continuous variable rather than as a categorical variable and by directly observing learner skill with those technologies rather than simply examining the use habits, patterns and adoption rates of NGLs.

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APPENDIX A

LEARNER COMPUTER LITERACY SELF ASSESSMENT SURVEY

1. This is my ___ semester of college.
   a. 1st
   b. 2nd
   c. 3rd
   d. 4th
   e. 5th or more

2. How many credit hours are you taking this semester?
   a. Less than 12
   b. 12 or more

3. What type of program are you enrolled in?
   a. Technical / Vocational / Certificate
   b. Academic / Transfer
   c. Don't Know or Undecided

4. How many hours per week do you use a computer for fun (personal use)?
   a. None
   b. Under 5
   c. 5 to 10
   d. 11 to 20
   e. 21 or more

5. Of the time you spend using a computer for fun each week, how many of those hours involved accessing the internet/web?
   a. None
   b. Under 5
   c. 5 to 10
   d. 11 to 20
   e. 21 or more

6. Of the time you spend using a computer for fun each week, how many of those hours involve using written communication technology (email, chat, text messaging, etc.)?
   a. None
   b. Under 5
   c. 5 to 10
   d. 11 to 20
   e. 21 or more

7. How many hours per week do you use a computer for work (including school work)?
    a. None
    b. Under 5
    c. 5 to 10
    d. 11 to 20
    e. 21 or more

8. Of the time you spend using a computer for work each week, how many of those hours involve accessing the internet/web?
    a. None
    b. Under 5
    c. 5 to 10
    d. 11 to 20
    e. 21 or more

9. Of the time you spend using a computer for work each week, how many of those hours involve using written communication technology (email, chat, text messaging, etc.)?
    a. None
    b. Under 5
    c. 5 to 10
    d. 11 to 20
    e. 21 or more

10. How many hours each week do you use verbal communication technology (telephone, cell phone, voice mail etc)?
    a. None
    b. Under 5
    c. 5 to 10
    d. 11 to 20
    e. 21 or more

11. How many hours per week do you use video or computer games?
    a. None
    b. Under 5
    c. 5 to 10
    d. 11 to 20
    e. 21 or more

12. When did you begin using a computer?
    a. I have never used a computer before
    b. 5 years old or less
    c. 6 – 8 years old
    d. 9 – 12 years old

e. 13 – 15 years old
f. 16 – 18 years old
g. 19 – 21 years old
h. 22 – 25 years old
i. 26 – 30 years old.
j. 31 – 40 years old.
k. 41 – 50 years old.
l. 51 years old or more.

13. How do you usually access a computer?
    a. I do not have regular access to a computer
    b. I have my own computer and can use it when I want
    c. I access a computer in my home and can use it on a regular basis
    d. I access a friend's computer and can use it when they are not using it
    e. I access a computer at school, the library, work or another place

14. If you selected 'Other' for the previous question regarding how you usually access a computer, please give detail here. (text field unlimited)

15. When did you begin using the internet?
    a. I have never used a computer before
    b. 5 years old or less
    c. 6 – 8 years old
    d. 9 – 12 years old
    e. 13 – 15 years old
    f. 16 – 18 years old
    g. 19 – 21 years old
    h. 22 – 25 years old
    i. 26 – 30 years old.
    j. 31 – 40 years old.
    k. 41 – 50 years old.
    l. 51 years old or more

16. How do you usually access the internet?
    a. I do not have regular access to the internet
    b. I have my own access to the internet and can use it when I want
    c. I access the internet in my home and can use it on a regular basis
    d. I access the internet using a friend's computer and can use it when they are not using it.
    e. I access the internet at school, the library, work or another place

17. If you selected 'Other' for the previous question regarding how you usually access the internet, please give detail here. (text field is unlimited)

18. Overall, how would you rate your general computer and technology skills?
    a. Poor, I do not know very much at all about computers
    b. Below Average, I am somewhat familiar with computers but am not confident in my knowledge or skill
    c. Average, I am familiar with computers and am confident in my knowledge and skill
    d. Above Average, I am familiar and confident with computers and can perhaps explain concepts and skills to others
    e. Excellent, I know computers very well and can confidently teach new knowledge and skills to others

19. Why did you give yourself the overall rating in question 18? What is it that you know or do not know about computers that lead you to give yourself that rating? Please describe in your own words. Please write clearly and carefully. (text field unlimited)

20. How many distance learning courses have you taken previously, including any distance learning courses you are currently taking?
    a. None
    b. 1
    c. 2
    d. 3
    e. 4
    f. 5 or more

21. Check the information and computing technology (ICT) areas in which you have ever taken a course or had formal training – check all that apply:
    a. Introduction to Computers
    b. Productivity applications such as Word, Excel, Powerpoint, Outlook or Access
    c. Windows or other operating systems
    d. Email
    e. Internet/World Wide Web
    f. Research, library or information science
    g. Programming

22. How many ICT courses have you previously taken, including any current courses? None
    a. None
    b. 1
    c. 2
    d. 3
    e. 4
    f. 5 or more

23. When did you take your first ICT course?
    a. I have never used a computer before
    b. 5 years old or less
    c. 6 – 8 years old
    d. 9 – 12 years old
    e. 13 – 15 years old
    f. 16 – 18 years old
    g. 19 – 21 years old
    h. 22 – 25 years old
    i. 26 – 30 years old.
    j. 31 – 40 years old.
    k. 41 – 50 years old.
    l. 51 years old or more

24. How many ICT training classes have you had outside of school – through work or another organization?
    a. None
    b. 1
    c. 2
    d. 3
    e. 4
    f. 5 or more

25. How well can you identify types of computers, how they process information, and the purpose and function of different hardware components?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

26. How well can you identify how to maintain computer equipment and solve common problems relating to computer hardware?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

27. How well can you identify how hardware and software work together to perform computing tasks and how software is developed and upgraded?
    Poor
    a. Below Average
    b. Average

c. Above Average
d. Excellent

28. How well can you identify different types of application software and general concept relating to application software categories?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

29. How well can you identify what an operating system is and how it works, and solve common problems related to operating systems?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

30. How well can you make use of an operating system to manipulate a computer's desktop, files and disks?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

31. How well can you identify how to change system settings, install and remove software?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

32. How well can you start and exit an application, identify and modify interface elements and utilize sources of online help?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

33. How well can you perform common file-management functions?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

34. How well can you perform common editing and formatting functions?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

35. How well can you perform common printing/outputting functions?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

36. How well can you, in a word processing application, format text and documents including the ability to use automatic formatting tools?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

37. How well can you, in a word processing application, use tools to automate processes such as document review, security and collaboration?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

38. How well can you, in a spreadsheet application, modify worksheet data and structure and format data in a worksheet?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average

e. Excellent

39. How well can you, in a spreadsheet application, sort data, manipulate data using formulas and functions and create simple charts?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

40. How well can you, in a presentation application, create and format simple presentations?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

41. How well can you identify network fundamentals and the benefits and risks of network computing?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

42. How well can you identify different types of electronic communication/collaboration and how they work?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

43. How well can you identify how to use an electronic mail application?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

44. How well can you identify the appropriate use of different types of communication/collaboration tools and the "rules of the road" regarding online communication ("netiquette")?

a. Poor
b. Below Average
c. Average
d. Above Average
e. Excellent

45. How well can you identify information about the internet, the world wide web and web sites and be able to use a web browsing application?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

46. How well can you understand how content is created, located and evaluated on the world wide web?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

47. How well can you identify how computers are used in different areas of work, school, and home?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

48. How well can you identify the risks of using computer hardware and software and how to use computers and the internet safely, ethically, and legally?
    a. Poor
    b. Below Average
    c. Average
    d. Above Average
    e. Excellent

49. Please add any additional comments you wish render:

APPENDIX B

Table A-1. Courses Included in the Study

Title & Description	Objectives
Comprehensive Formal Instruction	
Business Computer Applications This course discusses computer terminology, hardware, software, operating systems, and information systems relating to the business environment. The main focus of this course is on business application of software, including word processing, spreadsheets, databases, presentation graphics, and business-oriented utilization of the Internet. (BCIS 1305)	A. Development of a basic understanding of computer technology. B. An understanding of computer hardware and its use in a business environment. C. The ability to use Internet for business applications and research. D. Fundamental proficiency in software programs with business applications such as word processing, spreadsheets, databases, and presentation packages. E. An understanding of operating and information systems and their function in a business environment.
Integrated Software Applications I This course covers an introduction to business productivity software suites using word processing, spreadsheets, databases, and/or presentation software. It includes instruction in embedding data, linking and combining documents using word processing, spreadsheets, databases, and/or presentation media software. Fundamentals of personal computer operations and the Windows operating system will also be covered. (ITSC 1309)	A. Describe the components of a computer system and their functionality. B. Analyze hardware and software specifications to determine compatibility. C. Describe operating system functions. D. Boot a microcomputer and load an operating system. E. Use the operating system to manage a computer's files and folders. F. Use a web browser to access web page information. G. Use an email program to send email and attachments. H. Describe common functions of word processors. I. Use a word processor to create/open and save documents. J. Use a word processor to edit and format document contents. K. Use a word processor to control document printing. L. Describe common functions of spreadsheet programs.

Title & Description	Objectives
	M. Use a spreadsheet program to create/open and save a worksheet. N. Enter labels, values, and formulas into worksheet cells and ranges. O. Incorporate function calls in spreadsheet formulas. P. Use a spreadsheet program to control worksheet printing. Q. Describe common functions of database managers. R. Use a database manager to create/open and save database files and tables. S. Maintain a database file by adding, updating, and deleting records. T. Use a database manager to resequence records in a database table. U. Use a database manager to control printing. V. Use written or on-line documentation or help files to expand knowledge about a program.
Introduction to Computers This course is an overview of computer information systems. It introduces computer hardware, software, procedures, and human resources, and explores integration and application in business and other segments in society. Fundamentals of computer problem solving and programming may also be discussed and applied. It also examines applications and software relating to specific curricular areas. (ITSC 1301)	A. Identify the parts of a CPU and their purposes. B. Identify and categorize various hardware components and peripheral devices. C. Define key computer related terms. D. Distinguishes between various software packages including different human-computer interfaces. E. Distinguish between various classifications of computers and ways in which they are used. F. Evaluate methods and devices used for auxiliary storage. G. Differentiate between various popular programming languages used to write software. H. Describe the binary number system used to represent characters. I. Trace the steps of program development. J. Describe common operating system functions. K. Identify the tools and techniques used in program development. L. Identify primary hardware and software components used for telecommunications and networking. M. Configure a personal computer for personal use. N. Describe social issues involving computers.
Limited Formal Instruction	
Basic Computer-Aided Drafting This introduction to computer-aided	A. Utilize AutoCAD. Demonstrate the proper use of computer equipment. Operate and adjust system

Title & Description	Objectives
drafting, emphasizes setup; creating and modifying geometry; storing and retrieving predefined shapes; placing, rotating, and scaling objects; adding text and dimensions; using layers, and coordinate systems; and plot/print to scale. (DFTG 1409)	components that include input and output devices. B. Illustrate orthographic projection principles. C. Create hard copies of drawings to scale. D. Utilize industry recognized dimensioning techniques. E. Utilize Windows and/or AutoCAD commands to create drawings and manage files. F. Utilize commands to create and insert blocks. G. Create isometric (pictorial) drawings.
Design Communications I This is an introductory study of design development relating to graphic design technology, tools, media, layout, and design concepts. Topics include integration of type, images, and other design elements, and developing computer skills in industry standard computer programs. (ARTS 2313)	A. Apply design principles into visual communications. B. Organize design sequences into a comprehensive concept. C. Utilize computer software.
Fundamentals of Networking Technologies This course covers instruction in networking technologies and their implementation. Topics include network fundamentals and terminology; the OSI reference model; network protocols; transmission media; networking hardware and software; identifying media used in network communication; connecting servers and clients in a network; recognizing the primary network architectures/topologies; determining how to implement and support the major networking components, including the server, operating system, and clients; distinguishing between Local Area Networks (LANs) and Wide Area Networks (WANs); identifying the components used	A. Describe the major network vendors and their software/hardware. B. List the benefits of computer networks. C. Explain the two major types of network operation and the advantages/disadvantages of each. D. Recognize and identify the primary network architectures, their major characteristics and which would be most appropriate for a proposed network. E. Be able to distinguish between a LAN and a WAN and identify the components used to expand a LAN into a WAN. F. Identify and list the major types of network media currently in use today, and explain how to use them to connect to servers and clients in a network. G. Describe the main tasks performed by network administrators. H. Explain the proper use and benefits of electronic mail. I. Explain network security issues. J. Explain what network fault tolerance means. K. Be able to install, configure and manage DHCP network protocols. L. Demonstrate knowledge in the use of networking

Title & Description	Objectives
to expand a LAN into a WAN; how to implement connectivity devices in the larger LAN/WAN environments; and networking technologies as they apply to current Microsoft Windows Operating Systems. The students will gain experience installing, configuring and maintaining current Windows Operating Systems. (ITNW 1325)	software. M. Determine and demonstrate knowledge of how to implement and support major networking components including the server, operating system, and clients. N. Be able to install, configure, and maintain current Windows workstation/client and server software. O. Describe how to implement connectivity devices in the larger LAN/WAN environment. P. Gain experience and knowledge necessary to become MCSE certified. Q. Explain the advantages of the major types of networks.
Instruction Technology and Computer Applications for Educators This course focuses on teaching future educators how to use specialized educational technology. The topics include the integration of educational computer terminology, system operations, software, and multimedia in the contemporary classroom environment. Additional section included in college approved syllabi: This course is intended to develop the idea of the computer as a planning, preparation and record-keeping tool, to familiarize the student with the operation and capabilities of the microcomputer, to develop the fundamental principles of logic design and program development and to train the student for writing, testing and using simple programs, to familiarize the student with some of the educational software currently available and how to acquire and use it, and to familiarize the student with the terminology of computer and	A. Demonstrate knowledge of the evolution, applications, and social implications of computers in general as well as in the field of education. B. Demonstrate knowledge of data processing terminology and concepts. C. Boot a computer and use the operating system to format disks and manipulate files. D. Use the computer as a planning, preparation, and record-keeping tool. E. Use word processing software to create, edit, and print a document. F. Describe the goals and make use of computer assisted instruction software. G. Describe the goals of and make use of classroom management software. H. Evaluate software for use in the classroom. I. Demonstrate an ability to utilize multimedia in the classroom. J. Develop a course that relies heavily on the use of the computer for instruction and classroom management. K. Use the Internet as a tool in the learning environment. L. Read and interpret User's Guides and Reference Manuals for loading and running application software. M. Use journals, the Internet and other resources to gather information on the use of Computers in education.

Title & Description	Objectives
develop general literacy of computerized data processing. (EDTC 1341)	
Introduction to Computer Graphics This is a survey of computer design concepts, terminology, processes, and procedures. Topics include computer graphics hardware, electronic images, electronic publishing, vector-based graphics, and interactive multimedia. (ARTC 1325)	A. Define computer terminology B. Identify peripherals C. Demonstrate data-based, page-layout, multimedia, and peripheral software use
Introduction to PC Operating Systems This course covers an introduction to personal computer operating systems. Topics include installation and configuration, file management, memory and storage management, control of peripheral devices, and use of utilities. Operating systems covered include DOS, Windows and UNIX. (ITSC 1305)	Operating Systems Overview: A. Read and analyze written specifications or instructions for all projects or assignments. B. Describe the functions and components of an operating system. C. Explain how hardware and software interface within an operating system. D. Describe how an operating system is utilized within a network and distributed system. E. Perform number conversions between binary, hexadecimal, octal and discuss ASCII. F. Design a system configuration chart for a microcomputer. Windows Command Line (WCL) / Windows: A. Read and analyze written specifications or instructions for all projects or assignments. B. Explain the concepts and impact of the resident and transient parts of WCL command.com. C. Utilize the basic WCL commands and their parameters. D. Use WCL wildcards in WCL commands. E. Discuss recovery of deleted files using the appropriate utilities and procedures. F. Describe the purpose of file attributes and the procedures to change them. G. Discuss disk maintenance and backup and restoring of files. H. Create and manipulate directories within WCL/Windows. I. Use redirection, pipes and filters within WCL/Windows.

Title & Description	Objectives
	J. Set up and execute an autoexec.bat file within WCL/Windows. UNIX: A. Read and analyze written specifications or instructions for all projects or assignments. B. Describe the UNIX file system and the purpose of file attributes. C. Utilize basic UNIX commands including wildcard commands. D. Create and manipulate directories within the UNIX operating system. E. Use redirection, pipes and filters as is appropriate within the UNIX operating system. F. Create, edit, delete and save files using the UNIX Vi editor. G. Discuss the different command shells that are available to the UNIX operating systems users. H. Explore the differences between the WCL and the UNIX operating systems.
Informal Instruction	
Composition I Students are given extensive practice in reading and writing expository and argumentative prose. Various elements of composition, such as logical organization, effective diction, and complete and varied development are stressed. A formal research paper is required. (ENGL 1301)	Students will be guided in their development of a number of communication skills: A. Constructing compositions of a variety of lengths B. Critical Reading C. Research Techniques Students completing English courses as fulfilling the core requirements for computer literacy for designators should be able to: A. Purchase, format, and use the proper disk. B. Turn on the computer, monitor, and printer. C. Select the desired software package from the toolbar. D. Perform the operations necessary to produce an acceptable academic paper. Such operations might include: 1. Selecting a font and point size. 2. Setting margins. 3. Using formatting tools such as bold face and italics. 4. Accessing and saving files from the Internet. 5. Saving material on a disk. 6. Printing the final copy.
Newspaper Laboratory This course offers first-year participation on a weekly	A. Interview sources for newspaper assignments. B. Collect information necessary for newspaper assignment.

Title & Description	Objectives
newspaper and it is required for COMM 2311 and 2315 students. Any student may register for the laboratory portion only, with consent of the department chair. (COMM 1129)	C. Write copy for college newspaper (news stories, features, editorials and others as assigned) D. Prepare copy for publication E. Plan production of weekly newspaper F. Plan artwork for weekly newspaper
Newspaper Laboratory This course offers second-year participation on a weekly newspaper, and it may be taken a maximum of two times for credit. (COMM 2129)	A. Interview sources for newspaper assignments. B. Collect information necessary for newspaper assignment. C. Write copy for college newspaper (news stories, features, editorials and others as assigned) D. Prepare copy for publication E. Plan production of weekly newspaper F. Plan artwork for weekly newspaper

VITA

Christopher Michael Duke earned his B.A. in English from Baylor University in 1994. He began his graduate studies at University of Houston Clear Lake with an M.S. in instructional technology in August 2001 and concluded his studies at Texas A&M University with a Ph.D. in educational psychology. His research interests include computer and information literacy and institutional integration of technology into learning environments.

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