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Developing the Internet-Savviness (IS) Scale: Investigating the Relationships Between Internet Use and Academically Talented Middle School Youth

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Abstract

This study investigated the development and validation of a 32-item scale that measures *Internet-Savviness (IS)*. Relationships between this multidimensional construct and other primary variables of interest including age, gender, Internet access, Internet location, and Internet activities were explored. The sample population consisted of 241 academically talented middle school youth ages 8–14 years old. The IS scale showed satisfactory levels of reliability. An exploratory factor analysis revealed a clear, underlying structure of the following dimensions: (a) computer mediated communication, (b) creative expression, (c) information gathering, (d) Internet fluency, (e) Internet self-efficacy, and (f) social collaboration. Internet-savvy scores corresponded to self-reports of *Beginner, Intermediate,* and *Advanced* Internet users. Thirty-three percent of youth rated themselves as *Advanced* users, which aligns with previous research on Internet-savvy adolescents. Although females and males differed in Internet activities and young females scored below males on Internet-savviness, they caught up by age 12. Overall, there were no statistical differences on dimension or total IS scores for participants in this study. Doing something creative, access at home, exchanging images, access speed, age, and access at a friend's house were statistically significant predictors of IS scores.

Introduction

A rapidly evolving, knowledge-based global economy combined with "always on" digital communication and resource access has radically transformed the value of what, when, where, and how people learn. Although Drucker (1959) first coined the term "knowledge worker" almost 50 years ago, the creation and value of intellectual capital, from individual entrepreneurs to large multinational corporations, has greatly increased in a 24/7, connected world. The unique character of this shift is the individual's newly formed capacity to create new knowledge, collaborate, and compete globally. As Friedman (2005) pointed out in his book, *The World Is Flat*, "individuals must, and can now ask, where do I fit into the global competition and opportunities of the day, and how can I, on my own, collaborate with others globally?" (p. 10). This new era of global interaction is stimulating innovation and creativity in a way never before seen, and the phenomenon will likely continue, as Friedman exclaimed to his own children: "The world is being flattened. I didn't start it and you can't stop it, except at a great cost to human development and your own future" (p. 469).

Internet-Savvy Youth

This new wave of transformation is not only driven by individual entrepreneurs and multinational corporations, but is also manifested in the attitudes, beliefs, and behaviors of an emerging and distinct group of technologically elite young people. Most adolescents are prolific consumers of the Internet with 93% of American youth between the ages of 12 and 17 logging onto the Internet (Lenhart, Madden, MacGill, & Smith, 2007). Adults have marveled at the skills and knowledge of these tech prodigies for quite some time. These youth, through their attitudes, beliefs, and behaviors on the Internet, may reveal a great deal about learning in and outside the 21st century classroom.

Levin and Arafeh (2003) described an emerging group of technologically elite youth (ages 12–17) as being *Internet-savvy*. Many of these adolescents had been online for five to six years and were technologically fluent. Connecting to the Internet was part of their normal daily routine. They reported using a wide array of online applications and relied heavily on the Internet for school and social activities. This trend of young people vigorously embracing the Internet continues (Lenhart et al., 2007).

In another study, De Boor and Li (2007) described a group of Internet-using adolescents and referred to them as *non-conformists*, who eagerly explored the boundary line of Internet-related constraints and possibilities in and out of school. Galarneau and Zibit (2006) noted that these youth are engaged in an array of skills that fit well with 21st century technology needs.

Teenagers who have ready access to computers and broadband connectivity tend to view and use technology in radically different ways when compared to their parents, older siblings, and other peers (Levin & Arafeh, 2003). Their expectations of how the Internet might be used in the classroom are increasingly at odds with the way it is currently deployed. They tend to be critical of how teachers have under-utilized technology in the classroom, which is particularly disturbing because school continues to be the place where educators can guide students in using new technologies and the Internet for learning (Hitlin & Rainee, 2005). A number of educational theorists and researchers call for deploying instructional technologies in new ways that scaffold constructivist and authentic learning (Brown, 2007; Dede, 2000; Gee, 2003; Jenkins, 2006). While many youth are eagerly participating in these kinds of activities, their use is found primarily outside school.

Statement of the Problem

Although the Internet continues to evolve rapidly as a significant catalyst for increased productivity, creative expression, and innovation, education has not yet fully participated. A Harvard University Education professor and well-known scholar of educational issues, Dede (1998) expressed, "The most dangerous experiment we can conduct with our children is to keep schooling the same at a time when every other aspect of our society is dramatically changing" (p. 116).

With notable exceptions (Anderson & Dexter, 2003; Kaiser Family Foundation, 2003), schools seem bogged down in skill-and-drill practices and multiple-choice testing (Gee, 2003). One problem is the use of anachronistic instructional approaches that emphasize a teacher-centered, "blackboard and chalk" approach with de-contextualized facts presented to a passive audience of students.

Another problem is the widening gap between technology "haves" and "have nots" that has grown into a "digital-capabilities divide," exacerbating existing problems of gender and race under-representation in fields related to Science, Technology, Engineering, Mathematics (STEM) (Galarneau & Zibit, 2006). Individuals with low incomes and educational levels (regardless of race) are generally much less likely to use the Internet (Horrigan & Smith, 2007). Ninety-three percent of adolescents in households earning more than $75,000 per year are online at home with high-speed connectivity in most cases (Lenhart, Madden, & Hitlin, 2005). The Internet at school may be the only viable option for youth with no access at home.

Unfortunately, Internet-enabled schools do not guarantee access or a positive learning experience. Despite the fact that 99% of schools are wired for the Internet, 32% of adolescents do not use it in school (Hitlin & Rainee, 2005) and those who do plead for change (Levin & Arafeh, 2003). Skeptics cite the billions of dollars spent on technology with little research evidence of measurable academic outcomes. Norris, Sullivan, Poirot, and Soloway (2003), however, contended that positive instructional outcomes were not possible due to a continued lack of sufficient access. In their survey, two-thirds of K–12 teachers stated that they make minimal (less than 15 minutes/week) or no use of Internet technologies with their students. Internet-using students also reported that the greatest barrier to Internet use at school was the quality of Internet access. Additionally, they noted the need for better coordination between Internet use outside school with in-class activities and argued that "this could be a key to leveraging the power of the Internet for learning" (Levin & Arafeh, p. 5).

Constructivism

Having grown up with technology and access to the world's online resources, Internet-savvy youth have organically formed a constructivist culture of engagement and informal learning that Dewey would support. They have achieved this culture by shaping a digital world into their own and in so doing have acquired, as a by-product, 21st century skills. At the same time, they have unintentionally created a pedagogical road map by operationalizing long-standing learning theories—newly endowed by a distributed, connected environment—that can scale beyond one-to-one or one-to-few relationships in and outside the classroom. Paying closer attention to the attitudes, beliefs, and behaviors of these Internet-savvy youth may inform the instructional transformations needed to meet 21st century educational requirements.

Constructivism is a theory that views learning as an active and dynamic process with the learner at center stage, internalizing new information and synthesizing it with existing knowledge (Bruner, 1963; Piaget, 1955). Vygotsky (1978) suggested that social interaction and engagement are fundamental to learning and are necessary to develop one's full range of cognitive capabilities. When multiple perspectives are shared through thoughtful interaction with others, the learner, through reflection, can modify these representations or discard them. Social and intellectual growth becomes a positive sum experience (Bednar, Cunningham, Duffy, & Perry, 1995).

Vygotsky (1978) conceptualized Zones of Proximal Development (ZPD) as a set of activities in which individuals can optimize and enhance their own learning experiences and knowledge through the interested and active guidance of more advanced peers, teachers, and groups. Vygotsky explained the ZPD as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers" (p. 86).

Artifacts as Peers

In a virtualized, connected environment, many different individuals, community services, and artifacts can serve as proxies to guide learners into new areas of knowledge of interest to them. By extending Vygotsky's ZPD model into today's distributed, globally connected environment, the potential for co-constructed knowledge is greatly amplified. "More capable peers" might now include such artifacts as "intelligent agents" and other programmatically based objects designed to assist and guide users on increasing their understanding and knowledge of any subject. Figure 1 shows how the classic ZPD model could be represented in this new, connected environment.

The ease and ability to tap into many different kinds of embedded, collective intelligences represents a new potential for explicit and implicit learning. In this scenario, the ZPD becomes more iterative and granular, based on the kind and quality of the learning activities and artifacts included. Learners have more control over what and how they learn by choosing their own elements within the ZPD. They may customize and modify the ZPD's learning objects—perhaps with their own code—as necessary to facilitate their own learning needs. For example, a Google Alert is a service that allows users to receive the latest updates regarding any query or topic. Users can set up searches on news, blogs, groups, or the entire Web and receive notifications by email as updates occur. Further, they can modify and fine-tune Google Alert's object properties to provide the results desired on a daily or weekly basis. Internet-savvy youth have discovered these new learning tools and practice using them independently as well as collaboratively through informal communities of family and friends.

Distributed Intelligence

Distributed intelligence proposes that human knowledge and cognition are not confined to the individual but are externally manifested in the form of representative artifacts and across people, environments, and situations (Hutchins, 1995; Pea, 1993; Salomon, 1993). Proponents of this theory argue that artifacts, from language to computer algorithms, become representations or tools that are part of the process of intelligence (Hutchins; Pea; Salomon; Smagorinksy, 1995). Intelligence, "which comes to life during human activities," may be crafted and is part of the social and material dimensions of distribution (Pea, p. 50). Pea's argument, influenced

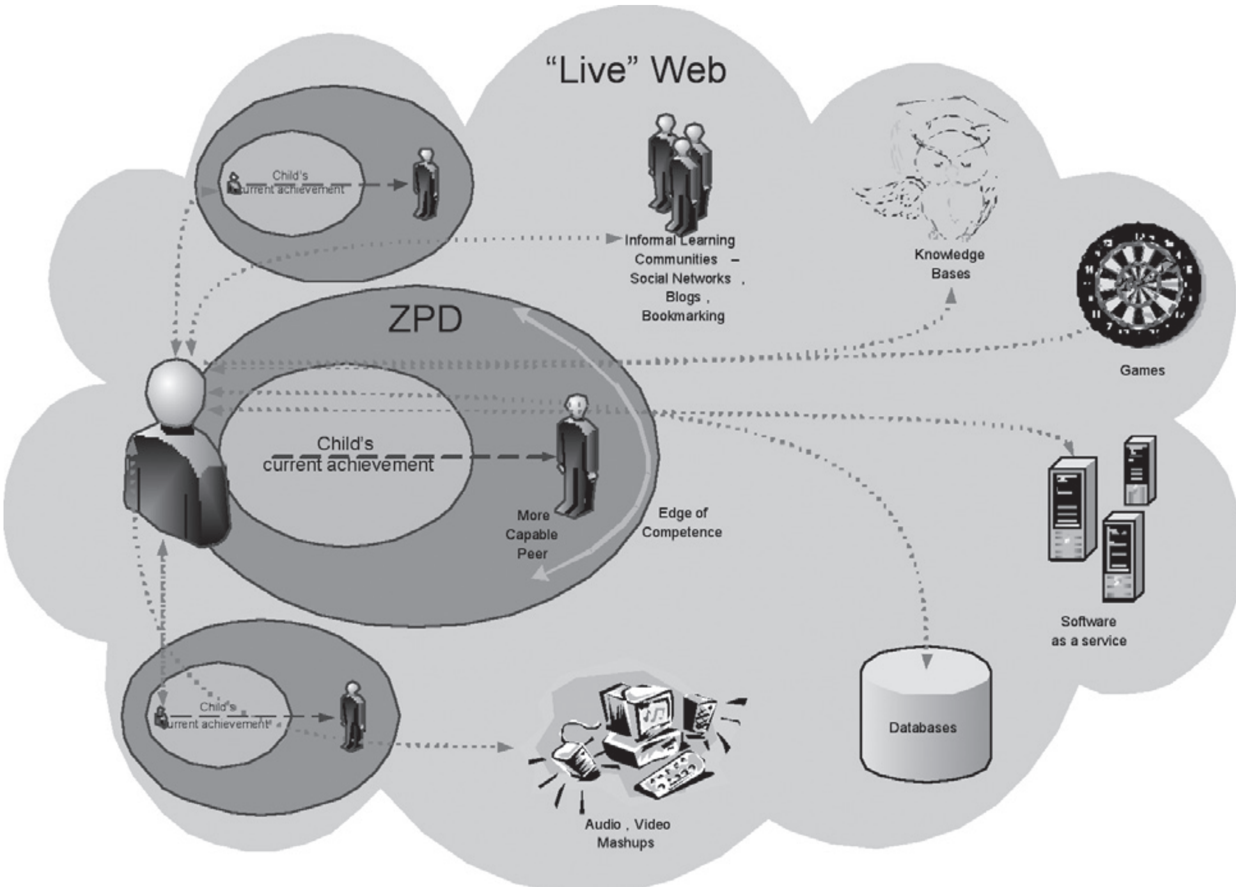

Figure 1. The Zone of Proximal Development in a distributed connected environment.

by Vygotsky's Zone of Proximal Development, described activities such as guided participation in parent-child interactions, apprenticeships, and people's collaborative efforts as key elements in constructing knowledge. Pea maintained that objects and tools could carry intelligence within them from previous reasoning in the form of physical and functional design. They have embedded a kind of economy, which can provide a cognitive short cut that helps minimize error. Attempts to imitate the design, form, or function through tinkering, playful discovery, or guided participation by experts potentially becomes an even more powerful learning experience. Dooling (2000) found that middle school youth liked to learn about computers by trying things out. They used a kind of trial-and-error method for individual exploration. A sixth grade girl in his study noted, "I personally prefer to explore the computer on my own. I learn by doing, not by listening" (p. 21). Well-programmed, open source software artifacts and open Application Programming Interfaces (APIs) not only carry "cognitive economy" (Pea, 1993, p. 53), but also provide the opportunity to de-couple and examine the implicit intelligence built into the design and function of the application. Exposing the coding logic, syntax, and structure becomes a guide and blueprint for learning new skills and contributing further to the affordances and innovation of the product.

A significant percentage of Internet-savvy adolescents "re-mix" existing content (their own and others) into new and unique creative products shared with others across the Internet (Lenhart & Madden, 2005; Lenhart et al., 2007). The result of these re-creations or "mashups" requires more expertise, skill, and imagination to develop. A wide range of abilities is needed to de-construct, modify, and manipulate a multitude of different media objects (audio, video, text) and programming interfaces into unique creations.

Many youth have grown up with a computer and have developed into facile users. They are becoming adept with a connected environment that greatly expands their opportunities to engage, create, and explore new knowledge in a context meaningful to them. When school learning and content goals coincide with what adolescents are engaged in outside school, the cognitive processing heuristics that form and take hold through "play" may manifest in what Salomon (1993) referred to as "cognitive residue" and what Brown and Thomas (2006) explained as "accidental learning." Pea (1993) suggested that human cognition aspires for efficiency, and a learner's activities naturally drive them toward the tools and conditions that best achieve this state. While Internet-savvy adolescents practice multimodal communication, re-mixing and sharing, collaboration, and creative expression outside the classroom, they are also engaging in knowledge-building activities that may serve them well in future learning and careers.

Constructs for this Study

The proposed dimensions of Internet-savviness were derived and triangulated from a diverse range of sources, including previous research articles and reports from both private and educational sources. Often, these dimensions are considered as key attributes of the 21st century learner. Further, they align with the updated National Education Technology Standards, (International Society for Technology in Education. 2007). Most compelling is the fact that these dimensions emerged independently and empirically as key attitudes, beliefs, and behaviors of adolescents who are passionate users of the Internet. The dimensions are: (a) computer mediated communication, (b) creative expression, (c) information gathering, (d) Internet fluency, (e) Internet self-efficacy, and (f) social collaboration. Although newly endowed in a digital framework, these constructs are acknowledged as powerful agents in cognitive processing and are grounded in the legacy educational learning theories of social constructivism and distributed intelligence.

Creative Expression

Divergent thinking and creative expression are pronounced typically as premier skills needed for 21st century success (21st Century Work Force Commission, 2000; New Media Consortium & EDUCAUSE Learning Initiative, 2007). The ability to think, act, and respond creatively within a digital framework holds obvious attraction for companies seeking individuals who can innovate and thereby help them stay globally competitive (Sternberg & Lubart, 1999). Robinson (2006), an internationally renowned expert in the field of creativity and innovation in business and education, contrasted what he described as the "extraordinary capacities" children have for innovation and creativity to the dearth of opportunities in schools to nourish these attributes. He maintained that supporting children's creativity in schools is as important as literacy and needs to be given the same status. At present, 64% of online youth, ages 12–17 years old, engage in at least one form of content creation and 39% share these creations on line (Lenhart et al., 2007).

Internet Self-Efficacy

Bandura (1986) defined the general construct of self-efficacy as a self-judgment of one's capabilities to achieve a successful outcome in terms of a behavior or task. Self-efficacy influences the choices we make, how much effort we put forth, how long we persist when confronted with obstacles or during the threat of failure, and how we feel about the result (Pajares, 1997). The concept of computer self-efficacy is important in the study of attitudes, beliefs, and behaviors toward computing. Compeau and Higgins (1995) found that individuals with high self-efficacy used computers more and experienced less computer-related anxiety. Cassidy and Eachus (2002) identified self-efficacy as a pertinent factor in the context of computer use, with higher levels of computer user self-efficacy (CUSE) associated with greater self-rated computer competency and experience. They also found differences in CUSE between males and females, with males reporting higher levels of computer self-efficacy across all measures including different levels of training. Eachus and Cassidy (2006) extended their study of computer self-efficacy to self-efficacy beliefs regarding the World Wide Web. They developed the Web Users Self Efficacy (WUSE) instrument for adults and tested self-efficacy beliefs across four domains—Information Retrieval, Information Provision, Communications, and Internet Technology. They showed that participants with experience in using the Internet had a stronger sense of self-efficacy and that males scored significantly higher than females in all four domains.

Computer Mediated Communication

Hoadley and Enyedy (1999) viewed Computer Mediated Communication (CMC) as one of the main components by which individuals construct and negotiate meaning within the larger framework of computer-based media. CMC is inherently communicative, interactive, and collaborative since all media presumes some audience even if the audience is oneself. CMC and its different manifestations (asynchronous and synchronous text, audio, and video) have been undergoing a renaissance in the last several years and have become more convergent, cheaper, and easier to use. Previously, these sub-systems rarely overlapped and were context specific to their respective domains of function and process. In a learning context, these systems are cohering on a Vygotskian platform that can provide a seamless means of communication and collaboration for participants as they move from novice to experts at a pace that suits them (Wertsch, 1985). These processes "make visible" a learner's early and less precise formations of meaning and understanding under the guidance and direction of more learned peers (p. 4). As understanding and articulation of a concept or idea becomes more clearly understood, it can then be synthesized and presented as a way to demonstrate competence and to establish consensus among a community of learners.

Internet-savvy adolescents vigorously use new CMC tools as a means for ubiquitous communication, personal and creative expression, and information exchange. They view email as a medium used to talk to "old people," institutions, or as a means to send complex instructions to large groups (Lenhart et al., 2005). While 49% of adults only occasionally use "modern gadgetry" and many others bristle over electronic connectivity (Horrigan, 2007), these Internet-savvy youth have become "super-communicators" (Lenhart et al., 2007) and use a variety of communication tools including instant messaging, text messaging, landline and cell phones, and email to stay connected. Forty-five percent have used IM to send photos or documents, links to articles and Web sites, as well as audio and video files (Lenhart & Madden, 2005).

Social Collaboration

The general law of cultural development (Vygotsky, 1978) proposed that higher mental functioning is initiated by interaction with learned others, followed by an internalized process of reflection, conscious realization, and then mediation through tools (Smagorinsky, 1995). From this perspective, cognition is no longer studied in individuals working in isolation. Rather, the emphasis is on individuals working with a variety of tools and people who help them carry out their goal-oriented activities in a socio-cultural setting. Until recently, these kinds of mediating tools were unavailable to educators in a way that supported their instructional use both in and outside the classroom. Now, however, a majority of youth seem to be leading the way in showing us how to "mediate" tasks, interests, and activities that are meaningful to them.

Currently, social software includes many different kinds of server based applications and services including text and video blogs, wikis, podcasting, bookmarking, and other social media like Facebook and MySpace. Adolescents are avid users of these technologies. Over 50% of online adolescents have a profile on a social network while 70% of them read blogs. Females blog more often than males with 35% having participated in blogging compared to 20% by males (Lenhart et al., 2005). All these manifestations of social software involve communities of users coming together to share, exchange, interact, and communicate ideas, thoughts, opinions, artifacts, and beliefs in varying degrees.

Information Gathering

The American Association of School Librarians and the Association for Educational Communications and Technology (1998) defined *information literacy* as "a keystone of lifelong learning" (p. 1). Currently, the grist of problem solving and creating solid knowledge foundations require rapid retrieval and the ability to evaluate critically new information and knowledge quickly for dealing with ill-structured situations and problems (Dede, 2000).

Seeking and gathering information in a way that informs thinking is a complex process, and involves multiple stages of questioning, asking and refining, information gathering, and finally, evaluation, synthesis, and use of the information (Wallace, Kupperman, Krajcik, & Soloway, 2000). Very little recent research exists on effectively searching the Internet for accurate, high-quality information. Information specialists complain frequently that the quality of online information varies widely and that credible information is too hard to find (Kiernan, 2006). Often, users decide whether to believe a particular Web site's information based on how professional the site appears or how closely the site's information matches their own views.

Wallace and associates (2000) in a study of sixth grade math students concluded that the process of information seeking requires intentional modeling and scaffolding over time. They investigated how sixth grade math students engaged in the information-seeking process. Their findings indicated that students spent the majority of their time (69%) negotiating the search engine and 31% of their time examining content, with only cursory examination and infrequent use of the content pages' links.

More than 9 out of 10 adolescents are Internet users (Lenhart et al., 2007). Finding information of interest is a primary activity and includes looking up information about health, diet, or physical fitness, religious and spiritual information, and research for school projects and activities (Lenhart et al., 2005). Lenhart and associates (2005) reported that 55% of adolescents seek political news online, 66% get news or information about current events, and 57% get information on events they might attend. Older teenage girls (aged 15–17) significantly led boys in the number of searches, time spent searching, and topics searched.

Internet Fluency

The underlying capability of participating in the increasingly rich avenues of learning and knowledge creation is related to proficiency in using today's new technology tools. Frequently, these tools are Internet based, synchronous, and reside in a socially collaborative and distributed framework.

A richly interactive, "read/write" online environment that is compelling to young people has eclipsed the "one-way," passive mode of learning that has characterized traditional media teaching. However, as Hoffman and Blake (2003) noted, current technology environments require a broad range of skills and competencies that continues to evolve rapidly. It is far different from a few short years ago. The new technologies of today may require knowledge of multiple program languages, a wide array of audio, imaging, and video skills, and proficiency with a myriad number of digital forms and applications that support the notion of just-in-time learning, a key 21st century skill.

Most of the dimensions cited above lack representation in actual classroom practice. These learning elements, cited in a plethora of previous research and considered to be vital in support of 21st century learning needs, are embodied in the attitudes, beliefs, and behaviors of technologically savvy adolescents and are practiced largely outside school.

Close examination of the construct of Internet-savviness and its dimensions in the framework of formal research and investigation may provide important clues about how K–20 education can better prepare all youth for the challenges of 21st century learning.

Methodology

Survey methodology using a mixed-method research framework was used to address the following research questions.

1. Can an instrument be developed that measures Internet-savviness and its underlying factors in children ages 8–14?
2. Is there a relationship between a measure of Internet-savviness and six measures of Computer Mediated Communication, Social Collaboration, Creative Expression, Internet Self-Efficacy, Internet Fluency, and Information Gathering?
3. Is there a relationship between Internet-savviness and age, gender, Internet access speed, and Internet use location (e.g., home, school, and library)?

Pilot Study

The purpose of the pilot study was to identify weaknesses in the design and methodology of using the online Internet-savvy scale and to refine the measures in preparation for the larger study.

The initial study used a convenience sample of 26 fourth through eighth grade students attending a small, private, K–8 school. The school's mission focuses on intellectual and personal growth for gifted and talented youth. Class sizes are small with an average of 16 students for grades K–8. Many teachers at the school hold master's degrees and several have a Ph.D. degree, including the computer resource teacher. Parental involvement is strong and parents vigorously support the school.

The survey, consisting of 36 Likert-type scale items and eight multiple choice profile items, was administered during spring 2007. An introductory letter explaining the research study and a parental consent form were sent home with 66 students. Twenty-six students returned a signed consent form for a 39.4% response rate. The 26 students, 8 females and 18 males, completed the survey during school hours under teacher supervision.

Results of the pilot study. Internal consistency of the measures was assessed using Cronbach's alpha. Results showed acceptable levels of reliability for the Internet Savvy Scale (0.946) and the sub-scales: Computer Mediated Communication (0.915), Social Collaboration (0.915), Creative Expression (0.761), Internet Self-Efficacy (0.844), Internet Fluency (0.863), and Information Gathering (0.764)

All results were statistically significant at $p < .001$. Other pilot study results included the following.

- More than 80% of the respondents reported that they access the Internet “regularly” or “most of the time” at home
- More than 46% said they access the Internet at a friend’s house
- Close to 70% of the respondents spend one to four hours a week using the Internet to “chat” (email, IM) with family and friends over the Internet
- Fifty percent use the Internet at least an hour a week playing games
- Fifty percent spend at least an hour a week engaging and collaborating with others over the Internet.
- Eighty-eight percent use the Internet at least one hour a week to look up information of interest to them with 35% spending at least three hours a week looking up information.

The survey prompted respondents to categorize themselves as a *Beginner*, *Intermediate*, or *Advanced* user. Their self-report indicated that 7% ($n = 2$) were *Beginner* users, 62% ($n = 16$) were *Intermediate* users, and 31% ($n = 8$) were *Advanced* users. Using ANOVA, a statistically significant difference in Internet Savvy (IS) scores was found across the groups with $F(2,23) = 11.343$, $p < .001$. Post hoc results indicated significant differences between *Beginner* and *Advanced* ($p = .014$) and between *Intermediate* and *Advanced* users ($p < .001$). Inter-item and inter-domain correlations were examined and anomalous items were identified, investigated, and modified.

Main Study

The survey population consisted of 677, 8- to 14-year-old academically talented youth attending a summer enrichment program at a large mid-Atlantic university in 2007. The mission of this program was to create a unique educational experience for talented learners. The program included three two-week sessions that ran consecutively from mid-June through the end of July. Two hundred twenty-four middle school youth attended sessions I and II, while 229 students attended session III.

Completion of the survey was voluntary. Before the survey was conducted parental consent and student assent were attained. Response rates for the study were determined by the number of parents returning a signed consent form and by the number of students who assented to taking the survey.

Instrumentation. Various scales that measure technology literacies, skills, and levels of computer self-efficacy exist, (Cassidy & Eachus, 2002; Eachus & Cassidy, 2006; Panero, Lane, & Napier, 1997), but none deal with Internet-savviness as a multidimensional construct or examine the use of the Internet by middle school youth. Consequently, the researcher developed a survey scale to measure the construct and its underlying dimensions. Six sub-scales measured the following dimensions thought to make up Internet-savviness: (a) computer mediated communication, (b) creative expression, (c) information gathering, (d) Internet fluency, (e) Internet self-efficacy, and (f) social collaboration. During development, a panel of experts consisting of 12 doctoral students and professors provided extensive formative feedback about the content and format of the survey. After analyzing the feedback, weak items were modified or replaced. Subsequently, the survey was reconfigured and respondents were asked to identify the dimension that related to the item stem.

Using a spreadsheet matrix, responses were tabulated and compared to the dimension intended for each item. Based on this additional analysis, items were further modified and refined. These multiple analyses helped identify issues of formatting, structure, and clarity that could affect item non-response and measurement error (Dillman, 2000). The exercises also strengthened the face, content, convergent, and discriminant validities that comprise the overall construct validity or “quality” of the measure (Krathwohl, 1998).

Part I of the survey consisted of the Internet-savviness scale and sub-scales. Each measure in the scale consisted of five to seven Likert-type items for a total of 38 items. Item choices consisted of *strongly disagree*, *disagree*, *agree* and *strongly agree*. Affirmation bias was controlled by wording half the items in a negative manner so that a strongly disagree/disagree response was needed to add to the composite score. An overall high score indicated high Internet-savviness. A minimum score on the Internet-savvy scale was 38 with a maximum score of 152 for the 38 items.

Part II included 10 questions regarding demographic information and Internet access speed, location of access, and time spent on Internet activities. The respondents rated themselves as *Beginner,* *Intermediate*, or *Advanced* Internet users to establish criterion validity and to gain statistical insight into the construct of Internet-savviness. In this study, *Advanced* users with high Internet-Savvy (IS) scores were viewed as having the highest degree of Internet-savviness. Group membership was analyzed with the other variables of interest in the study.

The survey instrument was developed with *SelectSurvey.NET,* a commercial online survey tool. The estimated time to complete the survey was 20 minutes.

Procedure. Approximately two weeks before each session, an email was sent to students' parents to introduce the study. This email also invited parents to preview a "live" version of the online survey planned for their adolescent child. About 10 days before program registration, a letter and consent forms were sent to parents. The letter gave details of the study and asked parents to carefully read the consent form, sign it, and bring it with them to registration. A reminder email was sent about five days before registration. The researcher was on hand to collect consent forms, greet parents, and answer questions. Blank consent forms were also provided to parents who forgot the form or had not completed the form, but who were willing to do so.

Completion of the survey was voluntary and anonymous. The first screen of the survey served as the youth assent verification. The survey began when each respondent clicked on the "I Agree" button. Not all eligible youth were able to take the survey due to schedule constraints. About a week after each session, a follow-up email was sent to consenting parents whose child had not taken the survey, which asked them to allow their child to take the survey at home. An additional 20 youth completed the survey in this manner.

Data recording and management. After each survey session, collected data were downloaded from the *SurveySelect* database into a secure Excel spreadsheet file. Data were coded manually and imported into SPSS v. 14 for analysis.

Limitations. The following limitations should be considered. First, the survey was completed by youth identified as academically talented from a non-experimental convenience group. Consequently, the degree of Internet-savviness could emerge differently in this group compared to other talented youth and other groups in the middle school population. Any discussion regarding generalizability of Internet-savviness to other groups and populations needs to proceed thoughtfully and carefully. Second, the self-report nature of survey methodology as well as a number of variables can potentially affect results. Among these variables are recall strategies, instructions, mood, time of day, and response formats (Stone et al., 2000).

Results

Three hundred twenty parents completed consent forms for a return rate of 47.3%. From this available pool of respondents, 243 adolescents completed the survey during the three main sessions and post sessions for a completion rate of 35.9%. One hundred thirty-two individuals (presumably parents or guardians) previewed the online survey before their adolescent child attended the summer session. The average time for all respondents to complete the survey was 17 minutes and 50 seconds.

Demographics—Age and Gender

The age of the participants was 8–14 years of age with over 95% of the sample falling into the 10- to 13-year-old age range. The average age for all participants was 11.63 years (SD = 1.165, n = 222). Females (M = 11.67, SD = 1.159, n = 142) were slightly older than males (M = 11.56, SD = 1.178, n = 80).

Data Inspection

The raw dataset was inspected visually and statistically by examining frequencies, boxplots, histograms, and Internet-savvy (IS) scoring distribution. One outlier, a nine-year-old female with an Internet-savvy score of 47, reported herself to be an *Advanced* Internet user (*Advanced* = 3). This IS score was almost three standard deviations from the mean of standard scores (z score = -2.997) for *Advanced* users and well outside the normal distribution of scores. The case was dismissed from the dataset, which reduced the number of cases to 242. Tests for normality (i.e., Shapiro-Wilk) and homogeneity of variance (i.e., Levene) on the IS scores were as expected.

Missing data can seriously affect statistical results (Greenlees, Reece, & Zieschang, 1982; Little & Rubin, 1987). In order to more closely approximate the true value of the unobserved missing score, an average of the item scores within each dimension was calculated and substituted for the dimension's missing score—thereby providing 242 complete cases for the dataset.

Table 1
Reliability Coefficients

Measures		Session I n = 73			Sesson II n = 57			Sesson III n = 93	
	Items	M	SD	α	M	SD	α	M	SD	α
Information Gathering	6	19.12	2.445	.633	19.468	2.895	.747	18.53	3.344	.837
Communication	5	16.57	3.005	.860	16.68	3.017	.836	16.10	3.484	.878
Internet Self-Efficacy	5	16.70	2.492	.825	15.89	2.657	.681	16.30	2.409	.775
Creative Expression	5	12.95	3.536	.811	13.03	3.692	.788	13.06	3.545	.823
Internet Fluency	5	12.58	3.618	.744	11.68	3.461	.692	12.37	3.523	.778
Social Collaboration	6	14.98	4.104	.826	14.69	4.223	.819	14.52	3.834	.789
Internet-Savvy Scale	32	92.90	13.886	.910	91.44	14.686	.910	90.88	14.993	.926

Table 2
Mean Scores, Standard Deviations, and Alpha-Dimensions

Measures		All Sessions N = 242		
	Items	M	SD	α
Information Gathering	6	18.90	2.99	.772
Communication	5	16.36	3.263	.858
Internet Self-Efficacy	5	16.29	2.482	.765
Creative Expression	5	12.88	3.616	.816
Internet Fluency	5	12.19	3.503	.742
Social Collaboration	6	14.62	4.004	.808
Internet-Savvy Scale	32	91.24	14.603	.913

Item Analysis and Reliability

Scale items may be removed or replaced based on their correlation and suitability with other items in their respective domains (Green, Salkind & Akey, 2000; Krathwohl, 1998). Thirty-eight items were developed initially for the instrument with the expectation that weaker and redundant items would be identified and dropped. Correlation was calculated using Pearson's Product-Moment Correlation Coefficient. Six items with weak intra-correlations were identified and dismissed from the measure, reducing the number of items from 38 to 32.

Internal consistency of the revised 32-item scale, measured by Cronbach's alpha was satisfactory for the overall scale and sub-scales. Mean scores, standard deviations, and alpha coefficients were consistent across all three sessions. The results for the three main sessions are presented in Table 1. The follow-up session results (n = 20) are not shown.

Summary mean scores, standard deviations, and reliability coefficients by dimension are shown in Table 2.

Factor Analysis

To establish further evidence of construct validity (Krathwohl, 1998) and to reduce the number of items to a more simple structure, an exploratory factor analysis was conducted using principal component analysis (PCA) with varimax rotation. The first attempt at identifying the simple structure of the scale revealed that all item loadings exceeded .40 except for one item in the Social Collaboration dimension index. This item was removed and the PCA analysis was re-run based on 31 items. Seven components with eigenvalues greater than one accounted for 60.46% of the total variance in scores as shown in Table 3.

The rotated component matrix was based on 31 items. Item Q7CE (0.523) double-loaded on Component 2 (Social Collaboration) and Component 3 (Creative Expression). Items Q10IG and Q37IG are very similar questions about Information Gathering with one question addressing information needs "for homework assignments…" and the other involving "gathering research data." Both relate to information needs at school, which may have caused them to form under a unique component rather than under Component 6 (Information Gathering), a more general component.

Table 3
Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.713	28.107	28.107	8.713	28.107	28.107	3.257	10.508	10.508
2	2.574	8.305	36.412	2.574	8.305	36.412	3.160	10.195	20.702
3	2.132	6.876	43.288	2.132	6.876	43.288	2.892	9.329	30.031
4	1.755	5.660	48.949	1.755	5.660	48.949	2.881	9.294	39.325
5	1.322	4.265	53.214	1.322	4.265	53.214	2.506	8.085	47.410
6	1.174	3.787	57.001	1.174	3.787	57.001	2.447	7.895	55.305
7	1.073	3.461	60.462	1.073	3.461	60.462	1.599	5.157	60.462

Validity
Construct validity is the unifying framework for evidence regarding whether or not we are measuring what we think we are measuring (Krathwohl, 1998). Item evaluation and reconciliation analysis by the panel of Ph.D. education cohorts was used to establish the face and content validity of the scale. Evidence of criterion validity was established by asking participants to rate their level of expertise on a three-point scale: *Beginner, Intermediate*, and *Advanced* (IS User groups). The expectation was that respondents who perceived themselves to be at a higher level of expertise would score better. *ANOVA* results indicated that this was the case with $F(2,237) = 43.779$, $p < .001$). *Beginners* scored lowest, followed by *Intermediate* users, with the *Advanced* group scoring highest. *Advanced* users were considered to be *Internet-savvy* for purposes of this study. Tukey's post-hoc test showed statistically significant differences between the *Beginners*, *Intermediate*, and *Advanced* groups, with $p < .001$.

Multivariate Analysis
A MANOVA was conducted to examine differences in IS score means across the dimensions. Dimension sub-scores served as outcome variables against the *IS User* groups. The results are shown in Table 4.

Post hoc test results indicated that differences were statistically significant ($p < .01$) except for Creative Expression and Social Collaboration where differences in scores were not statistically significant ($p < .05$) between *Beginner* and *Intermediate* users. Components that correspond to what the scale was intended to measure provide evidence of construct validity (Krathwohl, 1998). The results of the exploratory factor analysis clearly identified clusters of items that measured their intended dimensions.

Gender and Age – IS Scores
Mean Internet-Savvy scores were examined by gender and age. Although males had slightly higher average IS scores ($M = 93.30$, $SD = 14.360$, $n = 83$) than females, ($M = 91.17$, $SD = 14.424$, $n = 146$), this difference was not significant.

It was expected that older users would score better than younger users and this was the case, with $F(5,215) = 6.378$, $p < .001$. Post hoc results (eight-year-old eliminated) seemed to indicate that the 13-year-old threshold was meaningful in terms of the Internet-savvy total scores. Differences in scores of 9- to 12-year-old participants comparisons were not statistically significant but this changed at age 13 with 13-year-old group scores becoming significantly different against younger age groups of 9-, 10-, and 11-year-olds ($p < .05$) with 12-year-olds nearing significance ($p = .056$).

For the 9-, 10- and 11-year-old age groups, males scored better than females. However, at age 12, females ($M = 92.14$, $SD = 11.531$) surpassed males ($M = 90.28$, $SD = 14.482$) and stayed even at age 13. No females were in the 14-year-old age group, but these scores were not statistically different from the 13-year-old females. The overall scores for all age groups showed no statistical differences between males and females.

Table 4
Means & Standard Deviations by IS User Group and Domain

Domain	Beginner (n = 17) M, SD	Intermediate (n = 141) M, SD	Advanced (n = 82) M, SD	Total (n = 220) M, SD	F (2,237)*
Information Gathering	16.14, 4.167	18.51. 2.677	20.17, 2.659	18.91, 2.991	18.146
Communication	13.20, 4.586	16.03, 3.142	17.61, 2.510	16.37, 3.262	16.698
Internet Self-Efficacy	13.47, 1.7	15.65, 2.207	17.99, 1.941	16.30, 2.475	49.391
Creative Expression	10.94, 3.344	12.17, 3.328	14.51, 3.601	12.88, 3.620	15.029
Internet Fluency	8.65, 2.178	11.21, 2.770	14.57, 3.383	12.18, 3.477	46.347
Social Collaboration	12.81, 4.028	14.12, 3.567	15.88, 3.383	12.18, 3.477	7.330

* $p < .001$

Online Access, Location, and Activities

Rather than describing Internet access in broadband terms and speed (e.g., kbits\sec, DSL, cable, dialup) which might have been confusing to some participants, response speed was described in terms of "Fast," "Slow," and "Very Slow." An overwhelming majority of users (76.1%) reported having "fast" access at home, while 21% reported slow or very slow access. Only three participants reported having no access to the Internet at home and no one reported not having a computer at home.

A *MANOVA* revealed that differences in Internet use at home, $F(2,218) = 21.975$, $p < .001$, and at a friend's house, $F(2,218) = 5.140$, $p = .007$, were significant for *IS User* groups. No significant differences existed between males and females regarding where they accessed the Internet. Respondents were also asked about the types of Internet activities they participated in and the time spent on each activity. *MANOVA* results also revealed that differences in all of the activities were statistically significant ($p < .02$) for *IS User* groups. (See Table 5 for activities and weekly time devoted to each activity.

Table 5
Internet Activities by Participation Percent

Weekly Activities	never	%	less than 1 hour	%	Between 1 & 3 hours	%	Between 3 & 5 hours	%	Between 5 & 7 hours	%	7 or more hours	%	10 or more hours
Chatting (n = 232)	48	19.8	65	26.9	49	20.2	26	10.7	27	11.2	27	11.2	55.6
Creative (n = 229)	125	51.7	42	17.4	33	13.6	13	5.4	7	2.9	7	2.9	26.2
Playing (n = 228)	12	5.0	62	25.6	77	31.8	42	17.4	19	7.9	19	7.9	66.0
Sharing (n = 234)	118	48.8	60	24.8	28	11.6	8	3.3	10	4.1	5	2.1	21.8
Looking up (n = 233)	20	8.3	70	28.9	80	33.1	37	15.3	22	9.1	4	1.7	61.3

Significant statistical differences were revealed in *Chatting with friends and family* for females (M = 2.14, SD = 1.578) over males (M = 1.65, SD = 1.629) with $F(1,206) = 11.162$, $p = .038$ and *Playing games* with males (M = 2.56, SD = 1.423) outpacing females (M = 2.02, SD = 2.02) at $F(1,206) = 7.961$, $p = .005$. A comparison by age showed statistical differences in chatting online $F(6,193) = 5.435$, $p <.001$, doing something creative $F(6,193) = 3.238$, $p = .005$, and playing games $F(6,193) = 3.577$, $p = .002$.

Advanced Users and Internet-Savviness

Eighty-one participants (33.9%) reported themselves as an *Advanced* user of the Internet. Of those reporting gender affiliation, 29.6% of females in the sample (n = 145) considered themselves *Advanced*, while 37.3% of the males did though there was less than a one point difference in means between male (M = 102.30, SD = 10.662) and female (M = 101.59, SD 12.158).

Using stepwise regression, IS scores was used as the criterion variable while age, gender, access, location, and activities served as predictors. *Doing something creative* contributed 27.4% of the variance in IS scores while *Access at home* contributed 11.3 percent of the variance in IS scores. These two predictors contributed close to 40% of the variance in IS scores with *Exchanging images*, and *Access speed*, *Age*, and *Access at a friend's house* also contributing but at a lower effect, $p < .05$. Table 6 shows the R^2 and R^2 changes for all the predictors that were statistically significant in influencing IS scores.

Discussion

This study developed and validated the psychometric properties of a new instrument designed to measure Internet-savviness, a multidimensional, newly conceived construct. Reliability coefficients for the dimensions were satisfactory with the overall coefficient for the IS scale at 0.91. The exploratory

Table 6
Multiple Regression Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.524[a]	.274	.270	11.728	.274	70.980	1	188	.000
2	.622[b]	.387	.380	10.808	.113	34.373	1	187	.000
3	.657[c]	.432	.423	10.431	.045	14.732	1	186	.000
4	.672[d]	.452	.440	10.271	.020	6.861	1	185	.010
5	.686[e]	.471	.457	10.117	.019	6.655	1	184	.010
6	.695[f]	.484	.467	10.025	.012	4.408	1	183	.037

[a] Predictors: (Constant), Doing something creative . . . .
[b] Predictors: (Constant), Doing something creative . . . . access at home
[c] Predictors: (Constant), Doing something creative . . . . access at home, Exchanging images . . .
[d] Predictors: (Constant), Doing something creative . . . . access at home, Exchanging images . . .speed
[e] Predictors: (Constant), Doing something creative . . . . access at home, Exchanging images . . .speed, age
[f] Predictors: (Constant), Doing something creative . . . . access at home, Exchanging images . . .speed, age, access at a friend's house

factor analysis aggregated the influence of 32 Internet-savviness measurement items to a structure consisting of six main dimensions. Of the seven components that emerged, all eigenvalues exceeded 1.0 and all rotated factor loadings exceeded 0.50. One indicator double-loaded on creative expression and social collaboration. The two items designed as indicators of *Information Gathering* actually converged on a seventh component. The common element between the two items was gathering information in a school context as compared to the other four items, which were more generic in terms of search behavior. This may have caused the formation of the additional component. These issues will be addressed and refined in future iterations of the IS scale.

Internet-Savvy Scores – Age and Gender

Internet-savvy scores increased with age as expected, but a statistical difference was not detected until age 13. Although females started out below males on overall IS scores, they closed the gap by age 12 and stayed essentially even with the males through ages 13 and 14. Overall, the females showed a more consistent and accelerated rate of increase in IS scores with age. This trend is shown in Figure 2 (with 8-, 9- and 14-year-olds excluded due to low representation). Although more males rated themselves as *Advanced* than females as a percent of their total groups, mean average IS scores by gender were not statistically significant for this group of young people. A lack of statistical significance here is meaningful, as females have historically shadowed males in many technology-related attitudes, beliefs, and behaviors. This difference has also been suggested in research findings based on several of the dimensions of Internet-savviness including Internet self-efficacy (Cassidy & Eachus, 2002; Eachus & Cassidy, 2006).

These results are encouraging given that middle school is a formative time for females in terms of their attitudes and beliefs regarding technology (Shoffner, 2006). Females have demonstrated an attitude of "I can, but I don't want to" (American Association of University Women, 2000) regarding technology-related activities that have traditionally been male dominated. Have females found their "game" through more communicative, interactive, and socially collaborative activities that are now available on the Internet? Females in this study were more active than males in communicating with online friends and sharing images, audio, and video files across the Internet. This aligns with previous reporting (Horrigan, 2007; Lenhart & Madden, 2007; Lenhart et al., 2005) and further illuminates the emergent,

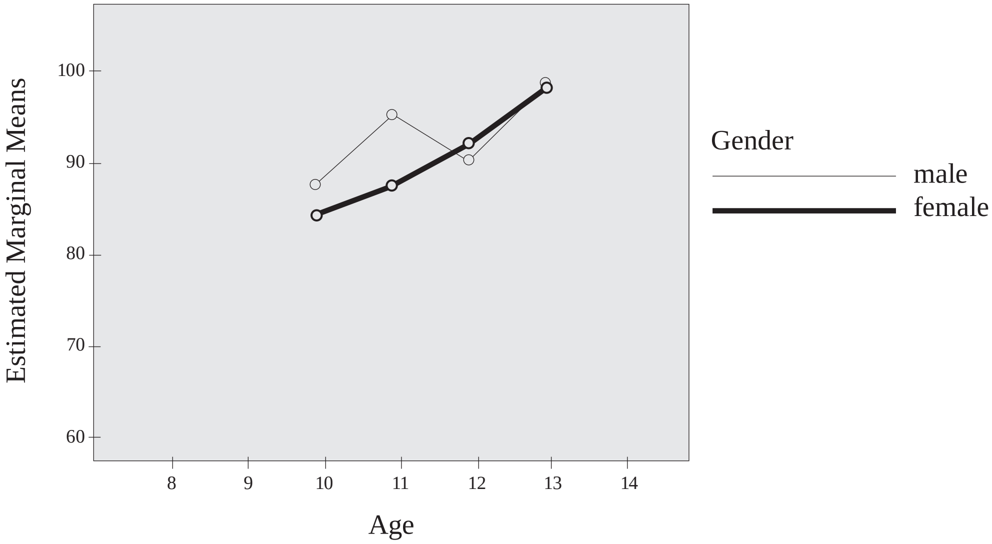

Figure 2. Internet-Savviness total scores – Age and gender

Internet-related behaviors of females. Pre-teen and early teen males and females are increasingly engaged in all types of social networking activities (De Boor & Li, 2007), but Lenhart and associates (2005) found that older adolescent females (15 to 17 years old) were much more involved than males in activities like communicating, blogging, and creating Web sites. The latest Pew Internet study by Lenhart and associates (2007) found this trend accelerating. Both studies indicated that blogging activities tended to correlate highly with sophisticated technology and Internet use in the form of content creation and other technology-related activities. Correlation is not causation and more research is needed, but it seems reasonable that new applications and opportunities for social interaction, communication, and creative expression may be appealing to females who previously eschewed the more specialized and male-driven aspects of technology. These new opportunities may finally be stimulating the interest of females and indirectly spawning new technology skills that otherwise might not have emerged. Salomon (1993) suggested that technology could be used as a kind of "Trojan Horse" to attract and engage students in higher order cognitive processing and social interaction that enhance learning. The use of new technologies that are appealing to females and other under-represented groups may serve as one strategic on-ramp to positively influencing intrinsic motivation, self-efficacy, interest, and increased participation in STEM (science, technology, engineering, mathematics) related areas.

Online Access Speed

The majority of participants (76.1%) enjoyed what they considered "fast" access at home with only three participants reporting no Internet access. No one reported not having a computer at home. If "fast" is assumed equivalent to broadband access, this group compares very favorably to a report by Fox and Madden (2005) in which 49% of 12- to 17-year-olds had broadband access to the Internet at home. Having sufficient or fast access is obviously a key element to participating in today's most compelling Internet, multimedia enriched applications. Synchronous activities—especially audio and video—require sufficient and unrestricted bandwidth to engage fully with digital media over the Internet. Most of the adolescents in this study seemed to have access to the hardware and bandwidth necessary to participate in these activities. The youth in this study spent a lot of time on the Internet at home compared to school and other locations and it seems logical that access speed was a contributing factor to this behavior. Home access and speed were statistically significant predictors for differences in IS scores. Hours spent on the Internet at home were statistically significant across IS user groups ($p < .001$).

Location and Activities

Home and a friend's house were the primary Internet access locations for the adolescents in this study. Over 93% of adolescents used the Internet, which compares favorably to Hitlin and Rainee's (2005) report of 78% and matches the most recent report of adolescent use of the Internet (Lenhart et al., 2007). However, about half the participants accessed the Internet at school less than an hour a week. A great majority of students (89.5%) reported using the Internet at home for more than one hour per week and 31.6% reported spending at least an hour per week on the Internet at a friend's house. A significant number of students reported using the Internet at home (29.3%) seven hours or more per week. *Advanced* users spent almost twice the amount of time on the Internet (M = 3.92, SD = 1.322) as *Beginning* users (M = 1.69, SD = .793). By converting the average item response coding to its temporal equivalent, the difference in time spent per week between the two groups amounted to about 2.5 hours per week, a substantively meaningful amount of time. A small percentage of students accessed the Internet at the library (14.6%) with local community centers seeing little Internet use activity.

These results begin to draw attention to the contrast between out-of-school and in-school Internet use. With the proliferation of Internet-connected mobile phones and other small devices that adolescents own (Horrigan, 2007), Internet access is approaching ubiquity even for youth. The majority of time spent on the Internet is taking place outside school and away from the guidance of teachers and other education personnel, which is troublesome on several levels. Schools are not proactively using the Internet instructionally and often block or severely restrict its use in the classroom (De Boor & Li, 2007). Opportunities for modeling and guiding youth on appropriate Internet behaviors and ethical uses are missed. Gathering accurate information and guarding against subliminally manipulated digital media are important skills, which require adult guidance and tutelage for appropriate development. "Teachable moments" by example and counter-example that ungarnished access to the Internet can provide, are lost.

At present, schools are struggling with the difficult challenges of using the Internet in a way that is instructionally beneficial and motivating to students. As of 2005, Wells and Lewis (2006) reported that 99% of public schools were wired for Internet access. Non-authentic and forced online assignments, numerous restrictions that limit access, and lack of free time severely dampen student enthusiasm for Internet use in schools. Levin and Arafeh (2003) found that 34% of students never use the Internet while at school. They indicated that while most students surveyed had used the Internet at school, almost half of them used it for less than an hour a week.

Internet Activity Types

The majority of participants reported spending at least one hour per week on the following three activities: playing games (66.0%), chatting with friends or family (55.6%), and looking up information important to them (61.3%).

Online games. The participants in this study were avid game players. Almost all (97.8%) have played a game online, compared to 81% reported by Fox and Madden (2005). Almost 8% reported playing online games for seven or more hours a week. Many of these games are free and incorporate socializing and communication elements in their play spaces. Creative expression often takes the form of character, scenario selection, and color palette choices for game space configuration and many games require a surprising amount of divergent thinking for problem solving (Gee, 2003). Many educators feel that integrating game play in the classroom is an ideal way to motivate and teach content (Gee, 2003; Prensky, 2001). As a way to motivate youth in school, Prensky (2006) suggested:

> …we must engage them in the 21st century way: electronically. Not through expensive graphics or multimedia, but through what the kids call "gameplay." We need to incorporate into our classrooms the same combination of desirable goals, interesting choices, immediate and useful feedback, and opportunities to "level up" (that is, to see yourself improve) that engage kids in their favorite complex computer games. (p. 10)

Chatting online. Over 11% of adolescents in this study spent seven hours or more chatting online with friends or family. Given the multitasking abilities of young adolescents (Foehr, 2006) and additional affordances seen in the most common (and free) instant messaging tools (hyperlinking, attachments, text, audio/video capabilities), the process of communicating often involves other related activities such as looking up information in a search window and word processing a homework assignment. Making plans with friends, talking about homework assignments, joking around, and checking in with parents are common threads of communication that adolescents engage in (Lenhart et al., 2005, 2007).

A popular notion is that Internet-based activities taking place outside school are non-school related. Many are not, but young people use the Internet as a way to understand, negotiate, and manage what is important in their world, and school is important to most adolescents (Levin & Areheh, 2003). De Boor and Li reported that almost 60% of students use social networking to talk about education topics online, and more than 50% talk specifically about schoolwork (2007).

Conclusion

Savvy youth are using the Internet in ways that interest educators and speak loudly through their attitudes, beliefs, and behaviors regarding the Internet. They comprise about 30 to 40% of all Internet-using adolescents and are early adopters and enthusiastic beneficiaries of a disruptive, global phenomenon that is rapidly diffusing across a digital, connected landscape. However, the social, cultural, and cognitively rich experiences that these youth participate in are largely taking place outside schools.

With regard to ignoring the *voice* of students Prensky (2006) offered:

> As we educators stick our heads up and get the lay of the 21st century land, we would be wise to remember this: If we don't stop and listen to the kids we serve, value their opinions, and make major changes on the basis of the valid suggestions they offer, we will be left in the 21st century with school buildings to administer—but with students who are physically or mentally somewhere else. (p. 13)

Most schools face a great challenge in integrating the Internet in their classrooms. Earlier in this study, it was suggested that Internet-savvy young adolescents were unknowingly laying out a pedagogical road map through their actions. Their attitudes, beliefs, and behaviors may be showing educators how to operationalize and scale a deep legacy of cognition and learning theory that has been difficult to implement beyond more that a few learners at a time. Creating, interacting, collaborating, sharing and exchanging information, original ideas, and artifacts across a connected, distributed environment are becoming the lifeblood of activity for young people. These activities harnessed and re-purposed for classroom exploration and learning, could very well serve as the cornerstones that education needs to jump-start itself into the 21st century.

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