

What Students Think About Technology and Academic Engagement in School: Implications for Middle Grades Teaching and Learning

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Students today live in technology-rich environments that shape their interactions with information and with each other. Children in the 21st century have access to a wide range of technology resources and tools for learning in real-life contexts. This study reports on a survey of 4000 North Carolina middle school students about what they need to be engaged and achieve in these 21st century settings. In addition to the large-scale survey, 48 students from three different geographical areas of the state participated in six focus group interview sessions. The results of the survey and focus group interviews are reported in the context of similar previously reported national surveys of students' uses and thoughts about technology. Collective findings from these studies suggest that students use technology differently inside and outside school. We argue that to facilitate student learning that is engaging and meaningful, middle grades teachers must bridge the gap between their students' uses of technologies in and out of school. Furthermore, we suggest that as middle grades teachers consider the various roles that technology plays in children's lives in and out of school they should pay special attention to the particular needs of middle level learners.

Recent advancements in technology including the emergence of ubiquitous computing, social networking, and digital representations of vast amounts of information have altered the way students interact with content and with each other. The implications of these developments for educators at all levels are significant with information becoming a currency of sorts for citizens in society. Middle grades educators in particular must help their students navigate these new computing, social, and information technologies and need specialized approaches and pedagogical knowledge for using technology in their classroom. This specialized knowledge should include an awareness of how children are engaging with each other and with information using various forms of technology. Teachers and researchers are in fact becoming increasingly interested in learning how technologies might improve K-12 education (Azzam, 2006; Bolick, Berson, Coutts, & Heinecke, 2003), but rarely have researchers asked the students themselves about their uses and perceptions of technology. In part to help fill this gap, we conducted an extensive study of 4,000 middle grades students in North Carolina as well as follow-up focus group interviews with 48 of these students about their beliefs, concerns, attitudes and experiences with technology. In this article, we summarize findings from our study as well as findings from two similar surveys of students' technological opinions, habits, and beliefs. We then consider the implications of this body of research for middle grades education. We frame the results of these surveys within three interrelated considerations of how middle grades teachers might consider teaching and learning in the 21st century, including (a) the shifting context of teaching and learning in the 21st century, (b) the nature of 21st century middle grades learners, and (c) the pedagogical challenges middle grades teachers face in the 21st century. First, we review general literature related to teaching and learning contexts, pedagogies, and learner needs relevant for teaching with technology in the 21st century.

TEACHING AND LEARNING IN THE 21ST CENTURY

21st Century Education

New information literacies and other skills or understandings that have emerged in the 21st century as vital to productive civic and economic life are influencing education in the 21st century. The New London Group

([NLG], 1996) described these skills and understandings as multiliteracies and suggested that these new literacies reflect emerging and evolving technological forms for representing texts as well as the plural cultural experiences that are a part of increasingly “globalized societies” (p. 61). The 10 NLG scholars who developed the concept of multiliteracies view their work as further reflective of changes in working, public, and private lives that are representative of what Gee, Hull, and Lankshear (1999) called “fast capitalism.” These changes include more nimble work experiences, a decline in public citizenship, and direct government involvement in public life, and the private being increasingly validated, yet at the same time, more transparent than ever before (Gee, Hull, & Lankshear).

Like the NLG, the Partnership for 21st Century Skills (P21) has begun work on clarifying the literacies that will be central to civic, economic, and social life in the years and decades to come. The P21 (2002) argues that technological, economic, informational, demographic, and political changes require that schools reconsider how they prepare young people for civic, economic, and social life. Arguing to “bridge the gap between how students live and how they learn” (p. 4), P21 has identified four key elements for 21st century education including, (a) core subjects and 21st century themes, (b) learning and innovation skills, (c) information, media, and technology skills, and (d) life and career skills. These four elements shape an educational reform agenda that P21 argues will enable young people to develop a wide range of skills (e.g., media, communication, critical thinking, creative, problem solving, interpersonal, and collaborative) while using information and communication technologies (e.g., computing, networking, audio-visual, and media) in authentic contexts.

The NLG and the P21 collectively suggest that technology plays an important contextual role in calls for educational change. While some of these contexts are economic (i.e., economic productivity and increasing standards of living around the world are closely tied to technological advancements) much of the talk about technological contexts for education in the 21st century focuses on the ways children live their lives and the tools and resources they use to communicate and socially interact. Both NLG and P21 argue that young people are becoming increasingly dependent on technologies to communicate, gather information, and extend social experiences and as these young people move into the workplace they are making increasing use of new technological tools to engage professional and personal interests. They further suggest that the 21st century workplace is infused with digital communication systems such as email, instant messaging, texting, and virtual networking as well as information management systems that expect work-

ers to have sophisticated technological skills and attitudes. Given the relatively early stage of development for many of these technologies, work and learning in 21st century technology-enhanced environments also requires attitudes receptive to change and adaptation. Static technology attitudes might well limit students and professionals in environments that value change and creativity.

Children in school today were born into social and educative environments where digital technologies were and continue to be a part of everyday life. The emergence of this technologically savvy digitally native generation is cause for an evaluation of educational systems including teacher education and professional development. Digitally native children bring new habits, interests, and needs to the classroom and teachers should try to understand these unique attributes to best meet their needs (Prensky, 2006). Although some of the rhetoric about the differences in learning styles that children in the 21st century bring to the classroom borders on hyperbole, we argue that it is important for teachers to understand the new technology-enabled social contexts that seem to be influencing the way children gather, interpret, and use information. These contexts include the devices children use as well as forms of access to information and social groups. Whenever technology is used in the classroom it also generates pedagogical challenges for teachers as they seek to take advantage of the affordances of technology in their instruction.

21st Century Educational Contexts

As a part of the larger educational environment, technology provides a context that is shaped in part by the ways teachers enable their students' uses of technological tools. Technological contexts include the actual devices students use and the systems that support these devices. These technology contexts are in a state of almost constant change as a result of both innovation and a deliberate effort to expand access to technology in the schools. The technological devices that students use inside and outside of school have rapidly developed over the last three decades as personal computing has become more ubiquitous and powerful. Today a variety of low-cost computing technologies including handheld devices are widely available and increasingly powerful. These devices typically make use of information systems such as the World Wide Web. Over the last ten years, the federal government in the United States has spent over 18 billion dollars wiring schools and enabling students to connect to the Web and other internet networks. As of

2005, over 95% of classrooms in U. S. public schools were connected to the Internet (Education and Libraries Network Coalition, 2005). With such high levels of basic connectivity, interest is now turning to the quality of these connections and the manner in which they are used. The North Carolina School Connectivity Program (<http://www.connectivity.fi.ncsu.edu/>) is one example of how state level funding is being directed to enhance the quality of K-12 classroom internet connections. Initially focused on rural and underperforming schools, the project seeks to expand and upgrade internet access in all North Carolina K-12 classrooms over the coming years.

21st Century Pedagogies and Technology

A growing number of researchers suggest that certain pedagogical approaches are best suited for instruction that makes use of digital technological tools. These pedagogical approaches to using digital technologies typically involve active engagement, social learning, continuous feedback, and real world application (Huffaker, 2003). Collectively, these instructional approaches reflect a constructivist pedagogy for facilitating technology-enriched authentic and active student learning designed to enable students as they develop autonomous understandings and transfer those understandings to useful or real-life settings (Doolittle & Hicks, 2003). Constructivist theory suggests that learners construct their own knowledge, but facilitating such knowledge construction in the classroom is complex. In an effort to further define the problem, Mishra and Koehler (2006) have theorized about a specialized form of knowledge called Technological Pedagogical Content Knowledge (TPCK) that represents the manner in which teachers integrate technology into instruction within the context of constructivist learning goals. When teachers apply TPCK to teaching and learning situations they are attempting to balance the overlapping qualities of academic content, pedagogy, and technology.

An accumulating body of evidence suggests that teachers are using technologies in interesting and creative ways, but these uses are primarily limited to computer-based technologies that support and perhaps enhance existing pedagogical beliefs. In the late 1990s, Hank Becker surveyed thousands of teachers about their pedagogical approaches to using technology. In a report on his analyses of the survey responses, Becker (2001) concluded that teachers' philosophies of teaching influenced the extent to which they used technology, but even stronger predictors of technology use related to teachers' technical expertise and the level of access they had to computers

and other technologies. Over half of the 15,000 teachers who responded to the 2005 Net Day SpeakUp survey (Project Tomorrow-Net Day, 2005) indicated that their teaching had been influenced by the availability of technology. The extent to which technology is influencing teaching compared to the extent to which teachers are adapting technologies for their own native pedagogies is an important distinction that researchers have yet to systematically address.

When teachers use 21st century technologies to facilitate student learning, evidence suggests that the learning that occurs is dynamic and multi-dimensional. In a study of 6th-grade students, Leh, Kouba, and Davis (2005) found five interactions common when students used 21st century learning tools. Specifically, they found that students who were using hand-held personal digital assistants (Palm Zire 71) to access and read texts, completed assignments (both writing-based and worksheet-based), and organized classroom work through multiple interaction formats, including (a) learner-content, (b) learner-teacher, (c) learner-learner, (d) learner-interface and (e) learner-community interactions. The learner-community interactions were further facilitated by pedagogical structures designed to enable students to work together inside and outside the classroom.

21st Century Learners

Technology-related contexts and pedagogies in schools give some shape to learning, but it is the prior knowledge, experiences, and attitudes of learners that most directly influences how learning will take form in the classroom. The experiences of children today are reflective of the rapid technological change that surrounds them. Twenty-first century learners are growing up with evolving technologies and are often adapting to changing quicker than educators who are trying to develop new and innovative ways to teach. Students in K-12 classrooms today are in the first generation of learners who were born with access to digital technologies such as the personal computer and the Internet. Prensky (2006) has suggested that this native access to personal computing changes the dimensions of their learning experiences. Considering these learners and their unique traits should be an essential task in the process of teachers facilitating their students' engaging and learning with technology.

One of the most powerful outcomes of taking knowledge of learners into account given instructional uses of technology has been the learning by designing process. Over 20 years ago Semour Papert (1980) and later

Michael Resnick (1994) developed the theory of learning-by-design. Their theory suggested that students should be involved in the design of digital environments as active participants in a learning process. This process enables students to construct knowledge through experience in an active and productive manner focused on tangible collaborative problem-based and authentic learning experiences (Papert, 1980). Such an approach to learning termed “constructionism” by Papert (1991) is a method of instruction that enables learners to construct their own knowledge while building their learning environment. Constructionism using 21st century technologies enables learners to be in charge of a design-evaluation-redesign cycle (Puntambakar & Kolodner, 2005). Learning by designing strategies can use a wide range of digital technology tools such as desktop and laptop computers, hand-held devices, cell phones, personal gaming devices, and smart phones for active and community-based learning experiences (Dede, 2000).

Given this review of research and theory on technology-related educational contexts for pedagogy and learning, we conducted a study of 4,000 North Carolina students’ uses of, and attitudes about, technology. We present a summary of the findings of our research along with the findings of two similar national surveys of students’ uses of technology and consider the implications of these studies for middle grades teaching and learning.

SURVEYS OF STUDENTS’ USES OF TECHNOLOGY

In this section, we report on a collection of surveys of students’ uses of technology that collectively seek to determine the nature and extent of students’ uses of technology in and out of school as well as the ideas and beliefs that students have about the most effective uses of technology in school and the workplace. The first survey on which we report (Having our say: Survey of 4,000 middle grades students in North Carolina) was conducted by the authors of this article and was directly focused on technology use by middle grades students. The additional surveys (Net Day Speak Up surveys and the Pew Internet & American Life survey series) complement and extend our survey of middle grades students by providing a context for technology use among children at all grade levels. We summarize our middle grades survey and these national multi-grade level findings and then narrow our focus in the implications section to just middle grades.

HAVING OUR SAY: SURVEY OF 4,000 MIDDLE GRADES STUDENTS IN NORTH CAROLINA

In the fall and winter of 2006-2007 we surveyed middle grades students (sixth, seventh, and eighth grades) who were in a North Carolina statewide after-school program. Students from all counties in North Carolina participated in the study. This mixed-methods study included the survey (made up of two questionnaires) as well as a sample of 48 students drawn from the larger group who participated in one-hour focus group interview sessions. For this study 4,000 middle grades students were selected using stratified random sampling from a population of 12,000 students enrolled in a North Carolina statewide after-school program. The sampling was made based on geographic region, race, gender, grade level, and family income and included 49% female and 51% male students; 49% African-American, 40% Caucasian, and 11% Hispanic, Asian, and other students.

Participants completed one of two surveys (an initial longer survey was split to reduce participant fatigue when completing the survey) developed by a five-member group of national experts in the field of instructional technology and middle grade education and validated using a group of 100 middle grades students to check for content appropriateness and semantic clarity. Data from the surveys was analyzed using descriptive statistical analyses (e.g., mean, standard deviation), Pearson's chi-square test, and tests of significance (e.g., repeated measures analysis of variance, ANOVA). In an effort to extend our understanding of participants' perspectives on school, technologies, and academic engagement, we selected six groups of students from the same after-school population and conducted focus group interviews. The groups included six to ten students who participated in one-hour semi-structured interviews focused on topics and themes similar to the surveys. All interview data were coded through multiple readings and ultimately organized into themes. An extended explanation of the methodology for this study is reported in a separate analysis given the larger policy implications of the findings (Spires, Lee, Turner, & Johnson, 2008).

In this previously published report, we organized the survey findings into seven categories: (a) computer usage, (b) basic computer skills, (c) technology use for sharing work and productivity, (d) technology usage for communication and entertainment, (e) activities liked best in school, (f) rural and low income schools, and (g) gender and ethnicity. In general, students reported high frequency computer use at home and at school with the higher frequency users of computers reporting using computers more at home than they used computers at school. Students also reported high levels

of basic computer skills including word processing and spreadsheet skills and reported that these skills were developed primarily in school-based contexts. Additional questions focused on how students used technology for completing and sharing school-based work. Large majorities of students reported using word processing, painting, and design technologies to complete and share their work.

In addition to basic computer skills and computer-based productivity tools use, students reported high frequency usage of video and online games, music services as well as email, instant messaging, and cell phone services. These technologies were used predominately out of school. This finding extenuated a distinct difference between what students said about their in-school and out of school technology uses. In school, students reported high levels of computer-based skills work and moderate levels of internet-based research. Students were also asked about where they found information for completing their work and 86.3% of respondents indicated that they used the Web as opposed to printed materials. When asked about activities they enjoyed in school, students listed working with computers above doing research on the Internet, working on projects in a group, working on a project by myself, listening to the teacher explain things, and doing worksheets. Females reported significantly higher computer usage at home than males, but there were no differences reported for school computer use. Analysis of survey data revealed no significant differences in computer usage in and out of school among ethnic groups as well as rural and non-rural students' uses of computers.

As we have previously reported (Spires et al., 2008), the focus group interview data took shape in four thematic areas: (a) "Do U Know Us?" (b) "Engage Us," (c) "Prepare Us for Jobs of the Future," and (d) "Let's Not Get Left Behind." In general, students expressed beliefs about technology that confirmed their digitally native (Prensky, 2006) status. Students described uses of technology that were authentic, personal, and social. They used entertainment and communication technologies at home and made clear distinctions between inside and outside school uses of technology as being separately focused on academics (primarily computer-based in school technology use) and personal/social (outside school both computer-based and personal communication/entertainment technologies). Students described uses of technology in the workplace and expressed an interest in school better preparing them for technologically sophisticated professions. They also expressed a desire to be engaged in using the technologies that suited their styles of learning and communicating. Included among the technologies that students expressed an interest in using in school were personal technology

tools as well as a variety of imaginative computer applications including more advanced personal computing, more uses of ubiquitous technologies such as cell phones, and creativity-enabling technologies such as video editing software and devices. Students also voiced concerns that they were being left behind in an age of technological innovation in which their schools seemed unable to keep pace.

Inside the school, students described their existing work with technologies as being focused on curriculum-based activities in all subject matter areas. Students made 30 specific mentions of in-school curriculum-based activities that made use of technology—12 in social studies and language arts, 16 in math and science, and 2 in fine arts. Particularly common were research-related activities, which students reported required that they use web-based resources. Other common activities included word processing and math software applications on computer and handheld devices.

Outside school students talked about using technologies to facilitate communication and entertainment activities. These included the use of social networking resources such as MySpace as well as cell phone text messaging and computer-based instant messaging. Students reported various interactions mostly with friends and occasionally focused on school-related activities including sharing information about homework. Although most of this interaction was with friends in their school, several students reported maintaining friendships at a distance with other young people in places such as California and South Carolina as well as more remote places including Korea and China. Students also reported extensive use of online and offline computer-based games and video game systems. Over half of the students in the focus groups responded that they regularly played video games. These games included a small number of curriculum-based activities, (all focused on math) several strategy-based games and other simulation games, sports, and role-play games. Boys were twice as likely as girls to describe their gaming experiences in focus group interviews.

Net Day Speak Up 2005 and 2006

In 2006 the national nonprofit educational group Project Tomorrow conducted its fifth Net Day Speak Up survey. The survey was an effort to collect and report feedback from students, parents, and teachers about key educational issues including the uses of technology in schools. In 2006 over 232,000 U. S. students responded. The survey draws on a national sample drawn of students in school systems that have agreed to participate. Students

in all grades participated with 43% of respondents in K-5, 35% in middle grades, and 21% in high school. Seventy-seven percent (77%) of student respondents indicated that they had an internet-enabled computer at home, while 11% had a computer with no internet access and 12% had no computer at all.

The preliminary 2006 Speak Up survey results painted a picture of increasingly sophisticated and wide-ranging technology uses. The top technology devices used by students who responded to the survey were digital cameras, MP3 players, and laptop computers. Over 53% of students played video games on a weekly basis. The most common uses of technology among K-12 students were gaming, email, instant messaging, and maintaining personal websites. The survey uncovered dramatic increases in these technology uses when compared to previous surveys. Downloading music increased four times over a two-year period. Maintaining personal websites such as MySpace doubled over a two-year period. Cell phones were found to be the most common non-computer technology with students at all levels saying that they use cell phones. Students in grades 9-12 used cell phones regularly, 73% on a daily basis. The percentage of students in grades K-2 using computers at least once a week increased 28% in one year. Students were also twice as likely as in previous years to learn about new technologies from parents and teachers. When asked how they would change technology use in their school, students said they wanted relaxed rules about email, instant messaging, cell phones, and website access as well as more access to laptop computers in school. Students were also asked about career related technology use. Particularly interesting findings emerged relating to students' participation in computer classes. Just over 50% of students in grades K-3 reported that they were in a computer class. This percentage dropped to 40% for students in grades 3-6 and under 15% for students in grades 6-12.

A more complete report from the 2005 survey revealed that students were adopting technologies around them, often from older siblings and peers and were using a variety of non-computer devices outside of school. More than half of younger children (K-3) were using technologies such as cell phones, video gaming systems, digital cameras, and electronic books. Older children reported using these same devices in even greater numbers as well as other digital devices such as electronic music devices (MP3 players). Students reported using computer-based technologies inside and outside school with outside use increasingly focused on social communication. Inside the school, students reported wide ranging uses of technology. The 2005 survey reported on the percentage of weekly use of eleven specific technologies¹ at three grade levels, K-2, 3-5, and 6-12. Technology use al-

most uniformly increased across these three grade levels for all eleven technologies. Students reported desktop computers as the most used of the eleven technologies (K-3=63%; 3-6=60%; and 6-12=82%) followed by video games (K-3=53%; 3-6=55%; and 6-12=61%) and cell phones (K-3=39%; 3-6=49%; and 6-12=75%). The least used devices were hand held personal digital assistants (K-3=n/a; 3-6=14%; and 6-12=16%) and scanners (K-3=8%; 3-6=8%; and 6-12=21%). The survey also reported on the extent to which students used internet and communication tools. Students were using a variety of technology tools to communicate including cell phones, email, internet instant messaging, and personal websites such as MySpace. Over 75% of students in grades 9-12 reported using email on a daily basis and 20% of students in grades 3 and 4 reported the same level of use. Students reported using computers at home for a wide variety of activities including listening to music (79%), playing games (79%), and talking or email with family and friends (75%). Students also said that they used the Internet to find information with 64% of students in grades 6-12 getting information about events, activities and hobbies; 54% getting news, sports, weather, and entertainment updates; 51% using the Internet for graphics, photo, video, and music editing; 47% conducting personal research; and 43% shopping.

Students reported extensive use of technology in school with the vast majority of this technology work being completed on desktop computers. Seventy five percent (75%) of K-3 students reported using technology in class. Students in higher grades reported using technology for increasingly sophisticated reasons. In grades 6-12 students reported that technology made school more efficient (69%), more accurate (68%) and more fun (66%). The 2005 survey showed increases in 12 specific in school-related (both in-school and out-of-school) activities.² Eighty two percent (82%) of 6-12 students reported using the Internet for school-related activities. The most common uses were creating an online presentation (62%), accessing the school website (60%), checking grades (50%), and instant messaging about a school project (43%).

Pew Internet and American Life Surveys

Beginning in 2000 the Pew Internet and American Life Project started conducting surveys on Internet usage in a wide range of contexts. The project has given special attention to the issue of how children use internet technology. A number of reports have focused on how children and teens use information and communication internet technologies including the following.

- Teenage Life Online, June 2001
- The Internet and Education, September 2001
- The Digital Disconnect: The widening gap between Internet-savvy students and their schools, August 2002
- Teens and Technology, August 2005
- The Internet at School August 2005
- Teen Content Creators and Consumers, November 2005
- Social Networking Websites and Teens, January 2007

Collectively these reports paint a picture of increased usage of internet technology among children and teens. In the first Pew survey of teen uses of internet technology (conducted in 2000), Lenhart, Lewis, and Rainie (2001) reported that 17 million children between the ages of 12 and 17 (73% of all teens) were using internet technology. Four years later the number had risen to 87% and in the most recent survey (conducted in 2006), Lenhart and Maddan (2007b) reported that 93% of teens use the Internet. Over this six-year period, teens made consistent use of social networking tools. Early on they relied on email and instant messaging with 98% and 72% of on-line teens respectively reporting that they used email and instant messaging in 2000. The 2004 survey showed continued high levels of communication technologies and the emergence of blogging and internet applications for sharing and manipulating digital resources (photos, music, and video). By 2006 social networking websites such as MySpace and Facebook were facilitating teens' social communication with one-stop web sites that included email, instant messaging and a wide range of text, audio and video tools. Lenhart and Maddan (2007a) reported in their survey of teens social networking habits that 55% of all online teens age 12-17 use internet social networks and had created an online profile.

The Pew studies provide interesting insight into the location of children's uses of internet technology. As early as 2000, students in Pew surveys were reporting in overwhelming numbers that students used the Internet to find information for school-related projects. Ninety four percent (94%) of online teens (ages 12-17) in the 2000 survey said they used the Internet for school research and 64% said they conducted that research in school, but only 11% listed school as the place they most frequently use the Internet. When asked in 2005 only 18% of students indicated that school was their most frequent location for accessing internet resources for school-based activities. By 2004 78% of online teens (ages 12-17) were using internet resources in school, but school remained a less common location for computing than home. The types of school-related activities these students engaged

in were mostly limited to sharing information about school-work with 78% of all online teens instant messaging about homework and conducting online research (Lenhart & Maddan, 2004). More than half of online teens in a different report of the same 2004 survey indicated that they were creating content in the form of blogs, videos, or music (Rainie, & Hitlin, 2005).

Summary

Collectively these survey results suggest that students are increasingly active online and are finding ways to use technology for learning activities that are not always conducted on computers inside the school. The students who participated in our study as well as students surveyed by Project Tomorrow and Pew Internet Life Project have opinions about how technologies should be used in school. In general, they want the technology experiences they have inside school to look more like the experiences that they have outside of school. At the same time all three surveys confirm that technology is present in schools and that students are using technology for a variety of purposes. The main distinctions that emerged between in and out of school technology use related to the intent of the technology use and the actual devices being used. Outside of school students are using technology for communicative and entertainment purposes. They also are more likely to use smaller handheld and gaming devices outside of school. Inside school students are using desktop computers for web-based research, word-processing, and other productivity purposes (spreadsheets, PowerPoint, etc.) as well as discipline-specific applications particularly in math and science. The surveys suggested that students' technology use inside school is often less creative and personally meaningful than their technology use outside of school. Students expressed strong opinions in all the surveys about what technologies they thought should be in school and how they thought these technologies should be used, and they viewed technology skills and understandings in general as essential for their success in adult workplaces.

IMPLICATIONS FOR MIDDLE GRADES TEACHING AND LEARNING

If we value students' perspectives on the role of technology in education, then teachers must be willing to consider and become more responsive to middle grades students' needs and real-life technology experiences. Three implications for middle grades teaching and learning emerge from our study.

First, we think that middle grades teachers need to develop creative and flexible attitudes about technology. Second, middle grades teachers need to be aware of technology tools and devices that are “native” to many of their students. Third, middle grades teachers should develop pedagogical knowledge suited for facilitating their students’ own development of 21st century skills and understandings. Each of these three implications is presented below given what we believe teachers should do to meet the technological needs of their students.

Middle grades teachers should develop creative and flexible attitudes about technology. Technological innovation occurs at a rapid pace. Much of this pace can be attributed to market forces seeking to maximize profit and productivity in the workplace. Education is not (and perhaps should not be) subject to the same market forces, but education is certainly impacted by the pace of technological innovation. Consider two recent examples. In November 1990, the first web page was published on the world’s first web server at a particle physicist association’s European laboratory. Sixteen years later in 2006, the Web had over one billion users. Through numerous boom and bust cycles, internet and web-based technologies have altered social life, personal communications, entertainment, worker productivity, and education. Consider a second example in the areas of social life and personal communications. Launched in March 2005 after a three-month development period with a shoestring budget, YouTube.com became an instant phenomenon. After only 16 months in operation Time magazine named YouTube its invention of the year for 2006 and the Google Corporation purchased the upstart company for an astonishing 1.6 billion dollars. These stories are meant to illustrate the energy and pace of technology development. Middle grades teachers’ need to recognize that their students live in a world where technologies rise and fall—captivate and distract—and are generally infused into children’s lives. To make use of technologies in productive ways, whether they are innovative, cutting edge, or more established technologies, middle grades teachers need attitudes that will facilitate adaptive, creative, and authentic technology use.

Teachers can craft experiences to engage their students using emerging technologies in safe and creative contexts. Such an approach to technology use requires that teachers understand the technologies themselves and be willing to learn new technologies as they facilitate their students’ uses of technologies. Technology use in middle grades classrooms should be done in an authentic and meaningful way. Teachers should make distinctions between technology use for its own sake and the use of technologies for specific content-oriented learning objectives. For example, the use of popular

games with middle grades students would not make sense unless the specific games had some potential educational value. Middle grades teachers need to understand how emerging technologies such as role-play or strategy-based games might be influencing their students' learning outside of class. Growing numbers of teachers are exploring how emerging user-oriented technologies such as wikis, blogs and other Web 2.0 tools such as YouTube can be adapted for educational purposes (Solomon & Schrum, 2007; Spires, McCammon, & Bourtese, 2007). Middle grades teachers can use these tools in content-oriented environments for inquiry-related purposes to provide their students with authentic experiences that are representative of their lives outside of school. Such experiences can also reflect 21st century workplace attitudes that value innovation, creativity, and adaptability.

Middle grades teachers should develop an awareness of technology tools and devices that are “native” to many of their students. Middle grades teachers should also maintain an awareness of emerging and educationally relevant technology tools given the related needs of their students. To best serve their students as learners, teachers must understand how their students learn and what they bring to the classroom in the way of prior knowledge, attitudes, and understandings. Some of these ways of knowing, particularly technology-related understandings, are developed outside the classroom. Appreciating what students' are learning and how they are learning outside the classroom potentially can enhance what teachers do inside the classroom. Connections between what goes on inside the classroom and outside the classroom have long been considered important to educators, beginning in the early 20th century when John Dewey first described this relationship as the aim of education. Our educational aims today require that we recognize the world within which children live and work and diligently provide them experiences to thrive in that world as children today and adults in the future. If teachers are disconnected from the world of children, they cannot expect to understand how best to use the technology tools and devices that are a part of their students' life experiences.

Prensky (2006) suggested that it is impossible for teachers to be proficient with every technology; but he adds that teachers must make every effort to be familiar with the key tools that students use. Teacher educators and technology mentors can play an important role in this process by modeling technology use and in general displaying a willing disposition to use new technologies as well as seeking to understand the relevance of those technologies in children's lives. Middle grades teachers can also draw on the knowledge and experiences of their students to help demonstrate the uses of

emerging technologies. For the most part tech-savvy students are underutilized as a valuable resource for introducing new technologies that support learning in the classroom.

Middle grades teachers should develop pedagogical knowledge suited for facilitating their students' 21st century skills and understandings. As children engage technologies in real-world contexts, they must also begin to develop what some are calling 21st century skills. P21 has defined three broad categories of 21st century skills: (a) learning and innovation skills; (b) information, media, and technology skills; and (c) life and career skills. These skills reflect what this group has identified as useful tools that will enable students to know how to learn in technologically rich environments and later apply those learning skills to the workplace. Success in school and in the workplace is increasingly dependent on technological know-how and such realities require teachers to consider the pedagogies best suited for facilitating learners in the 21st century.

In keeping with what P21 promotes, students in our survey as well as Project Tomorrow's Speak Up surveys and the Pew Internet and American Life surveys want active classrooms that are responsive to their interests and needs. They want the technologies of their lives incorporated into their academic experiences. Many of these technologies are in the schools already—most certainly the computer. Other personal, communication, and entertainment related devices might be emerging for school use, but the presence of these technologies does not insure that teachers will have pedagogical strategies in place for using them. Pedagogical knowledge rooted in a recognition that children in the 21st century are growing up learning in new contexts will enable teachers to make instruction more authentic and personal.

The purposes of education are also changing. Children today need a global awareness and new economic and civic literacies to work seamlessly with various technologies and integrate those in dynamic social environments. Pedagogies to support such work must be equally dynamic and facile. Such pedagogies enable students to complete multiple tasks in fluid environments with support for accessing and manipulating information in inquiry-based learning activities. As previously mentioned, teachers can develop these specialized forms of knowledge, also referred to as TPACK (Mishra & Koehler, 2006) by considering the pedagogical value of technology given academic content. Through technology-enhanced activities with specific academic content, middle grades teachers can provide their students meaningful opportunities to develop skills and an awareness that they can use in a range of academic and later professional contexts.

At the same time important caveats accompany calls for increased technology use in schools. Other studies paint a more nuanced and complex picture of the extent to which technology can influence and inform pedagogy. The most important of these complexities is the lingering gap between minority and nonminority technology users and between low and high Socio-economic Status (SES) families. A recent report by the National Center for Education Statistics (DeBell & Chapman, 2006) found large gaps in computer use at home with 78% of white children using computers and only 48% of Hispanic children and 46% of African-American children using computers at home. Large differences in children's computer use at home was also found on measures of educational attainment and income levels of parents or guardians, with children in homes of parents/guardians with a college education almost twice as likely to use computers at home. Income was an even more powerful divider. Only one third of children in homes with a household income under \$20,000 a year used computers. About half of children in homes with household incomes between \$20,000 and \$33,000 used computers, while almost 90% of children in the top income bracket (household incomes over \$77,000) used computers at home.

Additional issues must be addressed when educators consider how technology will be used in schools and in particular middle grades environments (e.g., quality of access, safety, hardware, and software resources). One area of particular concern is internet safety. Children in middle grades are particularly susceptible to exploitation in online environments. A recent study of 1,500 children aged 10-17 found that 9% of boys and 7% of girls ages 10-14 were harassed online. Twenty-five percent (25%) of girls and 21% of boys ages 10-14 were exposed to unwanted sexual material and 9% of girls and 5% of boys ages 10-14 were sexually solicited online (Ybarra, Mitchell, Finkelhor, & Wolak, 2007). Questions of students' safety and privacy when using internet technologies are of paramount concern for schools, but these concerns do not necessarily mean that students must be kept off the Internet. The National School Boards Foundation (2005) surveyed over 1,700 parents and students about safety and children's uses of online technologies. The findings suggested that when parents facilitated student use of online technologies at home for educational purposes these parents viewed the online experiences as enriching, productive, and social. Given these findings, the National School Boards Foundation suggested a balanced approach that values providing access to content as much as restricting access to content and is focused on ways to use technology to engage and connect to communities around the school.

CONCLUSION

John Seely Brown, former director of the Palo Alto Research Center, has referred to teaching in the 21st century as focused on learning to “be” someone as opposed to learning about something (Brown, 2006). Technologies can enable teachers to facilitate their own students’ constructions of their “being” but require that teachers speak “digital,” as Brown puts it, in such a way that will enable them to find and use technologies that facilitate productive forms of inquiry. Teachers in the 21st century should strive to create learning environments that harness the abilities and talents of digital natives and direct emerging ways of thinking about technology toward more sophisticated and meaningful learning opportunities for students. Although student perspectives alone are not sufficient, we argue that they are indeed a critical component in the design process for compelling models of 21st century teaching and learning. The voices of students should be prominently featured and resonate in this process; by listening to students teachers will not only be better informed, but also more effective as they facilitate their students’ education.

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Notes

¹The 11 technologies were: (a) desktop computer, (b) laptop computer, (c) cell phone, (d) hand-held device (PDA), (e) digital camera, (f) video camera, (g) scanner, (h) DVD or CD burner, (i) MP3 player or iPod, (j) video game player, and (k) smart board.

²The 12 online activities reported by students were: (a) using an online tutor, (b) taking an online test, (c) access school website, (d) creating a presentation, (e) instant messaging about a project, (f) blogging, (g) emailing teacher, (h) checking grades, (i) using an online textbook, (j) accessing an online class, (k) downloading a study guide, and (l) asking an expert a question.