Learner Identity, Learning Technologies, and Learner Diversity:

A Review of the Literature

Caroline E. Parker, Ed.D.

Technology has been heralded as a critical learning tool and as a potential source of equity and increased civic participation for groups and individuals that have not had equal access to learning and economic opportunities. Technology provides the potential for youth, in particular, to create and to participate in civil society in ways that have been unheard of to date. At the same time, extensive research has shown that patterns of technology use resemble patterns of involvement in science and engineering – women and minorities are less involved in all aspects of technology. Boys are the majority users of video games, and men continue to dominate the field of computer science. In addition, access to technology depends on socioeconomic status, so the poorest in both developed and developing countries tend to have the least access to technology. The potential of technology to transform lives has been limited by inequities in access. As physical access increases, however, the challenges of equity in technology are not only found in the 'digital divide' of access. Even with equal access, women and minorities are less likely to use technology and to choose technical careers. Technology has been heralded as 'neutral,' but biases in design and values implicit in technology affect different users differently. The way technology tools are structured and the paradigms of technology design and education often discourage women and minorities from using technology or participating in the process of technology development.

Defining technology is a monumental task – for this review, we limit ourselves to learning technologies. Even settling on a definition of learning technologies can be difficult, and

this review builds from a holistic definition (I. Alvarez & Kilbourn, 2002). Our definition of learning technologies extends beyond a particular piece of software, and encompasses several 'cultural artifacts' - the learning object itself (activity structure, content), the user, the process for use (scaffolds, pedagogy), the context for use, and the (learning) environment in which use takes place. Learning technologies are a combination of cultural artifacts that are interpreted and experienced differently depending on individual experiences, identities, and perspectives (Pinkard, 2004).

The processes of incorporating learning technologies into the learning process are shaped by, and shape, learner identities, learning technology design, and learning mediators, and it is with this perspective that we ask such questions as: How do learning technologies shape learner identities? How do learning mediators (often teachers) contribute to the learning process? Are issues of access, equity and diversity in technology similar to these issues in science, mathematics and engineering? How can different ways of creating and mediating technology better engage diverse populations of learners? How do we redesign technology systems and technologies themselves to make them more effective with and inclusive of diverse learners? Answering these questions demands multidisciplinary strands of inquiry that address several themes: classroom based technologies, digital learning in informal settings, the development of community and power dynamics within digital learning environments, and the development of computer science and its influence on supporting diverse learners.

This literature review focuses on the gap between current patterns of technology design and use and technology's potential to be a tool to promote individual and community development. We begin by looking at the digital divide, to provide a background understanding of historical issues of access and participation in both technology and the sciences. We then

consider the overlapping areas of culture and technology, and education and technology. The section on culture considers how learner identities and cultural background contribute to technology use and learning. The section on education looks specifically at the ways that technology has, or has not, been used effectively in formal and informal education. The review concludes with questions for further research.

Throughout the review we include excerpts from an online dialog conducted by the Gender, Diversities & Technology Institute in 2004 on the subject of 'Facilitating and Sustaining Diverse Online Communities.'- The Institute assembled an international panel of experts to explore such questions as: What are the requirements for creating, growing and sustaining diverse online communities? Do current technologies support and enhance online learning equitably across all learner diversities, including race, SES, disability and gender? How do existing learning technologies reflect and reproduce current societal and cultural biases?

THE DIGITAL DIVIDE: ACCESS, PARTICIPATION, RECRUITMENT, RETENTION

The digital divide has generally been defined as the gap in access to technology by socioeconomic status, race, and/or gender. The technologies most often used in studies of the digital divide are personal computers and Internet access/connectivity. Efforts to overcome the digital divide include increasing technology access in schools (Kane, Beals, Valeau, & Johnson, 2004) and development of community technology centers (Schon, Sanyal, & Mitchell, 1998). These programs provide the technology to populations who may not have the economic resources to acquire the technology for themselves. Home use of computers continues to show a gap by race, but that gap is closed substantially when community technology access is included (A. Alvarez, 2003). Internet use has an even wider gap between whites and minorities, with 29.3% of African Americans and 23.7% of Latinos using the Internet, as compared with 50.3%

of non-Latino whites (Fairlie, 2002). In a study of youth computer use, Eamon found that poor youth are much less likely to have a computer in their home (Eamon, 2004). Foster children are another group that has less access to computers (Finn, Kerman, & LeCornec, 2004). Women and minorities continue to be underrepresented in the sciences, especially computer science (Camp, 1997; Clewell & Campbell, 2002), although all science and engineering fields except computer science are increasing their proportion of women graduates (Losh, 2003).

> *"It seems to me...that the gender problem has more to do with the lack of instruction and involvement. Aunts, sisters, mothers, grandmothers and teachers (many being female) are often instructed in technology by people with the machines in mind and not the learning process…In general a female point of view, or a learners point of view that may be outside of a tech vision might be ignored. Many instructors have the machine in mind, not the outcome and the possibilities."*
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> Bonnie Bracey, Educational Consultant

In the field of science and mathematics, a number of steps have been taken to address inequities. The lack of women and minorities in the sciences can be partially attributed to a lack of preparation. When students do not have access to advanced math courses or to quality science curriculum, they are not qualified to pursue science and mathematics careers. Currently, the issue of gender differs from that of race. Over the last twenty years, girls, on average, have increased their attendance in, and success at, high school mathematics and science courses (Clewell & Campbell, 2002). However, when they reach the level of higher education, girls still do not choose science careers. In contrast, minorities have inadequate access to science and mathematics courses at the high school level, and so while they would choose science careers if possible, they are not able to do so (Clewell & Campbell, 2002).

"As an undergraduate Computer Science major at Stanford University, I often wondered why, in a school with 50% women and 30% African Americans, I was usually the only minority and one of only two woman taking programming courses."

Nichole Pinkard, Research Associate and Director of Educational Technology, Center for School Improvement, University of Chicago

While efforts continue to close the digital divide and to increase access to computers, the Internet, and technology, researchers and policymakers alike recognize that resolving the digital divide of access will not solve all the challenges of increasing technology access and use. There are issues beyond the digital divide, termed by some 'digital inequality' (A. Alvarez, 2003), which also must be addressed (*Dividing Lines*, 2001). Various frameworks have been developed to describe the complexities of these inequalities. Mossberger et.al. describe an access divide, a skills divide, an economic opportunity divide, and a democratic divide (Mossberger, Tolbert, & Stansbury, 2003). The economic opportunity and democratic divides, in particular, focus on attitudes, experiences, and beliefs regarding computers and computer use. Warschauer et al. (Warschauer, Knobel, & Stone, 2004) argue that there are many divides, including the workability of technology, the complexity of use, and teacher capacity (Warschauer et al., 2004). Clewell and Campbell identify four theories to explain gender differences in technology (and science) use: testing-based theories, biologically-based theories, social-psychological theories, and cognitively based theories (Clewell & Campbell, 2002). Without advocating one theory over another, they focus on concrete strategies to address continuing gaps, including changing pedagogy, increasing access to high level courses for minorities (noting that for the most part, girls and boys have reached parity in access to advanced high school science courses), and investing in longitudinal studies of learning technology models and of learning differences. Finally, like Zuga (Zuga, 2003), they advocate looking at the technology fields and the quality of

life they offer to women and minorities. Others argue that the online world is reproducing the same inequalities as the offline world, and losing an opportunity for social change (Cook, 2004).

> *"…A growing body of research is producing evidence that traditional off-line hierarchies and biases persist in CMC [computer mediated communications]. My own work, for example, has shown that males tend to dominate in mixed-sex computer-mediated interactions, including in academic discussion forums, through amount of talk, control of topics of discussion, claims to authority, and adversarial behavior such as challenges and put-downs. Such behaviors may cause females to limit their participation, fall silent, or withdraw from the forum altogether, with concomitant loss of access to the opportunities provided through the online environment."*
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> Susan Herring, Professor of Information Science, Adjunct Professor of Linguistics, Indiana University

Light (2001), in "Rethinking the Digital Divide" argues that other structural inequities can't be ignored, and that those concerned with inequities in the field of technology use have to also address institutional bias and how society is organized (Light, 2001). Schofield and Davidson (2001 - cite) looked at how access to technology was used as a form of reward in schools, and thus those who tend to get punished the most, Black and Latino boys (Noguera, 2003), were the least likely to have access to technology (Schofield & Davidson, 2001). "Researchers must look more closely at how schools, as social institutions embedded within a larger structure of inequality, are complicit in technological disparities" (Brown-L'Bahy, 2003, p. 16).

CULTURE, IDENTITY, AND TECHNOLOGY

Youth identity development: a framework

The field of youth identity development includes different theories and explanations for the way that youth develop their identities. How youth see themselves as learners, and consequently as active agents in their future well-being, has moved from reproduction theories

(Bowles & Gintis, 1976), arguing that schools reproduce society's structures and youth are helpless to change that, to resistance theories (Giroux, 1983; Macleod, 1995; Mehan, Villanueva, Hubbard, & Lintz, 1996; Willis, 1977) that identify ways that individuals resist the structures imposed on them. Youth develop their identities in interaction with the structures they face and the cultures they are part of (Davidson, 1996; Holland, Lachicotte Jr., Skinner, & Cain, 1998).

Within this framework of agency/culture/structure, learning technologies can be a part of agency, culture, or structure. When the technologies are foreign to youth, when they are an outside force to be reckoned with, they are structures that youth confront with their agency. When technologies are more integrated into youth identities, they are part of youth culture. Youth interact with technology based on their identity, and technology can shape youth identities. Thus, it is very important to understand how youth conceptualize their learning technologies – if the technologies are foreign to them, they become part of the structures that youth face daily. If technologies are an integral part of their lives, then they are part of the youth culture, and they both contribute to youth identities, and are interpreted differently based on different youth identities.

There is also research to support that youth use their prior cultural knowledge to understand and use the tools that mediate their interactions with the world (Vygotsky, 1978).

> *"The more the mediating tool draws from the prior cultural knowledge of users, the more likely they are to be able to use the tool for its intended purpose. Given growing classroom diversity and the continued silence regarding culture and design, it is highly possible that learning tools perceived as 'designed for all' by the design team are perceived as 'designed for some' by students'."*
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> Nichole Pinkard, Research Associate and Director of Educational Technology, Center for School Improvement, University of Chicago

Giese studied identity formation in one online environment and argues that computer-mediated communication produces both a new social environment and new opportunities for presentation of the self (Giese, 1998). Online communities are the source of study as a way of understanding the development of social identity (Cassell & Tversky, 2005). Youth think of themselves differently when they can interact with technology, use it for communication, and choose their own entertainment (Tapscott, 1998). Turkle suggests that the fluidity of identity means that computers can be part of an extended "cyber self" (Sherry Turkle, 2003). Others argue that while technology has changed some things, fundamental identity development remains the same (Katz, 1997).

This review argues that identity develops interactively, in relation to others, to culture, and to outside structures. What does it mean if some youth see technology as an integral part of their identity, or as an effective tool for communication and work, while others see it as a foreign structure? How do the identities of youth who are empowered by technology differ from those who are disempowered by that technology?

> *"I have observed my 14-year-old nephew, both f2f and online, in [the game] Runescape. It is amazing to me the complexity that this child is dealing with. Far beyond anything he is offered in school. He (and anyone else who persists in the game over time) is oddly motivated to practice numerous skills to achieve 'automaticity' as well as recognized achievement levels through what seems to me tedious repetition; learn and apply a great many new concepts and terminology; apply at any given time a multiplicity of dimensions and parameters for complex decision-making; and devise creative strategies involving both competition and collaboration with others in real time."*
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> Beverly Hunter, Dialog Participant

Culture and technology

Even when given access to technology, minority communities use the Internet less (Stanley, 2003). In a study of poor women who were given home computers and Internet access

for a year, women of color reported lower use, even when controlling for socioeconomic status (Jackson, Barbatsis, Biocca, Zhao, & Fitzgerald, 2003). The authors conclude that cultural factors play a key role in technology use, and need to be addressed in future research. In contrast, a study of black and white Internet use found more similarities than differences between the two groups, though "whites focus more on news, financial, and political Websites, whereas Blacks are drawn to education-related sites" (A. Alvarez, 2003). A study of distance education linking an urban classroom with a university music classroom via videoconferencing found that teachers imposed standards of behavior on the students and that cultural gaps between the two physical worlds were not bridged via the videoconferencing (Knight, Dixon, Norton, & Bentley, 2004). The videoconference reinforced the cultural differences between the student participants and the music school. These individual studies indicate that there are cultural differences in computer and Internet use, which is not particularly surprising. A study of four community technology centers looking at adults using computers for the first time (Stanley, 2003), identified three important ways to look at technology in order to understand technology use among those who do not use it. First, Stanley describes the relevance of technology: that is, if users don't see a link to their own life, they won't use it. Second, he looks at comfort zones, encompassing perceptions of high cost or difficulty of use. Third, he addresses self-concepts; how individuals see themselves in relation to technology. People who don't think of themselves as the type of person who uses a computer will not choose to use technology.

While differences in computer use between men and women are small, women who express interest in computers do not also express interest in computer-related careers, whereas men do (Creamer, Burger, & Meszaros, 2004), indicating that access is less of an issue than choice, for women. A study of women in technology classrooms described low self-confidence

and a sense that boys act like they know more (Gokhale & Stier, 2004). Clewell and Burger (2002) argue that "future efforts must include interventions to change the system of science and engineering so that it becomes more accepting of women (and other underrepresented groups)" (Clewell & Burger, 2002) p.252. Brown-L'Bahy posits, "Girls who appear to resist computer use may be resisting content matter or particular purposes or types of computer use" (Brunner, Bennett, & Honey, 2000; S Turkle, 1997 in Brown-L'Bahy, 2003, p.14).

> *"The question [boils] down to at what level are people the same, and at what level are they different from one another. This is a good and important realization paralleled in the field of anthropology. Notions of culture often imply that a particular group of people, whether they are a racial/ethnic group, or a gender group, or a socio-economic group, are all the same and there is no internal group diversity. This tendency to see culture as homogeneous has led to group stereotyping and a failure to understand the complexity of diversity."*
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> Wesley Shumar, Assistant Professor of Culture & Communication, Drexel University

Values and technology

Zuga claims that women have a "different way of knowing" than men, and the field of technology (and science) needs to incorporate those different ways of knowing (Zuga, 1999). She argues that technology is not a value-free science, and it must address ethical issues, such as environmentalism, in order to appeal to women.

> More technology educators could begin to address the subject of technology education with a critical view focusing on the role of technology as a system and as practice in which there are choices about our future course of action… Implementing a social reconstruction curriculum design in technology education encourages thoughtful critique of the status quo and existing practice with respect to technology (Zuga, 1999).

She continues, “addressing the critiques of technology would benefit all students by helping them to understand that technology is a debatable practice with both positive and negative consequences for the environment and different groups of people” (Zuga, 1999). Ebo points out that technology has been used to glorify war, particularly during the first Gulf War (Ebo, 1995). In addition to addressing the values and ethics of technology, others argue that emotions play a role in learning, and that this must be addressed in the field of technology (Kort & Reilly, 2002).

The field of values in technology use has been greatly understudied. While Zuga’s argument that women are inherently more ethical than men can be debated, her point is well taken that by portraying technology as value-free, those who disagree are less likely to involve themselves in technology-related activities. Similar findings showed that girls, rather than being computer-phobic, are critical of the content of computer technologies, particularly gaming (Wartella, O'Keefe, & Scantlin, 2000). Whether or not women innately look for the ethical value in technology while men do not, the need to address the issue is a valid one. What are the ‘ethics messages’ communicated by technology? How do different individuals and groups variously interpret these? Where are the ‘spaces’ in technology for addressing these issues? How do youth make sense of the ethical issues surrounding technology use?

TECHNOLOGY AND EDUCATION: OIL AND WATER?

Across the United States, public schools have been increasingly outfitted with technology hardware and wiring: computers, Internet access, PDAs, etc. Despite all of the investment, technology is rarely used effectively in school settings. Studies have shown some of the ways that technology in education is not working. Urban schools that have similar levels of investment

in technology similar to suburban schools continue to underutilize it, more often having students use computers for skills development through drills, whereas their suburban counterparts are using technology to acquire information or develop products (Shreve, 2005). In other cases, youth are using technology outside of the school setting in ways that far exceed the tasks teachers set for them, and the technology is underutilized in the learning context (Cuban, 2001a; Green & Bavelier, 2003; Papert, 1998a). In a review of technology, literacy and inequity, Brown-L'Bahy describes five assumptions about technology that influence the field of learning technologies: 1)the inherent goodness of technology; 2) the economic primacy of technology use; 3) intrinsically valenced forms of technology use; 4) neutrality of technology; 5) autonomous realms of technology; 6) and individualism (Brown-L'Bahy, 2003, p. 19). She notes that there is little or no research drawing a causal relationship between increased technology use and economic wellbeing (p. 25), and continues, "statistics also show that rapid growth in computer use among low income people and minorities over the last five years has neither resulted in significant changes in employment and poverty rates, nor has it erased patterns of technological disparity based on race and class" (Brown-L'Bahy, 2003, p. 26, from Bureau of Labor Statistics 2002, US Census Bureau 2002). She challenges learning technology researchers by noting that both teachers and students often "resist adopting recommended forms of technological use." Do teachers resist the technologies because they are unwilling to make positive changes? Or are learning technology advocates pushing a form of technology that is not relevant and, as Brown-L'Bahy has shown, does not have a research base to show its superiority to out-of-school technology use? In addition, learning technologists devalue students' out-of-school uses of technology. Brown-L'Bahy argues that by pushing technology on resistant teachers, and devaluing out-of-school youth technology use, valuable opportunities may be lost.

Attempts to address these and other challenges facing learning technologies are described here in four areas: technology programs that target specific groups of youth, software that targets specific groups of youth, learning mediators (teachers), and calls for the wholesale transformation of formal education to reflect the sea change in knowledge and learning that technology advances bring.

> *"In terms of educational tools there isn't a powerful market force necessitating that we design for diversity. There isn't a school district or university refusing to purchase products because they don't meet the needs of the diversity of learners that district or university serves."*
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> Nichole Pinkard, Research Associate and Director of Educational Technology, Center for School Improvement, University of Chicago

Targeted technology programs

In the field of education and technology, there have been many different interventions that target specific populations. Some focus on encouraging girls to pursue careers in science and technology (Spears, Dyer, Franks, & Montelone, 2004). One intervention that proposed to encourage girls' participation in STEM careers found that the strongest effect was on the women tutors, who found their own interest and confidence in STEM careers increased more than did that of the target girls (Crowe, 2003). By the same token, there is also research to suggest that targeted interventions for specific populations have positive effects across the board. What works well for girls also works for boys, but not necessarily vice versa (*Congressional Commission*, 2000; McCullough, 2001, *Tech-Savvy*, 2000). Some researchers present ways that technology can contribute to curricula that 'create liminal spaces for the negotiation of identity and knowledge' (Voithofer, 2002) and that are inclusive (Ibarra, 2000; McLoughline & Oliver, 2000;

Yong & Parrella, 2004), while others have found that online courses can be disengaging for teachers (Gabbard, Perez, & Atkins, 2002).

An extensive review of research focusing on the impact of interactive media on children (not focusing exclusively on schools), looked at access, impact on cognitive development, social development, and health and safety (Wartella et al., 2000). It found that boys use computer games more than girls, and that, as noted above girls are not computer-phobic but are critical of computer content (p. 7). The study also looks at the interaction between content, activities, conditions, and goals. Wartella *et. al*. argue that the content of the technology is more important than the process, counter to other researchers, who argue that the process of engaging with technology, regardless of content, changes the learning process (J. P. Gee, 2003; Papert, 1998b). Some researchers identify the characteristics of technology that contribute to learning, including learning through active engagement, participation in groups, frequent interaction and feedback, connections to real-world contexts, and expanding what children learn (Roschelle, Pea, Hoadley, Gordin, & Means, 2000). All of these highlight the importance of technological processes on learning, arguing that technology is more than just a different form of 'shell' for providing content.

> *"Exposing students to different styles of learning beyond F2F instruction can not only increase, but also help them feel better about their ability to learn. Therefore, in order to ensure equity, we need to design learning experiences that are inclusive and respectful of gender, culture, and race."*
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> Chris Dede, Professor of Learning Technologies, Harvard Graduate School of Education

Wartella et al. found no research documenting the effects on academic achievement of playing computer games, though games and technology are increasingly seen to have a critical role in education (Oblinger, 2004). Researchers look at how technology can bring 'serious play' into formal learning (Rieber, Smith, & Noah, 1998). Youth will spontaneously spend more than

100 hours playing complex video games that demand extensive cognitive development, but formal schooling has been unable to harness the principles of learning in video games that are so successful (J. P. Gee, 2003). To date, “edutainment” has been a weak effort to link vibrant technologies with formal education. Learning technologies have received their share of criticism (J. Gee, 2003). Gee argues that gaming is an environment far more conducive to learning, and that when educators attempt to copy gaming strategies into their learning technologies, they are weak imitations.

Content of learning technologies

Can modifying the content of learning technologies improve access to and interest in those technologies? Two studies argue in favor of this (Laffey, Espinosa, Moore, & Lodree, 2003; Pinkard, 1999). Laffey used interactive computer programs as part of a program to address behavior issues among at-risk African-American kindergarten and first grade students, and found that math engagement and attainment improved when loss of computer time was no longer used as a punishment (Laffey et al., 2003). Pinkard developed two ‘culturally responsive’ reading software packages that incorporate rapping and clapping into early reading, and found, again, that interest and attainment improved (Pinkard, 1999).

Pinkard found that students as young as seven years old identify software as gendered. Even in supposedly gender-neutral online chat rooms, studies have shown that men continue to dominate and use aggressive tactics to silence women, challenging their ability to be present and active in virtual public spaces (Herring, 1999).

Shreve describes the way that stimulating computer games can motivate students to learn academic material (Shreve, 2005). Online video games demand analytical

thinking, take a long time to complete, and allow students to engage actively in varied environments. When these elements are included in 'educational' learning games, if done correctly, then the computer games can also be learning experiences for school-based learning. However, this raises two issues: to what degree is out-of-school technology already helping youth develop the skills that schools try to give them; and, why is it so difficult to have formal learning technologies capture youth's interest in the same way as non-school computer games?

> *"We are interested in how multi-user environments (MUVEs) can be used in K-12 settings to foster learning. Multi-user virtual environments enable multiple simultaneous participants to access virtual contexts, to interact with digital artifacts, to represent themselves through avatars, to communicate with other participants and with computer-based agents, and to enact collaborative learning activities of various types. We designed a MUVE entitled, River City, that teaches science inquiry and process skills to middle school students. Our design is geared towards students in urban schools with lower SES who might not be engaged by traditional F2F instruction. In our first pilot…we found the multi-user environment we designed was motivating for lower SES students and for students of Hispanic descent. Hispanic students with low GPA and low SES improved their content score by approximately 20 points across the board."*
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> Chris Dede, Professor of Learning Technologies, Harvard Graduate School of Education

Mediators of learning technologies

Barbara Means envisions a classroom where teachers mediate online learning for students (Means, 2000). A qualitative study of low-and high SES schools, however, found that teachers at both schools tend to teach technology as an end in itself (requiring that students master all aspects of PowerPoint rather than learn how PowerPoint can be an effective/ineffective communication tool) rather than using it to increase the potential of student learning (Warschauer et al., 2004). Teachers tend to integrate technology less with low achievers (*Dividing Lines*, 2001). In order to integrate technology effectively, teachers must learn to see themselves as mediators and let go of the expectation that they will be the expert (Dede, 2004).

In a study of teacher use of technology in the classroom known as Effective Access, many of the challenges facing teachers were identified:

- teachers see the benefit from digital resources but don't know how to access them;
- teachers have minimal time;
- technology infrastructures are often insufficient;
- teacher skills are not adequate;
- teachers tend to use the web for content only;
- teachers identify a lack of quality professional development.

The study shows that most teachers' experiences are still a long way from Means' vision of teachers mediating online learning for students (Hanson & Carlson, 2005).

Transforming education

Increasingly, technology educators are advocating a full transformation of education, arguing that technology has the potential to incorporate more styles of learning than traditional educational models (Guild, 2001; Lemke, 2002; Spender, 1998; Sherry Turkle, 2003). Some argue that education should not limit itself to traditional conceptions of talent, but should see the potential for developing talent in rich environments (Barab & Plucker, 2002). Natriello notes that sociologists of education have an obligation to address the many changes in education that technology will bring in order to make sure that all students have access to all aspects of technology, not just the physical accoutrements (Natriello, 2001). In a Vygotskian framework, learning technologies are scaffolds for learning, and imply a transformation of formal learning (McLoughline & Oliver, 2000; Somekh & Mavers, 2003; Voithofer, 2002), including teachers as co-learners and students working more autonomously. An open classroom, and access to a

variety of technologies, allowed incarcerated youth to engage with learning in ways they had not previously (Cavallo, Papert, & Stager, 2004). However, as long as assessments continue to measure knowledge without taking into account the mega-changes in learning that ICT entails, the positive changes will not be measured (Somekh & Mavers, 2003). Roschelle et al. outline four areas for change: technology should use what is known about cognitive learning, technology should link to curricular reforms that provide access to more learning, there should be coordinated interventions, and there needs to be a

> *"As technology evolves or emerges there is a learning curve unlike anything we have ever encountered in education. Books are, or were introduced slowly, and were a guide to a static amount of information. Things have changed. The access to information has changed. The paths to learning have increased. The possibilities for individualization of learning have increased."*
>
> Bonnie Bracey, Educational Consultant

recognition that not all schools have the capacity to be transformed at the same time (Roschelle et al., 2000).

Papert argues that technology will change education through an evolutionary system (Papert, 1997). He does not expect large-scale reforms to incorporate the ways technology is already changing the experiences of youth, but rather argues that it will happen in a decentralized manner. Tapscott also argues that education has huge potential for transformation if it will build on youth experiences with technology (Tapscott, 1998). Cuban agrees that technology will not have a positive effect on schools, but he argues that this is because schools are too resistant to change (Cuban, 2001a, 2001b; Wartella et al., 2000). He argues that the money spent to 'connect' all US schools has been a poor investment, and that teachers do not take advantage of all that technology has to offer. Atkinson et al. (2001), in a meta analysis of research looking at

the effects of technology on children's learning, found that technology did have a positive effect on children's learning (Atkinson et al., 2001).

While technology is often associated with science and math, a growing body of literature is examining the way that literacy is shifting as a result of technology. Both the expansion of information via the Internet, and shifts in youth literacies based on new technologies (for example, instant messaging), need to be incorporated into formal education (Alvermann, 2004; Tully, 2003; Williamson & Facer, 2004). Just as youth engage in technology outside of school, so do they have a whole series of literacy practices that do not fit well into the confinement of formal schooling (Luttrell & Parker, 2001). Some of these changes are taking place already, but too often the shifts in pedagogy are used only with privileged youth. Students of different social classes describe different ways of viewing themselves, the value of their out-of-school literacies, and their future roles (Gee, 2000; Luttrell & Parker, 2001).

Who does the designing?

Who designs technology? Druin argues that children should be actively involved in the design of learning technologies (Druin, 2002), and has implemented projects that do just that. Cultural issues in technology design are rarely addressed, both who designs the technology, and which audiences are left out of the design process.

> *"The consequences of a lack of awareness by researchers and designers of their cultural assumptions and the framework for how culture can influence design can result in a cultural disconnect between designers of learning tools and their intended audience, which leads to unachieved learning goals and lack of student engagement."*
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> Nichole Pinkard, Research Associate and Director of Educational Technology, Center for School Improvement, University of Chicago

While some argue that technology shows its bias only in the content, this review argues that the way technology is designed can also show bias. There is a language of power in technology terms like webmaster, mother board, master server (Brown-L'Bahy, 2003). Technology is designed, for the most part, by white men, and while some try to argue that the technology is neutral, others point out its biases (Ebo, 1995; Zuga, 1999). There is an interaction between "designers' creation of virtual environments" and "users' construction of identity" (McDonough, 1999, p.856). McDonough continues, "technological development involves a process in which the technological artifacts which designers create embody the designers' understandings of the potential uses of their product" (McDonough, p. 857). A clear example of this is the design of "avatars," figures that individuals choose to represent themselves in virtual space. "By disproportionately drawing upon certain cultural sources for worlds' themes, designers are closely bound with particular groups within the culture of the US" (p.862).

> "*Because designers can make many different decisions that have cultural implications then I would argue that it is not that the technology itself is inhibiting diversity but the design decisions by designers are inhibiting diversity.*
> Nichole Pinkard, Research Associate and Director of Educational Technology, Center for School Improvement, University of Chicago

CONCLUSION

The literature covered in this review indicates that there has been some learning and understanding of the ways that learning technologies have differential impacts on different groups of people. We know that culture matters, that different people interact with technology differently. We know that for some youth, technology has become an integral part of their identity (as Turkle described one person she interviewed who had a computer strapped to his body and considered it an extension of himself (Sherry Turkle, 2003)), while for others, it is an

outside structure that they must confront. We know that technology is not value-free. We know that learning technologies are not living up to their potential. The programs described in the studies here are generally small-scale, targeting small groups of individuals, and their effects are hard to measure, as are the effects of the software designs that have targeted specific populations. We know that there is minimal research to date on the way that teachers can be learning mediators, and on the changes that teachers can/are experiencing in their roles. Together with that, we know that those who advocate a wholesale transformation of education face huge hurdles to get there. Finally, there is almost no literature at all on the designers of technology, and the ways in which the designers have an impact on differential experiences of technology.

Because learning technologies present an avenue for social and civic engagement and creation and communication, the implications of being left out of technology advances has potentially greater implications than other areas of learning inequity. For some youth, technology is part of their culture, something that they interact with, are shaped by, and shape. For others, technology is part of an outside structure that is not part of their self-concept. What can be done to change this? There are a number of fields currently serving as a focus of research, and we support continued research in those areas, including understanding how culture and identity interact with learning technologies, and understanding the way that technologies interact with the learning process. Individuals build their identities, and their identities are shaped by their interactions with technology. Similarly, the ways that technology is designed influence how a person interacts with that technology. In the area of culture and identity, we have identified the following questions for ongoing research:

- How do youth define technology, what functions to they assign to technology, and what does this imply about technology design? (both youth who are integrally involved and those who are not)
- What barriers need to be taken down for greater access and availability of technology?
- How do the implicit and explicit values found in technology design and use affect the ways that diverse learners interact with those technologies?

In the area of education, we have identified the following questions:

- How can learning technologies respond to ALL learners, not just those for whom current technology models are most effective?
- How can we assist teachers and others to become effective learning mediators, to integrate and use technology in learning environments in a way that enhances student learning?
- How can content and technology be aligned with the realities of individual schools?
- How can learning technologies increase economic opportunity?

In the area of technology design, we have identified other areas for further research:

- Who designs the technology and what are the implications of this? As technologies become more malleable and 'user-friendly', does this increase access or provide a limited number of options designed by someone else?
- How can technology be designed differently, taught differently, and involve more diverse peoples and perspectives as part of these processes?

In conclusion, we argue that further research on learning technologies should focus on the relationship between youth identities, learning mediators, technology designers, the learner setting (school), and the technology itself.

"As prior research on gender and technology has found, one size does not fit all; for example, gendered design creates gendered participation. While we don't expect everyone to have the same experience, we hope that both women and men, participants of any race, ethnicity, native language or class, will have equally satisfying experiences. Equity involves integrating a combination of experiences with various synchronous and asynchronous media. It also means including design features that are interesting to all types of learner diversity."

Chris Dede, Professor of Learning Technologies, Harvard Graduate School of Education

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