

Engaging More Students from Underrepresented Groups In Technology: What Happens if We Don't?

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Abstract

Despite the growing number of students of color entering our k-12 public schools African American, Native American, and Hispanic youngsters enter technology/ICT careers in far fewer numbers than their White counterparts. Intersect social class and gender, and the results are even more grim. Children from under-resourced areas are less likely to occupy schools with advanced level computer science courses than those attending more affluent schools (see for an example Goode, 2007). Girls of color enter technology fields at a lower rate than White females. The consequences of not actively engaging more female, students of color in technology activities and/or careers can best be understood along economic, technosocial and educational lines. In this conceptual article, we consider these potential implications and how they affect teacher education for in-service teachers.

Introduction

Despite the growing number of students of color entering our k-12 public schools (NCES, 2007) African American, Native American, and Hispanic youngsters enter technology/ICT careers in far fewer numbers than their White counterparts (NSF, 2006). Intersect social class and gender, and the results are even more grim. Children from under-resourced areas are less likely to occupy schools with advanced level computer science courses than those attending more affluent schools (see for an example Goode,

2007). Girls of color enter technology fields at a lower rate than White females (Good & Margolis, 2004; NSF, 2003; Margolis & Fisher, 2003). The Kaiser Foundation (2004) explains this disparity as a result of low-income students navigating schools ill-equipped to encourage and prepare more of their youngsters to consider ICT/STEM careers. Lack of resources is only one of many variables that contributes to the disparity. The current digital divide is a result of differential curricula (Goode, 2007); teacher preparedness (Margolis et al, 2008); and programs' absent of culturally relevant activities that include and respect under-represented groups' identities (see Werner, Denner, & Campe, 2006; Scott, 2005; Eisenhart & Edwards, 2004). The consequences of not actively engaging more students of color in technology activities and/or careers can best be understood along economic, technosocial and educational lines. In this conceptual article, we consider these potential implications and how they affect teacher education for in-service teachers. We begin with a working definition of culturally responsive computing.

Culturally Relevant Computing (CRC)

Dialogue about Culturally Relevant Computing cannot be considered complete without laying a clear foundation with regard to Culturally Responsive Pedagogy (CRP). The general definition of Culturally Responsive Pedagogy is best stated by Ladson-Billings (1995) in that it is pedagogy that recognizes the importance of including students' cultural references in all aspects of learning. It involves being *responsive* to their culture, recognizing the "dynamic or synergistic relationship between home/community culture and school culture," (Ladson-Billings, 1995). Culturally responsive teachers are cognizant of the knowledge students bring with them to the classroom, as well as the belief systems that inform student behavior. The learner is truly at the center of the classroom as effective CRP teachers deliberately relate the curriculum and instructional strategies to the experiences, cultures, and belief systems of the students. Howard (2003) includes within the definition of Culturally Responsive Pedagogy a need for "teachers to engage in honest, critical reflection that challenges them to see how their positionality influences their students in either positive or negative ways" (p. 197). In short, effective CRP teachers reflect upon and recognize how their own culture, beliefs, and values inform their teaching. The tenets of Culturally Responsive Pedagogy are directly linked to that of Culturally Relevant Computing. It is necessary for educators to ask the question, "For whom is technology relevant?" It is clearly evident that current computer technologies (good examples are computer/video games) are typically designed to appeal largely to a young, white, male population. Even when such technologies are explicitly designed to appeal to other groups, they tend to reflect stereotypical assumptions about group preferences and interests. For example, a growing number of video games are designed for girls, but tend to emphasize game play around stereotypical interests such as fashion, pets, or babies. In designing computer science and IT courses, it is imperative for educators to seek out ways to expand the appeal of technology to a larger audience, specifically to that of minority women, while at the same time avoiding the reification of stereotypes. A Culturally Relevant Computing stance would require teachers to recognize and value the knowledge and understanding minority girls bring with them to the classroom with regard to technology, as well as general epistemologies and values reflected in their cultures. Simultaneously, educators must examine their own perceptions, as well as potential biases, related to the field of computer science and potential student participation. In practical terms, effective CRC teachers would implement curriculum that allows for students to participate in meaningful lessons that build on their own technological knowledge, while also developing an understanding of computing and IT as a means to advance their communities.

Economic Implications

The relative lack of culturally relevant computing in schools has a significant impact on the participation of minority populations, as well as women, in a field that is considered highly influential and elite. In other words, they are closed out of a job in the STEM field before they even realize they have an opportunity to enter. In an interview in 2002, social scientist and scholar Jane Margolis spoke of the implications of diversity in the STEM field:

In terms of design teams and designing products, there's evidence from other industries that if you have an exclusively male team, you could have a flawed product. For example, 8 percent of mechanical engineers are female, and most of the teams working on air bags were predominantly male. When air bags were invented based on the male body as the norm, they ended up being potentially deadly to women and children (<http://news.cnet.com/2008-1082-833090.html>).

As another example, according to Karen Branch-Brioso (2009), "Hispanics, who are the largest minority in the country at 14 percent and growing, earned just 7.5 percent of bachelor's degrees in

engineering in 2005, according to a recent report from the National Action Council for Minorities in Engineering. They earned just 7.5 percent of the bachelor's in biological sciences that year; 6.8 percent in computer sciences; 6.5 percent in physics; and 5.8 percent in mathematics."

Aside from implications on the quality of products, the increased opportunity for stable employment is another benefit of increasing the access of minorities and women to the field of technology. The Bureau of Labor Statistics published a report recently that stated the unemployment rate for African Americans for the month of February 2009 was 13.4%, which almost doubled that of whites (7.3%) and was higher than Hispanics at 10.9% (Bureau of Labor Statistics, 2009). An increase in the use of Culturally Relevant Computing strategies in schools, while not sufficient alone to ensure minorities' and women's participation in the STEM field, is at least a step toward addressing this problem.

Notably, the National Science Foundation's Innovative Technology Experiences for Students and Teachers Program takes seriously the potential economic impact of not having a critical mass of American STEM workers whereas, "The ITEST program is funded by H-1B visa revenues in direct response to the need to ensure a high-quality future STEM workforce that can meet U.S. technology needs" (<http://www.nsf.gov/pubs/2009/nsf09506/nsf09506.htm?org=NSF>).

Technosocial Implications

Little attention has been paid to how technology can maintain, empower, and create social and cultural identities in both real and virtual spaces. The absence of this exploration seems to have created two technosocial results: 1). Technology creators do not represent the increasing diversity of the k-12 population; and 2) The divide between technology and culture broadens, particularly for Indigenous communities.

Technology users have a greater potential of becoming technology creators than non-users: "who innovates is absolutely critical to the kinds of innovations produced...who they are the kind of things they like, and the kind of things they want dictate the limits of their imagination for new inventions and features" (Sandvig, 2008, p. 90). To date, there is a disproportionate number of White, middle-class male technology creators (NSF, 2006). This may explain, among other discrepancies, the overabundance of White male protagonists in computer games.

With the ever-changing and abundance of media and technology, students are constantly exposed to a plethora of messages and content. Media like video games have the opportunity to have a positive or negative impact on the cognitive and social development of young people. In the Kaiser Family Foundation's study entitled, "Generation M: Media in the Lives of 8-18 Years olds (2005)," the authors found that: 1) young people spend about 50 minutes a day playing video games, 2) 83% of youth have a video game console in their homes; and 56% have two or more, and 3) African American and Latino youth spend more time with all forms of media as compared to White youth. Since African American and Latino youth consume the most media, it should stand to reason that the media should reflect them and their culture.

Prior research suggests that video gaming may be most children's (girls' as well as boys') first introduction to and experience with digital media. Accordingly, it is worthwhile to examine the images of gender, race, and culture within these media. Much of the research on diversity in video game content comes from gender studies, specifically on the portrayal of male and female characters (Burgess, Stermer, and Burgess, 2007). These research studies continue to show that games have a bias towards male protagonists and females in stereotypical, passive roles. More recently, the issue of character race in video games has become a focal point. In 2002, Children NOW examined 60 video games and examined the racial diversity of character portrayal. The study found that of the male player-controlled characters, 52% were White, 37% African American, 5% Latino, 3% Asian, and 3% Other. Among female-controlled characters, 78% were White, 10% African American, 7% Asian, 4% Multiracial or Other and 1% Native American. (No Latina characters were found.) After this study was released, more research studies on video game character portrayals included statistics on race. In 2005, Dill et. al's study of 20 games included race as part of their content analysis and found that among the main characters, 68% were White, 11% Black and 11% Latino. Among the secondary characters, 72% were White, 10% Black, 0% Latino and 9% are mixed race. Among the target, or victim, characters, 75% were White and 25% were Middle Eastern. Jansz and Martis (2007) studied 12 video game introductory films and found that 70% of the video game characters were White. In leading character roles, 9 of the 12 leading characters were White, 2 were African American and 1 was Asian. There were no Latino/a characters in leading roles. In

supporting character roles, 6 of the 10 characters were White, 1 was African, 1 was Latino/a and 2 were Asian.

Burgess et al. (2007) conducted three different studies to examine racial stereotypes in video games. The first study looked at six top-selling video game magazines and examined the largest male and female character on each page. It was found that white males were overrepresented in relation to black males and that Hispanics, blacks and Others (such as Middle Eastern characters) were found to be more aggressive than whites. Additionally, black characters were more likely to be represented as athletes. The second study looked at 225 video game covers and looked at the frequency of the characters' races in comparison to the US Census. It was found that white characters exceeded the census (78% to 66.9%) while black and Other characters were represented below (7.1% compared to 12.8% and 11.6% to 16%). Again, black characters were more likely to be portrayed as athletes (31.8%) than white characters (6.6%), while Asian and Hispanic characters were not. This study conducted a further investigation to expose players to games that featured both black and white characters in violent and non-violent settings. Participants were asked to identify images that appeared on screen and identify it as violent or non-violent by pressing down on an electronic pad that recorded their time. Each image portrayed a violent or non-violent image with either a black or white character. It was found that participants identified violent images more quickly if there was a black character than a white character.

Identity plays a role in academic achievement of African American students (Oyserman, Harrison, & Bybee, 2001). Media creates cognitive and affective environments that describe and portray people, places, and things that carry profound general and specific cross-cultural learning experiences for young people in a media saturated society (Berry & Asamen, 1993) and influences how and what young people learn about race (Everett & Watkins, 2008). Although technological changes have opened the way for more sophisticated representational depictions, and a more diverse range of themes and characters, the portrayal of race and gender in video games remains remarkably narrow (Everett & Watkins, 2008). Playing video games seems to function as a crucial starting point for an interest in technology, leading to pursuit of education and careers in mathematics and science-related fields (Hayes, 2007; Williams, 2006a). If any group feels alienated from gaming, they will be less likely to engage in informal learning experiences with technology, such as game modding, or to become designers of games or other technology themselves, thus perpetuating the cycle of exclusion (Williams et al., 2009).

There are a variety of theories and explanations of the specific effects of gender and racial representations in games and other media on young people (Williams et al., 2009). As one example, research on female gamers has found that female players tend to choose feminine, sexy and strong characters to play (when they are available) in video games (DeJean et al., 1999; Royse et al., 2007; Taylor, 2006). The appeal of female characters may be due in part to women's need to find ways to construct meaningful experiences for themselves within the context of still predominantly masculine themes and content of most games (Hayes, 2008). If such characters are not available, girls may have less interest in gaming and less satisfying experiences.

Educational Implications

African American and Hispanic children are three times more likely than Whites to attend an impoverished urban school (Orfield & Lee, 2005). Such settings tend to focus more on developing students' test-taking strategies than their critical thinking skills (Kozol, 2005). Teachers in these contexts feel disempowered and disengaged (Nichols & Berliner, 2007; Lederman & Bernstein, 2006). These sentiments contribute to youngsters dropping out of school (Christle, Jolivette, & Nelson, 2007), obtaining low paying jobs (NCES, 1999), and feeling that little can be done to address the disparity of their school experiences and/or lives (Freire, 1970). The inclusion of technology into these settings does little to challenge these ways of being. Rather, under-resourced students' technology education focuses on developing the habits of behavior Anyon (1981) noted as differentially shaping the school curriculum for low-income and working-class populations. That is, the presence of technology in poor schools still encourages docility, rote memorization, and obedience; it emphasizes low-level skills that will not translate into the critical thinking, independent, collaborative behaviors the technology activities implemented in more affluent school programs. In the end, technology in and of itself is not the great equalizer once believed as it reinforces the stratified educational system which founded America's school.

Schools have historically stripped away Native American cultures (Lomawaima, 2000). Perhaps as a result, it is believed that technology and Indigenous communities are incommensurate. Anecdotal data reveal that many Native communities do want their youngsters engaged in school and to be technologically

savvy, but school should engage culture (Brayboy & Castagno, 2009, p. 31). Without understanding this connection, technology for Native communities will continue to be used for cultural maintenance purposes rather than as an empowering cultural tool. Using technology to preserve Indigenous language is an important first step to bridging Native cultures with ICT. However, guiding Indigenous youngsters to critically analyze, manipulate, and create new technologies that advance their communities involves the critical thinking skills necessary for 21st century success. Learning how to produce, and not just consume popular culture, is one good starting point for the critical process, since through productive activities, learners can develop a meta-knowledge and meta-language about how technologies are designed, a crucial step towards asking questions about social goods and interests (Hayes & Gee, 2010).

In general, in-school technology programs seem to lag behind out-of-school enrichment experiences. Understanding that identities are complex and culturally contextual that can inform how technology is used by individuals and communities, there is a growing interest in culturally relevant computing. The next section provides a snapshot of culturally relevant computing as a means to both include and challenge diverse groups to work within and change the boundaries of ICT.

Implications for preparing teachers

In proposing culturally relevant computing practices in K-12 schools, the authors recognize that a shift in thinking on the part of educators, as well as society as a whole, is required in order to have the large-scale impact necessary for a change in representation in the computer science field. While we would hope that society would come to understand the value of CRC in schools, it is beyond the scope of this paper to address this broader change in approach. There are many factors that will impact implementation of CRC practices specifically in relation to technology education, but we will explore three here: stereotypes of computer science participants, teachers' level of technological knowledge, and teachers' understanding and implementation of culturally relevant practices.

In their 2000 report, *Tech Savvy*, the AAUW Foundation Commission on Technology, Gender, and Teacher Education reported that girls' perception of computer scientists was in line with the typical stereotype of computer professionals who "live in a solitary, anti-social, and sedentary world" (page 10). While this certainly may not seem appealing to many girls, this stereotype is also largely false, as computer science is rarely done in isolation. Girls, in particular those from ethnic minorities, do not see themselves represented in the field, nor do they see themselves as potential participants. Along this same line, teachers may hold biases that *maintain the dominant stereotype* regarding those who participate in computer science. Without deep critical reflection on their own perceptions, teachers may unwittingly be maintaining the status quo with regard to minority girls' participation in computer science. The direct implication is that teachers must be provided the guidance and support, as well as the time and resources to engage in such critical reflection.

Very often, those who are teaching Computer Science classes at the high school level are teaching outside their original certification. In fact, if higher level computer classes are offered at the high school level at all, they are very often led by a teacher from a separate department who has a personal interest in computer science (Margolis et al, 2008). While this is admirable on the part of dedicated teachers, the situation very often leads to frustration and an eventual end to the class due to circumstances beyond the teachers' control (e.g., lack of curriculum, access to software, technical support, and professional development opportunities). In order for teachers to successfully implement Culturally Responsive Computing, teachers need to know and understand the technology they are teaching at a *high level*. Margolis et al (2008) report the story of a young teacher in the Los Angeles Unified School District:

There was no official computer science teacher at Westward (High School) so these classes were being taught by a young, uncertified history teacher, Mr. Reyes, who had volunteered to teach the students drawing on his prior experience as a Web designer. Reyes was a brand-new teacher, well liked by the students, and he readily admitted that he was learning how to teach as he went along. (page 54)

While this particular example describes a teacher with some background knowledge in the area of technology, it speaks to the larger problem that teachers must be supported in their endeavors by quality professional development centered not only on Cultural Relevancy, as we will address in the next section, but also on the content of computer science, as the field is constantly changing.

Along with developing teachers' capacity in terms of technology, simultaneous endeavors must assist teachers in exploring the framework of Culturally Relevant Computing as it pertains to real practices in the classroom. It is one thing to agree that it is important to respond to and incorporate the various cultures of students in a technology classroom, and it is quite another to actually accomplish this task.

Teachers must be afforded repeated opportunities to make sense of the framework, while also collaborating with peers on actual implementation of CRC practices. They must have the opportunity to ask themselves and colleagues, “What does this look like? What constructs and methodologies can I employ to accomplish ‘Cultural Relevance’ for students in the classroom?” At the same time, teachers must engage in reflective conversations that help them flesh out their own perceptions of technology, ethnicity, gender, and socioeconomic status; as well as how those perceptions manifest themselves in the classroom. While an understanding of the culturally responsive framework is key to implementation, it does not preclude *successful* implementation. The process of understanding CRP is messy work. As we will discuss in the next section, there are significant barriers in the way of teachers' successful implementation practical strategies in the classroom. There are significant parallels between multicultural education and the framework of Culturally Responsive Pedagogy. As discussed by Jay (2003), multicultural education has yet to make a significant impact on the education of American youth.

Barriers to Implementing

There are significant barriers for teachers to overcome in creating a more culturally relevant climate in schools, particularly in relation to technology. Specifically, these include barriers related to accessibility issues and high-stakes testing.

In general, students attending high-poverty and high-minority schools have less access to computer technology than those in affluent majority school contexts. Importantly, research also illustrates that the schools with high poverty and disproportionate numbers of students of color are less likely to have advanced technology classes such as AP computer science (cite). While these schools may have more computers than ever before, thereby causing some to believe the digital divide is nonexistent, the computers are being used for basic skills, work processing and other tedious, culturally irrelevant tasks that do little to advance students' computational thinking. Therefore, the digital divide continues; less defined by access and more articulately shaped by use. Teachers who are working outside their area of certification often teach high school computer science classes, if the classes are available at all. While these teachers may see the importance of providing the opportunity for students to participate in higher level computing classes, they may lack the technological skills to provide students with a quality educational experience, which leads us to another area to explore related to accessibility.

As stated before, teachers must be afforded multiple opportunities to engage in critical reflection as it pertains to Culturally Relevant Computing practices. While we are well aware of the time constraints placed upon teachers due to a variety of factors beyond their control, we also recognize that it is absolutely imperative for teachers to have the *repeated* opportunities to collaborate with colleagues in order to work toward changing the landscape of the IT field. It is necessary for systemic change to occur as it relates to supporting and continuously developing the skills of teachers, specifically those in the field of technology education.

Another significant barrier to the implementation of CRC practices in K-12 schools is the pressure related to high-stakes testing. In an effort to increase accountability for teachers and students alike, high-stakes testing has unfortunately come to be perceived by many as the ultimate goal of schooling (Nichols & Berliner, 2007). The pressure applied to schools has created a culture that encourages a fix-it-quick attitude. While larger society looks at these tests as a way to ensure that all students are learning the necessary content in order for them to demonstrate academic competence, educators in the field recognize that student success is measured in numerous ways. The outcomes of high-stakes testing can have drastic implications on schools and their ability to work toward a Culturally Relevant Computing model. Implementation of a CRC framework would not be a simple fix. In fact, quite the opposite; the training needed for teachers presents a significant dedication of time and energy, as well as resources. Noting the various structural limitations present in schools today, it is clear that implementation would be a continuous process along an extended timeline.

Conclusion

While changing schools and education is not the sole answer to inequities in STEM education and careers, teachers can play an important role in affecting the aspirations and self-perceptions of their students. All teachers are now expected to integrate technology into their classrooms and to support students' technology-related learning, yet clearly they are not adequately prepared to do so, and even less prepared to introduce technologies in culturally responsive ways. Perhaps most importantly, teacher educators need to establish positive attitudes and confidence with culturally responsive computing among

preservice teachers, as a foundation for their continued learning. Indeed, applying principles of culturally relevant computing to teacher education itself may be a more effective way to engage teachers with technology than more typical technology training approaches, that tend to focus on specific technical tools devoid of any meaningful context. Teacher educators themselves may need to critically reflect on the assumptions underlying their programs, with the goal of modelling the kinds of practices that we hope to have teachers emulate.

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