Race and Gender in Culturally Situated Design Tools

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INTRODUCTION

In theer study of equity issues in information technology (IT), researchers concerned with workforce diversity often utilize the metaphor of a "career pipeline." In this metaphor a population full of gender and race diversity enters the pipeline in kindergarten, but its delivery at the pipeline outflow in the form of software engineers and other IT workers is disproportionately white and male. While we might question the metaphor—its lack of attention to economic class or social construction, its illusion of rigid boundaries, etc.—the phenomenon it describes is well established by a broad number of statistical measures. For example, the U.S. Bureau of Labor Statistics' Current Population Surveys shows that between 1996 and 2002 the percentage of women in the overall IT workforce fell from 41% to 34.9%; during the same period the percentage of African Americans fell from 9.1% to 8.2%. Not only are women and certain minority groups under-represented, but the gap is in some cases getting worse. Returning to the pipeline, we might ask what barriers are encountered by women and minorities that act as impediments to this flow. Some of these barriers can be attributed to economic status; in particular the impact that poor educational resources have on low-income minority student academic success (Payne & Biddle, 1999). But other barriers appear to be more about cultural identity, including both race and gender identity. This essay describes Culturally Situated Design Tools (CSDTs), a suite of Web-based interactive applets that allow students and teachers to explore mathematics through the simulation of cultural artifacts, including Native American beadwork, African American cornrows, ancient Mayan temples, urban Graffiti, and Latin percussion rhythms (see http://www.rpi.edu/~eglash/csdt.html). Our preliminary evaluation indicates that some of the identity barriers preventing women and minorities from participating in IT careers can be mitigated by the use CSDTs in classroom and out of class learning environments.

BACKGROUND

Cultural Identity Conflict in Science and Technology Curricula

While many problems in minority student performance can be directly attributed to economic circumstances, other barriers are more cultural. Fordham (1991) and Ogbu (1998) document the ways in which African American students perceive a forced choice between Black identity and high scholastic achievement (e.g., the accusation that they are "acting white," which Fordham connects to "peer-proofing"). Although some researchers (Ainsworth-Darnell & Downey, 1998) have critiqued this framework for its conflict with the positive view of education reported on minority attitude surveys, Mickelson (2003) has shown that there is a difference between what she terms "abstract" conceptions of education, which all racial groups respond to positively, and "concrete" conceptions of education which differ across racial groups and correlate with disparity in academic achievement. Martin (2000) reports a similar finding in African American conceptions of "cultural ownership" of mathematics. Powell (1990) found that pervasive mainstream stereotypes of scientists and mathematicians conflict with African-American cultural orientation. Eglash (2002a) describes conflicts in the identity of the "black nerd" in both popular imagination and reality. Similar assessment of cultural identity conflict in education has been reported for Native American students (Moore, 1994), Latino students (Lockwood & Secada, 1999), and Pacific Islander students (Kawakami, 1995). In addition to peer-proofing and identity conflict, the recent NSF-sponsored study of how minority students are lost in the science and technology career "pipeline" (Downey & Lucena, 1997) is also consistent with these results: many minority students with good math aptitude reported that they dropped out because they did not see how science or technology could have the connections to their cultural background offered by arts, humanities and social studies. Thus, perceived social irrelevance is a third obstacle to minority flow through the pipeline.

Mathematics is a key gate-keeper to the science and technology career pipeline, and the above cultural barriers—peer-proofing, identity conflict, and social irrelevance—can all be observed in minority barriers to mathematics achievement (Martin, 2000; Moore, 1994). In addition to these conflicts between cultural identity and mathematics education, another component for the poor mathematics performance in these minority groups is suggested by the work of Geary (1994). His review of cross cultural studies indicates that while children, teachers, and parents in China and Japan tend to view difficulty with mathematics as a problem of time and effort, their American counterparts attribute differences in mathematics performance to innate ability. This myth of genetic determinism then becomes a self fulfilling prophecy, lowering expectations and excusing poor performance.

Similar barriers are found for gender. Stipek and Heidi (1991) for example found that girls in their study expressed a persistent belief that they lacked an innate math ability. Tiedemann (2000) found that teachers in his study tended to attribute poor performance in girls to genetic causes, and poor performance in boys to lack of effort. The recent controversy over comments by the president of Harvard University proclaiming his belief that the under-representation of women in the sciences could be attributed to biological differences shows that this mythology persists at the highest levels of education. In addition to biological determinism, the kinds of cultural determinism that minority students must resist—peer-proofing, identity conflict, and social relevance—also operate as barriers to girls. For example, Armstrong (1979) found that sexist stereotypes of parents, peers, and teachers influenced girls' decisions not to participate in math. The previously cited study of Downey and Lucena (1997) showed that some female students, like minority male students, also reported that they dropped out because they did not see how science and technology could give them the focus on beneficial social change offered by arts, humanities, and social studies.

Ethnomathematics: An Alternative View of Mathematical Knowledge

Ethnomathematics (Ascher, 1992; D'Ambrosio, 1990) is the study of mathematical practices in various cultures. While many studies have reported on variations in numeration systems (the Mayans used base 20, etc.) ethnomathematics takes a much broader view. It also considers the mathematical practices that are embedded in designs such as architecture, baskets, beadwork, divination, navigation, sculpture, textiles, etc. What distinguishes ethnomath from the broader category of "multicultural mathematics" is that ethnomathematicians strive to *translate* between indigenous concepts and the corresponding representations in standard (Western) mathematics. In my own work (Eglash, 1999) for example, interviews with traditional African artisans showed that they used specific geometric algorithms to construct recursive scaling structures (fractals). Other researchers have applied the same translation process to vernacular knowledge rather than indigenous knowledge. Lave (1998) for example considers the algebraic properties of knitting, which is generally more identified by gender than race. Other examples of gender-based ethnomathematics analyses can be found in Gilmer 1998.

Cultures characterized as "primitive" by colonialists can be shown to utilize sophisticated mathematical ideas, and vernacular knowledge that was dismissed by sexist stereotypes as trivial "women's work" can be appreciated in a new light. Thus ethnomathematics analyses are useful in opposing harmful myths of cultural and biological determinism in both race and gender.

Given the race and gender barriers to math achievement in pre-college education, it might seem like an obvious step to move from this academic research on ethnomathematics to direct application of ethnomathematics in the K-12 classroom. But this is more difficult than it sounds. First, many of these