Culturally Relevant Computing Programs: Two Examples to Inform Teacher Professional Development

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Abstract: Children from under-resourced areas are less likely to attend schools with advanced level computer science courses than those in more affluent schools. Girls of color enter technology fields at a lower rate than White females. Perhaps responsively, there is a growing understanding of how to change the tide and level the technological playing field by using culturally relevant computing practices. In this article, we discuss how two National Science Foundation funded technology programs--Game Design through Mentoring and Collaboration (GDTMC) and COMPUGIRLS--implement culturally relevant computing and philosophies through engaging in-service teachers in extensive professional development focused on the use of varied digital media as well as culturally relevant pedagogical practices. Implications for teacher education in general and our programs in particular are considered.

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-related careers in far fewer numbers than their White counterparts (NSF, 2006). The Kaiser Foundation (2005) explains this disparity as a result of low-income students navigating schools ill-equipped to encourage and prepare more of their youngsters to consider information technology (IT) or STEM careers. Goode (2007) corroborates this point illustrating how children from under-resourced areas are less likely to attend schools with advanced level computer science courses than those in more affluent schools. Lack of resources is only one of many variables that contributes to the disparity. Differential curricula (Goode, 2007); lack of teacher preparedness (Margolis et al, 2008); and the absence of culturally relevant activities that include and respect under-represented groups' identities (Werner, Denner, & Campe, 2006; Scott, 2005; Eisenhart & Edwards, 2004) all serve as features encouraging the current digital divide. However, there is a growing understanding of how to change the tide and level the technological playing field by using culturally relevant computing practices.

In this article, we discuss how two National Science Foundation-funded technology programs—Game Design through Mentoring and Collaboration (NSF #0737667) and COMPUGIRLS (NSF# 0833773) -- implement culturally relevant computing by engaging in-service teachers in multiple forms of professional development. Drawing on evaluation data from the respective programs, we share lessons learned and consider the implications of our findings for teacher education in general and our programs in particular. Both programs draw three elements from culturally responsive pedagogical theory: 1) *Reflective action*--teachers must recognize, appreciate, and value the knowledge and understanding that students of color bring with them to the classroom, (Gay, 2000, 2002; Howard, 2001, 2003; Villegas & Lucas, 2007; Lee, 2007). To acquire this skill often requires teachers examine their own racialized-, genderized, class consciouse biases and perceptions of students' intellectual capabilities (Howard, 2003) and funds of knowledge (Gonzalez, Moll, & Amanti, 2005); 2). *Asset building approach*—by valuing students' knowledge systems, educators connect what youngsters know to what needs to be learned (Hilliard, 2003; Howard, 2001; Lee, 2007). In this context, students receive multiple opportunitites to showcase their cultural understanding as significant; and 3) *Connectedness*-- practitioners foster a sense of connectedness between students and their community whereas students feel a sense of responsibility to something grander than themselves (Gay, 2000; Howard, 2003; Ladson-Billings, 1995; Lane, 2006). How this 3-point framework appears in our programs will consume the next section. For the GDTMC, the latter two features apply more directly while COMPUGIRLS focuses more on the first two.

Culturally Relevant Computing Programs

COMPUGIRLS

COMPUGIRLS is a culturally relevant technology program aimed at adolescent (grades 8-12) girls. Since the initial pilot program in Summer 2007, participants have included more than 60 girls from Phoenix's high needs schools. The program consists of a two-year-long sequence of courses with three objectives: 1) to use multimedia activities as a means of encouraging computational thinking, 2) to enhance girls' techno-social analytical skills using culturally relevant practices; and 3) to provide girls with a dynamic, fun learning environment that nurtures the development of a positive self-concept. As of Summer 2009, staff work in two sites, Arizona State University's Downtown Phoenix campus and the Gila River Indian Community's (GRIC) Boys and Girls' Clubhouse of the East Valley, Sacaton. At both locations, girls meet during the summer for 100+ hours and after-school during the entire academic year (4 hours a week for a total of 16 weeks) in small groups of five to research a social and/or community issue. Girls are selected based on their expressed interest in the program, and reflect a wide range of academic, racial, language, technological, and grade level diversity. The current majority of girls are of Hispanic descent (62%) followed by a sizeable African American population given Arizona's context (19%) and a notable Native American constituency (17%) with the remainder participants classified as White (1%) or Other (1%). Facilitated by a mentor-teacher, the small groups work through six distinct courses.

In this culturally responsive context, the educators' responsibility is to teach the participants how to identify a topic within their own lived experiences (*reflective aciton)*, build on their topical knowledge to explain its significance as a social justice issue (*assett building)*, articulate the research journey in easily accessible written and oral language, and clearly explicate how their research and findings can advance the community while simultaneously contribute to reducing various social and economic inequities (*connectedness)*. In other words, "Teachers lead students to recognize cultural beliefs and practices while gaining access to the dominant culture and promote sociopolitical consciousness that empowers students to navigate lives in and out of schools" (Davis, Ramahlo, Beyerbach, & London, 2008, p. 225). COMPUGIRLS purposely recruits both graduate students from various disciplines and in-service teachers as mentor teachers. We have learned that this combination allows for a cross-pollination of ideas that would not occur if we limited the opportunity to one population over another. The graduate students tend to have a greater understanding of the technology but limited teaching experience; the in-service teachers are often well versed in instructional strategies but less knowledgeable about technology. Teaching experience, race/ethnic background, technology knowledge and current employment yielded a rather diverse group of mentor-teachers: At the Mercado site, there are three teachers who currently work in the local high school district, with only one of them working specifically in a technology classroom. The graduate students come from different backgrounds, including the social sciences and counseling. At the Gila River Indian Community site, there are two mentor teachers, one of whom has a background in teaching, as well as culturally responsive pedagogical practices. The second mentor teacher is a member of a local Indigenous community, who is extensively well-versed in the technological aspects of this program.

The COMPUGIRLS mentor teachers were carefully selected based on observations, professional recommendations, and/or multiple screenings. They participate in a variety of professional development activities prior to and during their work as mentor teachers. The potential mentor teachers began with an eight-week, five-hours-a-week class, "Social Justice, Technology and Education," co-taught by the PI and a co-PI. Organized around several modules led by professors and staff across disciplines (e.g. sociology of education, computer science, literacy, curriculum and instruction), the course instructors used: discussion, lectures, and virtual meetings to introduce the prospective mentor teachers to the theoretical frameworks informing COMPUGIRLS; guided conversations to explore how these frameworks can be enacted via digital media; and included hands-on exercises and prolonged chats encouraging them to think of ways to critically assess their own understanding of technology, social justice, and CRP as intersecting variables that can lead to leveling the technological playing field *or* maintaining the digital divide (*reflective action)*. In particular, we made clear that COMPUGIRLS' approach to equity and equality differed from many. We clearly stated that providing every child a laptop may be an attempt at gaining equality; however, teaching youngsters ways to manipulate the technology as a tool that they see themselves controlling (see Gee, 2004) may require additional resources and time but could result in a more equitable society. An integral part of our discussions involved the teachers in creating a rubric to assess each others' pedagogical practices to actualize the above aims. At the end of this course, the mentor-teachers wrote a paper proposal about a videodocumentary that addressed a social justice issue from their own lives (*assett building)*. They also hosted a poster presentation of this work.

Before the Summer 2009 COMPUGIRLS girls' session began, the mentor-teachers engaged in more technologically-focused training. The ultimate goal of this 24-hour session was to have the mentors carry out their proposals once they received more hands-on training with the iLife suite. Again, they presented their projects to each other and received feedback. At this point, we charged the mentor teachers to develop activities for each objective the PI and co-Pi's articulated for Course I: Videodocumentary. Prior to interacting with the girls, we required that they workshop these activities for their fellow COMPUGIRLS' colleagues who would provide suggestions based on the co-created culturally responsive rubric.

Before the COMPUGIRLS returned to take Fall 2009 Course II: Modding the SIMS, the mentor-teachers met for 12 hours over four weeks, while completing the same homework assignments that would be given to the girls. They also worked in pairs to to create culturally responsive lessons to again obtain the specified curricular goals specific to SIMS. Each pair then met with a curricular coach. Building on the capacity she gained during her tenure in the public schools, the coach worked closely with each pair of teachers to further develop and critique their own lesson plans. A goal of the pairing was to increase collaboration between mentor teachers in order to strengthen their use of culturally responsive strategies.

The GDTMC Project

The GDTMC's key aim is to provide opportunities for year-round IT instruction for middle and high school students, primarily from traditionally underserved populations in Washington, DC and the metro area. Our goals are to use engaging instruction in the popular area of game design to create awareness of, and interest, self-efficacy and skills in STEM fields. Its curriculum has three primary computer science foci: programming, modeling, and simulation. A key instructional strategy to encourage student engagement is situating programming, modeling and simulation in contexts that are complex, relevant and interesting to the students, even for middle school level students with little prior experience. For example, in a beginning project students create three dimensional representations of a basketball court and animate the ball going through the hoop. As students advance, they are exposed to increasingly complex programming tasks within the context of using the game design engine—and they have increased freedom to make their own designs. Students work collaboratively to make models of objects and humans and simulations of actions using software such as MAYA. In addition to this focus on developing students' technical skills, conceptual understanding, interest and self-efficacy in computer science, GDMTC aims to build connections to other STEM disciplines. We do this in three main ways: 1) discussing with students how the technologies they are learning are used in other science and engineering fields, both informally in the classroom and through presentations by STEM experts in summits we host for students, their families and the larger community, 2) identifying and highlighting content connections with other STEM fields, such as how it is necessary to understand the way gravity operates on fixed and moving objects when programming in MAYA's dynamic animation mode, and 3) using the game design process to foster ways of thinking and processes important to other STEM disciplines. For instance, students learn about the importance of models in scientific research and how they are created and evaluated. We try to harness students' interest in games to develop skills, interest and self-efficacy with technology use and computer science, and then use their developing interest in computer science and technology to build interest and awareness of other STEM fields.

The GDTMC project was developed in collaboration with McKinley Technology High School (MTHS). Located in Northeast Washington, DC, MTHS enrolls students from all quadrants of the city. Though it is a "by admission" school, the average GPA is about 2.5. The demographics are 57% female, 97% Black, 2% Hispanic, 0.6% each Caucasian and Asian. The school has excellent IT resources including numerous Mac and PC desktops and laptops and a stable network. Students have personal access to computers in all IT and science classes. The GDTMC program builds on an informal Saturday program McKinley teachers had been offering in IT: the "Institute of Urban Game Design" (IUGD). The primary teachers in the GDTMC program are also IT teachers at MTHS. Over the three years of the GDTMC program, there have been over 250 participants in the Saturday and summer program, ranging in age from 8-18, with a mean age of 13 years. Although it varies slightly year to year, on average the participants are generally around 90% African-American, and have ranged from 77-95% male. While we were not initially explicit about employing a culturally relevant curriculum, we find that cultural relevance in the GDTMC program emerges out of our process of continual formative assessment to make the program work for our participants, and that cultural relevance theory can helps us make sense of the patterns of changes we have made.

The original IUGD program was fairly traditional in its pedagogical structure: a teacher demonstrated step-by-step projects while the students followed along. We decided this structure was problematic for GDTMC for a number of reasons. First, we want to create a more "studio" environment to foster the students' creativity, exploration, engagement and collaboration rather than just learning technical skills (Hetland, Winner, Veenema & Sheridan, 2007). Second, the teacher-led classroom created considerable difficulties given the somewhat unwieldy nature of our program where students ranged in age from 8-18, and on any given week 25% of the students may have been coming for years, 25% coming for months, 25% for weeks and 25% there for the first time. To build a more student-centered *asset building* approach, we identified an evolving group of about 30-35 high school students who had gone through the program to serve as mentors for the newer students. There is a mentor student ratio ranging from 1:1 to about 1:5 depending on the number of the students in the program at any time. Through formal training sessions, ongoing observations and informal professional development we work with the mentors to help them interact and support the projects of the students. The role of the instructor then shifts to provide the basic framework and resources for the project and to help the mentors support students' work on the project. Our professional development with teachers then shifted to help them adapt their more traditional classroom practices to fit the mentorship model. We supported teachers' development of more open-ended projects that could be adapted to various experience and skill levels, and also helped them find strategies for supporting the mentors based on our collective data gathering and informal observations.

The mentorship model has worked well as a classroom management strategy. Analysis of a random selection of 5 hours of field note observations before instituting this model and 5 hours of observations after, we find that about 60% less of the documentation is devoted to direct teacher instruction in the mentorship model than in the teacher-led sessions. Pre-mentorship field notes are almost a running account of teacher instruction, with some description of students' attention or inattention. Post-mentorship model notes tend to describe the interactions among students and mentors, with the teachers' instructions punctuating their actions. Moreover, there are fewer reports of off-task behaviors such as playing games (other than the ones designed or discussed in class) or texting. In pre-mentorship sessions, this was a common note of "problems to be addressed" in the coversheet of our field notes; it is rarely mentioned now. Our curriculum, pedagogical strategies are all richly informed by the insights of our student mentors, and the student mentors do the bulk of the teaching (*asset building)*.

The mentorship model also seems to foster more collaborative work and increased sense of *connectedness*. More student projects are finished and the results are more complex and diverse. In the field notes, there are more instances of collaboration and discussion among students once the mentorship model was fully developed. When the mentors work with younger or more inexperienced students week after week they begin to take pride and feel responsible for their students' learning. As one mentor said in an interview, "It bugs me when I can't figure out how to help someone. Like we worked on that counter forever and [another mentor] and me just worked on it afterwards and it was like aha. But [I] didn't just tell [the student] how to do it. But I knew how to help him then. And he did it. He 100% did it with just a little clue." We encourage the mentors to talk with the students about their own stories of coming up through school, becoming interested in technology and STEM and coming through the GDTMC program, and to listen to their students' ideas, experiences and interests. Given that they are close in age, often from the same neighborhoods and school systems, and in quite a few cases even from the same extended families, the mentors and the students are able to build on each other's shared cultural knowledge. Former mentors who have gone on to college, come back in the summer to serve as mentors again or as instructors, fostering a broader sense of community and also potentially helping other students make the bridge from high school to college (*connectedness)*. One of our current GameMaker instructors is a former mentor who is currently in college studying computer science. She and her co-teacher have developed a year's worth of lesson ideas for both beginning and advanced students informed by her experiences in the GDTMC program. We regularly discuss with the mentors their ideas for innovations in the program.

Both GDTMC's and COMPUGIRLS' mentoring models solved a number of key pedagogical issues, but also created new challenges in terms of professional development. In our concluding section, we discuss the key insights we have for teacher development discerned from our two years of observation using the mentorship model.

Teacher Education and CRC: Lessons Learned

For both GDTMC and COMPUGIRLS, evaluation is central to improving and sustaining our programs. Quantitative and qualitative evaluation data for both programs were collected by external evaluators. Additionally - and perhaps most importantly from a formative evaluation perspective - the PI's and Co-Pi's in each respective program observed the mentor teachers, their projects, and class interactions. We cannot stress enough the importance of this ongoing contact with and understanding of the actual dynamics of the classroom.

Connecting theory and practice

In COMPUGIRLS, the Spring pre-service course was intended to provide teachers with an understanding of the conceptual underpinnings of the program, as well as give them opportunities to experiment with CRP in designing activities for their peers. However, course evaluation data indicated that the mentor-teachers did not make strong connections between the course content and their roles as mentor teachers. They believed the course was very theoretical and, at times, too biased. While many participants found the content interesting, often challenging their own notions of social justice, equity, and technology, after their initial teaching experience in Summer 2009, they reported that the course material was not relevant. Based on the survey administered once the mentor teachers completed teaching the first COMPUGIRLS' course, the respondents felt the Spring course did not adequately prepare them for the summer given the low mean score of 3.3 of a 5-point system (1=low and 5=high). They felt concurrently "cheated" and "confused." The messiness of talking about issues of equity and equality took its toll with one mentor teacher physically removing herself from many class discussions. Later conversations revealed that she was perplexed as to why conversations we initiated did not occur in her graduate training which coincidentally was in multicultural education. In the future, we will borrow from Ladson-Billings (2009) practice of not beginning with theory but with what teachers know about CRP and guide them to actualize it in practical lessons. Just as we expect mentor teachers to employ *assett building approaches*, we too as teacher educators must engage in the same practice with our instructors.

In GDTMC, we have almost the reverse issue: we have made strides towards culturally relevant practice without yet engaging with theory. We have never been explicit with teachers or mentors about culturally relevant practices. While we know and sometimes discuss issues particular to the lives of some of our students—hitches in their college application processes, issues surrounding early parenthood or immediate financial concerns—we have tended to keep it concrete and not connected to a broader philosophy of cultural relevance. At this point, we need to reflect: Is there a role for theory in our program? Is there value in directly engaging in reflection about the cultural contexts of the students and mentors? As we share our templates for lesson plans that use our technical and conceptual approach for using simulations and games for STEM understandings, how do we effectively share our insights on how to create a mentoring community that embodies these culturally relevant practices?

As we reflect in these different ways on both our programs, we are sensitive to the need to avoid reducing CRP to a “formula” and to build teachers’ confidence in their own abilities to design culturally responsive learning environments.

Building teachers' confidence and skills with technology and/or pedagogy

One of the core areas for professional development identified in GDTMC was the need to provide opportunities for student mentors to update and expand their technical expertise. Student mentors mentioned feeling uncomfortable when they did not have in-depth knowledge of the aspect of the program being used, or if they were not given adequate notice of the skills they were going to need to remember. In addition, we want them to continue to build their skills and interests to model the learning process for the younger students and to get excited about things they can share with them. Conversely, the teachers in the GDTMC program all had technical expertise, however they had limited explicit training as educators. They were hired as MTHS teachers because of their technical expertise, and were expected to pick up how to teach those skills through “on the job training.” We found that the mentorship model eased some of the difficulties they felt as a novice teacher since it made classroom management easier, and allowed them to focus on the bigger ideas of the lesson. However, there were additional challenges with the mentor model: teachers would sometimes struggle to find a balance between being too laissez-faire and fail to offer enough support and guidance to the mentors or becoming too directive and failing to allow them adequate freedom to support students more individually. We found explicit discussion of this tension was the best approach to finding workable strategies.

Somewhat ironically, for COMPUGIRLS, even though many teachers were attracted to our programs because of the emphasis on technology, they were often intimidated or hesitant to experiment with digital tools that were new to them. We posit that, just like students, many teachers have been 'schooled' to think of themselves as passive consumers, not producers of technology, and are perhaps even more reluctant than students to "play" with new technologies, to feel comfortable with learning *with* and *from* their students (*assett building)*, not just teaching them. In addition, in COMPUGIRLS most of the teachers were women and thus had particularly limited experience with media such as gaming. This gender-experience combination may have contributed to their insecurity.

While the COMPUGIRLS teachers, for example, were given multiple opportunities to explore the parameters of new digital tools, they typically did not take advantage of these occasions. For instance, a representative from Apple conducted a workshop on iLife, but the mentor teachers paid little attention to the instruction, expressing the belief that it was a purely promotional event for Apple: “The trainings provided by the employee from Mac were not trainings, rather commercials for why Macs are better than PCs. He didn’t ask *at any point* what knowledge we brought to the table. That aspect of the tech training was a waste of time.” In fact, the mentor teachers scored this training lower than any other programmatic component providing a mean score of 3.1. Few experimented with iLife, as reflected in the video productions they created for their summer IT training. As an additional example, the MOD THE SIMS training deliberately did not require the teachers to complete any readings, but rather focused on allowing them to become familiar with *The Sims* software through hands-on experimentation and sharing their experiences with other teachers. However, almost all of the teachers seemed to spend little time with the game, despite their expressed anxiety about using it with the girls. Ironically, in response to the survey question requesting respondents to articulate changes for future sessions, one individual wrote “More preparation and better organized tasks.” We have concluded that future professional development activities may need to engage teachers in critical reflection on their own technology experiences as a means of 'unpacking' the roots of their anxieties and seeming reluctance to pursue self-directed learning. Specifically, we need to provide more and sustained *reflective action* exercises for teachers just as we provide for the youngsters we are engaging.

Supporting collaboration

Both programs emphasize the importance of collaboration among mentors and teachers, partly as a model for the work that students are expected to pursue. COMPUGIRLS' mentor teachers indicated in their narrative survey responses that “creating rapport and team unity within the group”, “having a great bunch of girls and working with compentent mentor teachers”, and the “sense of community” were the best parts of the summer program. However, providing appropriate structure and support for such collaboration continues to be a challenge.

One goal for the GDTMC program is to provide clearer guidelines, roles and ongoing support systems for student mentors, whose involvement is crucial to the program's effectiveness. GDTMC also has realized the importance of professional development which involves student mentors and instructors working in collaboration to set up plans for how they can work together effectively. In addition to more formal collaborative professional development, we have found informal ongoing structures such as using the first five to ten minutes of class, while students are starting up their programs and opening their work, for mentors and teachers to reconvene and refresh their memories about the goals for the session is critical to mentors’ confidence in working with students.

Similarly, COMPUGIRLS has moved towards a model of pairing mentor teachers, while involving the group as a whole in collaborative lesson planning. This model requires both a technical infrastructure of support for sharing documents and gaining peer feedback, as well as an administrative structure that coordinates and moderates teachers' working relationships. The role of the coach has been essential in facilitiating these relationships. As of the time of this writing, we do not have data on the impact of these strategies.

Conclusion

While the original goals of both projects focused on student outcomes, rather than outcomes for teachers, we now see that effective professional development for teachers is essential to attaining our project goals. Enabling teachers to implement culturally relevant computing is a daunting but not impossible task. While in our above discussion we have emphasized the challenges we face, there have also been heartening successes, such as a Native American mentor teacher in COMPUGIRLS who devoted hours to mastering *The Sims* and created a *Sims* version of "the Rez" as a model for her students, and a GDTMC instructor who dramatically improved his instruction and the environment of his classroom by utilizing the student mentors. Ultimately, we have realized that principles of culturally relevant computing should be a basis for teacher professional development, and we need to more fully explore how to engage teachers in activities that are personally and culturally meaningful for them as well as for their students.

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