STRUGGLE, STRIVE AND SURPRISE
HOW WOMANIST PERSPECTIVES MIGHT BROADEN PARTICIPATION IN COMPUTER SCIENCE

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ABSTRACT
This white paper suggests a direction for a womanist approach to computer science and computing education that might inform alternate paths into computing and new modes of inquiry in computing education and careers.

INTRODUCTION
To remain economically and globally competitive, the United States needs to increase the size and diversity of its advanced, domestic science and technology workforce (America Competes Act (ACA), 2010), especially in computing disciplines. Significant efforts have been made to increase participation in these fields, but most of these are fragmented, and do not attend to underlying issues of culture. Put differently, research on effective strategies has been meager (Dalbotten, 2008; Mehan et al, 1996; Oakes and Rogers, 2006). Several researchers have worked consistently to provide evidence of what works to overcome barriers and promote the success of underrepresented groups in STEM. Focusing on the experiences of women of color in STEM—who remain more underrepresented than white women and all men—Carlone and Johnson created the model (2007) Espinosa used to analyze the experiences of 1250 women of color and 891 white women at 135 US higher education institutions (2011); and Johnson et al later used to illustrate the difficulties of science identity formation for young women of color in STEM (2011). Grounded in the seminal work of Malcom, Hall, and Brown on minority women in science (1976), Ong lead a synthesis of empirical studies (2011). Currently, the team led by Ong and Hodari is completing an analysis of narratives about STEM women of color published over the last 40 years (2009-2013). This work reveals mismatches between the knowledges valued by STEM practitioners and underrepresented populations, which serves as a barrier to increasing diversity and inclusion in STEM (Hodari et al, 2013).

Overall, STEM cultures—especially mathematical and physical sciences where poor and minority students are most underrepresented—value abstraction and theoretical knowledge; while poor and minority communities often value more practical knowledge. In computer science, a hierarchy seems to exist between the “hard science” computing contexts (machine language, networks, systems) and “soft science” contexts (human-computer interaction, human-centered computing). This hierarchy is analogous to hierarchies operating in other STEM disciplines which value abstraction over application.

Based on our work studying the lived experiences of women of color in computing, we present some ideas about a womanist approach that might help bridge this values gap. Although this paper aims to broaden participation in computing, at its core it is about the doing of computing, the content—that Roy calls the “technical core” of science (2008). It follows Subramanian’s suggestion to reconstruct science, rather than merely critique what has been done before:

Most of feminist science studies seemed to me to be loosely called a project of deconstruction—that is, taking apart the visible workings of science to highlight the invisible factors that shaped the interconnections between nature and culture, science and society. The project I wished to embark upon was one of reconstruction—to
In accepting Subramanian’s challenge, this paper seeks to articulate four approaches to the scientific work of computing that may serve as a bridge between current disciplinary practices (and the demographic participation outcomes that correspond to those practices) and a broader, more diverse set of practices that expand opportunity both for the science itself and those who engage in it. First, we present two key definitions.

**Feminist Science**—Recent work by feminist philosophers of science and feminist science studies scholars have focused on critiquing existing science practice and differentiating the scientific work of feminists grounded in these critiques from the scientific work of nonfeminists. One example of an approach to science based on a feminist critique is Haraway’s description of the primate observation methods Altman designed from feminist principles, now considered by the community as more objective than previous practice (1989). Examples with obvious feminist outcomes include King’s discovery of the BRCA1 gene allele that cause some breast cancers (Lee, 2011) or Colwell’s discovery that eight layers of sari cloth reduces the population of *Vibrio cholera* in drinking water that reduced the cholera incidence in Bangladesh by half (Colwell, 2008).

In these life science examples, gendered scientific content is clear. However, in the mathematical and physical sciences, where the objects of inquiry are not themselves gendered, it is more difficult to see how feminist approaches connect to the scientific content itself. Fortunately, Whitten has taken the first steps forward by positing nine categories of projects for a feminist physics (2012). The approaches she articulates employ physics logic and knowledge to question underlying cultural beliefs and suggest opportunities for expansion. One example is Whitten’s suggestion that feminist physics should take up projects which “problematize the knowing subject/object of inquiry split” by employing feminist critiques of objectivity, but also by acknowledging the entangled nature of observed object and measurement apparatus required for quantum mechanics, as well as Barad’s extension of entanglement to include the human observer (2007).

**Womanist Perspectives**—Womanist perspectives expand on the feminist critique of science by addressing the gender-race-class trifecta. Coined by Alice Walker (1983), womanism deals with issues of race and class, often excluded from feminism. In doing so, it makes room for woman of color to exist as whole people, with all aspects of themselves visible, relevant and valued. Womanism is defined and characterized by Patricia Hill Collins (1990) and applied in the educational context Beauboeuf-Lafontant (2002) in three primary ways:

- They **embrace the maternal** viewing education as community-focused and with shared responsibility, rather than private with focus individual burdens. Here, the maternal is not limited to women, and its communal nature doesn’t preclude it from the exercise of authority. Rather, teachers operating in this mode see their students as belonging to them both personally (as they would their own children) and communally (as members of a larger group);

- **Political clarity** acknowledges that society, and the educational enterprise that is embedded within it, is structured to privilege some and disadvantage others. Thus, educators must see students holistically, not just in relation to education. Beauboeuf-Lafontant (2002) cites Foster’s (1997) quote from a former student of a segregated school, who said, “Our teachers could see our potential even when we couldn’t, and they were able to draw out our potential. They helped us imagine possibilities of life beyond what we knew.” Audrey Thompson describes the cultural significance of [openness about the political context of schooling] as analogous to what happens, “in the [b]lack family,” because it must be conscious of society to, “provide children with the understanding and the strategies they need to survive racism. … [and] not step back from the world in order to change it” (1998);

- Education rests on an **ethic of risk** which understands the need for interdependence and a commitment to fight for justice, in which teachers recognize that injustice is “deep-seated and not easily dismantled,” so working for social change requires humility and a process of self change. Thus education requires a personal commitment to work for the long-term common good, as Beauboeuf-Lafontant quotes from her own earlier work, “[Change] is increments. It’s little steps. And I value
the process. … It’s the process through which we go that’s often the time during which you learn the most” (1997).

From these perspectives, womanists make an explicit choice for entanglement with others, including those who perpetrate and benefit from oppression, even as they critique oppression and its consequences (Beaubouef-Lafontant, 2002; Collins, 1990; Collins, 1991; Walker, 1983). This entanglement choice is central to the insights that may be gained from womanist critiques of computer science.

WOMANIST APPROACHES TO COMPUTING

ASK DIFFERENT QUESTIONS

Ultimately, all approaches to scientific inquiry, including the traditional, mainstream approaches that primarily operate today, involve active choices by the scientists enacting them. As one interview participant form our current study of women of color in computing articulated in answering a question about whether she’s seen any evidence that people with different identities produce different computing content:

Well there’s something to be said for…like, look at architecture. Houses that were built by men, designed by men, have small closets, not that great of kitchens. And when women started getting into the action, we suddenly had His and Her walk-in closets and we have these wonderful kitchens and it’s because the woman who really runs the house, women started thinking, ‘Well, I want my dream house.” Right? So there’s an example of having women in a field can really make a big difference. All of my physicians have been…other than my pediatrician as a little girl…the physicians I’ve chosen as an adult, my internists…always women. Just because you like to talk with a woman about women things, you know? And in Computing, I think that woman have a role…a knack for always thinking about how what we do is going to affect the end user or affect the developers and that kind of…because we just generally tend to be very caring and maternal. It’s in our DNA and I think it helps us to design things with more thought frankly. I’m not saying that men don’t. I’m saying that in general, more women than men think that way unless they happen to be men who are working in Computer-Human Interaction or Human-Centered Computing.

Georgette, Latina Computing Professional

CHALLENGE ALL STUDENTS AS THE BEST ARE CHALLENGED

By embracing the maternal, computing educators can accept the challenge to develop students beyond their technical skills and knowledge. As Dylan described in the quote below, his male program director, often challenged him with high expectations:

On the first day of [program activity] in [year], within the first few minutes of formerly meeting [program director] during a group meeting, I told him to 'give me a break'. The glare he gave me goes unmatched to this day. What he said to me after stays with me. He pulled me aside and asked if I really wanted him to give me a break, and if that's what I wanted, I could go home. I didn't go home. I didn't get a break, and I never asked for one again. That day defined our relationship for the rest of my time at [university name], and I can say for a fact, I wouldn't have made it this far, academically or professionally, without him in my life demanding more of me with a single fierce, yet caring, look.

Dylan, Undergraduate STEM Program Alumni

Dylan describes the kind of interaction few computing student enjoy unless they have close mentoring relationships with professionals or faculty. Our research shows that many women of color not only do not have these relationships, but that they often receive the discouragement of low expectations. This kind of intense but positive engagement with students is an explicit choice computing educators and professionals could make, alongside matching high-level resources and support structures would make room for the success of a broader set of students beyond those who arrive with sufficient internal motivation to succeed.

INCREASE THE HUMANITY IN HUMAN-CENTERED COMPUTING

Womanists’ focus on political clarity includes a deep recognition of the inherent humanity of all. As many scholars and practitioners attest, practices that increase the success of underrepresented groups increase the
success of everyone (Maton e al, 2009). Feminism has already provided evidence of this, as young men who are more involved in childrearing than their fathers were now benefit from the same family-friendly policies that were designed to help women. From this this insight, computer scientists might consider approaches that explicitly seek to mix theory and applications from the computational, natural and social sciences. To prepare students to use these kinds of entangled approaches, computing educators would provide opportunities for them to combine educational and experiential knowledge as Danielle describes:

\begin{quote}
I want to go to medical school, but as of right now I’ll be doing Teach for America for two years and then going to medical school. ... And the whole goal of Teach for America is to bridge the achievement gap, meaning that students in low income communities will get the same education that students in higher income communities, which is something I’m passionate about, because I went to a horrible high school. ... So I know what it’s like to go to a school and not get the same education that other people would get. ... So it’s something that I can relate to, and I know it's something I’m passionate about, and I feel like I would be able to make a difference there.
\end{quote}

Danielle, Computing Undergraduate

Danielle’s belief is that her interest in computational medical research to benefit low-income communities would best be developed by her formal and informal computing education, as well as her plans for teaching and medical school. She hopes that all of these forms of education will allow her to use her love of coding and her passion for service to make life better for kids who go to schools like the “horrible high school” she attended.

\textbf{INCREASE OUR WONDER IN THE SCIENCE ITSELF}

Lastly, while many people appreciate using the products of computing, few are engaged as creators and producers of these products. As Whitten suggests, a key motivational feature is “increasing our respect and awe” for the science itself (2012). In physics, examples abound in nature, especially in astronomy, concepts like an accelerating universe, dark energy and dark matter, challenge our understandings and strain our imaginations. As one of our research participants expressed it, they also inspire passion:

\begin{quote}
And, like, as the wings are getting lifted up, the movement is just so graceful, so beautiful, just visually arresting, that I couldn’t get it out of my head. So, you know, one of the reasons why I switched to aerospace is for very visual, beautiful, aesthetic reasons. And that’s like something that’s a big part of me, is I can’t do anything unless I see the physical poetry behind that thing.
\end{quote}

Meena, Engineering Undergraduate

Computing educators need to ensure that the elegance and beauty present in their work is visible to potential students. Not just as inspiration, but as fuel. As our research suggests, this is often the energy that students who face social and culture obstacles use to survive and succeed (Ko et al, 2013; Ko et al, Under Review).

\textbf{CONCLUDING THOUGHTS}

We are a group of scholars whose researcher focuses on the lived experiences of women of color in STEM. None of us has expertise in computer science as a discipline, which limits our ability to paint a full picture of how the approaches we suggest connect to content. It is our hope that the insights we have garnered from our research participants and their collective voices as students and practitioners in computing will spur discussion on new directions to consider that may create space for broadened participation in computing education and careers.

The theme of NSF’s 2012 Joint Annual Meeting – which convenes awardees supported HRD – the theme was Broadening Participation Research. It included a session entitled, “Women of Color in STEM,” moderated by then HRD Program Director Kelly Mack. Toward the end of the session, Dr. Mack challenged panelists and audience members to articulate “one thing they can do on Monday morning” to make a difference for women of color in STEM. The suggestions varied widely, from actions individual faculty members could take to those requiring the power, influence and resources of institutional leaders. No matter how grand the recommendations were, Dr. Mack consistently followed up, refocusing the discussion on
immediacy and proven effectiveness. It is our hope that these suggestions remind the computing education community, as Dr. Mack’s quiet persistence reminded us, of the importance of the everyday, the immediate and the expansive actions needed to increase opportunity and success in computing.

REFERENCES
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