Despite the fact that women represent the largest percentage[1] of students enrolled in four-year institutions, they continue to be underrepresented in many science, technology, engineering, and mathematics (STEM) fields (NSF 2015). There are promising statistics in the biological sciences where women earned 58% of the bachelor's degrees awarded in 2012; however, there has been little improvement in the fields of engineering, mathematics, computer science, and physics (ibid). While the statistics of gender disparity in STEM fields are disheartening, the statistics for women *of color* in STEM fields are alarming. For example, in 2012, only 372 Latinas were enrolled as graduate students in the field of computer science, a low number in its own right but astounding when compared to the 3,040 White women and 11,725 White men enrolled as graduate students in the same field (ibid). These statistics demonstrate that for women of color there isn't a participation "gap" in STEM fields, there is a chasm.

In response to the low participation rates for women of color in STEM fields, researchers have advocated for greater outreach at the primary and secondary school levels, mainly in the form of in-school and after-school STEM programs designed specifically for girls. A common STEM intervention approach has been to increase the number of girls participating in technology endeavors by strengthening their computational skills. This approach has led to the development of technology programs for girls that emphasize the acquisition of various computing skills, such as learning a programming language or acquiring web development skills. A subset of these programs focuses on "underrepresented" girls, which are commonly defined as girls of color from underserved schools.

Unfortunately, many technology programs for girls of color simplify the complex problem of disparity in technological initiatives as mainly a "computing skills" problem. Race, gender, and class are used primarily as selection criteria for program participation. Despite the aim of addressing disparity in STEM fields, these programs do not engage theoretically or programmatically with race, gender, and class as interlocking systems that structure the institutional oppression faced by girls of color who are traversing the "pipeline." Thus, many technology programs focus on "populating the pipeline" with girls of color without interrogating the nature of a "leaky pipeline" that has been unable to retain women of color in STEM fields at the undergraduate and graduate level. To borrow Charlotte Bunch's (1987) famous critique of the "add women and stir"

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[2] The authors are aware that intersecting identity categories are not limited to race, gender, and class. Additional identity categories such as sexual orientation and ability have also been the focus of intersectional analysis (Taylor, Hines, & Casey, 2010; Annamma, Connor, & Ferri, 2013). However, for the purposes of this paper, the authors will focus on the interplay between race, gender, and class.

approach to dealing with gender disparity, many technology programs for girls of color subscribe to the similar mentality of "add girls, sprinkle a programming language, and stir."

Furthermore, the pipeline metaphor implies an impartial method of transport that obscures the fact that the pipeline is political. Girls of color do not simply "leak" out; they are pushed out by a pipeline wrought with concrete locations of institutional oppressions. Racism, sexism, and classism occur in the institutions - universities and work places - that girls and women of color must inhabit as they pursue STEM degrees and careers. Therefore, if technology programs are to address disparity as a complex problem, they need a theory of technology that examines how race, gender, and class function as interlocking systems of oppression that socially shape technology, both as an artifact and as a social system.

Instead of encouraging girls of color to merely enter technology fields in which "the current shape of modern technology is broadly endorsed," this paper proposes using an intersectional lens to theoretically engage with the concept of the social construction of technology (SCOT) in order to critically examine how normative notions of technology obscure difference and contribute to gender, racial, and class disparities in technology fields (Faulkner, 2001, p. 90). This paper operationalizes intersectionality as a conceptual and analytical tool for investigating the "contextual dynamics of power" that result from the interplay of race, gender, and class and their relationship with technology (Cho, Crenshaw, and McCall, 2013, p. 788)[2].

First, this paper argues that applications of SCOT in feminist science and technology studies (STS) have largely focused on analyzing how gender and technology are coproduced, resulting in lack of scholarship that examines the mutually constitutive relationship between technology, gender and other intersecting identity categories, such as race and class. Second, this paper argues that an intersectional view of technology can dismantle the language of objectivity deeply embedded in technological artifacts by revealing how gender, race, and class are integral components of "the social shaping of technology" and by extension participation in technological initiatives (Faulkner, p. 90, 2001). Finally, through a brief discussion of CompuGirls, a culturally responsive technology program for girls of color, this paper demonstrates how an intersectional, social constructionist[3] approach to technology education can

[3] The terms "constructivism" and "constructionism" have both been used to describe the social shaping of technology. The authors have chosen to use "constructionism" based on the claim that social constructionism represents a "critically and politically engaged set of views on knowledge and science" while

challenge stereotypes of girls of color as passive victims of technology and provide a counter-narrative that can empower girls of color to form generative relationships with technology.

Mode of Analysis

This paper engages with the concepts of intersectionality and the social construction of technology within the discipline of feminist science and technology studies. Contextualizing the discursive space in which intersectionality is employed reveals the institutional formations that influence this paper's epistemological stance. As Cho et al. (2013) discuss, the emergence of intersectionality is grounded in "intellectual and institutional methodologies" that stemmed from critical legal studies and "the practice of subjecting existing doctrines to trenchant critique, a practice predicated on the belief that uncovering the rationalizations that reinforce social power is a necessary, though not sufficient, step toward transformation" (p. 790). This paper continues the tradition of "subjecting existing doctrines to trenchant critique" by using intersectionality as a lens to critique the objective and neutral interpretations of technological artifacts that are perpetuated by technology programs that subscribe to the "add women and stir" mentality (Bunch 1987).

Cho et al. (2013) have outlined three "loosely defined sets of engagements" with the concept of intersectionality: 1) debates about intersectionality as a theoretical and methodological paradigm; 2) applications of intersectional frameworks to research and teaching projects; 3) uses of intersectional lenses as a political intervention in a wide range of phenomena or praxis (p. 785-786). This paper engages with the concept of intersectionality as both a framework for research *and* lens for political intervention in praxis that can be used to analyze how normative notions of technology contribute to gender, racial, and class disparities in technology fields.

As a framework for research, this paper uses intersectionality as a heuristic for understanding how intersecting identity categories affect the design and use of technological artifacts and systems. Thus, intersectionality is used as an analytical tool for disassembling the "perceived neutrality" of modern technology in order to rebuild a view of technology that recognizes how technological artifacts and technical work can be classed, raced, and gendered both "materially and symbolically," whether through design practices or through popular notions of *who* creates and innovates in technology fields (Faulkner, 90, 2001). In praxis, an intersectional lens is employed to advocate for the development of technology programs that go "beyond mere comprehension of intersectional dynamics" and

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constructivism is a "broader set of views on the nature of knowledge and cognition" (Restivo & Croissant, 2008, p. 225; Smith, 2006).

aim to challenge accounts that position girls of color as victimized and passive technology users (Cho, Crenshaw, and McCall, 2013, p. 786). CompuGirls is used as an example of how a technology program for girls of color can incorporate the concept of intersectionality pedagogically and programmatically.

Considering the dual purpose of this paper, it is guided by two main research questions: 1) How can an intersectional lens be used to theoretically engage with the concept of the social construction of technology in order to reveal how technology is classed, gendered, and raced? 2) How can an intersectional, social constructionist theory of technology be employed in praxis to develop technology programs for girls of color?

The Troubles of Traversing a Political Pipeline

For several decades, researchers and policy-makers have studied the issue of disparity in STEM fields and have attempted to shed light on the factors that contribute to the historically low statistics of women of color who obtain STEM degrees. For example, in order to better understand the factors that sustain such a large and deep chasm, Ong, Wright, Espinosa, & Orfield (2011) performed an extensive review of approximately forty years of empirical research on the postsecondary educational experiences of women of color in STEM fields and found that the factors that influence retention, persistence, and achievement of women of color in STEM fields are complex, multiple, and varied.

While the underrepresentation of women of color in technology fields cannot be attributed to one cause, researchers have worked to identify contributing factors along the educational continuum. For instance, at the primary level, Archer et. al (2013) surveyed over 9,000 school children and interviewed 92 school children and 78 parents. Many of the girls surveyed and interviewed reported enjoying science, dispelling the myth that girls are simply not interested in science; however, their responses also revealed they viewed participation in science as a gendered activity – a "boy thing" (p. 11). One respondent reported ceasing participation in an after-school science club because it was "all boys" (p. 11). As a result of feeling excluded from science learning environments, the girls viewed scientific inquiry as a "masculine" activity and did not identify themselves as potential scientists. At the secondary level, Dasgupta and Stout (2014) argue that gender stereotypes continue to threaten girls' interest in pursuing STEM degrees and careers. The authors identified parents' and teachers' expectations as influential factors in the development of girls' academic self-concepts.

At the postsecondary level, Reyes (2011) interviewed participants in the National Science Foundation–funded Futurebound program and found that the retention rates for women of color who have transferred from community colleges to universities is extremely low due to pervasive and repeated microagressions. The respondents reported hostile learning environments where they faced direct

and indirect "slights" based on aspects of their identity – age, ethnicity, and gender – and preconceptions about the academic preparation of community college transfer students. According to Figueroa and Hurtado (2013), the few women of color who successfully earn undergraduate STEM degrees and enroll in graduate level STEM programs continue to face hostile learning environments as they find themselves less likely to be invited into research experiences due to negative stereotypes about their academic abilities.

Bearing in mind the hostile environments that women of color encounter in STEM fields, it is not surprising that the latest NSF statistics on women, minorities, and persons with disabilities in science and engineering reveal that the disparity between women of color in STEM is far greater than that of their white counterparts. For example, in 2012 only 5 Native American women were enrolled as graduate students in the field of mathematics and statistics, compared to the 3,253 White women and 6,814 White men. While this example may seem extreme and atypical, the NSF statistics show a consistent pattern of disparity across multiple STEM fields (see figure 1).

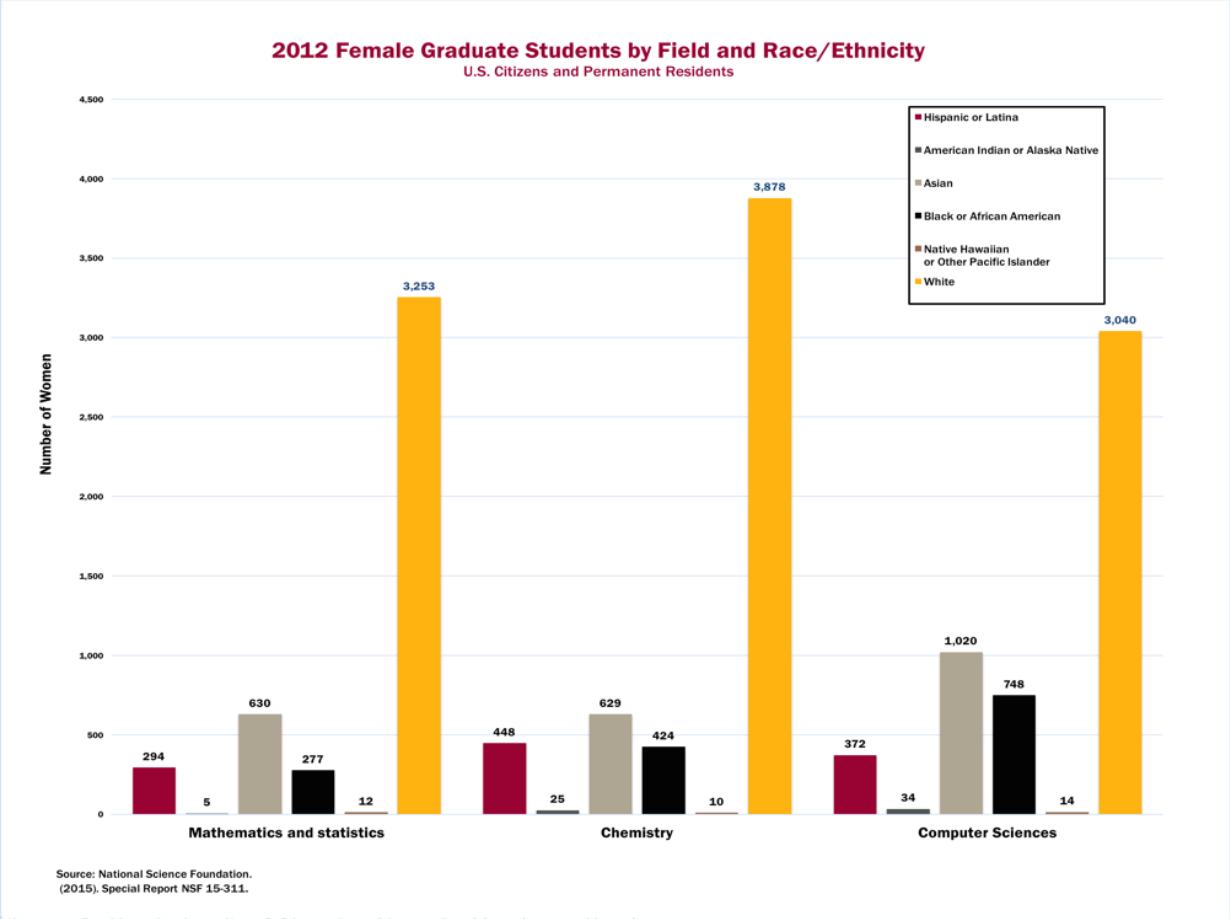

Figure 1: Statistics for Minority Female Graduate Students

As the statistics demonstrate, the endorsement of the current pipeline narrative and the failure to interrogate the fundamental assumptions framing education and work in technology fields has resulted in continued disparity; women of color continue to enter STEM fields where they are slotted into existing roles and capacities where merely doing their job requires them to fight against exclusionary tactics (Mellstro¨m 2009; Rommes 2007).

Demystifying Technology

Considering the complex and persistent nature of the problem, outreach efforts aimed at preparing girls of color to enter technology fields cannot ignore how intersecting power relations of race, gender, and class in institutional domains affect women's abilities and likelihood to enter and succeed in STEM fields. Instead of propagating a sense of technological optimism by promising

girls of color success in STEM fields if they can simply master the technical knowledge, we need a critical of view of technology that examines how race, gender, class, and technology are co-constituted. This paper proposes demystifying technology by utilizing the theory of the social construction of technology (SCOT) to examine how technologies are sociotechnical systems influenced by existing societal power relations. Instead of viewing technology as neutral artifacts and technological development as an objective process, we advocate for interpreting technology as value-laden and socially shaped. Drawing from SCOT, we view technology as "a seamless web, where there is neither a social superstructure nor a technological core, but rather a situation where the technological is co-negotiated and co-stabilised with the social" (Cronberg, p. 11, 2003). Thus, we apply SCOT as a set of "sensitizing concepts" or "heuristics with which to study technological development" as a sociotechnical system (Bijker, 1995, p. 49).

Thoroughly tracing the scholarly history of how the theory of social constructionism has been applied to study science and technology is beyond the scope of this paper[4]. Instead, this paper provides a broad overview of SCOT and introduces key tenets as a preface to the discussion of how feminist science and technology scholars have applied the concept to study the mutually constitutive relationship between gender and technology.

An early application of social constructionism, the theory that objects and knowledge are constructed by social or cultural factors rather than natural factors, was undertaken by Latour and Woolgar (1979) in their book *Laboratory Life*, described by the authors as an anthropological study of "social construction of scientific knowledge" (p. 32). Based on Latour's fieldwork in a laboratory at the Salk Institute, the authors describe how scientific knowledge is produced through social relations and the creation of texts, such as journal articles, that communicate "facts" across scientific communities. As such, *Laboratory Life* is an early example of how scientific knowledge became an "object of social analysis" (Restivo & Croissant, 2008, p. 214). The study of the social construction of scientific knowledge continued with work by authors such as Knorr-Cetina (1981, 1999) who studied "epistemic cultures" in high-energy physics and molecular biology, Zenzen & Restivo (1982) who studied scientific knowledge in a colloid chemistry laboratory, and Haraway (1988) who critiqued objectivity by introducing the concept of "situated knowledges" to feminist epistemology.

Following the study of the social construction of scientific knowledge, scholars working in the area of sociology of technology began to challenge linear

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[4] For a detailed account of social constructionism in science and technology studies see Restivo & Croissant, 2008.

and deterministic notions of technological development that privileged scientific discovery. For instance, MacKenzie and Wajcman (1985, 1999) critiqued technological determinism, the belief that technologies develop in predetermined directions and govern social change, by examining the "social shaping of technology"; they argued for a view of technological development that accounted for the organizational, political, economic, and cultural factors that affect the design and use of technology. By focusing on the social context of technological development, MacKenzie and Wajcman (1999) revealed how the simplistic idea that "technology just changes" perpetuates a passive relationship with technology where society focuses on learning "how to *adapt* to technological change, not on how to *shape* it" (p. 5).

While some scholars used the terminology "social shaping" and others used "social construction," they shared the common interests of studying technology as an object of social analysis and shifting the focus from the predetermined "'impacts' of technological change" to understanding the "content of technology and the particular processes involved in innovation" (Williams & Edge, 1996, p. 865). For the purposes of this paper, we engage with the definition of SCOT articulated by Pinch & Bijker (1984) and Bijker, Hughes, & Pinch (1987), and we are particularly interested in three main tenets: interpretive flexibility, relevant social groups, and closure.

Instead of viewing technology design as a closed process, the concept of interpretative flexibility maintains there is "negotiability" in how people design and interpret technological artifacts (Cronberg, 1992). As Pinch & Bijker (1984) simply state, "There is not just one possible way, or one best way, of designing an artifact" (p. 421). In addition to describing the "flexibility" involved in the design process, the concept of interpretative flexibility also contests interpretations of technology as artifacts with stable and fixed meanings. As Wajcman (2000) writes, "users can radically alter the meanings and deployment of technologies" (p. 450). The ability for different user groups to alter the interpretation of technologies highlights the role that diverse communities can play in meaning-making and the shaping of technology "for different ends and different kinds of 'technological' and 'social' outcome[s]" (William & Edge, 1996, p. 867).

Situating technological development within particular social circumstances rejects the notion that "technology just changes" and reveals how members of social groups influence the design and use of technology. Pinch and Bijker (1987) define "relevant social groups" as "all members of a certain social group [who] share the same set of meanings, attached to a specific artifact" (p. 30). Relevant social groups are the *shapers* of technological development. However, while they may attach the same meanings to artifacts, they are not stable homogenous groups. The constitution of a relevant social group generally consists of a heterogeneous mix of producers and consumers, and can change over

time. Through their shared understanding of a technological artifact, relevant social groups have to the power to bring "closure" to an artifact. Closure is defined as the stabilization of a technological artifact through a shared agreement on the existing configuration and design (Pinch & Bijker, 1984; Klein & Kleinman, 2002). The ability to decide which meaning of a technology dominates is a powerful position – a position that many social groups are effectively prevented from holding.

These three tenets – interpretive flexibility, relevant social groups, and closure - provide a basis for a critical view of technology that centrally positions the role of social forces in technological development; however, if we are to intentionally employ a sociotechnical approach to technology education as a way of challenging dominant deficit narratives of girls of color, we need to ask questions about *who* is involved in the social shaping of technology. Although we view SCOT as a set of useful heuristics for researching issues of technological development, we are acutely aware of and in agreement with critiques of SCOT which argue that the theory and its related concepts do not properly address the power dynamics between social actors involved in the shaping of technology.

For instance, Klein and Kleinman (2002) have critiqued SCOT for failing to "adequately attend to power asymmetry between groups" (p. 30). Thus, while this paper agrees with the basic premise that technological development is a flexible process open to the influences of social groups, it also argues that the theory insufficiently addresses the power dynamics governing how social actors interact on an individual and institutional level. Not everyone sitting at the proverbial decision-making table is treated equally, and most importantly, some groups, such as women of color, are rarely present or invited. Thus, in order to adequately address disparity in technological initiatives, we propose using an intersectional lens to theoretically engage with the concept of the social construction of technology (SCOT). Interpreting technology design as an open process centrally positions the role of societal influences and allows us to examine the ways race, gender and class shape technological development.

The Co-Construction of Gender and Technology

Feminist science and technology studies scholars have introduced gender into discussions of the social construction of technology and have argued that gender and technology are constructs which are "performed and processual in character, rather than given and unchanging" (Faulkner, p. 82, 2001). These scholars have challenged the belief that scientific and technical knowledge is objective or neutral (Harding 1991) and have examined how gender and technological artifacts are co-constructed (Lohan & Faulkner, 2004; Wajcman, 2004, 2000; Faulkner, 2001; Cockburn, 1992). According to Wajcman (2000), the "traditional concerns" of feminist scholarship on technology have largely centered

on "women's access to technology, the differential impact of technology on women, and the patriarchal design of technologies" (p. 453).

In addition to these common concerns, feminist STS and critical technology scholars have examined gender divisions in digital labor and technological work. For example, Roberts (2014) has shown how digital labor is gendered female and rendered invisible through an analysis of the labor pool used for video content moderation by powerful Internet media companies like YouTube. The decision-making processes of a largely female workforce who are moderating content is obscured by the technology and the industry, yet their work is critical in determining what users encounter on the other end of the screen. The invisible labor of female tech works reveals how certain tech identities such as "startup whiz kid" are romanticized and gendered male by mass media, such as the HBO show *Silicon Valley* which features six "adorkable" young men who pioneer a data compression algorithm worth millions, while other identities are less desirable and largely hidden from the end user.

As Wajcman (2000) further elaborates, "More women are literally present, the further downstream you go from the design process"; however, the "undervaluing of women's 'unskilled' and delegated work serves to make them invisible in mainstream technology studies" (p. 452). The assertion that more women are found undertaking "unskilled" technological work "downstream" from the design process is closely tied to another feminist STS concern – the gendering of technical knowledge. As the previously cited study by Archer et. al (2013) revealed, many of the girls surveyed and interviewed about their participation in an after-school science camp reported that scientific knowledge and the act of participation in scientific inquiry is a "boy thing" (p. 11). According to Wajcman (2000), in "contemporary Western society, hegemonic masculinity...is still strongly associated with technical prowess and power"; thus, to possess technical knowledge and to produce technology is a "highly valued and mythologized activity" reserved for males (p. 454).

Although feminist STS scholars have convincingly articulated the mutually constitutive relationship between gender and technology, there has been less scholarly attention paid to the relationships between these constructs and other intersecting identity categories, such as race and class. Disparity in technology fields is not limited to a lack of gender diversity. As NSF statistics (2015) and previous research demonstrates, the number of women *of color* in technology-related fields is dismal. Thus, if we are to comprehensively address disparity in technological work, we must move beyond the focus on gender to examine how technology and a broader range of identity categories are "socially constructed and mutually constituted through historical, social, political and economic processes" (Noble, 2013, p. 19). We propose using the concept of intersectionality as a conceptual tool for feminist analysis of the mutually

constitutive relationship between women's complex, multilayered identities and technology.

An Intersectional Analysis of Technology

The origin of intersectionality as a concept is often attributed to Black legal scholar Kimberlé Crenshaw (1991) who argued that "feminist and antiracist discourses ha[d] failed to consider intersectional identities" and inadequately examined the "race and gender dimensions of violence against women of color" (p. 1242-1243). According to Collins (2009a), the term "intersectionality" gave a name to "a heterogeneous set of practices that had gone on for some time" and had been implemented by previous scholars and activists who were critiquing the systems of inequality affecting marginalized groups. (Collins, 2009a, p. vii). Since the emergence of intersectionality in the legal academy, feminist scholars, particularly those in the fields of ethnic and gender studies, have employed the concept to study how social power relations are mutually constructed and used to oppress women of color (Crenshaw 1989, 1991; Collins 1993, 2009a/b; hooks, 1992, 2000; Anzaldu´a, 1999; Moraga & Anzaldu´a, 2002).

For girls and women of color who are pursuing careers in technology-related fields, experiences with oppression do not occur in "mutually exclusive terrains"; instead, "racism and sexism readily intersect" in their lives as they traverse the pipeline and attempt to enter historically exclusionary institutions (Crenshaw, 1991, p. 1242). The oppression encountered by girls and women of color is "not a singular process or a binary political relation," and thus, disparity in technology fields cannot be attributed to a single oppressive force (Carastathis, 2014, p. 304). The roots of disparity in technology fields are distributed throughout four interrelated domains of power: structural, disciplinary, hegemonic, and interpersonal (Collins, 2009b). As Tillapaugh and Nicolazzo (2014) articulate, "power and privilege are granted (or not granted) based on the intersections of one's social identities, as well as how these systems are maintained and replicated within society" (p. 113). Yet, many approaches to addressing disparity in technology fields have focused on gender as the determining variable and have not scrutinized technology as a sociotechnical system that maintains and replicates power and privilege through the matrix of domination (Collins 2009b). This paper brings the concepts of SCOT and intersectionality in conversation to challenge neutral notions of technology by investigating how race, gender, and class socially shape technology and affect the experiences of girls and women of color in technology fields.

Despite the focus on gender, a number of scholars in the fields of feminist science and technology studies, critical media studies, and information studies have made significant contributions to the study of the mutually constitutive relationship between race, gender, class, and technology. For instance, Kvansy

(2006) examined the intersection of race, gender, and class by studying how the lived experiences of working-class African American women shape their standpoint on information technology (IT). Kvansy argued that the focus on developing a "skilled" female workforce who build and design technology has overshadowed the needs of working-class African American women who view IT training programs as a route to escape poverty. Instead of solely focusing on women studying at universities, Kvansy (2006) advocates for redesigning IT training programs, such as those available in trade schools, to address "the persistent structural barriers of poverty, spatial isolation, illiteracy, sporadic work, and racial and ethnic discrimination" faced by working-class African American women (p. 13).

In addition to studying issues of workforce development, scholars have focused on the visual representation of gender and race on the Internet. For instance, in order to contest overly optimistic notions concerning the liberatory powers of cyberspace, Lisa Nakamura (2008, 2002) has argued that the Internet functions as a networked system of visual representation where online identities, or "cybertypes," mirror established racial and gender stereotypes. Nakamura (2002) defines "cybertypes" as the "distinctive ways that the Internet propagates, disseminates, and commodifies images of race and racism" (p. 3). Instead of offering an escape from embodiment, the roleplaying act of "cyberplay" often results in "identity tourism" and the propagation of raced and gendered stereotypes.

More Than Screen Deep: Examining the Design and Histories of Technological Artifacts

While studying the reception and interface of technological artifacts has been a fruitful academic endeavor, a critical investigation of how technological artifacts are socially constructed requires that we investigate technological artifacts as "more than screen-deep" (Chun, 2005, p. 129). Analyzing how technological artifacts are racialized, gendered, and classed materially and symbolically necessitates "really looking at digital media, not only seeing its images but seeing *into* it, into the histories of its platforms, both machinic and human" (Nakamura, 2014, p. 920).

Although still concerned with the representations of girls of color online, Noble (2013) has peered behind the screen and revealed how the seemingly objective algorithms used by commercial search engines such as Google perpetuate hyper-sexualized representations of Black girls. Noble (2013) uses the results from keyword searches on terms like "Black girls" to expose how commercial search engines mediate "access to information on racialized and gendered identities in biased ways" that perpetuate "symbolic, harmful, and familiar misrepresentations derived from traditional mass media and popular

culture" (p. ii). Ultimately, Noble (2013) challenges "Black women to explore what kind of new learning or creativity can stem from both theorizing and designing socio-technical systems like commercial search engines from an intersectional perspective" (p. 10).

Nakamura (2014) goes offline to study the history of semiconductor manufacture at the Fairchild Semiconductor. Built on Navajo reservation in Shiprock, New Mexico, the Fairchild plant employed hundreds of Navajo women to assemble circuits. Assembling integrated circuits was a job that was simultaneously tedious and painstakingly detailed. Nakamura (2014) draws on internal company and marketing documents to describe the racialization of early electronic manufacture. Throughout their marketing literature, Fairchild used cultural accounts of Navajo women as "makers" who "were good at their assembly jobs because they were good blanket weavers and jewelry makers" (Nakamura, 2014, p. 931). Navajo women were portrayed as "docile, flexible, and natural electronics workers" who expressed their "creativity by creating electronic artifacts that resemble indigenous artifacts" (p. 932-933). Nakamura (2014) reveals how if we look beyond the screen into the "roots of the computing industry and the specific material production practices," we find women of color and an industry that "positioned race and gender as commodities in electronics factories" (p. 937).

Beyond Victimization: Fostering Agentic Relationships with Technology

While there has been important work that examines the co-constitution of race, gender, class and technology, much of the scholarly literature has positioned girls and women of color in a victimized relationship with technology. These studies reveal troubling patterns describing how girls and women of color are represented, and how these representations negatively affect self-perception and the way these groups are perceived by society. We are lacking positive and empowering portrayals of the relationship between girls and women of color and technology.

For instance, there has been little research on girls of colors as *agentic producers* of technology and culture. Jenkins (1998) has described a participatory media culture where youth participate in the production of culture as "remixers" using the Scratch programming language; however, the work fails to address how intersecting identity categories may shape how youth produce technology and use technology to produce. Ito (2009), who also writes on youth participation and new media, has deliberately chosen to develop youth "profiles" that are not based on "given categories such as gender, class, or ethnic identity" in order to avoid the claim that certain characteristics of participation and production with new media "attach categorically to individuals"; instead, Ito bases the profiles on online social and recreational practices, such as "geeking out" (Ito, 2009, p. 17).

Although these works present promising portrayals of youth as users of new media technologies and producers of culture, they exclude discussions of the mutually constitutive relationship between intersecting categories and technology. Thus, the dominant narratives that remain surrounding girls of color are those that position them as passive and victimized users of technology, further perpetuating "cultural images of technology" that "are strongly associated with hegemonic masculinity" and whiteness (Faulkner, p. 90, 2001).

When the discussion of girls and women of color and technology primarily mirrors back commodified, hypersexualized, and racialized visions of representation in cyberspace, we run the risk of perpetuating a sense of misrecognition and the further "imprisoning of [girls and women of color] in a false, distorted, and reduced mode of being" (Taylor, 1994, p. 25). By using the term "misrecognition," we do not mean to refute the claims that technologies, especially networked technologies, have enabled the pornification and commodification of girls and women of color on the Internet. These harmful representations certainly exist and scholars such as Nakamura (2008, 2002) and Noble (2013) have convincingly articulated the dangers of these representations. However, the failure to recognize an alternative relationship with technological artifacts that isn't predicated on a lack of agency can lead to a form of *non*recognition. When girls of color are confined to the roles of the consumer and the consumed, we "mirror back to them a confining or demeaning or contemptible picture of themselves" (Taylor, 1994, p. 25). While many alternative relationships with technology can be imagined, this paper is concerned with positioning and representing girls of color as agentic producers of technology.

An intersectional perspective allows us to see technology and identity in a "moving relational process" and places our relationships with technology in a broader social, cultural, and political ecology (Wajcman, 2000, p. 456). By interpreting identity and technology as multidimensional and fluid, we leave room for acts of intervention and the reinterpretation of race, class, and gender as sources of power. We can move beyond a focus on victimized representations of girls and women of color to what Noble (2013) describes as the "theorizing and designing" of "socio-technical systems" from an "intersectional perspective" (p. 10). It is time to provide a counter-narrative that empowers girls and women of color to become agentic users *and* producers of technology.

In arguing for a counter-narrative that positions girls of color in agentic relationships with technology, we are not turning a blind eye to the current problematic paradigm in which technology is designed, produced, and used. However, by accepting an interpretation of technology and identity as intersectional and socially constructed, we open up the possibility for change. We can be attuned to the current problematic technological paradigm *and* offer a

narrative of girls of color and technology that challenges the dominant deficit views.

CompuGirls: Challenging Deficit Narratives of Girls of Color in STEM

CompuGirls is a culturally relevant technology program serving adolescent (grades 8-12) girls of color from under-resourced schools. The program is administered by the Center for Gender Equity in Science and Technology (CGEST) at Arizona State University and supported by grants from the National Science Foundation. The CompuGirls program aims to transform girls' perceptions of themselves as users of technology to innovators and producers of technology. The curriculum aspires to foster girls' identities and self-perceptions to become "techno-social change agents" in their community. Techno-social change agents are envisioned as "individuals who can challenge dominant narratives and construct more liberating identities and social relations as they create new technologies" (Ashcraft, Eger, & Scott, in press). Three objectives drive the program: 1) to use multimedia activities as a means of encouraging computational thinking[5]; 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.

The CompuGirls curriculum is guided by a reconceptualized theory of culturally relevant computing[6] that intentionally incorporates the concept of intersectionality into the pedagogy and curriculum. Incorporating intersectionality into a technology program for girls of color accounts for students' multiple subjectivities in STEM education (Scott & White, 2013). According to Scott et al. (2014), technology education programs for girls of color have focused on academically preparing girls to enter STEM fields by increasing their technical acuity; however, these programs have failed to attend to "the multiple identities and layered selves of learners and how these impact their experiences with technology" (p. 9). Thus, the CompuGirls program views technology as a "vehicle by which students reflect and demonstrate understanding of their intersectional identities" (Scot et al., 2014, p. 10). Understanding that oppression can occur at

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[5] Computational thinking is defined as "the thought processes involved in formulating problems so their solutions can be represented as computational steps and algorithms" (Aho, 2012, p. 832)

[6] Culturally relevant computing is a form of technology education that draws from culturally relevant teaching, a pedagogical strategy constructed to culturally engage diverse youth that values reflection, asset building, and connection. For more on culturally relevant teaching see Howard 2013, Ladson-Billings 2000, and Lee 2007. For more on culturally relevant computing see Scott et al 2014, and Eglash et al. 2013.

the institutional, symbolic, and individual level, CompuGirls encourages girls to interrogate their own personal intersecting identity categories through technology, as well as analyze how their individual experience fits within the broader historical and structural contexts of STEM disciplines and professions.

The goal of using intersectionality as an analytical framework and guide for CompuGirls programming is not to perpetuate exclusionary politics. The program does not aim to dwell on difference for the purpose of exclusion; instead, the acknowledgement that women, especially women of color, are subject to power relations that stem from their intersecting identities allows for contextualized interventions to extremely situated problems, such as the disparity of participation by women of color in scientific and technological initiatives. Intersectionality is used as a framework to develop technology programs for girls of color that encourage the growth of "agentic and emerging social actors and selves in context" by recognizing girls in "all [their] global diversity" and acknowledging the "multiplicity and simultaneity of social identities" (Wyer, et al, 2013, p. xxvi). In order to illustrate how CompuGirls implements an intersectional, social constructionist approach to technology education, we will provide illustrative examples from the curriculum.

'How Do *You* See Yourself?': Contesting Oppressive Representations of Girls and Women of Color in New Media

According to Collins (2009b), the "[h]egemonic domain of power deals with ideologies, culture, and consciousness" (p. 302). Although traditional mass media, such as television, continues to propagate the dominant ideologies of society, new media[7] has the ability to spread images and representations of girls and women of color to millions of Internet users with the click of a "share" button. In order to promote a positive self-concept among participants, the CompuGirls curriculum encourages girls to think critically about how technologies are used to create and disseminate classed, raced, and gendered representations of women on the Internet. In an "About Me" exercise, the girls are asked to learn Scratch, a visual programming language, to create representations about how they believe society views them *and* how they view themselves. The first goal of the Scratch project is to train them to identify oppressive representations of girls and women of color in traditional and new media. The girls identify stereotypical images of girls and women of color that are being spread through new media, such as blogs and YouTube videos, and participate in a group discussion. They are then prompted to answer questions, such as "Who are the stakeholders? What interest do they have in spreading this image?"

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[7] New media is defined as content available through networked digital devices, such as blogs, social networking sites, and podcasts.

The second goal is to support the girls in contesting these oppressive representations by using similar technologies to produce different outcomes – a positive representation of how they see themselves. Thus, instead of only training girls to identify oppressive and victimized representations of women of color, the Scratch project encourages them to contest these representations through the use of technology and the expression of their own identities. For example, after discussing how Latinas are portrayed as "ghetto bullies," one Latina participant used Scratch to create an animated presentation depicting herself as an anti-bullying advocate (see figure 2).

Figure 2: Representing Latinas as anti-bullying advocates.

Another participant chose an image of a model that was being used as an advertisement for a perfume. The group discussed how the standard of beauty represented online was "blonde and straight-haired." In response, the Black girl who chose the image used Scratch to display pride in her natural hair (see figure 3).

Figure 3: Scratch project displaying pride in "natural" hair.

Ultimately, the project stresses the interpretative flexibility of technology and teaches girls to explore and represent their intersectional identities. A social constructionist view of technology and an intersectional analysis of one's own identity prepares the girls to "interrogate those ideologies and representations, to locate and uncover their origins and multiple meanings, and to examine the reasons for their existence and persistence" (Dill & Zambrana, 2009, p. 10).

Navigating Virtual Worlds: Exploring the Limitations of Representation in Online Spaces

In addition to examining the representation of girls and women of color online, the CompuGirls curriculum teaches the girls to examine the relationship between identity and technology as more than "screen deep." In the virtual worlds module, the girls create virtual representations of themselves and are encouraged

to critique the limitations of the technology. The girls answer questions such as, "Does the technology allow you to authentically represent yourself? What would an 'authentic' representation of yourself look like in a virtual world?" After many of the girls struggle to create an avatar that has the right skin tone or hair texture, they have group discussions around questions such as "What were the limiting factors in creating an avatar? What does the inability to create avatars with hair types or skin colors that reflect your own physical characteristics say about the creators and designers of the virtual world?" The lesson does not end with the identification of their inability to represent themselves "authentically" in a virtual world; instead, the lesson pushes the girls to think deeper about the values embedded in the design of the technology.

Figure 4: Example of avatar created by participants. The girl who created this avatar was unable to get the "right" skin tone. She described the avatar's skin tone as too "red and weird."

By the end of the module, the girls are able to view the technology as a socially shaped artifact developed by designers who make decisions about how women can be represented. When using a technology that is aimed to create virtual

representations of the self, the program encourages the girls to not passively accept the available representations. They are taught to ask critical questions about how the design of the technology fails to represent a diverse user group.

As the examples reveal, the CompuGirls curriculum does not focus solely on understanding how technology victimizes girls and women of color. While the program does prepare girls to identify how technology can have the (un)intended effect of reproducing social hierarchies, it also equips girls with the tools to *change* how technology is designed and used. In the context of design, the CompuGirls curriculum enables girls of color to become technologists not only by increasing their technical competence but also by training them to consider the values embedded in design practices and technical knowledge. In the context of use, the CompuGirls curriculum trains girls of color to become *informed* and *critical* consumers of technology. Through the participation in CompuGirls, girls of color leave the program with an understanding that their identities and technologies are "socially shaped and so potentially reshapeable" (Faulkner, p. 80, 2001).

Conclusion

This paper uses the concept of intersectionality as a heuristic for examining the power dynamics inherent in the complex relationships that girls of color form with technology - as users and producers, as have and have-nots, and as should and should-nots. This paper not only aims to address the marginalization of girls and women of color in technology fields but also examines how the failure to critically examine technologies as value-laden socially constructed artifacts perpetuates simplified accounts of a complex problem.

Discussions of disparity in STEM fields should no longer focus on "gender or race as the exclusive variable to describe difference between students' STEM pathways" (Scott, et al 2014, p. 13). Disparity in technological initiatives is a complex problem that requires a robust and nuanced theory of technology that examines how race, gender, and class socially shape technology as an artifact and as a social system. We advocate for a view of SCOT that uses intersectionality as a lens to problematize the "purported colour-blindness, neutrality, and objectivity" of institutions (Nash, 2008, p. 2). A "sociotechnical" notion of technology captures the sense that technology and society are mutually constitutive, and an intersectional lens expands this notion to include race, class, and other intersecting identity categories in the coproduction process.

In order to illustrate how an intersectional, social constructionist approach to technology education can be implemented, we provided illustrative examples from the CompuGirls curriculum that positions girls as agentic users and producers of technology. The CompuGirls program challenge stereotypes of girls

of color as passive victims of technology by encouraging them to explore the mutually constitutive relationship between their intersectional identities and technology. Positioning girls of color as agentic users and producers of technology is an important step toward disrupting dominant narratives of girls of color as victims trapped behind computer screens. In building a counter-narrative, we hope to empower girls of color to become critical producers and users of technology who are able to identify the values embedded in the design of technologies and recognize how these values create technologies that are raced, classed, and gendered.

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