The Journal of Negro Education, 83 (3), 400-419

Using Culturally Responsive Practices to Broaden Participation in the Educational Pipeline: Addressing the Unfinished Business of Brown *in the Field of Computing Sciences*

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The effective integration of African American students into previously segregated careers was one of the main goals of the Brown *decision and, in turn, the outcomes of such efforts have been the subject of much scholarly interest). This qualitative study, drawing on critical race theorist Derrick Bell's critique of* Brown, *makes the case for applying culturally relevant pedagogy theory (CRPT) to positively impact student achievement and career choice, particularly as it relates to the STEM field of computing sciences. Cultural barriers such as early exposure to technology, students' perceptions of their own potential in the field, and the lack of culturally relevant social support, often deter African American students from pursuing careers in STEM fields, particularly computing sciences. Although there is a dearth in the literature regarding how to expand the pipeline to computing sciences using culturally specific practices, this study produced results that suggest culturally responsive practices as an effective method for broadening participation in computing. Using CRPT, this qualitative study identifies culturally relevant practices that positively affect the persistence of African Americans in the STEM field of computing science.*

Keywords: Brown v. Board of Education*, STEM, school integration, career choice, culturally relevant pedagogy*

> Sometimes I wonder if we really did the children and the nation a favor by taking this case to the Supreme Court. I know that it was the right thing for my father and mother to do then but after nearly forty years we find the Court's ruling unfulfilled.
> —Linda Brown Thompson, plaintiff in *Brown v. Board of Education* on the fortieth anniversary of *Brown* (Patterson, 2002, p. 207)

Over the last 60 years, *Brown v. Board of Education* (1954) has achieved iconic status within the cannons of historical, educational, and legal scholarship, inspiring scholars, historians, and contemporaries of the decision to evaluate the decision's effectiveness well beyond its legal purpose (McPartland, 1978; Patterson, 2001, 2002; Reed, 2002). *Brown* has become so paradigmatic, that it has separated the canon of civil rights law into two distinct eras—before and after of *Brown*. This is ironic, to say the least, given the fact that although it has been celebrated, and rightfully so, for its social, symbolic, and historical importance, *Brown* was, first and foremost, a legal decision, and one with a fairly limited reach. In the Court's opinion, state-sponsored racial segregation of America's public schools was struck down, as it was viewed as a violation of the Fourteenth Amendment to the Constitution. Nevertheless, despite its strong language about the importance of education, *Brown* lacked a clear declaration that equal education was a right enforceable in federal court (Bell, 1978). Segregation in education—especially in southern areas—would endure more than a decade (Patterson, 2002). The Court would eventually act to extend the reach of *Brown* into other areas, first very quietly in a series of *per curium* decisions in the late 1950s and then in other more detailed opinions (Patterson, 2002).

Nevertheless, by focusing narrowly on separation of White and non-White children, *Brown* left other aspects of racial inequality in the education system untouched (Bell, 1978).

Brown's legacy has been rendered even more curious by the ongoing debates it has engendered regarding exactly what it has accomplished (Balkin, 2001; Patterson, 2002). One of *Brown's* most incisive critics, Derrick Bell, post-litigiously challenged the *Brown* formula by questioning whether the Court's decision to end segregation in public education was in actuality the best means to ensure equality of educational opportunity for Black children (Bell, 1978; 1987; 2001). Approximately 60 years post-*Brown* and in the wake of Bell's 2011 passing, it seems appropriate to assess the effectiveness of culturally relevant instruction as one possible means to address the unfinished business of *Brown*. This article grapples with this problem by focusing on the occupational considerations among African Americans in arguably one of the most in-demand fields in the U.S. economy: computing sciences. The lack of participation in these advanced technology domains is partly the product of inadequate preparation and advising in K-12 education (Charleston, 2012; Maton, Hrabowski, & Schmitt, 2000; Moore, 2006). Simultaneously, the majority of children born in the United States during the 21st century will belong to groups that are currently underrepresented in STEM-related disciplines, as a result of increasing shifts within the country's demographic landscape (Charleston & Jackson, 2011). While *Brown* legally prohibited segregation in the nation's schools, African Americans are among the subgroups who have historically and consistently suffered from the greatest educational disparities in general as compared to their White counterparts, thereby limiting their career choices in STEM fields (Charleston, 2012; Jackson et al., 2012).

The field of computing sciences is a critically important object of study given the discipline's vital role in the future of technology and innovation (Margolis, Goode, & Bernier, 2011). However, a lack of ethnic minorities pursuing careers in computing sciences could have detrimental effects on the United States' standing within the competitive global market (Buzzetto-More, Ukoha, & Rustagi, 2010; Charleston, 2012; George et al., 2001; Goode, Chapman, & Margolis, 2012; Jackson et al., 2012; Malcolm et al., 2005; Morell, 1996; Syed & Chemers, 2011). Although there has been a slight increase in the percentage of African Americans attaining degrees in computer sciences, the proportion still remains inadequate in comparison to growing proportions of other underrepresented groups in the field (Charleston et al., 2014). More often than not, cultural barriers deter African American students from pursuing careers in computer science. These barriers include the lack of early exposure to technology, the students' poor perceptions of their own potential in computer science, and the lack of culturally relevant social support throughout the educational pipeline. Despite the significance of this disparity, there is little published research regarding how to expand the computing sciences pipeline using culturally specific practices. This study seeks to investigate effective culturally responsive practices related to African American success stories in education and careers in computing sciences.

REVIEW OF RELEVANT LITERATURE

As the courts have expanded the reach of the *Brown* decision into the higher education context, scholars have moved to examine the long-term effectiveness of *Brown's* integration strategy on the educational achievement and career choices of African American students in institutions of higher learning (Guinier, 2004). One area that has not demonstrated the long-term benefits and effectiveness of Brown is the educational and occupational fields related to STEM, and particularly the computing sciences. For example, African American students are less likely to have access to or be actively engaged with computers and technology at an early age in comparison to their White counterparts, which can have long-term effects on their career trajectories (Buzzetto-More, Ukoha, & Rustasi, 2010; Charleston, 2012; Malcolm et al., 2005; Margolis, Goode, & Bernie, 2011; Morell, 1996). Additionally, high-need, urban schools with high concentrations of African American students are less likely to have qualified teachers in STEM areas, which linked to low student achievement in the subjects critical to success in computer science (Kirchhoff & Lawrenz, 2011). Furthermore, in a study by Jane Margolis (2008), African American students were found to be unlikely to enroll in computer-related classes even when presented with high access to them, often due to perceptions of low self-efficacy in a culture of computers and technology. Such a lack of exposure leads to low levels of computer socialization and a lack of motivation to explore more advanced computer functions (Charleston, 2012).

A disparity in African American students' engagement in computing sciences is also apparent at the high school level. Currently, there is a lack of culturally responsive teaching practices in areas of math and science that accurately represent diverse cultures as components of Western ideology (West-Olatunji et al., 2010). Additionally, high school students in the United States are testing with less proficiently in math and science each year, making them less likely to successfully matriculate into the computing sciences pipeline (ACT, 2006). This is especially true for African American students, who on average scored the lowest in the areas of math and science in 2012 (ACT, 2012). Moreover, a report by the American Association for the Advancement of Science (2001) lists the degree of high school rigor as a major contributor of underrepresented minorities' success in STEM careers. The report also noted that high-achieving Black students with high SAT scores and high-grade point averages are still less likely to pursue STEM careers due to poor preparation, lack of encouragement from parents, and low self-perceptions of their potential success in the field (George et al., 2001). The literature also suggests that high school counselors' ability to employ culturally responsive practices when advising African Americans plays a major role in their trajectory into STEM careers (Buzzetto-More, Ukoha, & Rustagi, 2010; Charleston, 2012; Joseph, 2010; Moore, 2006; West-Olatunji et al., 2010).

According to a report by the National Science Foundation (NSF) and the National Center for Science and Engineering Statistics (2013), underrepresented minorities are less likely to enroll as full-time undergraduates; perhaps consequentially, African Americans' participation in science and engineering is lower than it is in the United States' workforce as a whole. Although there has been a steady annual increase in the percentage of underrepresented minorities pursuing computer science studies (e.g., Malcolm et al., 2005), African American men and women still only make up 5% of workers in all science and engineering occupations, which are otherwise composed of 51% White males (NSF, 2013). Moreover, a report by the *Journal of Blacks in Higher Education* ("No Need for a Calculator to Tabulate,"1999) found that while African American students are increasingly pursuing undergraduate degrees in computer science, such improvement is yet to be demonstrated at the graduate level. Although African Americans represent 6% of university faculty in the United States, they make up only 1.3% of faculty in the area of computer science (Malcolm et al., 2005), a problem that will only be mediated by an increase of Black computer scientists pursuing PhDs.

A number of studies (Barton & Tan, 2010; Buzzetto-More, Ukoha, & Rustagi, 2010; Charleston, 2012; Goode, Chapman, & Margolis, 2012; Joseph, 2010; Moore, 2006; West-Olatunji et al., 2010) have cited the importance of cultural-specific practices in relieving the disparity of African American students in STEM fields in general and computer science in particular. This existing literature, however, still remains insufficient. Culturally sustaining pedagogies are a necessity for producing competent and successful students (Paris, 2012). Moreover, supplying a cultural context facilitates identity-building among students in the computer science pipeline, which consequentially increases the likelihood that they will pursue the discipline further (Barton & Tan, 2010). In 2012, the Exploring Computer Science Program reported the benefits of using culturally relevant practices in encouraging young minorities to explore the field of computer sciences. The report stated,

> Access to courses is not enough. Rather, our model of broadening participation in computing focuses on increasing access to high quality and culturally relevant curriculum and teaching in classroom settings populated by culturally diverse students (Goode, Chapman, & Margolis, 2012, p. 52).

The existing literature also suggests that one explanation for the disparity is that the culture of computer sciences is strikingly individualistic (Charleston & Jackson, 2011; Morell, 1996). Such a culture is often alienating to African Americans, who are likely to cite social support as a major influencer in their decision to pursue careers in computer sciences (Blake & Gilbert, 2010; Charleston, 2012). One remedy to this problem is improving the prominence of cultural mentorship in the field, as demonstrated by The Institute for African American Mentoring in Computing Sciences (iAAMCS; Charleston et al., 2014). This effort, funded by the National Science Foundation, provides African American undergraduates pursuing computer sciences with mentoring opportunities aimed at increasing diversity in computer sciences at the highest academic levels (Charleston et al., 2014; NSF, 2013).

Despite these findings, there is still a scarcity of research regarding specific, culturally relevant-practices that successfully engage African American students and steer them toward entering computer sciences pipeline. This study sought to bridge this gap. In doing so, this study was guided by the following research question: What factors contributed to the successful pursuit and persistence of African Americans in the computing science educational and occupational pipeline?

METHOD

The methods employed in this study are outlined and discussed in the next section.

Theoretical Framework

The authors employ culturally relevant pedagogy theory (CPRT) as a theoretical framework underpinning the study. Ladson-Billings (1995a) contended that culturally relevant pedagogy rests on three criteria or propositions: "(a) Students must experience academic success; (b) students must develop and/or maintain cultural competence; and (c) students must develop a critical consciousness through which they challenge the status quo of the current social order" (p. 160). Within this framework, students must evolve academically, instructors must strive to develop academic competence, and students must maintain a sense of pride in their own culture (Ladson-Billings, 1995a). Referencing a widely cited article from Fordham and Ogbu (1986), Ladson-Billings (1995a) stated African American students in particular are ridiculed for "acting White" when they take pride in their academic pursuits. To this end, she argued that instructors must use culture as a "vehicle for learning." Within CPRT, students are enabled to develop the skills necessary to view with a critical eye. Ladson-Billings (1995a) continued "students must develop a broader sociopolitical consciousness that allows them to critique the cultural norms, values, and institutions that produce and maintain social inequities" (p. 162).

CRPT is particularly appropriate for this study, given that at its core, it is an effort to address the educational disparities left unresolved after decades of desegregation. Many of the themes identified by CRPT researchers—academic success, cultural competence, and critical consciousness—were mainstays of high performing majority African American schools in the decades both before and after *Brown*. Although this facet of educational history has largely been overshadowed by the specter of *Brown*, scholars, like Bell (1987), have argued that the education African American students received from teachers in segregated schools during the pre-*Brown* era created a critical consciousness and cultural pride that made the desegregation cases possible. Bell noted, for example, that "teachers and principals who, despite the restraints of 'separate but equal' policies, somehow enabled generations of black children to learn enough to both survive and fight successfully for school desegregation" (Bell, 1983, p. 292). Central to this accomplishment, was a focus on student aptitude, cultural instruction, and the cultural intelligence of teachers (Bell, 1983; 1987).

In *The Journal of Negro Education,* Bell (1983) outlined characteristics of successful strategies for educating African American children. He looked to African American educators and parents, who despite being excluded from school desegregation strategies, had made impressive strides in developing techniques to increase the level of learning in African American schools. Bell used examples of successful predominantly African American schools to highlight useful strategies, most of them ongoing from the pre-*Brown* era. As Bell argued, with millions of minority children attending all-minority schools in urban areas so dense that desegregation by the racial balance model was both a political and demographic impossibility, the time was ripe for considering alternatives to the racial balance model of *Brown* (Bell, 1983).

The converse of the CRPT model, which Bell deemed "even-handed integration," had disastrous educational outcomes for African American students (Bell, 1987). *The Invisible Children* (1978), a study by social scientist Ray Rist, highlighted the potential implications of ignoring cultural differences within the context of the classroom (Bell, 1987). Rist studied a group of young African American children bused to an upper-class, predominantly White school. As Bell (1987) noted of the study, there is an impossibility involved in integrating African American children into a predominantly White context when the "curriculum, texts, and teaching approaches were designed for the White middle-class kids" (p. 110). Although Bell's analysis predated the coining of the phrase "culturally relevant pedagogy theory" (CRPT) to describe this model of education, the ideological underpinnings of Bell's writing, and the CRPT framework similarly highlight the importance of culturally relevant instruction within the classroom.

A review of strategies Bell espoused reveals skeletal implications that foreshadow the work of the CRPT theorists. At its core, the educationally oriented strategies he proposed revolve around two central ideals: (a) empowering principals and teachers to challenge inequities in the educational of African American students, and (b) ensuring that teachers—regardless of race—approach education from the perspective that African American students can learn (Bell, 1983). Among other suggestions, Bell (1983) advocated for what he termed "self-contained classrooms modified by some teaching and tempered with affection and consideration; using effective teaching materials not approved by the board, especially phonics, mathematics word problems, and black history, culture, and literature" (p. 298). Furthermore, culturally tailored learning environments were particularly targeted to encourage excellence, and teaching the "skills and self-assurance that have produced scores of successful blacks in business and the professions" (Bell, 1987, p. 113).

The ideas regarding culturally relevant instruction, to which Bell alluded, have been brought into fuller view by theorists of culturally relevant pedagogy. These theorists have expanded the strategies used by educators post-*Brown* to make school choice a meaningful pathway for advancement. Through considering the challenges of educating African American students in the early 1980s, Bell's goal is quite similar to that of the theorists of culturally relevant pedagogy: how to address student achievement while also helping students to affirm their cultural identity and develop critical perspectives that challenge inequities that schools (and other institutions) perpetuate (Ladson-Billings, 1995b). The approach of the CRP theorists, while building on these early perspectives, can in some ways be considered a second generation post-*Brown* approach, expanding the perspectives of the first generation to more concretely assess how to empower students to challenge inequitable educational outcomes in the post-*Brown* era.

Application of CRPT to Faculty/Student Mentoring, Living and Learning Communities, and Research Experiences for Undergraduates

For the purpose of this study, the authors discussed the relevance of faculty/student mentoring and living and learning communities and tie them in to culturally relevant teaching practices. According to Inkelas and Weisman (2003) those who participate in pre-college programs can be expected to make a smoother transition to college, as pre-college programs allow for mentoring relationships that have a major impact on the persistence of underrepresented students, particularly in STEM fields (Charleston et al., 2014). Charleston and associates (2014) suggest that decisions to pursue and persist in STEM fields like the computing sciences is based on factors that are mainly socially constructed—processes that not only involve CRP, but also effectively socialized potential STEM workforce contributors through multifaceted mentorship practices. Charleston (2012) posited that multifaceted mentorship in computing serves to:

- assist in the academic preparation of African American students;
- provide social contacts to enhance experiences through the educational trajectory (e.g. computing organizations);
- provide educational and occupational career advice;
- provide apprenticeship opportunities;
- acquire or refer sources of funding; and
- assist in job search and acquisition, directly correlating with previous successful strategies. (Charleston, 2012, p. 236)

This multifaceted mentorship model, which includes formal and informal mentoring, addresses the type of support that may be essential for CRP to be effective particular as it relates to STEM fields.

Another practice that figures heavily into CRPT concerns living-learning programs. Stassen (2003) found that living-learning program participants had higher first-semester GPAs, tended to persist more readily from the first to the second year, and reported higher levels of institutional commitment and integration into the institution's academic systems than non-participants. Pike (1999) found gains in intellectual development, a point further supported by Inkelas and Weisman (2003) who noted living-learning program participants reported greater gains in critical thinking skills and greater enjoyment of challenging intellectual pursuits than resident students who were not participating in a living learning program. Another benefit is that in many living-learning programs, faculty members teach courses directly in students' residence halls. According to Johnson and others (2006), in doing so, opportunities for both formal and informal interaction are maximized. Additionally, students who participated in living-learning programs were more likely to report that their residence hall was academically and socially supportive than those who were not in living-learning programs, and they reported a greater number of discussions with their peers around academic and social issues than non-participants. Similarly, living-learning participants reported more frequent instances of faculty mentorship than those students who were not in living-learning programs (Johnson et al., 2006).

Recently scholars examined culturally relevant pedagogy and the success of underrepresented students in STEM fields (Hippel et al., 1998; Hrabowski, & Maton, 1995; Johnson, Soldner, & Inkelas, 2006; Soldner et al., 2012; Russell, Hancock, & McCullough, 2007; Szelényi, & Inkelas, 2011). For example, Hippel and colleagues (1998) examined the impact of a program promoting student-faculty research partnerships on college student retention. The program, built on the premise that successful retention efforts integrate students into the core academic mission of the university, targets first- and second-year undergraduates. Their findings showed research partnerships are most effective in promoting the retention of students at greatest risk for college attrition (i.e., African American students and students with low GPAs). Additionally Russell and associates (2007) contended that students who participate in undergraduate research opportunities have more clarity about their career options in STEM fields. Undergraduate research opportunities increase interest, confidence, and awareness among underrepresented students in STEM fields. Also, the researchers found that student participation in undergraduate research opportunities increased students' likelihood of pursuing doctoral degrees in STEM fields. These practices not only encompass the socialization of STEM fields, they also expose students to the culture of the field and what is necessary to be successful therein—a key component of CRP.

The characteristics of culturally relevant pedagogy have been an implicit presence in much of the literature we examined, suggesting that it may be an ideal framework in which to base this study. Concepts such as faculty/student mentoring, living-learning communities, and faculty/student research experiences link back into the framework of CRP and Ladson-Billing's (1995a, 1995b) three propositions on which the theory rests: academic success, development and maintenance of cultural competence, and challenging the status quo of the current social order.

STUDY DESIGN

The complex nature of this topic led to the pursuit of a research design that employs qualitative methods, gathering data primarily through one-on-one interviews with African American students pursuing computing science degrees. This method of data collection aimed to enable the researchers to review and analyze a variety of factors that influenced persistence in and matriculation through the STEM field of computing sciences. Interviews enabled the participants to respond to the research questions in their own words and in a manner that was comfortable and devoid of preconceived notions imposed by the researchers (Creswell, 2007). Applying this method of inquiry within the qualitative research design strengthened it by not only providing various contexts for inquiry and discovery, but also enabling the researchers to triangulate the data across interviews (e.g., researcher notes, transcriptions, digital audio recordings). This triangulation served to validate the research findings (Creswell, 2007).

Participant Selection

Due to the nature of this study, the researchers needed to gain the participation of African American students pursing computing sciences degrees. This is a scarce population. For example, based on data collected by the Computing Research Association's (CRA) Taulbee survey, the foremost source of data for the computing community within the U.S., there were only 22 African American PhD recipients in 2008—amounting to just 2% of all computing science doctoral degrees granted that year (Zweben, 2010). Of those 22 PhD recipients, only 12 were hired in a tenure track, researcher, post doc, or teaching faculty position. Therefore, this study used purposive sampling (Bogdan & Biklen, 2007) to strategically target this unique population. The data under review came from conference participants of the 2009 African American Researchers in Computing Sciences (AARCS) program. While the AARCS program in its entirety consisted of three components: (a) targeted presentations, (b) future faculty/researcher mentoring, and (c) an annual AARCS conference, this study dealt with and extracted information solely from AARCS conference participants. Although the AARCS conference was a research and skill-building conference for undergraduate and graduate students, it also included a networking and mentoring component comprised of computing scientists at all levels (i.e., undergraduates, master's level practitioners, tenure-track faculty PhDs, as well as research scientists and analysts). The AARCS conference averaged a yearly attendance rate of about 50 African American computing scientists and computing science aspirants, thereby making the conference an ideal location to gather qualitative data due to a larger sample size when compared to any other concentration of practicing and aspiring African American computing scientists within the United States and abroad.

Thirty-seven computing sciences aspirants and practitioners were interviewed based on their individual time constraints and willingness to be participants in this study (55 percent female, 45 percent male). Interviews ranged from 30 to 45 minutes, one for each individual in the sample. Participants varied across educational levels: 22 percent were undergraduate students, 48 percent were graduate students, and 30 percent were PhD-minted professors or researchers. In addition, 50 percent of all participants either attended or were in the process of attending predominantly White institutions (PWIs), while 42 percent attended historically Black colleges and universities (HBCUs) and 8 percent attended predominantly Black institutions. All participants resided in various regions of the United States ranging from the Southwest to the Northeast, and all were African American and had majored in or were majoring in a computing science-related field. The average participant age was 29 years. Participants had family socioeconomic status backgrounds across the spectrum of income categories. Most interviewees, however, were from middle-income, dual-parent households. In addition, the majority did not have a parent involved in computing sciences. The educational backgrounds of those participants with dual-parent households were similar insofar as they all attained similar levels of educational accomplishment, regardless of socioeconomic status. The individual interviews were conducted in a meeting room at the conference host site, a major computing industry company located in the northwestern region of the United States.

Data Collection

An interview protocol was used to guide the qualitative inquiry, employing open-ended questions that facilitated the recollection of experiences related to the educational and social experiences in college STEM spaces. As Creswell (2007) dictated, the questionnaire served to

- provide structure and organization to ensure that all areas of inquiry were covered in the same order for each participant;
- establish a guide for the range of the discourse; and
- ensure and protect the broader purpose and objectives of the interview.

The interview protocol was a predetermined set of questions established to invoke conversational discourse with the participants in the study.

In addition to the open-ended questions in the interview protocol, the researchers exercised the freedom to follow-up with sub-questions, both present and not present on the protocol, in an effort to gain clarity of responses (Miles & Huberman, 1994). The open-ended questions developed for the protocol were non-directive in nature, but the follow-up probes were designed to seek specificity. The interview protocol questions were developed by the researchers in accordance with the primary research question, the objectives of the study, as well as previously researched literature that guided the study.

Data Analysis

Using Strauss' (1995) constant comparison method, emergent themes were analyzed after all data were collected through participant interviews. Themes of particular interest to the researchers were those associated with elucidating the research question for this study. The themes were labeled and described independently by two researchers. These themes and their descriptions were cross-verified by the researchers together, re-labeled, and defined. Each researcher then re-examined the original transcripts for separate verification of the presence of the emergent themes. Original transcripts from these data were extracted as supportive evidence for the existence of each theme. The researchers combined findings from the separate analyses to produce a final description of each theme, along with their properties and dimensions.

Coding was an integral part of analysis within this study. Through first-level coding, data were extracted and placed into many themes and meaning categories, which enabled the researcher to summarize portions of data (Strauss & Corbin, 1990). Additionally, analyzing the data through codes achieved the goal of dissecting the interview data in a meaningful way, which in turn helped the researcher maintain the relationships of thematic representations (Miles & Huberman, 1994). Through the coding process, the emergence of categories and their theoretical underpinnings began to align and make sense. The theoretical implications that gradually formed from the categories that created meaning formed relative patterns. Strauss and Corbin (1990) posited that pattern coding enables the placement of first-level coding into more concise themes. Similarly, the patterns and thematic representations that emerge embody grounded theory (Glaser & Strauss, 1967). When all the incidents were readily classified and the categories were saturated as represented through the emergence of much regularity, the researcher concluded the data collection and analysis portion of the study (Lincoln & Guba, 1985).

Validity

In an effort to address reliability and validity of the qualitative inquiry within this study, the researchers employed a naturalistic approach. While traditional empirical research addresses validity in terms of reliability, internal validity, and external validity of measures and procedures, the corresponding terms in naturalistic inquiry include audibility, credibility, and fittingness (Guba

& Lincoln, 1981). Reliability in qualitative research involves the ability to replicate the study given a similar set of circumstances. Through naturalistic inquiry, the raw data ascertained by the researcher were coded in a manner whereby the contrived themes and theories are not only understood by another individual, but that individual is also able to arrive at a similar conclusion through the consistencies of the coded raw data.

Credibility within this study, in concert with naturalistic inquiry, was achieved by corroborating the structures that made up the study. More plainly, corroboration was ascertained by spending ample time with study participants to check for distortions, which facilitated prolonged engagement with study participants. Consequently, the participants' experiences were explored in sufficient detail that exemplified persistent observation. Additionally, multiple data sources were checked through comparing various forms of data such as digital audio recordings, physical transcriptions, consultation with other investigators, as well as researcher notes. The aforementioned processes of prolonged engagement, persistent observations, and checking multiple data sources embody the process of triangulation. Rudestam and Newton (1992) asserted that peer debriefing, revising working hypotheses throughout the data collection process, clarifying preliminary findings with study participants, and audio-/videotaping the interviews in an effort to compare to other means of data collected are customarily the procedures used to ensure the credibility of a study. Through the current study's primary method of individual interviews, triangulation occurred through corroborating persistent observations, checking multiple sources of data through an in-depth literature review, recording field notes, and the clarification of categories and narrative stories among study participants. These processes fostered structural corroboration of the study.

Positionality

This study was designed in an attempt to make meaning of African American participants' experiences throughout the course of their STEM education trajectory. As such, the authors repeatedly reflected on their own positionality and the impact of their complex racial, gender, and socioeconomic status, as well as educational identity of the interactions with participants and the interpretation of the resultant data. Moreover, inductive data strategies were employed, allowing the data to serve as the foundation of understanding while the findings are acutely descriptive and conveyed through direct quotes and thematic analyses.

FINDINGS

Study participants cited a number of experiences throughout their educational trajectories in which aspects of culturally relevant interactions were instrumental in their decisions to pursue the computing sciences. While other research regarding persistence in STEM has illuminated negative social influences that deter underrepresented populations from persisting (e.g., Moore, 2006), the participants within this study expressed mostly positive social interactions that aided them throughout their trajectories. The participants under study were those who had gained measurable success in computing, which may be reflective of the positive iterations regarding their social experiences relating to computing. This is not to say that there were not sociocultural barriers experienced by the participants; however, these participants overcame these negative experiences—namely, with positive ones.

Although some participants cited their own interest and curiosity as a contributor to their information-seeking and knowledge-attainment surrounding computing careers, most of the participants credited their parents, professors, advisors, teachers, and friends who either majored in computing sciences, or encouraged and supported them throughout their trajectory as their primary reason for obtaining educational and occupational success. The thematic representations of these sentiments emerged in the form of culturally situated experiences that formed three major sub-themes: (a) peer and community modeling; (b) positive familial cultivation; and (c) multi-faceted mentorship. These three themes conjoin to encompass the participants' support structures where there is recognition—whether by parent, teacher, or mentor—that given the cultural, social, or racialized barriers to degree attainment by African Americans, the participants required direction, support, or assistance in overcoming these obstacles. Participants did not explicitly describe their support structures and communities as consciously adopting CRPT practices. Nevertheless, in so much as supporters recognized cultural, social, or political barriers to educational achievement and enacted culturally specific strategies to surmount them, they were implicitly adopting strategies theorized by CRPT.

Peer and Community Modeling

While parental and familial encouragement was deemed an essential cultural factor affecting participants' success, many stated that their parents or surrogates were not knowledgeable about the field of computing, which limited their direct contributions to specific academic aspects of the field (i.e., coursework). However, positive peer interactions and community modeling were extremely salient in influencing participants' effective pursuit of and persistence in computing. Peer modeling promoted positive relationships that facilitated the socialization to computing among the participants. More plainly, it was this socialization process that often introduced participants to computing sciences, along with the concepts and constructs surrounding computing. These experiences provided a roadmap for navigating the computing educational pipeline and landscape, ultimately sparking sustained interest among the participants. Engagement with a peer cohort in computing was significantly instrumental throughout the participants' educational paths toward and through degree attainment. For instance, several participants shared narratives about having a supportive community of peers who significantly influenced their trajectory in computing science. This sentiment was best illustrated in the following participant's comments about having friends who shared similar interests in computing:

> I had friends that had computers too so I would watch them and we would do programming . . . Small group of friends and we would look at what each other had done or what programs each other had written. That's how interests got bigger. Seeing things being done and being exposed to friends' projects then going home to try to replicate it. Being exposed to different things as your friends did them . . . I have a PhD in computer science because there was an upperclassman who mentored me who was in graduate school.

Similar to the narrative shared above, another participant clarified how peer support weighed heavily in her decision to pursue graduate studies in the computing sciences. When asked about her influences and motivations for pursuing higher education, she responded:

> Actually I became really good friends, well it was like five of us (all African Americans), and we actually started finding more things to do like, there used to be like different tweaks that you could put or even like in operating systems like 95 and 98, there's a lot of different tweaks that you could do, like our own extra stuff… I actually have one of my friends who I met freshman year as well . . . We always had this competition about our computers like . . . What new specs are we gonna buy?! So it's kind of like a competitive and feeding type thing at the same time.

Whereas the quote above elucidated the importance of developing and sustaining social groups and community in the computing sciences, the next example demonstrates how positive cultural interactions and relationships can enhance ones' ambitions:

> My cohort, all of us, decided to go get a PhD. It was six of us and we went together. I wanted to go with people who have a similar aptitude. It would have been a lot harder on me mentally if I went by myself.

In addition to positive social groups, peers, and community dynamics being influential to participants' pursuit of computing, often the participants cited individual friends who encouraged them to pursue computing. In many cases, these friends were involved in more advanced computing and had social relationships with the participants. The encouragement of these friends (community modeling) frequently persuaded participants to change their major to computing from a related area, such as mathematics. In most cases, friends were academically or occupationally more senior than the participants they influenced. Consider the next example:

> One of my friends started teaching me about programming C++. The next semester I took an intro to programming . . . As an undergrad, I was an applied mathematics person. My friend told me to join the Olympiad (Computing and Robotics) team. I went to the CS [Computer Science] professor and expressed my interests . . . she was computer science and I was math and I would just sit there and watch her do programming. She was creating stuff that I didn't know was there. And when I got to the computer science class, I said ok, I might actually want to do this.

The participant in this example explains how she was initially exposed to computer programming through a friend, which subsequently fostered her intellectual and professional desires to pursue computing science as a career. The next participant sheds light on the intentionality behind his approach for gaining knowledge about the field and building meaningful connections with professionals:

> I tried to surround myself around people who knew what they were doing. Doing online research on my own and hanging with older folks who knew what they were doing . . . One of the guys I grew up early childhood with, sophomore year, said he went to Georgia Tech, after Georgia Southern and said he was a computer scientist and told me about the stuff he was doing and that sparked me.

While some participants received inspiration from older role models, others shared insights on the encouragement and guidance they received from peers, which allowed them to overcome academic challenges:

> My friend in undergrad told me I was good and I should take more classes. At first I was like: this is hard, I want to quit. I had one friend quit and I said I cannot quit and my (other) friend took his time to help me through the class and after that I was good. He already had a master's . . . He said it's not that hard and he said let me help you out and then I got it.

As evidenced from the example, several participants shared how they developed interests and persisted in computing science through establishing a community of peers providing support and encouragement around the discipline of computing.

Positive Familial Cultivation

Parental and familial support and encouragement also played a significant role in culturally situated practices that influenced decision-making toward the computing sciences among participants—mainly up and through undergraduate entry and matriculation. This positive familial cultivation was often developed through moral, educational, and financial support for study participants. It generally began through early computer purchases, as well as the cultivation of computer adeptness through subsequent support by means of hardware and software purchases, encouraging or sponsoring supplementary education toward computing, or individualized efforts toward computer-related knowledge-gaining (e.g., having a friend teach their children programming). In several cases, the participants' parents were engaged in some aspect of computing, teaching, or mathematics, which was likely a consequence of the participants' majority middle-class backgrounds. As such, the educational attainment level of the participants' parents may have played a role in the depth of positive familial cultivation. For instance, one participant shared:

> My mom's a math teacher, and she's really into computers so we had a Macintosh . . . My mom was the biggest influence so far as computers. In junior high, she got me in the science club, so I was kinda nerdy. It got me in the door then I went into NSBE (National Society of Black Engineers) as a junior in

> high school. I actually went to undergrad for computer engineering . . . She (mother) opened my eyes up to meeting people in the field and they all nurtured me. My mom was very techy.

As the aforementioned study participant described, familial cultivation enhanced her interest in the field. The next participant shared similar insights regarding her early exposure to computing sciences as an adolescent:

> My dad was into science . . . but I probably saw a computer at 11-12. We had the Atari Trask 80. . . We had the very first home computer . . . Whenever stuff came out, we got it! My parents always bought computing type games, summer enrichment programs, summer exposures, (2 as an undergrad) internships at companies. It nurtured me to wanting to stay in the field . . . I would say who introduce me to science was my family having an interest in science. We had to go to science camps in the summer and through these experiences I found out about computing science . . . My parents are educators so I was pretty much on the right track.

Familial cultivation not only proved to be an influential factor in the development of a positive self-concept among participants but also in terms of their trajectory into the field of computing science. In the next example, one participant recounts his experience in a summer computer camp:

> In 6th grade my parents enrolled me in a summer computer camp so I learned how to program. I took programming in 7th and 8th grade at another school and Savannah State college—All away from my school. It was really a computer simulation type thing. My parents really fed into it. When they saw that I liked computers, they supported that interest . . . My dad set the bar high for me.

As the data demonstrate, some participants benefited greatly from the social influences of their parents and families. These forms of cultivation often exposed the participants to aspects of computers that sparked their interests and persuaded them to further their interests in computing. The parental nurturing they received enabled them to enhance their engagement in and around aspects of computing. Furthermore, these cultural influences facilitated more social interactions and engagements with technology that reflected the diverse aspects of computing sciences that made the field culturally attractive to participants.

Multi-Faceted Mentorship

In addition to peer and community modeling and familial cultivation, multifaceted mentors served as subjects of cultural practices that played a significant role in socializing the participants to the world of computing, leading to degree attainment among the participants. Mentoring was particularly significant as it related to the participants and their aspirations and trajectories toward the highest levels of degree attainment (i.e., PhD) in computing. The study participants often expressed hesitance about not persisting had it not been for the intervention of a mentor. In many cases, it was the role of mentors who provided the actual introduction to the field of computing sciences to study participants. These mentors most often came in the form of professors and more senior students (i.e., advanced graduate students). Additionally, some participants' parents served as mentors. In many cases, the participants' interests in mathematics served as a catalyst for professors and advanced students to provide mentorship toward the field of computing. For example, because there is a direct relationship between computing sciences and mathematics, an interest in mathematics among the participants often sparked the input and intervention of individuals with more breadth of knowledge about the relationship between the two fields.

Most study participants attributed their persistence at least partly to good mentorship. The following example, from a female participant, best illustrates the influences of good mentorship to computing persistence toward degree attainment:

> My boss realized someone was getting into these (computer) systems. He asked me if I had been to school. He said keep trying to get in (the computer systems) and tell me when I can't. He gave me books

> and encouraged me to go to school (for computing sciences) and told me he could not tell them that some kid had hacked the system. He was my first mentor . . . He (graduate advisor and mentor) made sure I had funding and had tokens for transportation. He made sure I was able to be present and do what I had to do. Occasionally he had to push back on people outside of the department but he was awesome.

As illustrated in the narrative, some participants noted how they found mentors who went above and beyond to not only provide encouragement and support, but also to defend and shield them from departmental politics. In the next example, one study participant recounted how his mentor restored his confidence and conviction about pursuing a career in the computing sciences:

> At first I was not very optimistic about it. I really struggled at the beginning. Then one of my professors was looking for a student to hire for the summer. She took me on board and was a very good mentor. She pretty much tutored me. She answered the most stupid questions and that's what gave me confidence that I could do it.

Despite experiencing some degree of self-doubt, this participant recounts how he developed conviction due to his mentor's unwavering support. In the next example, one participant shared how her mentor inspired her to pursue advanced studies in computing sciences:

> In the course of doing research for education [previous degree], my advisor was a computer scientist who moved over to education and told me [that] for what I wanted to do, I needed a PhD. I found a paper by Dr. X (prominent African American computer scientist) and he sucked me into computer science.

These data reveal that the positive community dynamics and culturally responsive practices experienced by the participants were significantly instrumental in their decision to pursue and persist in computing sciences through degree attainment. This is not to overstate the connection between CRPT and the evidence of culturally responsive practices as expressed by the participants. Positive cultural practices experienced by participants were not explicitly due to the influence of CRPT. However, the actions of mentors, parents, and teachers in recognizing the particular social, political, and cultural factors that serve to limit African American participation in STEM fields, and their actions in overcoming these barriers are reflective of the CRPT framework. In many cases, these positive social influences and interactions provided the tools to promote self-efficacy, self-concept, and a STEM identity among the participants—that is, the belief that they belonged in the field and could achieve degree attainment in computing and be successful. As such, peer and community modeling, familial cultivation, and multifaceted mentorship were salient indicators for success through culturally relevant practices by promoting community and fostering the socialization of the participants to the field of computing sciences, as well as facilitating a STEM identity and success in computing among study participants.

CONCLUSION AND IMPLICATIONS

The results of this study suggest that the factors leading to the pursuit and persistence of the STEM field of computing sciences are largely attributed to culturally responsive practices whereby social construction trumps academic outlook among African Americans. Many participants demonstrated levels of aptitude, ambition, and self-initiative; however, these findings were not salient factors contributing to their pursuit and persistence in STEM. What proved more salient were the positive social influences, community building, and sense of belonging, which developed self-efficacy and relevant self-concepts. These factors were often the catalyst for not only the introduction to computing sciences among the participants, but also the underlying rationale for successful matriculation and persistence in their STEM area through degree completion. These culturally centered experiences at the college level proved to overcome the all-too-often inadequate K-12 preparation experienced by the participants. However, in reviewing the curricular and non-curricular elements that enabled the success of participants, the researchers were presented a vivid depiction of the work that lies ahead even 60 years after *Brown*.

In *And We Are Not Saved* (1987), Derrick Bell and his alter-ego and fictional protagonist Geneva Crenshaw, presented a harrowing depiction of precisely what *Brown* had not accomplished. Bell famously used the mediums of allegorical fable and science fiction to analyze the school desegregation cases of the 1960s and 1970s in his "Chronicle of the Sacrificed School Children." Bell (through Crenshaw's narration) recounts her memories of integration day: the moment, when after years of delay and negotiation over integration plans to achieve a full measure of racial parity in schools, implementation day dawned. But the plan itself pleased no one. White residents resisted the integration of Black children into predominantly White schools. African American parents, whose children attended the W. E. B. Du Bois School, which had become a model for African American excellence in education for the nation, launched a vigorous protest. The African American parents—those who had not been in favor of integration, but had been ignored by civil rights attorneys—argued that they should be allowed to design their own curriculum and implement their own remedy.

The morning of integration day, as African American parents walked their children to the soon-to-be-integrated schools, the African American children simply disappeared—from buses, from homes, from the clasp of their parents' hands—without a trace. When the children could not be found, funding in the district, which was based on the total number of pupils, was slated to be cut. Similarly a number of projects paid for by federal education subsidies, including future construction plans, planned annexations, and so forth, were also cancelled. The message to the public was clear: While the desegregation debate had focused on whether African American children would benefit from busing and attendance at racially balanced schools, the reality was that virtually every White person also benefited from integration in tangible ways (Bell, 1987).

In the process of negotiating for integration, the particular needs of African American school children had been completely lost in the fight against racial segregation. The "sacrificed Black school children" as Bell described them, symbolically represented the African American children who were the casualties of desegregation. In Bell's assessment, African American school children "disappeared," although they themselves did not vanish in such a dramatic fashion. As African American educators were fired and never replaced and African American schools were dismantled, all the lessons learned regarding how to educate African American children in culturally specific contexts were also discarded. Unfortunately, and ironically, it was only when the students vanished before the plan could be implemented that the citizens realized that students and education had become the casualties rather than the beneficiaries of the desegregation remedy. Bell was neither for segregation nor against integration, but rather had the sensibility that advocates had been slow to recognize; how African American children could be denied the "equal education opportunity" promised by *Brown* in integrated schools despite compliance with court orders to the contrary.

In a series of articles reflecting on *Brown*, Bell would retrospectively lament the limitations of litigation, the legal team's overreliance on the desegregation strategy, and the silenced voices of some parents who called for better—not integrated—schools for their children. Bell's goal was both simple and extreme: to uncover the civil rights innocence of his readers and to awaken them to the reality that the fundamental vice with which they were at war was not legally enforced racial segregation—for this was only a by-product of the greater disease of White supremacy (Bell, 1983). While desegregation had not occurred until well over ten years following the desegregation decisions, and even then in fairly limited fashion, schools were still far from integrated by the time that Bell began his reminiscences. Sixty-three percent of African American students around the country during the 1980-1981 school year attended racially isolated schools (Bell, 1983).

Even though not romanticizing the era of segregation, Bell's analysis underscores the importance of culturally specific teaching and mentorship in propelling students toward high educational attainment (Bell, 1983, 1987). His work highlights what was lost—institutions geared toward encouraging students to pursue educational attainment in fields that had traditionally been beyond the reach of their communities. The statements by study participants similarly highlight the continuing importance of teachers, mentors, and parents' recognition of the culturally specific needs of African American students in an effort to help broaden their participation in underrepresented STEM fields. In many cases, the African American participants within this study were not privy to the fact that computing science was an educational or occupational field until they were already well into college. These data corroborate other studies (e.g., Byars-Winston, 2006, 2010; Charleston, 2012; Cheatham, 1990; Parham & Austin, 1994) that illuminate the unique circumstances regarding the restriction of occupational opportunity confined within minority group status; and further stresses the need for interventions culturally situated around career development patterns.

According to most career development theories, by the time students reach college-age, they will have already discerned which occupations are viable to match their skills, abilities, and specific interest. Furthermore, they have already passed critical stages of their development that may have necessitated the acquisition of skills and abilities that may or may not have been available to them; thereby eliminating STEM fields such as computing sciences due to either lack of knowledge that the field exists, or lack of prerequisite skills or community identity which would facilitate its pursuit. While the literature related to race/ethnicity and career choice has indicated that race or ethnicity does not seem to contribute greatly to variations in career aspirations and decision-making, perceptions of barriers and career opportunities vary among different racial and ethnic groups (Charleston, 2012; Fouad & Byars-Winston, 2005). As such, even if students possessed the skills and abilities to achieve in computing or other STEM fields, their desire or decision-making toward these fields could be stifled as a result of believing that it is simply not for them. Therefore, these findings surrounding culturally relevant practices could assist this student population in creating a STEM identity characterized by self-efficacy and self-concept (ability) in STEM that could circumvent inadequate K-12 preparation.

As the most eagerly anticipated and theatrical judicial decision of modern times, it is not surprising that *Brown* has achieved an iconic status. Many of *Brown*'s contemporaries saw the decision as the first major blow to racial discrimination in the United States (Patterson, 2001). The arguments of the victors—those raised by African Americans in support of the suit, plaintiffs' counsel, as well as the decision penned by Justice Warren for a unanimous Supreme Court—all shared the sense that education was the source of advancement in life. Subsequent studies of *Brown's* effectiveness, drawing on these sources, have adopted this optimistic vision of *Brown*, lamenting its failures in light of its promise (e.g., Guinier, 2004). The courts have been, to some extent, complicit in building this legacy through jurisprudence, both correcting for *Brown*'s limitations in some instances, while limiting its reach in others. For example, in *Swann v. Charlotte-Mecklenburg Board of Education*, the Court after 17 years of cases indicated that it was appropriate to measure compliance with the *Brown* decision by the degree to which desegregation in each school matched the percentage of African Americans and Whites in the school districts as a whole. However, in the post-*Brown* era, numerous scholars have grappled with assessing the implications of the decision in *Brown* beyond its limited scope. For example, as the courts have moved to extend *Brown*'s implications into the higher education context, so too have scholars, addressing the strengths and limitations of its application to postsecondary education (Guinier, 2004).

This study illuminates the possibility for using pre-*Brown* educational strategies—re-conceptualized through the lens of CRPT—to achieve educational successes in the post-*Brown* era. Familial cultivation and encouragement was very instrumental in the trajectories of the study participants. Parental support in the form of verbal and moral encouragement, educational encouragement, and opportunity-seeking (e.g., science and computer clubs), as well as financial support (e.g., computer purchasing) has an integral effect on students' disposition toward mathematics, sciences, and computing. It is the support of parents and surrogate parents that motivate young African Americans to succeed in the computing sciences. Even where parental predispositions were not geared toward computing, positive encouragement proved to enable the participants and foster their aspirations in computing. The purchase of computers and computer-related products for use in the home benefits young African Americans and enhances the likelihood of computing aspirations. However, where finances do not permit, verbal and moral encouragement serve as a technological incubator, if the individual has access to computers elsewhere. Essentially, access to technology is a significant factor for generating interest in and facility with computers. While the home serves as the first line of technological incubation, schools can and do play a significant role in nurturing African Americans toward science, technology, and computing-related interests. The participants within this study often cited schools as their first introduction to computers. As such, the school is an ideal place to begin the trajectory toward STEM-related fields and disciplines. Schools must reach beyond facilitating remedial engagement with computers (simply consuming information as oppose to creating it), and move toward encouraging and facilitating advanced engagement. Teachers shape children's lives and often serve as role models. When teachers encourage and facilitate technology use in the class room, it not only has the ability to enhance the learning outcomes of students, it also exposes them to technology and its variety of uses, which has the potential to spark an interest in computing sciences and other STEM fields. When teachers facilitate the creation of information and knowledge, African American students become exposed to computing, thereby sparking their interest in the field.

Sixty years after *Brown*, the pattern of racially isolated schools continues and in many ways, the isolation of African American students from racially segregated careers is poised to become yet another frontier in the fight for educational parity. African American students continue to find themselves underutilized in certain career paths—namely, STEM-related fields like computing sciences. Computing sciences is a field that requires socialization (e.g., Charleston & Jackson, 2011) it is a field in which to be successful it is necessary to become acculturated with the social and technical aspects of the field. This is most effectively achieved through the formulation of communities containing individuals who are culturally adept and of a comparable skill level who can navigate through computing with the students. In these circles (i.e., mandated computing laboratory work, group projects, special programs), African American students feed off of each other and work together on problems related to computing. In a cohort/community-based, living-learning model, community dynamics are established that facilitate teamwork where activities, projects, and assignments are completed collaboratively. Similarly, the use of a culturally responsive community in navigating computing sciences programs facilitates degree completion.

Computing sciences is a White, male-dominated field that encompasses many constructs that are foreign to African American life. These constructs range from technical application methods to social construction. As such, the best chance of persistence among African Americans is to make use of peers as academic and social resources. Positive community building and culturally relevant practices through the educational trajectory minimizes alienation and isolation within the field. The development of a sense of belonging and community improves prospects of degree attainment, cultivating a sense of accountability among African American students.

The field of computing sciences is associated with a variety of stigmas, which serve as deterrents for potential African American contributors. Some of these stigmas include the idea that computing sciences is for nerds, only for White people, only for geniuses, or that in order to participate in computing, it is necessary to be isolated in a cubicle and buried under work. Therefore, the anomaly of participating in advanced level computing demands a robust support network. Add the social isolation that comes with being an anomaly (African American) in an already isolated field (computing sciences or other STEM fields), and the necessity of culturally relevant practices and pedagogy becomes more apparent. Participation in a community around computing is often the deciding factor determining persistence in challenging domains such as computing sciences. As such, cohort-building and participation in a community of practice or a living-learning community is an essential recommendation stemming from results of this investigation and its implications.

The participants in this study identified mentorship as a significant factor contributing to their degree attainment. The mentors played active roles in their academic and social development in computing, and their socialization in the field. They served as motivators, encouragers, and in many cases empowered their mentees to persist. Subsequently, mentors not only provide social, moral, and physical support, they also serve as conduits and models for achieving a STEM identity among the participants. It is in this context, that culturally specific educational practices become a more invaluable means of relieving the disparity of African American students in previously segregated fields, particularly the field of computer science, and achieving the successes *Brown* symbolized, but did not directly provide.

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