A Qualitative Investigation of African Americans' Decision to Pursue Computing Science Degrees: Implications for Cultivating Career Choice and Aspiration

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Abstract

Pearson (2002) claims that underrepresented groups are underrepresented in STEM (science, technology, engineering, and mathematics) fields. African Americans are one of these under-represented populations. For the sake of the American economy, it is crucial to increase the number of people studying computer science and other STEM subjects (J. F. L. Jackson, Charleston, George, and Gilbert, in press; Moore, 2006; Pearson, 2002). The author sheds light on the lives of African American students pursuing degrees in computing at the undergraduate, graduate, and doctoral levels via the use of the grounded theory methodology. There are implications for encouraging participants to pursue computer science degrees and for encouraging them to pursue their professional goals in general that stem from the findings of this research. The research yielded a heuristic approach for increasing access to computers.

Keywords; Broadening involvement, African Americans, computer science, and higher education are some of the keywords here.

Introduction

White males dominate the upper echelons of the U.S. scientific and technology workforce (Moore, 2006). However, African Americans make up less than 3% of these same STEM-related occupations, and these participation patterns are not expected to change much despite efforts to diversify the scientific workforce (Hrabowski & Pearson, 1993; Moore, 2006).

African Americans confront several obstacles in their pursuit of careers in the STEM fields (Charleston & Jackson, 2011). Because they are frequently neglected by the K-12 education system compared to their White counterparts, African Americans are among those under-represented communities who both historically and regularly indicate larger educational demands upon college acceptance (Ashby, 2006). The proportion of this population enrolling in elementary and secondary schools without the necessary Charleston and Jackson (2011), Graham (1997), and Moore (2006) all stress the need of a solid foundation in math and science for future academic and professional success, particularly in STEM disciplines The steady decrease in the percentage of African Americans in the most advanced levels of science and engineering (American Council on Testing [ACT], 2006; Ashby, 2006; Graham, 1997) can be attributed to the pervasive obstacles that these students en- counter during their undergraduate, graduate, and post-graduate years. With the aforementioned historical and educational factors

continuing to perpetuate this underrepresentation of African Americans and hindering persistence in STEM-related fields, this qualitative investigation into the lives of African American men and women in higher education computing sciences contributes valuable insights to this body of research. It aims to provide light on the ways in which people of varying levels of educational attainment navigate the typically monolithic subject of computer sciences. Article Summarization The present rate of involvement in the STEM fields in the United States is at a historic low. Prior to 1994, for formerSurprisingly, however, there was no indication of a rise in engineering and technology-related occupations (Ashby, 2006). In addition, a lack of professionals with these kinds of expertise hasn't been seen since the '50s (ACT, 2006). While college attendance has grown overall during the last decade, fewer students are earning degrees in science, technology, engineering, and mathematics (STEM) subjects, according to research by Gilbert and Jackson (2007). According to data compiled by the ACT in 2006, inadequate preparation for success in STEM-based, college-level course-work is a major factor in this drop. Preparation in STEM-related fields and the computing sciences is becoming necessary to increase access to an information-based and knowledge-driven workforce as technology continues to proliferate on national, global, and economic scales (ACT, 2006; Flowers, Milner, & Moore, 2003; Gilbert & Jackson, 2007; Ma- ton, Hrabowski, & Schmitt, 2000; Moore, 2006).

As computer usage increases throughout all aspects of contemporary American society (Carver, 1994; J. F. L. Jackson, Charleston, George, & Gilbert, in press), the computing sciences have emerged as an essential component of STEM education. To stay globally competitive and meet labor market demands, the United States, however, can no longer depend entirely on White males as the only source of viable scientific and technical talent (Gilbert & Jackson, 2007; J. F. L. Jackson et al., in press). African Americans continue to be underrepresented in the STEM fields, notwithstanding affirmative action laws approved by the United States government (Maton et al., 2000). Margolis, Estrella, Goode, Holme, & Nao (2008) found that inadequate K-12 education, a lack of institutional encouragement, educational opportunities, and adequate preparation all contributed to the low number of African Americans who went on to pursue computing science-related fields of study or careers. In less privileged areas, where students of color are disproportionately represented, the availability of high-quality computers has increased, but they are often put to use for remedial purposes. seldom inspire students to pursue careers in the field of computing (McAdoo, 1994; Margolis et al., 2003).

Existing research (Margolis et al., 2003) confirms that students in grades K-12 from a variety of socioeconomic backgrounds are actively engaged with technology through media such as music, video, graphic arts, and the Internet; however, interdisciplinary connections between computing sciences and these activities are rarely presented in a way that promotes academic or professional interest. More importantly, the study confirms the dearth of relevant technology-based curricular supplements inside popular courses that might pique students' interest in the computer sciences (Margolis et al., 2003).

In addition, prior studies (MacLachlan, 2006) argues for the inclusion of more initiatives and programs to help African American students succeed in STEM fields. The goal of these courses is to prepare students for teaching and research careers in STEM fields and computer science from the time they are undergraduates. Since 1998, African Americans have never made up more than 2.0% of assistant professors, 1.4% of associate professors, or 0.7% of full professors in the field of computer science. In addition, throughout this same time frame, African Americans have never made up more than 2% of computer science PhD graduates in any given year (J. F. L. Jackson, Charleston, et al., in press). Given that African Americans make up 12.9% of the U.S. population (U.S. Cen- sus Bureau, 2008), these numbers need careful consideration.

In 2005, the Na- tional Science Foundation created the Broad- ening Participation in computer initiative to particularly address the gaps in represen- tation within the computer sciences. The goal is to increase the representation of women, people with disabilities, African Americans, Hispanics, American Indians, Alaska Natives, Native Hawaiians, and Pacific Islanders in computing science

fields among permanent residents and citizens of the United States. The program primarily targets college and university students, although it also encourages projects for high school and even middle school students. Very little data on the efficacy of any programs or interventions aimed towards this demographic with respect to computer science can be found within the existing literature on African

American participation in STEM subjects. Therefore, I aimed to compile the most important elements that encourage such participation in this field in this qualitative research. In addition, this research gave

African American practitioners a chance to share their motivations for entering the STEM and CS fields. Therefore, the study set out to answer the following question: "What key factors contribute to African Americans pursuing degrees in computing science?" The answer to this question sheds insight on the path taken by African American computer scientists to get their degrees and the experiences that proved most influential in fostering a lifelong passion for the industry. Similarly, the implications and potential solutions for encouraging African American kids to study computers are pointed out by the responses.

Method

While many qualitative research designs prevent a hypothesis from emerging from the data, this one did quite the opposite. Since no predetermined theoretical framework was used as a basis for this research, a heuristic model was developed via the application of grounded theory.

Grounded theory is the practice of doing both of these things at once. In order to understand, compare, and track the evolution of investigated phenomena, this kind of data collecting is necessary (Glaser & Straus, 1967; Mason, 1996). Because it permits them to keep analysis and theory production safe inside the data, this consistent, comparative type of data analysis is crucial to grounded theory methodology (Gla- ser & Strauss, 1967). The procedure entails (a) contrasting the facts applicable to each conceptual category, (b) integrating the categories and their attributes, (c) delimiting the emerging theory, and (d) writing theory (Jorgensen, 1989).

The Group of Four (Conrad, Neumann, Haworth, and Scott)

 (1993) state that there are four intertwining phases of grounded theory. Because of this,

The first step in any multi-stage process is to gather relevant data and organize it into as many distinct categories for analysis as possible. Similar notions discovered by the researcher via incessant data comparison are reflected in these classes. At this early stage, the researcher is forced to think about the theoretical aspects of these emerging ideas. The second iteration incorporates theoretical sampling, which helps direct data collecting while the researcher fills in holes in the evolving theory. The third overlapping, iterative step is the development of a preliminary theory, which is achieved through further honing of relevant ideas and their interconnections. In this phase, the researcher actively seeks evidence for or against key hypotheses and ideas. In a similar vein, this procedure allows for the change or removal of notions based on the strength of the evidence available. After the first three phases of grounded theory are complete, an integrated theory emerges to provide theoretical saturation (Conrad et al., 1993).

Research may be continuously refined in light of emerging themes and concepts thanks to the data scrutiny made possible by grounded theory. Furthermore, it educates its observers on the finer points and worries of the research participants, which in turn disclose access characteristics that permit gradual improvement (Glaser, 1999). Grounded theory and the continual comparative technique allow researchers to be adaptable and avoid sidetracks that might damage the study's credibility. Since the aims of the African American Researchers in Computer Science (AARCS) program were congruent with those of this study, qualitative inquiry in the form of individual interviews was conducted among AARCS participants at one of their annual conferences.

The goal of this research was to better understand what motivates and inspires African American students to major in computer science. The study's goal was to provide light on the experiences of accomplished African American computer scientists. persons in an attempt to draw attention to the ramifications for new policies, new programs, and new lessons. The research topic for this study explained the relevant aspects that contribute to studying the computer sciences, and an interview technique was also designed to facilitate this. Concerns about (a) early exposure to computers, (b) K-12 and college curriculum, (c) extracurricular programs and activities, (d) in- ternships and work experiences, and (e) key role models and positive peer influence were also clarified through the qualitative research

In contrast to quantitative techniques, which would fail to get to the core of the phenomena under research (Glaser & Straus, 1967), conducting individual interviews allowed for a comprehensive comprehension of participants' computing-related experiences. Using a qualitative approach allowed us to learn more about the participants' perspectives on their personal paths to earning a degree in the computer sciences (Lincoln & Guba, 1985).

The study's design allowed for the inclusion of a wide range of social, environmental, and educational interactions between the participants and factors connected to computer science. The interview approach also required a protocol instrument that allowed for some degree of flexibility during the inquiry process, which in turn encouraged some degree of spontaneity. Another benefit of qualitative technique is that this aspect allowed for a more reliable data retrieval process. All of these features of the study's design facilitated the collection of detailed information, which is a necessary component of any credible qualitative research.

Participants There were a total of 37 one-on-one interviews, all of which followed the same format. Each person in the sample was interviewed for 30–45 minutes. The percentage breakdown of those interviewed was as follows: 22% were undergraduates, 48% were graduate students, and 30% were faculty or researchers with doctoral degrees. In addition, half of the people involved had gone or were enrolled in a school that primarily served White people, while the other half went to historically black colleges and universities.

Number Crunching I used a fundamental qual- itative analysis procedure (Miles & Huberman, 1994) to examine the study's audio recordings, transcripts, and notes. The following are the steps I took: These steps include (a) assigning multiple word codes to the transcribed interviews; (b) making notes about reflections and related observations in the right-hand margins; (c) sifting through the data to identify and record similar phrases, patterns, commonalities, and differences; (d) isolating these patterns and processes for the next wave of data collection; (e) gradually expanding a small set of generalizations that address consistencies in the database; and (f) confronting said generalizations This six-stage procedure was critical in developing theme categories from the collected data. connections, and 8% went to schools that were mostly Black. The average age of the participants was 28.5 years (see Appendices A-D), and they were all African Americans who had majored in or were majoring in an area relevant to computer technology.

The socioeconomic backgrounds of the participants' families spanned a wide range. However, most participants came from two-income families. And most of them didn't grow up with a dad who worked in IT. Participants from two-parent homes had comparable educational backgrounds in that they all achieved high levels of schooling regardless of family income. Identified coding-based themes This paper's study made extensive use of publicly available source code. First-level coding allowed me to summarize the data by pulling out relevant information and classifying it into understandable categories (A. C. Strauss & Corbin, 1990). With the use of codes, we were able to breakdown the interview data in a meaningful way, which allowed us to preserve the connections

between our themes (Miles & Huberman, 1994). The process of encoding may be seen as the origin of both categories and the logic that underlies them. Things began to click into place and make sense. As the theoretical implications of the categories that generated meaning developed, relative patterns began to appear. A. C. Strauss and J. R. Corbin's (1990) theory of pattern coding suggests that this approach may be used to further categorize initial codes. The participants' experiences, like the ensuing patterns and thematic representations, are prime examples of grounded theory (Glaser & Strauss, 1967). When sufficient regularity had emerged within the categories, indicating that all the episodes could be classified with relative ease, I concluded the data collection and analysis portion of the study (Lincoln & Guba, 1985; A. L. Strauss, 1987).

Using the interview guide, I was able to have a focused dialogue with the participants about their experiences with computers, from their early exposures to its current use in education and the workforce. Separate categories based on commonalities were developed from the interview transcripts. I was cautious not to assume the interrelatedness of the material before observation and analysis, as shown by the inductive development of themes outside of chronology. The investigation in this study made extensive use of open-source software that may be downloaded for free. By using first-level coding, I was able to synthesis the data by drawing out salient information and classifying it into meaningful categories (A. C. Strauss & Corbin, 1990). Using codes, we were able to categorize our interview notes in a way that revealed connections between seemingly unrelated issues (Miles & Huberman, 1994).

The very process of encoding offers a plausible explanation for the development of categories and the reasoning behind them. It everything started to make sense and fit together. Relative patterns emerged when the theoretical ramifications of the categories that provided meaning matured. According to the idea of pattern coding developed by A. C. Strauss and J. R. Corbin (1990), this method may be used to further classify primary codes. Grounded theory is exemplified by the experiences of the participants and the resulting patterns and thematic representations (Glaser & Strauss, 1967). Data collection and analysis were completed (Lincoln & Guba, 1985; A. L. Strauss, 1987) when it became clear that sufficient regularity had evolved within the categories, suggesting that all the events could be categorised with reasonable ease.

With the use of the interview guide, I was able to conduct in-depth conversations with the participants regarding their exposure to and usage of computers throughout their lives. The transcripts of the interviews were broken down into several groups according to their shared characteristics. The inductive growth of themes outside of time shows that I took care not to presuppose the material's interrelatedness before observation and analysis. This study sought to understand the educational and professional tra- jectories of African American participants in the area of computer sciences by using a qualitative research approach. Consequently, I often thought on my own positionality and the influence of my own complicated racial, gender, socioeconomic, and educational identity on my interactions with participants and my interpretation of the resulting data. In addition, I used inductive data techniques, whereby I let the data serve as the basis of understanding and reported my findings in a very descriptive fashion, relying on quotable passages and theme analysis. Credibility and reliability I used a naturalistic methodology for this study to ensure the credibility and authenticity of the qualitative research conducted here. In contrast to the focus on validity in traditional empirical research, In naturalistic inquiry, words such as audibility, credibility, and fittingness relate to reliability, internal validity, and exter- nal validity of measurements and methods (Guba & Lincoln, 1981). In qualitative research, reliability is shown by repeating the study under the same conditions. I used naturalistic inquiri- cy to code the raw data in a way that makes it possible for another person to not only understand the fabricated themes

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and theories, but also to reach the same conclusions I did by examining the consistency of the coded raw data.

This study's credibility was established by independent confirmation of the study's underlying structures, a method that is consistent with naturalistic inquiry. To put it another way, consistency was ensured by establishing extensive contact with research participants to check for inconsistencies. Persistent observation was also shown by the thoroughness with which the individuals' experiences were explored. In addition, we double-checked our numbers by comparing several data types, including digital audio recordings, physical transcriptions, consultation with other researchers, and researcher notes. Triangulation encapsulates the aforementioned practices of prolonged involvement, persistent observations, and evaluating numerous data sources. According to Rudestam and Newton (1992), it is common practice to audio- or videotape interviews in order to compare them with data gathered from other sources, conduct peer debriefings, revise working hypotheses as data is collected, discuss preliminary findings with study participants, and so on. Individual interviews served as the primary data collection technique for this study, and triangulation was achieved through data corroboration, source checking, field note taking, and the clarification of participant categories and narratives. These activities contributed to the study's structural confirmation. I've made an effort to meet Wolcott's (1990) nine criteria to ensure the reliability of this qualitative research and increase its validity.

Take turns talking and listening. I made an effort to arrange a get-together with the target audience felt at ease; I paid attention; I spoke out when appropriate; etc.

1. Keep precise notes. To prevent misunderstandings, I made every effort to document each person's exact words and actions as they occurred.

Start writing early. I got a head start on writing so I could find flaws in the data or methods used more quickly.

3 Permit the audience to judge for themselves. In an attempt to broaden the scope of my observations and interpretations, I decided to get feedback from others on primary data.

4 Give a complete account of what transpired. Although I do not describe every inconsistency, I have made an effort to entertain the possibility of inconsistencies and the implications of their various interpretations.

Fifth, tell the truth. Throughout the study's qualitative phase, I made an effort to maintain my own biases.

Ask for comments. I actively sought input throughout the process to ensure that neither the study's themes nor their presentation were over- or under-developed.

7. Strive towards equilibrium. To avoid focusing too much on extreme cases, I made an effort to capture a representative sample of incidents.

Edit your work thoroughly. Throughout the process of writing this paper, I made an effort to ensure that it made sense and was logically sound.

Through the study method and, more especially, the recording and presentation of data, I aimed to give legitimacy and credibility in response to these nine concerns. **Results** The factors that led to degree completion in computing science fields were determined by analyzing the various forms of data collected in this study, and the following categorical themes emerged: (a) early exposure to and engagement with computers and computing, (b) positive interaction and computing socialization, (c) galvanizing factors concerning computing sciences, and (d) essential considerations for occupational decision-making with regard to computing careers. Given that not all of this information can be neatly In several parts of our inquiry, topics developed that did not fit well into any one area.

The Benefits of Beginning Your Computing Career Early The participants shared a wide range of their first encounters with computers. Although most people's first experience with computers was during their elementary school years (about ages 6-11), this exposure was seldom followed by any serious interest. On average, participants in the research had been exposed to

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computers for six years before they started using them regularly. School exposure and parental buying were two significant elements that promoted early experience with computers. Because some of the students whose schools exposed them to computers did not have access to individual computers but rather shared a small number of computers throughout the whole school, the phrase "classroom exposure" was avoided. When asked about her first experience with computers, one female graduate student echoed this sentiment:

In elementary school, only the most capable children were given access to the clunky computers. This was an exclusive club. A computer filled a need; it was something I'd seen but hadn't given much thought to until my father purchased the family one.

Although there was wide variance in the grades at which participants were introduced to computers and in the extent to which they became involved, the nature of that introduction was very consistent across all schools. Consistent with other findings, such introductory remedial encounters did not spark greater interest in computers among disadvantaged students. These sorts of early involvement were also indicative of individuals' exposure to a home computer environment. Keyboarding/word processing, video/educational games, and schoolwork were the three most prominent aspects of early computer use. Participants' descriptions of these activities as dull and uninteresting lend credence to the idea that they should be classified as remedial engagement. computing. This claim from a female graduate student participant illustrates the following ideas:

When I was in middle school, my family bought a Gateway desktop computer. I used it seldom, mostly for typing up papers. It was a one-time occurrence before I started typing papers, doing PowerPoint presentations, and so on in high school. The doing of the task. Many students did not acquire a lasting interest in computing even after being exposed to it in the classroom via activities and assignments that required the use of computers. These tasks were described more as obligations than as opportunities, and they did not highlight the versatility and power of the computer. Students also stated how they were often rewarded with computing time for gaming purposes, suggesting that gaming was an important element of participants' early involvement with computers in classroom settings.

However, participants were not kept interested or encouraged to learn more about computers as a result of these exercises. Although these claims were not often made outright, they were frequently hinted to using slangy language, as in the following statement by a female doctoral student: We used computers to complete math programs for about three hours a week while I was in middle school. Just some computer-based puzzles and exercises. Even when my mom acquired a computer at home, I didn't have anything to do with it. Students who started using computers at a young age, even if just for basic skills like word processing, progressed quickly to more complex uses of the medium. Students whose families had access to personal computers in elementary school performed better on standardized tests and showed more interest in learning overall. computer use for more complex tasks at a younger age, namely by the third grade, were shown to have made more strides in this direction. Prior to enrolling in college, the vast majority of participants had no experience with high-level computer tasks like programming or coding. Those that did so did so via their high school's required coursework, scientific and technology-based extracurriculars, and/or their own personal networks of family and friends. Some of the people we spoke to had taken computer science classes in school.

encouraged further involvement, but several respondents were still unhappy with the lack of options available to them in high school. After enrolling in university, most students showed advanced interest in computers. Many students had never used a computer before coming to college. Consequently, most of these individuals came into college with little to no background knowledge in computing sciences. Those students who did not initially want to major in computer science changed their minds either during their time as an undergraduate or when they began thinking about continuing their education at the graduate level. Positive Socialization and Computers Many of the respondents who decided to major in computer science credited influential conversations with friends and family members. The participants in this study largely described social interactions that helped them in their educational and computing development, in contrast to other research pertaining to STEM disciplines that has illuminated negative social influences that

deter underrepresented populations from persisting (ACT, 2006; Gilbert, Jack- son, George, Charleston, & Daniels, 2007; Moore, 2006). Interviewees typically reported significant achievements in computers, but this did not mean that they had not encountered social difficulties. However, these reiterations often included thinking back on past experiences with computers and discussing the elements of the field that were least appealing.

Many participants' parents, professors, advisors, instructors, and friends were influential in their decision to pursue computers at a higher level and with more intensity, while others listed their own natural curiosity as a factor. These people either majored in computer sciences themselves or actively promoted, supported, or funded others who did. Three primary subthemes, (a) peer modeling or positive peer influence, (b) parental caring, and (c) mentoring, developed from these good social interactions and computer socialization. Regarding computer perseverance, peer modeling or supportive peer influence was crucial. Participants were exposed to the computer sciences, pertinent ideas and constructions, and the educational pipeline that supports them. All of these factors worked together to keep people engaged throughout the study. The findings of positive peer pressure and impact are supported by the following statement made by a female faculty member: I made some great friends; there were about five of us in total -- and we found even more things to do, such as installing various "tweaks" into our respective operating systems (back when "Windows '95" and "Windows '98" existed) and creating our own supplementary materials.　　　One of my closest pals is someone I met in college.　　　Weconstantly had this rivalry over our computing abilities.　　　It's a combination of competition and sustenance as we decide what new equipment to purchase.

Friends were a common source of encouragement for those who said they wanted to get into computers. Many of the respondents' peers were older than them, either academically or professionally, and were involved in more complex forms of computers. In many situations, friends influenced participants to switch their major in college or university from a similar field like

mathematics to computers. Friend of mine has been teaching me C++ programming, says female graduate student. I took an introductory programming course the next semester.　　　I majored in applied mathematics at the undergraduate level. A close buddy of mine encouraged me to try out for the [Computing and Robotics] Olympiad. I sought out the conditioned stimulus instructor and introduced myself.　　　I was more of a mathematician, but I used to sit and watch her code because she was so good at it. She was making things appear that hadn't existed before. As I sat down in my first computer science lecture, I thought, "OK, I might actually want to do this."

Positive social interactions also benefited greatly from parental care. largely by enrolling in and settling into a college or university's undergraduate program. The moral, scholastic, and monetary assistance of others were common manifestations of these beneficial social interactions. It was discovered that the most of these advancements start with the acquisition of a computer and go on to the growth of computer literacy through hard-items like software and hardware. It was also found that many parents actively encouraged or financially supported their children's pursuit of computer-related information (such as the teaching of programming) via formal or informal means.

Mentorship provided a pleasant social contact and acclimated individuals to the world of computers in addition to peer modeling and parental nurturing, all of which contributed to degree

results for participants. Study participants often mentioned how they would have dropped out of their computer science programs if it weren't for the involvement of a mentor, highlighting the importance of mentoring in terms of participants' goals for the greatest levels of degree achievement in computing sciences. Many of the interviewees' mentors were the people who introduced them formally to the subject of computer sciences by putting them in touch with faculty and graduate students in the field. Because of the intersection- ality and direct association between mathematics and computers, participants' interests in mathematics sometimes sparked unique types of computing- related

mentoring. The following quote from a male faculty member is illustrative of the way in which mentoring encourages computing-related degree completion: Someone was hacking into these [computer] systems, and my supervisor caught on to it. Asked me whether I had attended class that day. To paraphrase, "Keep trying to get in [the computer systems] and tell me when I can't." He offered me books and encouraged me to enroll in a computer science program, telling me that he could not reveal the identity of the young hacker. He guided me in my early years. He [myMy adviser and mentor in graduate school arranged for my financial support and provided tokens for public transit. He made sure I could show up and do my thing. He was great overall, but there were times when he had to stand up to folks outside of his division**.** Impulsive Elements in the Computer Sciences Several participants highlighted several features and qualities of the computing sciences that they find intriguing. Most of the participants got started with computers because of the Internet, visuals, or games. Their interest in computers grew in tandem with the depth of their knowledge of the subject. Four key characteristics of computing were regarded most common, despite numerous individuals claiming extremely specialized interests connected to computers, such as artificial intelligence and programming. computer science's (a) adaptability/interdisciplinary character, (b) its dynamic nature, (c) its emphasis on addressing problems, and (d) its value in facilitating human-computer interaction.

As they made analogies between computers and other sectors of work, several participants remarked on the allure of the subject. Respondents to the survey said they were drawn to computers because they believed it would open doors to other fields of study and because its malleability made it unlikely that they would ever become bored with the field. Participants were happy to report that they could pursue whatever hobby they wanted thanks to computers. Because of this adaptability, professionals may move freely across fields, expanding their potential career options. Basically, I can give everything a go, a female professor said. What "it" is, I can figure out. How can I make a living doing what I enjoy? With a graduate degree in a hard science.

Because of its ubiquitous nature, computers is difficult to pin down; its breadth means that its practitioners may specialize in almost anything while still finding satisfying work. It is also interesting to notice that several respondents highlighted the dynamic nature of computers as a driving force for their interest in the field. In discussing why they chose to work in the field of computers, several respondents mentioned their insatiable appetite for knowledge and how excited they were by the prospect of working with cutting-edge technology. As a result, the potential for education generally and its practical applications stands out as a defining feature of the computer sciences. One of the female professors suggested, You can perform a wide range of things. There is always more to learn, and I believe that those of us with advanced degrees (or those working toward them) recognize this. Our passion is towards education. We like learning new things very much. And unlike many other professions, you can advance in this one. Since there is always a new facet of it (computing science) coming out or something that is already out that you haven't, you know, had an opportunity to get to know, you may learn as quickly or as slowly as you choose. So it's a whole universe that you can explore if you want to. Participants did report enjoying the challenge of solving problems, but they were far more enthusiastic about the rewards they reaped from their efforts. mary school years through college. Computing- related cohort building describes the formation of a group of individuals collectively pursuing computing sciences throughout their educa- tional trajectory. Knowledge of the interdisci- plinary nature of computing involves informing individuals of the connection between comput- ing sciences and other disciplines. Multifaceted mentorship refers to sustained mentoring from an individual with a vast knowledge of the field of computing throughout the educational and vocational trajectory.

Early advanced engagement with comput- ers and computing. The findings of this study revealed that early exposure to computers alone did not facilitate further interest in com- puters for the majority of the participants. Fur- thermore, remedial engagement with computers such as word processing, playing games, and non– computing-related class assignments did little to spark the

interest of participants. What did spark their interest in computing was ad- vanced engagement in the form of program- ming, hardware installation, and information creation (i.e., creating games). Because this ad- vanced exposure facilitated further interest in computing sciences, it is necessary to expose students to these and other types of advanced engagement with computing during their pri- mary years or as early as possible. This engage- ment serves to facilitate the desire to learn more about computers.

Advanced engagement introduces the pros- pect of creative possibilities. That is, once in- formation creation is accomplished, this fosters further interest in the limitless possibilities and functions of computers, and how the computer can aid students in bringing their ideas to frui- tion. It facilitates the opportunity for young African Americans to be owners of technolog- ical innovations, which in turn encourages them to pursue further education or knowledge re- lated to computers and computer technology.

Advanced engagement in computing fosters sustained engagement. Remedial engagement such as word processing, keyboarding, and gaming does not facilitate sustained involve- ment. These remedial tasks lack the necessary intriguing elements of computing that are pres- ent in advanced engagement. Advance engage- ment involves the element of creation, which invokes a recurring desire in African Americans to "do it again." The creation of a product that

sciences. Therefore, these programs provide technological incubation essential to degree at- tainment of African Americans in computing sciences.

Rigorous grounding in science and math- ematics. Many studies (e.g., Gilbert et al., 2007; Hrabowski & Pearson, 1993; Maton et al., 2000) cite the necessity of a solid foundation in mathematics and sciences in an effort to be adequately prepared for STEM occupations. As computing sciences have risen to the forefront of STEM fields, a strong background in math- ematics and science is necessary. Many retro- spective considerations posited by the study participants suggested that they would have pursued additional and more advanced courses in preparation for the field of computing sci- ences. The direct connection between mathe- matics and science and the field of computing sciences necessitates significant aptitude in math and science, which must be attained throughout the educational trajectory. As such, a solid foundation in science and math fosters the decision to pursue the computing sciences among African Americans.

This phase merits robust K–12 curricula in

mathematics and sciences. African American student preparation is often representative of an inadequate educational system. Wherever pos- sible, supplementary education in science and math must be provided. This attainment can take shape in extracurricular math-based pro- gramming, tutorial sessions, or robust or sup- plementary classes in school for science and mathematics. Many of the successful computing sciences participants in this study attended sci- ence and technology-based high schools that enhanced their preparation for computing. However, many public schools do not ascribe to these advanced preparatory systems. As such, the aforementioned alternatives must be applied to increase the likelihood of educational and occupational participation in computing sci- ences among African Americans.

Computing-related cohort building.

Computing sciences is a field that requires so- cialization. That is, to be successful in the field, it is necessary to become indoctrinated with its social and technical aspects. This is most effec- tively achieved through the formation of groups with individuals of comparable skill level who can navigate through computing together. In these circles (e.g., mandated computing labora-

Conclusion

The purpose of this research was to identify influential characteristics that encourage African Americans to major in computer technology. Previous studies on African Americans and their persistence in the computing sciences focused on people who dropped out or were just starting out

in the field; this study took a different approach by analyzing the career paths of current and aspiring computing scientists. This research has allowed for the implementation of a heuristic model that encourages African Americans to pursue computing science-related fields, as well as the articulation of experiences from African Americans who have reached the highest occupational and education levels in com- puting, and those in the undergraduate and graduate pipelines.

The study's most important results indicate that African Americans' choice to pursue degrees in computer sciences was dependent on socially constructed conditions. While some subjects showed very highaspiration and individualism were not major determinants in students' eventual success in college. But the most revealing factor was the presence of supportive social factors that not only sparked initial interest in the subject of computer sciences but also provided the motivation to stay in it and get a degree. Answering the study's initial research question of "What factors contribute to African Americans' pursuit of computing sciences de- grees?" may be accomplished by classifying these elements into six broad categories. (a) early and advanced exposure to computers and computing, (b) technical incubation, (c) a solid foundation in the hard sciences and mathematics, (d) the formation of a cohort of peers interested in computing, (e) an understanding of the interdisciplinary nature of computing, and (f) a wide range of mentoring opportunities.

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