

Work in Progress:

**Students' Exposure to CUREs: Assessing Science Identity
Development of Underrepresented Engineering Students at an
HBCU**

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Abstract

Despite the national efforts to increase diversity in STEM, student retention continues to be dismal. The PCAST report suggests the critical factors for success and retention of students in STEM fields include intellectual engagement, achievement, motivation, and identify factors, which are elements in research experiences (PCAST, 2012). In an effort to understand the influence of research experiences on a group of engineering undergraduate students at an HBCU, this study uses the PITS survey to focus on science identity, project ownership, networking and self-efficacy. Also of interest is the role of mentorship on students' persistence in STEM fields. Students from this research study were exposed to a variety of research skills, while participating in ongoing research projects that involves biomaterial fabrication/characterization and 3D printing.

Keywords

STEM, Engineering, HBCU, Science Identity, and CUREs.

Introduction

The President's Council of Advisors on Science and Technology (PCAST) calls for a million more STEM professionals by 2022 to meet growing economic and global demands in the STEM fields ¹ and to create a larger and more diverse STEM workforce. In 2012, Blacks accounted for only 7.5 percent of all STEM undergraduate degrees and only 4.5 percent of doctoral degrees awarded in STEM ². These statistics illuminate our national deficit and need for diversity in STEM that must be addressed. In order to meet this national need and to encourage diversity in these efforts, underrepresented populations that include women and Blacks must be supported in their progress toward attaining STEM degrees. Underrepresented students enter college, at the undergraduate and graduate level, with intended STEM majors at the same proportion as the majority students, but have a higher attrition rate ³ and lower STEM degree completion rates ^{4,5}. Therefore, it is important to understand factors contributing toward underrepresentation and also to determine what elements help to promote attainment among underrepresented students in order to help create a strong and diverse workforce ^{6,7}. Of note, some students earn Ds and Fs or tend to withdraw from gateway courses during their first to second year in school⁸ and change their major to non-STEM disciplines. In order to encourage students to persist in their classes and persist in STEM fields, active learning, along with authentic research experiences, have been called to the forefront ^{9,10}. In this study, we characterize Black engineering undergraduate student experiences in the context of two forms of undergraduate research: traditional apprenticeship-

style undergraduate research experiences and course-based undergraduate research experiences (CUREs). Previous studies shows that participation in authentic research experiences has an influence on students' level of engagement, interest in science, and retention in STEM majors and careers¹¹⁻¹⁵. Following previous literature in the field, this paper examines the role of authentic research experiences and mentorship on themes from the Persistence in the Sciences (PITS) survey that include development of student science identity, project-ownership, self-efficacy, and science community values¹⁶. Results from this study will advance the STEM education knowledge base forward, as little is known about the impact that CUREs may have on Black engineering students at HBCUs.

Research Questions

In order to examine these factors, we propose to answer the following research questions:

1) What are the important factors in engineering research experiences that influence the persistence rates and science identity development of Black students' pursuit of engineering degrees at an HBCU? 2) What role does mentorship play in Black engineering students' decision to commit to scientific work and pursue STEM careers?

Methods

Participants. The participants in this study were 14 undergraduate students of junior classification enrolled in engineering courses. Student participation in the survey was not required by the instructor, but was optional for the students. The participation rate for this survey was 100%. (Refer to Table 1 in Appendix).

Procedures. The data for this study is from a Persistence in the Sciences (PITS) survey instrument that was administered to the students in paper written format at a Historically Black College or University (HBCU). (Refer to Table 2 in Appendix). This survey was administered by an education researcher during this fall semester of 2018. The request to participate in the survey was in compliance with the IRB approval code (#20170406) at Hampton University. A majority of the questions (92%) on the survey were completed by the participants. There were some questions in which students provided N/A (non applicable) or no responses. Those answers were not counted for our data. The survey is organized into six themes. These themes measure project ownership (content), project ownership (emotion), science self-efficacy, science identity, scientific community, the intent to become a scientist and networking.

Preliminary Results

The first factor being assessed is project ownership. Students are 64.2% of the students are confident in their ability to use scientific literature to guide their research. When asked about their level of comfort with reading scientific literature, a majority of the students stated they were comfortable with it, especially since they had been practicing using peer-reviewed articles during their classroom activities. Approximately 35.7% of the students expressed lack of confidence in using scientific literature to guide their research and had anxiety about scientific literacy. A majority (92.8%) of the students have discussed their research with their friends and family and felt comfortable explaining their research when asked.

The second factor assessed is scientific identity. An estimated 71.4% of the students found the daily work of a scientists appealing and looked forward to being part of a larger scientific community over time. Overall 85.7% of the students answered yes to the questions, “Do you see yourself as a scientist?” Some of the students stated that since they were comfortable in generating potential research questions, were reading scientific literature, and were in daily communication with practicing engineers as their mentors, they identified as scientists. The also had the encouragement of their research mentors to stay in the STEM fields, which impacted how they see themselves. This gives them the perception that the possibility is there for being part of the community of practice. The 14.2% of the students that did not classify themselves as scientists stated that they would not see themselves as scientist until they attain their PhD, but believe they are currently scientists in training.

In assessing the third factor, 78.5% of the students felt they belonged in the field of science. Some of the students personally knew scientists in their field of interest and stated that this partially influenced their decision to enter STEM fields. Most of the students did not personally know engineers or scientists outside of their university. They mentioned a few they met at conferences, but did not personally interact with others outside their university. 72% of the students stated that during their summer internships outside their current university, they were encouraged by their research mentors (none that were African American) to pursue graduate degrees and so they felt somewhat welcomed to join the field.

In open-ended questions, students self-reported that the factors that influenced them to enroll in and maintain the pursuit of engineering degrees are the job opportunities after graduation and the current mentorship they receive from the African American CUREs and traditional style research mentors. In their opinions, the hands-on activities and the possibility of novel findings is a major factor that keeps them engaged with the research aspects of their labs and courses.

Conclusion and Future Work

As these results are preliminary, we will survey additional students in the fall semester to include sophomores and seniors in order to have a wider range of student thinking.

We understand that there are limitations in our current dataset. Therefore, we will continue to monitors factors such as the fluidity of science identity over time. Of interest is the potential continuity of high level of science identity over the coming semesters and what factors play a role. In other areas of this study, our future work will include full analysis of our data from a mixed-method approach. We will analyze the results qualitatively but also quantitatively with statistical analysis to measure reliability of the data. We will also analyze our findings within a theoretical framework that specifically focuses on science identity and self-efficacy amongst minority students pursuing degrees in STEM fields.

Overall, students currently seem to understand that scientific literacy and hands-on experiences are two contributing factors necessary in the field of STEM. Therefore, they actively seek opportunities to engage in research, especially university provided CUREs. Over time, we anticipate a higher level of project ownership and increased networking as students experience novel findings and matriculate to upper level courses

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Table 1. Racial Self-Identity and Gender

Racial/Ethnic Identification	Percentage of Sample	Gender	
African American or Black	85.7%	Female	66.6%
		Male	33.3%
More than one race	14.2%	Female	0%
		Male	100%

Table 2. Sample questions from the PITS Survey

Factor	Individual Item on PITS survey
Project Ownership	I am confident that I can use scientific literature and reports to guide my research
Scientific Identity	I have discussed my research in this course with my friends.
	The daily work of a scientist is appealing to me.
Self-Efficacy	I have come to think of myself as a scientist
	I am confident I can generate a research question to answer
	I feel like I belong in the field of science.

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Isi Ero-Tolliver, PhD is an Assistant Professor of Biology at Hampton University. Her research focuses on the factors that influence minority students STEM identities and what barriers or successes for minority students to have access to research opportunities that impact their career trajectories. Dr. Ero-Tolliver graduated from Jackson State University with a B.S. and M.S. in Biology and a Ph.D. in Biological Sciences and Science Education from Vanderbilt University. She teaches introductory and upper level biology courses to majors and non-majors, while serving as PI and Co-PI on multiple grants that provide opportunities and scholarships for minority undergraduates in STEM programs of study.

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