An Exploratory Analysis of STEM Student and Faculty Perceptions at a Historically Black College and University (HBCU)

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Work-in-Progress: An Exploratory Analysis of STEM Student and Faculty Perceptions at a Historically Black College and University (HBCU)

Abstract

This work-in-progress discusses the efforts of researchers focused on broadening participation in STEM fields. The survey data discussed was collected from students, faculty, and administrators from a single HBCU (Historically Black College and University) and focuses on the experiences of students in STEM. The purpose of the survey was to identify critical areas of concern that warranted further investigation. Preliminary data suggest that future research studies should focus on students' confidence, study skills, and academic preparation as well as faculty development. Also, future research studies will investigate data from additional HBCUs and identify common areas of focus that should be addressed nationally.

Introduction

STEM (i.e., science, engineering, technology, and math) fields are critical to the advancement of the United States in the global economy. Therefore, it is important that institutes of higher education support students succeeding in STEM education by completions of STEM degrees. Advancing STEM education plays a fundamental role in improving student learning in STEM fields and, in turn, can enhance the production of STEM graduates. By investigating STEM education at colleges and universities, we can expose areas of needed improvement and enable programs to become more effective and efficient. If the field of engineering wishes to broaden participation, it is imperative that such efforts include institutions that heavily serve students from underrepresented groups, such as Historically Black Colleges and Universities (HBCUs). Because HBCUs were originally created to provide African Americans with access to higher education, there is an expectation for such institutions to provide a diversity-driven, low-stress campus climate for STEM students—and perhaps more educational opportunities (e.g., minority scholarships, fellowships, diverse student organizations, and diverse mentorships).[1] Thus, HBCUs have greater potential to support students in higher education pursuing STEM degrees.

To assist the nation in broadening participation and improve student success in STEM, a group of research scholars are collaboratively conducting a research study focused on HBCUs. These researchers leading this effort are from various HBCUs and aim to investigate individual factors, environmental factors, institutional practices, procedures, and policies that may adversely affect student success. This work-in-progress discusses preliminary findings from one selected HBCU. To inform the present research study's efforts and development, the researchers thoroughly discussed areas of concern and observed trends, both nationally and at their respective institutions, to arrive at key research thrust areas for investigation: (1) institutional climate, (2) cultural intersectionality, and (3) STEM career trajectory. Research across each of these areas will be guided by the conceptual framework model for the college experience as developed by Terenzini and Reason, focusing the work on specific factors affecting student persistence and participation in STEM as early as the first year of college.[2] The desired impact is to advance understanding of the educational experiences of STEM students at HBCUs, enhance the persistence of STEM students at HBCUs, foster STEM education research competence within HBCUs, and meaningfully support the body of current literature and information regarding valuable strategies for broadening participation.

Purpose

The purpose of this work-in-progress is to describe a pilot-study focused on identifying barriers to student persistence and participation in STEM at a single HBCU. To address this purpose, the researchers aimed to answer the following question: From the perspective of students and STEM leaders, what issues do students encounter when pursuing STEM education at a HBCU? The long-term goal is to increase persistence by exploring the extent of and to address the identified barriers.

Prior Work & Theoretical Framework

Previous research has found that student relations, such as with peers and faculty, along with factors of race and gender influence a college student's experiences.[3] For example, researchers found that Black students note more contact with faculty at HBCUs.[4] According to Perna et al. (as referenced by Hurtado et. al.), HBCUs have been credited with Black students achieving approximately 30% of bachelor's degrees in the STEM fields.[4] Incredibly, the number of African American students obtaining STEM undergraduate degrees from HBCUs has persisted, with few declines over the years.[5] Qualitative analyses of STEM student experiences have also found that student ethnic identity, such as African American women, is desired to be preserved with the growth of a STEM professional identity.[6] These findings emphasize the potential role of HBCUs as cultural establishments fostering the student identity of ethnic minority students in STEM. HBCUs offer historical relevance, diversity promotion institutionally, with educational opportunities for minority populations in the United States.

To build upon the existing literature, this research study is grounded in Terenzini and Reason's comprehensive model of influences on student learning and persistence.[2] This framework connects the multiple influences that research suggests impact student outcomes. According to the framework (see Figure 1), it is important to consider student characteristics or education prior to entering college, campus environment (faculty behaviors, peer interactions, etc.), and the student's overall collegiate experience among other factors when investigating a learning environment and the resulting student outcomes.[2]

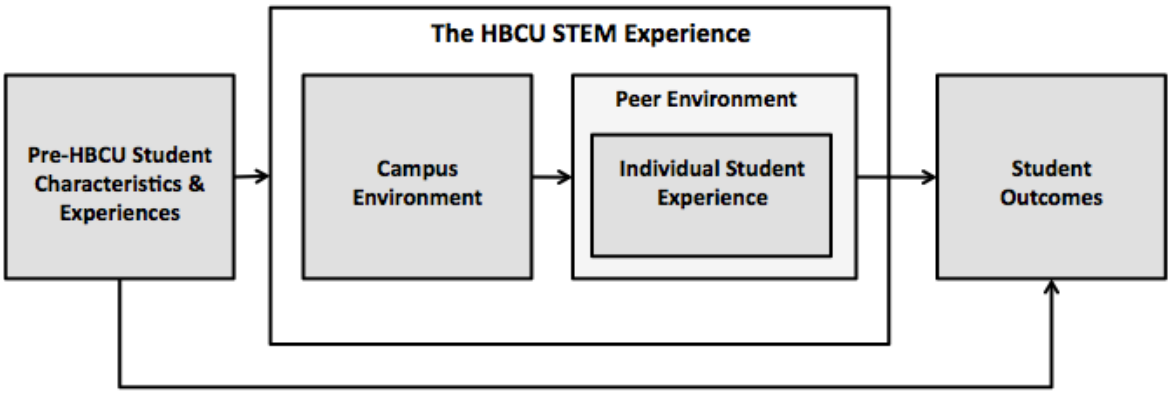

Figure 1 – Simplified model of influences on student learning and persistence

These factors shown in the model have proven to have pronounced power on student success and completion of programs and are directly linked to student persistence. The factors outlined in this

framework will be central to understanding student success at HBCUs and enable the connection of the present study's findings to existing literature.

Methods

The researchers implemented an iterative, descriptive research model by including the following action items: (a) engaging research participants; (b) developing data collection strategies; (c) defining variables and constructs; and (d) gathering information and investigating research question(s). This paper focuses on the data collected currently from one institution. The present research study findings are informed by quantitative data. Data from additional HBCUs will be collected and analyzed subsequently.

Participants

Participants included the following: STEM Students; STEM Program Directors, Coordinators, and Staff; University Executive Administrators; STEM Academic College Deans; STEM Faculty; and STEM Mentors and Advisors. Each volunteer participant was eighteen years of age or older and was either enrolled or worked for the participating HBCU. For brevity and clarity when referring to participants we will discuss the groups collectively as two separate groups. The two groups will be referred to as students (Group 1) and as leaders for faculty and administrators (Group 2).

Instrument Development

To solicit the opinions of students and leaders, the researchers developed a questionnaire with a Likert scale (Rating: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree, 6 = Not Sure) for participants to rate their perception of experiences in STEM majors at the HBCU. Survey items were developed to reflect the common reasons for student departure as outlined in *Talking About Leaving* and the experiences of senior leaders on the project, each of which having years of experience at HBCUs.[7] To ensure the survey focused on the intended areas and that the researchers engaged in a comprehensive approach, each survey item was aligned with a research thrust area and compared with the theoretical framework. To account for differences in demographic information needed, two parallel surveys were created for each group.

Data Collection

Data were collected from students (Group 1) and faculty (Group 2) using surveys. The surveys were distributed online, in-person, or using both approaches. Examples of specific questions included in the survey are shown in Table 3. Hard copies were printed and disseminated to students in STEM major classes, student organization meetings, and at the university student center. Students were also emailed a link to the survey for online completion. For faculty, only online methods were used. These efforts resulted in a total of 87 participants across Group 1 (n = 71) and Group 2 (n = 16). The majors and departments represented in this sample are listed in Tables 1 and 2 below. All student classification levels were represented in the survey results, from freshmen to graduate students. The largest group of participants self-identified as seniors (n = 33). Majority of participants self-identified as Black or African American in both groups. Women comprised 49% (n = 35) of Group 1 and 38% (n = 6) of Group 2.

Data Analysis

For preliminary data analysis, descriptive statistics—averages (i.e., means) and standard deviations—were derived using Microsoft Excel after initial data inputting, cleaning, and coding (where needed) were completed. Participant survey responses indicating a rating of 6 for "Not Sure" were omitted, as this was considered equivalent to a participant offering no response or no opinion. The goal was to identify trends for further exploration upon collecting more data nationwide.

Table 1: Participant's major from Group 1

Major	# of Participants
Biology	17
Chemistry	4
Electrical engineering	6
Mechanical engineering	8
Civil Engineering	5
Mathematics	3
Political Science	1
Computer Science	19
General Engineering	1
Architectural Engineering	6
Did Not Answer	1
Total	71

Table 2: Participant's department from Group 2

Department	# of Participants
Computer Science	1
Civil Engineering	1
Psychology	1
Life and Physical Sciences	1
Physics	1
Mathematics	2
Mechanical Engineering	1
Biology	3
Engineering	2
Did Not Answer	3
Total	16

Preliminary Results

The preliminary research findings are presented in Table 3, where results are highlighted based upon the following color grouping method: Items rated above 4.0 are highlighted dark gray and items rated between 3.0 and 4.0 are highlighted light gray. As depicted, Group 1 (students) rated Question 3 (i.e., Students lose confidence due to low grades in early STEM courses) highest followed by Question 13 (i.e., Students encounter language difficulties with foreign faculty or TAs) as the most significant reasons for students leaving STEM majors. Group 2 (leaders) rated Question 7 (i.e., Students are overwhelmed by fast paced STEM courses) highest followed by Question 5 (i.e., Students have inadequate high school preparation in study skills) and Question 4 (i.e., Students have inadequate high school preparation in STEM subjects) as the primary reasons students leave STEM majors.

Table 3: Preliminary results from a single institution

	Group 1: Students		Group 2: Leaders	
Questions	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
1. Students lose interest in STEM majors	3.44	1.29	2.67	1.07
2. Students choose STEM majors for reasons that prove to be insufficient	2.75	1.22	3.62	1.26

Table 3: Preliminary results from a single institution				
	Group 1: Students		Group 2: Leaders	
Questions	Mean	Standard Deviation	Mean	Standard Deviation
3. Students lose confidence due to low grades in early STEM courses	4.35	0.72	4.25	0.87
4. Students have inadequate high school preparation in STEM subjects	3.94	0.97	4.31	0.85
5. Students have inadequate high school preparation in study skills	3.98	1.11	4.46	0.66
6. Students have inadequate family support	2.63	1.22	3.82	1.08
7. Students are overwhelmed by fast paced STEM courses	3.79	0.99	4.5	0.67
8. Students experience poor teaching by STEM faculty or TAs	3.46	1.05	2.92	1
9. Students receive inadequate advising or help with academic problems	3.43	1.19	3.17	1.11
10. Students are turned off by the foreseen length of earning a STEM degree	3.73	1.09	2.67	0.89
11. Students experience problems related to class size	2.6	1.22	2.25	0.97
12. Students have inadequate access to lab or computer lab facilities	2.75	1.48	2.17	1.34
13. Students encounter difficulties with faculty or TAs	4.02	1.11	2.73	1.27
14. Students think non-STEM majors offer better opportunities	2.57	1.28	2.08	0.9
15. Students think non-STEM majors are more interesting	2.94	1.29	2.33	1.23
16. Students think STEM career options or rewards are not worth effort to get degree	2.41	1.31	3	1.41
17. Students shift to more appealing non-STEM career options	3.38	1.63	2.83	1.03
18. Students reject STEM careers and associated lifestyles	2.74	1.17	2.58	1.24
19. Student morale is undermined by competitive STEM culture	3.25	1.17	3.18	1.47
20. Students have a lack of peer support in STEM majors	2.9	1.33	3.2	1.32
21. Students are discouraged by unsupportive faculty	3.16	1.27	2.82	1.25
22. Students experience prejudice and discrimination in STEM majors	2.68	1.3	2.33	1.07
23. Students do not gain a sense of belonging in their STEM majors	2.76	1.25	3	1.28

Discussion & Future Work

The preliminary results highlight different aspects of STEM education at this HBCU that may be affecting student success. The preliminary responses of student and faculty groups indicate difference of opinion regarding the top reasons why students leave STEM majors. Such findings will guide further investigation and narrowing of the research thrust areas with more HBCUs. Conclusions will be made greater with more data gathered and more in-depth analyses conducted. For example, if such trends continue from more data collected and analyzed, it may be that improved preparation for STEM curriculum, academic support, such as tutoring and instructional methods all may reduce the likelihood of lower grades and students deferring from STEM majors at HBCUs. Additionally, student perspectives in encountering language difficulties with foreign faculty and TAs may be linked to curriculum and instructional methods, which may be potentially relieved by enhanced student communication or faculty development.

Further research will advance an understanding of the overall experiences of STEM students at HBCUs and exposure to strategies that will broaden participation and improve student persistence in STEM fields nationwide. Continuous data gathered nationally will be analyzed further to inform the development of strategic methods and models to effectively broaden participation and support student persistence in STEM fields.

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