Student STEM Learning, Motivation and Achievement in the HBCU Context: Evidence from the Black Excellence in Science/Mathematics Teaching (BEST) Education Research Project

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CETLA Lecture Series:
Teaching African American Students

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Mixed-Methods Study Design

What are the individual, instructional and institutional factors related to success in producing African-American science and math teachers at HBCUs?

- Science/Math Teacher Interviews
- STEM Freshmen Longitudinal Survey
- Teacher Education Program Case Study
Research Question

• What individual, instructional, and institutional variables promote the achievement and retention of undergraduate students who have declared a major in STEM?
Statement of the Problem

• Broadening participation in STEM of African American and Black students across the world is one of the most important tasks of higher education.

• HBCUs lead thousands of other colleges and universities in producing African American undergraduates who earn PhD’s in the sciences and engineering (National Science Foundation, 2008); yet, little scientific evidence exists concerning how HBCUs have attained these results.

• These achievements warrant scientific investigation in order to discover the factors related to success at HBCUs, with the purpose of advancing education theory and models of educational excellence that can be replicated in other settings as well as strengthen HBCUs.
Factors Related to STEM Achievement

• A long tradition in STEM policy and education research to draw attention to resources and structural variables that are related to STEM achievement
  – science and mathematics teacher quality
  – school resources
  – course taking in science and mathematics
  – inequities in educational opportunity
Factors Related to STEM Achievement

Psychological and sociocultural factors are equally if not more important to investigate and understand success in STEM education and workforce development.
Theoretical Framework

Achievement Motivation

• Contemporary theories of motivation emphasize students’ cognitions, beliefs and “meaning making” of their environments as central in understanding students’ motivation and performance (Perry, Turner, & Meyer, 2006; Schunk, Pintrich, & Meece, 2008).

• We examine HBCU students’ perceptions of their university and classroom environments to understand their motivation and performance in STEM.

• Prior research has shown students’ motivational beliefs (e.g., self-efficacy) to be significant predictors of STEM achievement (Perna, et al, 2009).
Theoretical Framework

Identity

• Identity is an emergent structure within human personality that develops throughout the lifespan.

• Identity is the critical psychological task during adolescence and emerging adulthood (Erikson, 1968): Who am I?; What will I do with my life?; How do I fit in the adult world?
  – Multidimensional (personal and social)
  – Hierarchical (salience and centrality)
  – Developmental (stages)
Related Research on Students in STEM at HBCUs

• The extant literature on the topic of higher education in Black contexts suggests that Black students at HBCUs are able to persist and achieve in school because of the support and encouragement they receive from faculty, staff, and administrators (Kim & Conrad, 2006; Palmer & Gasman, 2008).

• Kim and Conrad (2006) found that Black students are more involved in faculty research projects on HBCU campuses than HWCU campuses, which helps to retain students.

• Other research on HBCUs attributes their success to the nurturing, family-like environment as well as the emphasis on increasing Black awareness and self-development (Fleming, 1984; Freeman, Rouland, Winston et al., 2011), in contrast to the discrimination or social challenges African Americans tend to experience in predominately white institutions (Hurtado, Han, Saenz, Espinosa, Cabrera, & Cerna, 2007).
Study Rationale

• A portrait of the multiple dimensions of college students’ achievement motivation and identity can provide insight into who these individuals are as persons and students, which in turn can shape efforts to retain and recruit them into the STEM workforce.

• Existing theory and research on achievement motivation and identity support the importance of these factors in the academic development of college students at the transition between high school and college, as well as from the developmental stage of late adolescence to emerging adulthood.

• Researching student perceptions and “meaning making” of college education can provide insight into areas for instructional and institutional development.

• We seek to understand the psychology of student success in STEM at HBCUs.
Research Questions

- What factors influenced student selection of Howard and STEM major?
- What are achievement motivation and identity characteristics of an HBCU STEM cohort in their first year of college?
- What individual, instructional and institutional variables predict student STEM achievement?
- What is the value of an HBCU education, to students?
Howard University Engineering and Science Success Survey (HUE(S)³)
Longitudinal Design

• Following students over time as they progress through their undergraduate studies.
• Nine-wave longitudinal, self-administered survey.
• 2008 freshmen cohort of Howard University students who at start of college had declared a major in science, engineering or mathematics.
• Examining factors that predict retention and achievement in STEM.
• Conducted comprehensive assessment of students at baseline.
Sample

- In total, 323 students were included in the sample, which represented approximately 80% of the total STEM freshmen population at the university.
  - 71% women
  - 29% men
  - 74% Black/African American
  - 7% Black/Other
  - 14% Multiple Race
  - 65% biology majors
  - 18% engineering majors
  - 7% chemistry majors
  - 4% computer science majors
  - The average level of education among students’ mothers and fathers was some college.
Variables

- faculty and peer relationships
- experiences in science, engineering, mathematics courses
- learning and study strategies
- motivational and academic beliefs
- gender, racial, occupational identity
- parental expectations
- educational and career aspirations
- satisfaction with institution
- involvement in clubs and groups
- financial aid
- high school course-taking
- socioeconomic indicators
- faculty instructional practices and quality
- value of attending an HBCU
Top 5 reasons that influenced students’ decision to attend Howard University

- This college has a very good academic reputation: 86%
- This college’s graduates get good jobs: 67%
- This college’s graduates gain admission to top grad/prof schools: 65%
- This college has a good reputation for its social activities: 58%
- It is an HBCU: 53%
Influential people in students’ decision to become STEM major

- Parents, Siblings and other Relatives: 80%
- Other: 7%
- Other Teacher: 6%
- Friend: 3%
- Science Teacher: 2%
- School Counselor: 1%
What factors influenced student selection of Howard and STEM major?

- Academic reputation of Howard, prospects of graduates, and that HU is an HBCU.
- Families play the significant role in student’s decision to major in STEM.
- Chief among families’ interest in science is as a pathway to a good career.
Achievement Motivation at Baseline

- Work Avoidance: 2.5
- Mastery Goals: 3.83
- Academic Self-Efficacy, Math: 3.98
- Academic Self-Efficacy, Science: 4.21
- Initial Performance Expectations: 4.69
Learning Strategy Use at Baseline

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Score</th>
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<tbody>
<tr>
<td>Peer Learning</td>
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<tr>
<td>Self-Regulation</td>
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<td>Organization</td>
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<td>Elaboration</td>
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<tr>
<td>Time/Study Environment</td>
<td>5.19</td>
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<tr>
<td>Effort Regulation</td>
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</table>
Educational Expectations at Baseline

- Bachelor's degree (B.A., B.S., etc.): 4%
- Master's degree (M.A., M.S., MBA, M.Ed.): 18%
- Ph.D. or Ed.D.: 26%
- J.D. (Law): 1%
- B.D. or M.Div. (Divinity): 0%
- Other: 1%
Students’ Racial Identity and the End of Freshman Year

- Private
- Membership
- Identity Centrality
- Public
Gender Identity

Who is Math or Science More Important for, Males or Females?

![Bar chart showing the percentage of males and females who believe Math or Science is more important for them.]

- **Males:**
  - A Lot More Important for Males: 1%
  - A Little More Important for Males: 6%
  - Equally Important for Males and Females: 18%
  - A Lot More Important for Females: 1%

- **Females:**
  - A Lot More Important for Females: 73%
  - A Little More Important for Females: 1%
  - Equally Important for Males and Females: 6%
  - A Little More Important for Males: 5%

Legend:
- A Lot More Important for Females
- A Little More Important for Females
- Equally Important for Females and Males
- A Little More Important for Males
- A Lot More Important for Males
Gender Identity

Do You Think it Will be Harder to Get Ahead in Life because of Your Gender?
What are achievement motivation and identity characteristics of an HBCU STEM cohort in their first year of college?

• Positive motivation and identity – developmental and cultural strengths.
• Improvement of learning strategy use is an area for programmatic intervention.
• Despite egalitarian views about the importance of and competence in science for males and females, women perceive barriers.
Research Questions

Controlling for individual baseline factors, what HBCU instructional and institutional factors predict the motivation and achievement of undergraduate students in STEM majors?

From the students’ perspective, what is the value of attending an HBCU?
# Regression Analysis Predicting First-Year GPA

<table>
<thead>
<tr>
<th>Variable</th>
<th>Individual β</th>
<th>Institutional β</th>
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<tbody>
<tr>
<td>SAT</td>
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<td>.43***</td>
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<tr>
<td>Male</td>
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<td>-.17*</td>
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<td>.01</td>
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<td>Faculty Instructional Skill</td>
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<td><strong>Faculty Caring Attitude</strong></td>
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<td>R²</td>
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<tr>
<td>Δ R²</td>
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*p ≤ .05, ** p ≤ .01, *** p ≤ .001
**Regression Analysis Predicting Institutional Commitment**

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<td></td>
<td>.05</td>
</tr>
</tbody>
</table>

**Peer Relationships**

| Involvement in Clubs & Groups           | .27**              |
| R$^2$                                    | .14                |
| $\Delta$ R$^2$                          | .27                |

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$
What do you think the greatest value is of attending a historically black university, in terms of your educational ambitions? Please provide as much detail as possible.
Results
Themes in Students’ Constructions about the Value of Attending an HBCU

• Connectedness
• Cultural Socialization and Pride
• Unique, High-Quality Education
Connectedness

The greatest value of attending a historically black university is the connection to history you feel. When I arrived at Howard and visited the museum in Founders library I saw a picture from 1950 of women standing in the building I now live in; I felt as if I was a part of history. That feeling encourages me to do the best I can.

I feel that I will experience a special kind of nurturance that will prepare me for a successful career. I want to learn from and with people that look like me. Knowing that prestigious Blacks have graduated from black schools shows as motivation and inspiration.

Being able to be taught by Black professors and seeing them as an example of an accomplished Black individual.

There is a sense of unity and pride in the black community that I never really had before coming to Howard. At Howard, I know that I will be receiving a quality education from people who look like me and know what I have to go through not only in the realms of academia, but also in everyday life.

Being surrounded by people who look like me and are focused, intelligent, and driven towards a positive goal is amazing. It makes me proud and pushes me to do better.
Cultural Socialization & Pride

...is really exposing me to a lot of things historically, professionally, and socially that I do not feel I could have learned at a non-HBCU. It teaches me the things about the African American race and history that I was not taught in school making me more confident and proud to be a black woman.

... I have felt the remarkable power of being educated amongst my social and cultural peers. Our race ties us together because of our shared common history; I could not receive this educational experience at any PWI. For many Black students, the chance to live and learn amongst a racial majority establishes a sense of equality and self-worth that was previously unexplored. HBCUs are well-known reservoirs of Black culture and history; many aspects of the HBCU curricula incorporate African-American, African, and Black studies and history, providing their students with a strong sense of their history, culture, and purpose. As repositories for black heritage, HBCUs are rich arenas that help promote and incorporate Black and African history in American society and more importantly, my life.
Unique, High-Quality Education

There are so many opportunities available as well as an excellent curriculum.

Networking with future Black leaders and current ones.

It has exposed me to so many different networking opportunities with the different job fairs, conferences, workshops, and lectures. This is helping my professional and networking skills that I will be able to take with me into the corporate world...

I think I am afforded many more connections in my industry of choice here. I also know that there are more opportunities for work graduating from my school than if I was anywhere else. The companies are coming to HBCUs for highly trained black people.

The fact that you get a sense of culture as well as a good education.
One of the greatest values of attending a historically black university, is that I am surrounded by people that look like me, who want to be great leaders in the healthcare world, politics, and business world along with other professions. Many times as minorities, we are looked at in a negative light, and the stereotypes that are out about us, portray many young women as single teen mothers, who will not graduate from high school. The males are looked at as drug dealers, or drop outs who will end up either in jail or dead. Being at this university I see many young blacks defying the stereotype and letting the world know, we are making a difference. Being here also gives us an advantage and many companies are looking for the next generation full of thriving and determined young minds. They more than likely will find it at a historically black university.
Summary

• The value of attending an HBCU for students’ motivation and achievement in STEM is the connectedness students feel in a Black educational context, as well as the culturally responsive and quality education provided by the institution.

• Relationships with faculty and peers play a significant role in students’ achievement and retention.

• The cultural responsiveness of the institution seems to create an ideal synergy to foster healthy psychological and academic development for Black students within STEM in higher education.
Questions & Discussion