Modeling Graduate Student Persistence in Science, Technology, Engineering, and Mathematics Programs at a Historically Black University

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Abstract

The participation of African-Americans in science, technology, engineering, and mathematics (STEM) fields has become a topic of great interest in recent decades. While several studies have examined African-American students’ persistence in STEM programs at predominantly White institutions, little empirical work has been done to examine what factors may explain their persistence at historically black institutions. In an effort to close this research gap, we use a longitudinal dataset and discreet event history analysis to model the persistence of African-American graduate students enrolled in STEM programs at a HBCU located in the south-eastern United States. Several factors including degree attainment, gender, and interruptions during matriculation (stop-outs) appear to explain persistence patterns at the HBCU.
Introduction

The participation of African-Americans and other historically underrepresented groups in science, technology, engineering, and mathematics (STEM) programs remains a concern for both academicians and practitioners. This concern is fuelled by a number of factors including a growing shortage of potential human capital in the STEM educational pipeline (Suitts, 2003; Herzig, 2004; National Science Foundation, 2000), and a concern by some that the cultures inherent to STEM disciplines and programs work against the inclusion of minorities (Nixon, Meikle, and Borman, 2007). These and other factors may have longstanding effects on the number of underrepresented minorities who enroll in and earn degrees in STEM programs, and ultimately on the number who ultimately pursue careers in STEM fields.

Much of the research examining student persistence in STEM programs has been directed toward studying attrition patterns for undergraduate students who begin their postsecondary careers enrolled in STEM programs, but who ultimately either change their majors to non-STEM fields, or leave altogether. Examples of this work include Holland and Eisenhart, 1990; Lietze, 1996; and Seymour & Hewitt, 1997. These studies may be limited in their abilities to address questions about the long-term implications of student departures from STEM programs as their samples are more likely to include students who had only marginal interests in STEM, or who realized that their long-term career interests were better served by pursuing majors in other areas. The pursuit of a graduate degree may speak more to a student's commitment to the study of, and a career in, a STEM field. Hence, studying graduate student persistence in STEM programs is likely to yield significant theoretical and practical benefits.

Prior studies have shown that in general, students with STEM majors have higher persistence and graduation rates than students enrolled in non-Stem programs (e.g. Brewton and Hurst, 1984). However, other research suggests that this is not generally true for women and minorities (Government-University-Industry Research Roundtable, 1987; Strenta, Elliott, Adair, Martier and Scott, 1994). Lower persistence and completion rates for women and minorities may be attributable to a number of factors including: 1) a lack of academic preparation (Strenta, et al. 1994); 2) math anxiety/avoidance (Rendon, 1982); 3) a lack of faculty role models (Regional Policy Committee on Minorities in Higher Education, 1987); and 4) poor academic integration and social integration experiences (Steele, 1995). These conclusions were reached by examining general student persistence on college campuses. The extent to which these factors influence persistence for graduate students has not been widely tested. Additionally, prior research suggests that different factors might influence minority student success at predominantly White institutions (PWIs) versus institutions where minority populations make up the largest portion of the student body.

Understanding that persistence in STEM programs is to a significant degree a by-product of student preparation and environment, the primary focus of this study is on African-Americans enrolled in STEM programs at a historically black university (HBCU). Specifically, it models persistence and completion patterns for graduate students enrolled in STEM master's degree programs for eight academic years (1999/2000 ÿ 2006/2007). Two primary questions are addressed by this preliminary study. First, we seek to answer: When is attrition from STEM programs most likely to occur. Second, we ask: What variables best predict persistence and attrition for African-American students enrolled in master's degree level STEM programs at the HBCU.
Institution Profile: 2007

Location:
Southeastern United States

Carnegie Classification:
Doctoral/Research Institution

Enrollment: 11,567
Men: 4,784
Women: 6,783

Percentage of Students by Ethnic Origin Fall 2007

- Asian/Pacific Islanders: 1.08%
- Black: 90.11%
- Hispanic: 2.01%
- Amer. Indian/Alaskan Nat.: .19%
- Non-Resident Alien: 1.16%
- White: 4.86%
- Not Reported: .60%

Source: University Factbook 2007-2008
2007 Graduate Student Enrollment by Status

- **Lower Division**: 52%
- **Upper Division**: 31%
- **Beginning Graduate**: 14%
- **Advanced Graduate**: 1%
- **Unclassified**: 2%

Source: University Factbook 2007-2008
Master’s Level STEM Programs Offered

- Agricultural Sciences
- Biology
- Chemistry
- Computer Software Engineering
- Physics
- Physics Education
- Science Education
- Biological Engineering
- Civil Engineering
- Electrical Engineering
- Industrial Engineering
- Mechanical Engineering
- Mathematics
- Mathematics Education
Sample Description

Å Subset of master’s level students enrolled at university between Fall 1999 and Summer 2007 semesters;

- Persistence for individuals included in the sample is tracked over 12 academic semesters;
- The data are right-censored to account for individuals who never experience attrition.

Å 1,458 total observations:

- 280 for students enrolled in STEM;
- 1,178 for students enrolled in non-STEM disciplines
Method

• Discrete-Time Survival Analysis
  - Allows for analysis of patterns of attrition/persistence over time

• Dependent variable (Attrit) is a measure of whether or not student left the university:
  - Coded “0” for each term that the student persisted
  - Coded “1” during term of attrition

• Independent variables:
  - Program Type (coded “0” for Non-STEM; “1” for STEM)
  - Degree (whether or not student earned master’s degree in STEM)
  - Undergraduate GPA
  - Cumulative graduate GPA
  - Financial Aid Flag (whether student received need-based aid)
  - Gender (coded “0” for female; “1” for male)
  - Race (coded “0” for Non African-American; “1” for African-American)
  - Stop-Out (coded “0” for no; “1” for yes)
Model Results

Insert Results Table Here
Results (continued)

When are students at the subject HBCU most likely to leave STEM programs at the subject HBCU?

Students are most likely to leave STEM programs after completion of their fifth semester. The likelihood of attrition increases from the fifth semester on.

What factors best explain student attrition?

Five variables appear to predict the amount of time students spend in STEM programs at the subject HBCU.

Degree attainment, gender, stopping out, cumulative grade point average, and undergraduate grade point average appear to be the best predictors of attrition.

No significant variation was found in attrition patterns STEM vs. Non-STEM students or based on financial need.
Discussion

- **Degree Attainment**: Of course, earning a degree increases the likelihood of attrition. The likelihood of attrition is .29 units greater ($p < .1$) for those who earn a degree versus those who do not.

- **Gender**: The likelihood of attrition is .37 ($p < .05$) units greater for males than for females. While this describes persistence patterns, more investigation into the causes of this pattern is required.

- **Results for the two variables measuring preparation for graduate STEM work were mixed**:
  - Higher cumulative graduate GPA appears to be associated with attrition ($p < .1$). Whether this is a true effect, or is influenced by limited variation in values for this variable requires further analysis;
  - Higher undergraduate GPA is associated with persistence ($p < .1$).

- **Stop-Out**: The likelihood of attrition within the observed time periods (12 semesters) is .7 ($p < .05$) lower for students who experience at least one stop-out.
  - While these students may ultimately earn their degrees, the amount of time required to do so is longer.
Kaplan-Meier survival estimate

semesters

0.25
0.50
0.75
1.00

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Kaplan-Meier survival estimates: Degree Attainment

- Degree = 0
- Degree = 1

semesters
Kaplan-Meier survival estimates: By Gender

The graph shows Kaplan-Meier survival estimates for different genders over semesters. The x-axis represents semesters, ranging from 0 to 14, and the y-axis represents survival estimates ranging from 0.25 to 1.0. The lines for males (M) and females (F) are indicated by different colors.
Conclusions

Â There are several ways to think about persistence and attrition from STEM programs.

ï Positive attrition through master’s degree attainment appears to be most likely following the fifth semester (approx. two academic years), with the odds of leaving due to degree attainment increasing each semester thereafter.

ï The model suggests slightly lower persistence rates for males. While gender does not “cause” attrition/persistence, other factors associated with gender may. Possible interactions (e.g. gender and degree attainment) require additional investigation.

ï Stop-outs have a significant effect on student persistence. Students who experienced at least one interruption during their matriculation were less likely to leave during the observation period.

Â Stop-outs may extend time to degree.

Â Because of the costs that long-term persistence beyond desired degree attainment timelines impose on both students and the university, more attention may need to be paid to understanding the causes and nature of stop-outs.