

Exploring the Association of a Cultural Engineering Student Organization Chapter with Student Success

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Introduction

In order for engineers to produce solutions that more effectively address complex societal challenges, perspectives from all members of the global community are needed. Yet, within the United States, it has been stated that “Engineering has a ‘diversity’ problem” (p. 73) [1] given the lack of participation of underrepresented minorities (URMs) in Science, Technology, Engineering, and Mathematics (STEM). National data suggests that an urgent, sustained, comprehensive, intensive, coordinated, and informed national effort is necessary to increase success of underrepresented minorities (URMs) in STEM [2]. URM is the classification given to the following groups: African American, Hispanic American or Latino, Native American, Native Hawaiian or Pacific Islander. In the US, these groups comprise 31.1% of the population [3], yet they are only 17.4% of the student population pursuing engineering degrees [4].

In general, the successful pathway to a career in STEM typically requires “the acquisition of knowledge, skills, and habits of mind; opportunities to put these into practice; a developing sense of competence and progress; motivation to be in, a sense of belonging to, or self-identification with the field, and information about stages, requirements, and opportunities” (p. 5) [2]. Research has demonstrated that these pathways are not equivalent across race and gender populations [2]. For URM populations in particular, these pathways are critical because such populations typically face additional barriers including academic and social isolation, and stereotype threat. Consequently, traditionally underrepresented groups, including first-generation college students, leave engineering in disproportionate numbers [5].

Engineering student organizations are generally recognized as an avenue to address retention issues and foster student development benefiting the student academically, professionally, and interpersonal skills [5], [6]. The broader role of extracurricular activities in the development of an engineer is a area of exploration for the engineering education community, including the nature of the activities and time spent participating [7]–[9], as well as the development of non-technical skills such as ABET Outcomes, 21st century skills, or Engineering of 2020 traits [10]–[12]. However, the impact of student chapters of professional organizations remain relatively unexplored [13], [14]. In addition, within both the general and more discipline specific extracurricular literature, there is a need to explore the experience of URM students in extracurricular activities due to low sample sizes or lack of consideration in current studies.

Involvement in minority engineering student organizations is encouraged as a key extracurricular experience for students from underrepresented groups [13], [15]–[17]. University support programs that target students from URM groups, such as Minority Engineering Programs (MEPs), explicitly identify cultural student organizations as an avenue to increase the quantity of student interactions outside the classroom in addition to other initiatives [15], [18]. With aligned goals in the recruitment and retention of URM engineers, minority engineering student

organizations and MEPs tend to interact in some capacity at PWIs. For example, MEP staff may serve as chapter advisors and provide institutional support for student organization activities as a retention strategy [15], [19] or organization members may participate in or volunteer for the MEP program [16]. In fact, some minority engineering programs are the result of student organization initiatives that became institutionalized [16].

In studies exploring the persistence and retention of African-American engineers, participation in the National Society of Black Engineers (NSBE) has been identified as a contributing factor or emerging theme in African-American student success at particular institutions [14], [20]–[22]. Increasing participation in NSBE among the broader African-American community can help target not only collegiate persistence and student development concerns but the development of the broader engineering pipeline due to the organization's pre-collegiate, collegiate, and professional membership.

National Society of Black Engineers Overview

One engineering student organization that targets students from Black or African-American backgrounds is the National Society of Black Engineers whose mission is to “increase the number of culturally responsible engineers who excel academically, succeed professional, and positively impact the community”. It is a non-profit, student-led, US-based organization with a global membership of approximately 30,000. Its membership spans a demographic of 6th – 12th grade students, university students (undergraduate and graduate) and working engineering professionals. The organization is student-led and therefore university students are the core of the organization. The first chapter originated on a college campus (Purdue University) in 1975 and has grown to a national organization where the primary Regional and National Executive Board offices are only eligible to engineering and affiliated major students. As an organization, NSBE membership offerings include academic and professional development activities, leadership training, mentoring opportunities, and career placement services.

Studies of participation in NSBE, especially at a PWI, suggest positive academic success outcomes are experienced by members [14], [22] as a result of program offerings, professional and leadership skill development opportunities, a family environment with community support, and positive role models with similar backgrounds and goals [11], [13], [14], [22], [23]. For example, in a study of one small, Midwestern, private university over the 2005-2015 time period, it was identified that of the 29.7% of black students who graduated with an engineering degree within 6 years, a vast majority were active members of NSBE (81.8%) [14]. Access to comprehensive chapter participation data has limited the exploration of the impact of NSBE chapters at various institutions. To add to this relatively underexplored body of knowledge, this paper aims to explore indicators of the potential impact of participation in NSBE at another PWI. The research questions are as follows:

1. What are the persistence and completion patterns of black engineering students at a Midwestern PWI?
2. Is there an association between NSBE involvement and graduation rates of black engineering students at 4-,5-, and 6-years post entry?
3. How do graduation rates of black engineering students compare to graduation rates of the total student population?

4. Are there differences in departure rates between students involved in NSBE and those who are not involved?

Methods

Cohort Definition

Each study cohort was limited to degree-seeking, first-time, full-time students who entered the College of Engineering during a fall term. These students begin the engineering program in the Fall Semester and pursue the degree full-time. This definition was selected as retention within the student reporting database of the university is based on tracking first-time, full-time students from a beginning term.

Study Period

Although the student reporting structure of the university has historical data on student admission and retention with validated reports from 1990 to present, the records of student organization membership for this study were available from 2003 onwards. Additionally, this study focuses only on cohorts that have at least six years on enrollment data for the purpose of examining 6-year graduation rates. As such, the cohorts selected for this study was Fall 2003 – Fall 2010.

NSBE Participation Definition

NSBE participation in this study was defined as paid membership as denoted by both the roster listed for the university in the national membership database and local chapter membership rosters.

Data Analysis

Profile data containing demographic information, enrollment, retention, academic performance, and graduation data on all students enrolled in engineering cohorts from Fall 2003 - 2010 were extracted from the student reporting database and imported into Tableau Desktop 10.1.1 for further analysis. National and local membership rosters were reconciled to match individual membership each year to university data on persistence and performance.

The analysis was performed using the following categorization. First, each engineering cohort was analyzed in total (referred to as TOTAL) with students who identified as Black or African American removed from the cohort. Students who identified themselves as Black or African American at entry were divided into two groups: unaffiliated (referred to as nonNSBE) or NSBE-affiliated (referred to as NSBE) as defined by membership within NSBE for a least 1 year during the study period.

Persistence status was determined at 4, 5, and 6 years after entry in 4 categories: (1) graduated with an engineering degree, (2) graduated from the university a non-engineering degree, (3) still enrolled at the university, (4) left the university (either dropped or voluntarily withdrawn). The data was aggregated between cohort years for statistical analysis.

Fisher's exact test was used to analyze statistical differences ($\alpha < 0.05$) in 4, 5, and 6-year graduation rates and university departure at 6 years between the unaffiliated and NSBE-affiliated

Black engineering students. Each of these subgroups was also compared to the total cohort in a one-sided one-proportion test using total cohort data to select the hypothesized proportion. All statistical analyses were performed using MiniTab 17.

Results

Demographic Data

Table 1: Cohort Size

| | Fall 2003 | Fall 2004 | Fall 2005 | Fall 2006 | Fall 2007 | Fall 2008 | Fall 2009 | Fall 2010 |
|----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| TOTAL | 1532 | 1531 | 1712 | 1741 | 1590 | 1692 | 1651 | 1728 |
| nonNSBE | 24 | 26 | 21 | 22 | 20 | 20 | 19 | 24 |
| NSBE | 15 | 8 | 14 | 18 | 13 | 12 | 18 | 13 |

Table 2: Gender Breakdown of Black Engineering Cohorts

| | | Fall 2003 | Fall 2004 | Fall 2005 | Fall 2006 | Fall 2007 | Fall 2008 | Fall 2009 | Fall 2010 |
|----------------|--------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| nonNSBE | Female | 10 | 8 | 6 | 5 | 9 | 3 | 2 | 6 |
| | Male | 14 | 18 | 15 | 17 | 11 | 17 | 17 | 18 |
| NSBE | Female | 5 | 4 | 6 | 5 | 4 | 7 | 7 | 2 |
| | Male | 10 | 4 | 8 | 13 | 9 | 5 | 11 | 11 |

Graduation Rates by Cohort

Four-, five-, and six-year graduation rates were plotted by individual cohort year for the total cohort, unaffiliated Black engineering students, and NSBE-affiliated Black engineering students (Figure 1, Figure 2, and Figure 3). Graduation rate plots demonstrate a consistent upward trend from cohort to cohort for the entire population of engineering students. Some volatility in graduation rate over time is seen in the Black engineering student subgroups which may be the result of relatively small numbers compared to the cohort. There are some years in which the NSBE group meets or exceeds graduation rates of the TOTAL group. This does not occur in the nonNSBE group. The NSBE group graduation rate typically exceeds the nonNSBE graduation rate for all cohorts with the notable exception of the Fall 2007 cohort.

4-Year Graduation Rate in Engineering

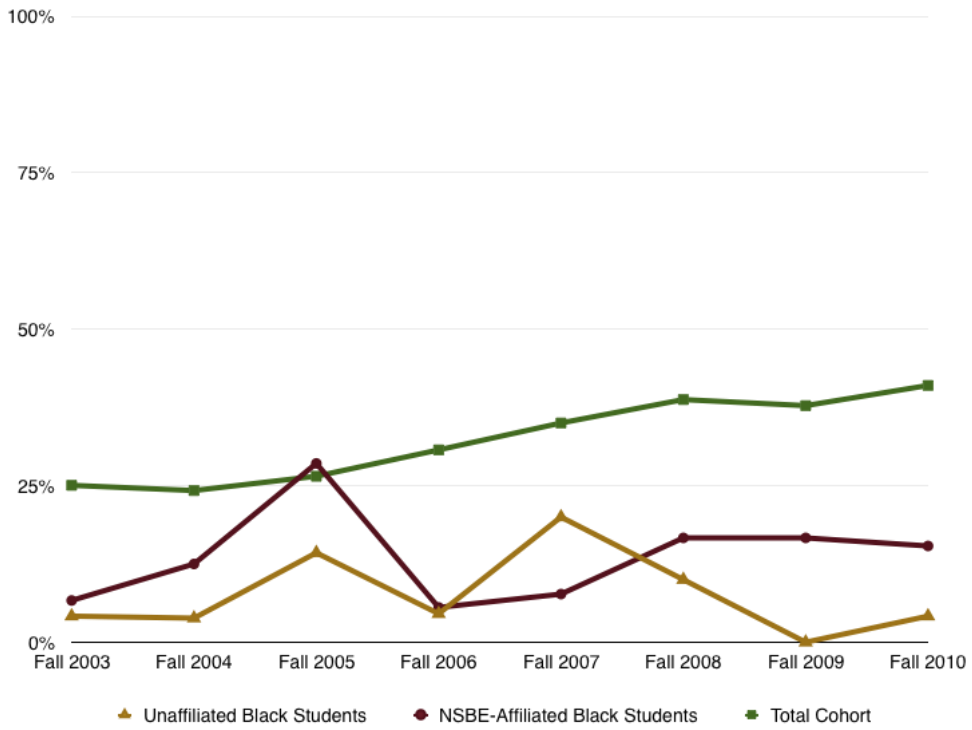


Figure 1: 4-Year Graduation Rate in Engineering

5-Year Graduation Rate in Engineering

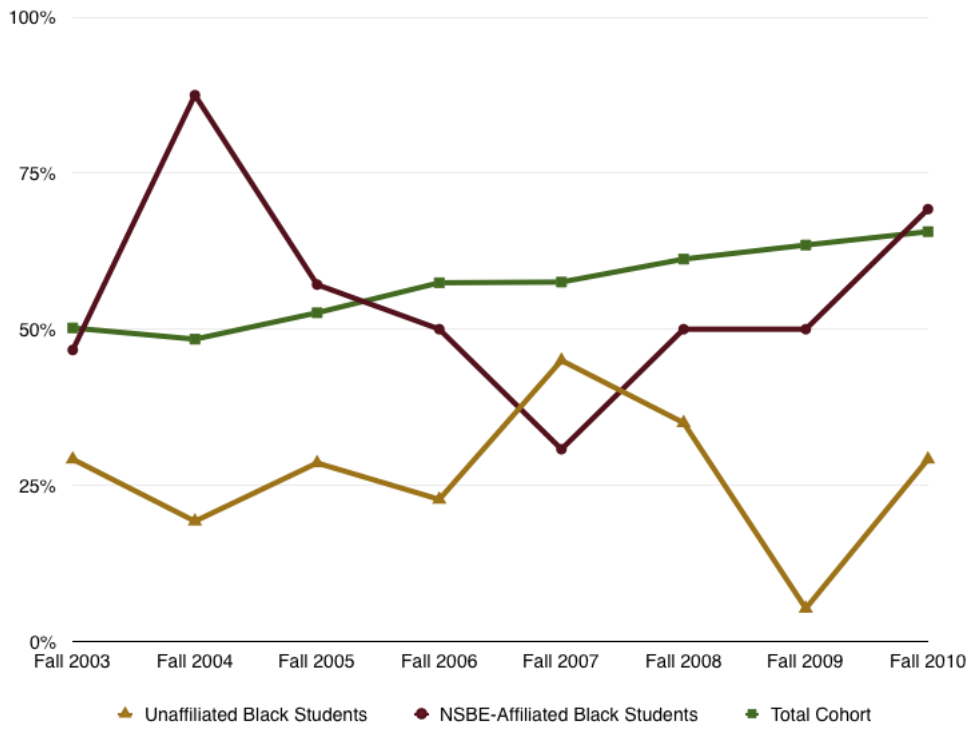


Figure 2: 5-Year Graduation Rate in Engineering

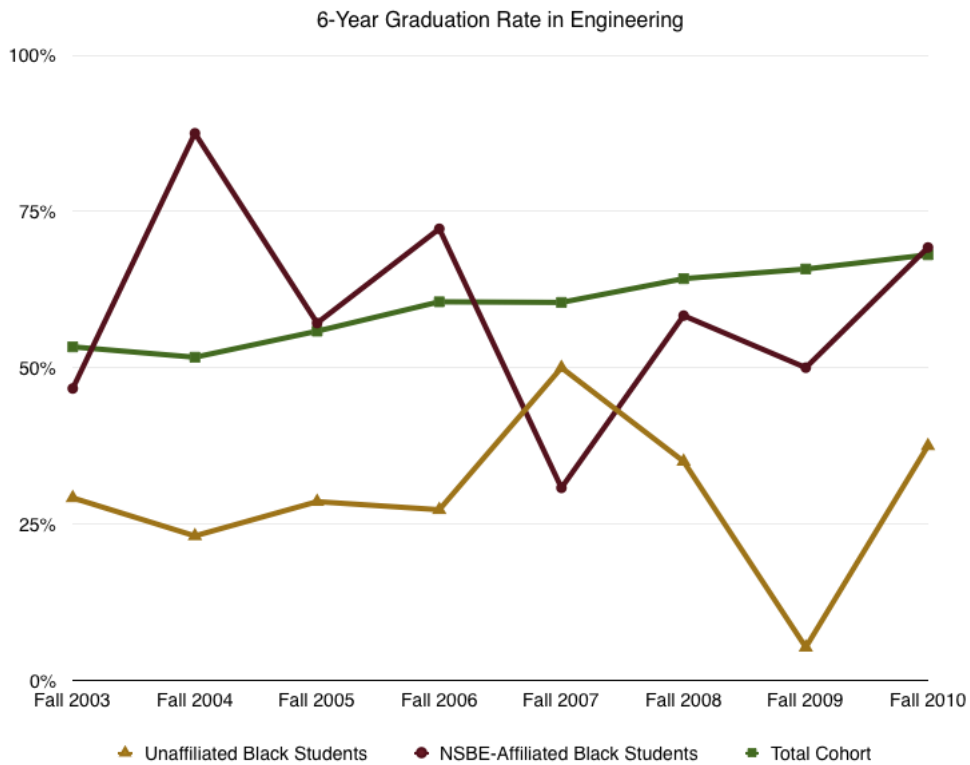


Figure 3: 6-Year Graduation Rate in Engineering

Aggregate Graduation Rates

Table 3 and Figure 4 shows the aggregate graduation rates for the Fall 2003 – 2010 cohorts broken down by the total cohort (TOTAL), Black engineering students affiliated with NSBE (NSBE) and Black engineering students who are unaffiliated with NSBE (nonNSBE). No statistically significant difference was detected in the 4-year graduation rates of black engineering students affiliated with the organization at 13.5% ($p = 0.105$) indicating that there is no association between membership in NSBE and graduation in 4 years for black engineering students. However, marked differences were noted in the 5- and 6-year graduation rates between these two groups ($p < 0.001$). When compared to the total cohort, the nonNSBE group of students graduated at statistically lower rates than expected ($p < 0.001$). While there was a difference in the 4-year graduation rate between NSBE and expected 4-year graduation based on the total cohort, there was no significant difference detected at 5-years ($p = 0.191$) and 6-years ($p = 0.294$)

Table 3: Aggregate Graduation Rates

| | 4-year | 5-year | 6-year |
|----------------|--------|--------|--------|
| TOTAL | 33.1% | 57.7% | 60.6% |
| nonNSBE | 7.4% | 26.7% | 29.6% |
| NSBE | 13.5% | 53.2% | 57.7% |

4-, 5-, and 6-Year Graduation Rates of Aggregated Cohorts (Fall 2003 - 2010)

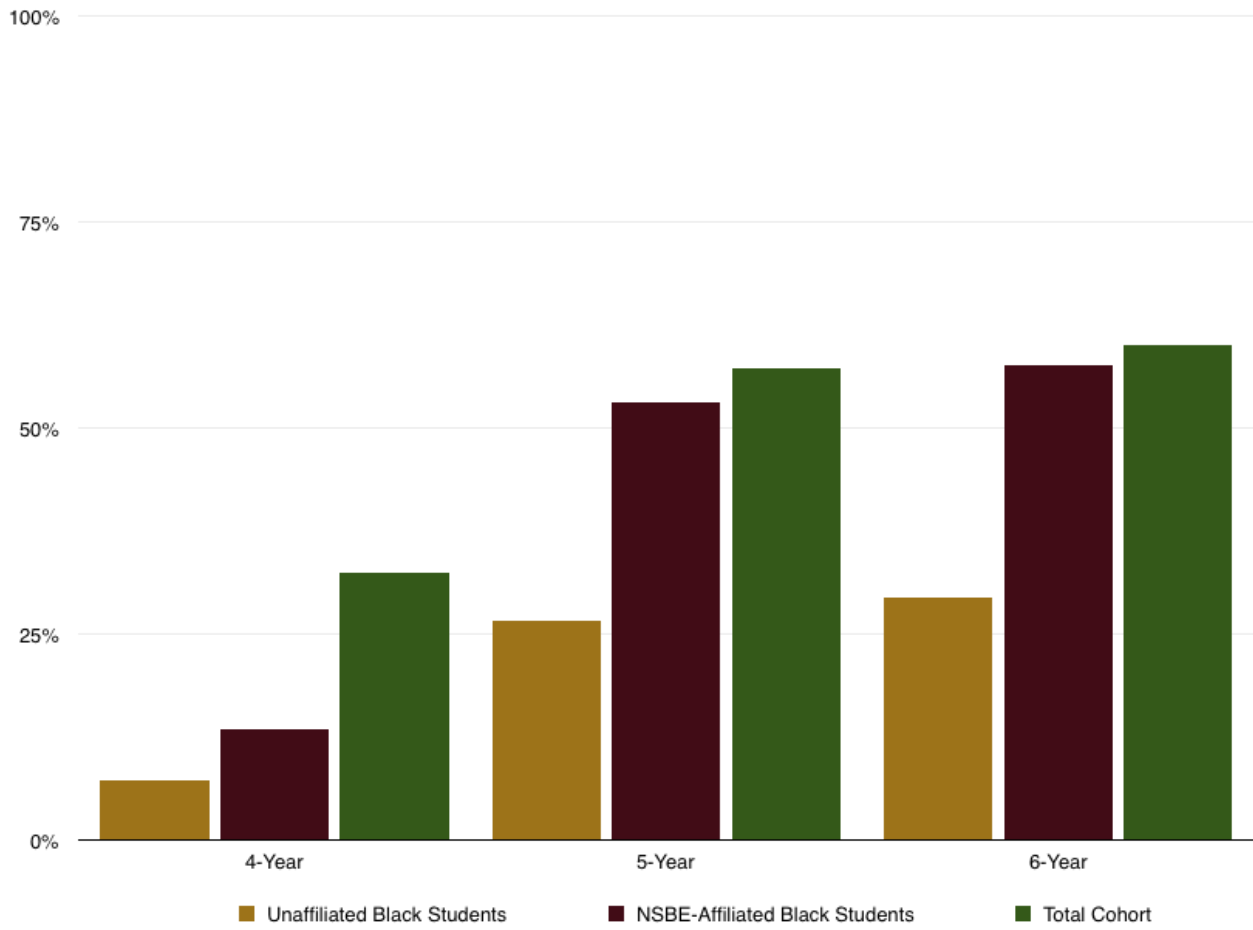


Figure 4: Aggregate Graduation Rates in Engineering

Departure Rates

Plotting the departure rate year by year after entry into the college of engineering reveals a steady linear increase for all subgroups during the first three years of college. Afterwards departure rates slow. Statistical analysis indicated notably higher departure rates for the nonNSBE group for every year within 6-years after beginning. Note that this departure rate captures those who leave the university and can include those who have been dropped or voluntarily withdrawn.

Table 4: p-values from statistical analysis of departure rates

| | 1 Year | 2 Years | 3 Years | 4 Years | 5 Years | 6 Years |
|-------------------|--------|---------|---------|---------|---------|---------|
| NSBE vs. nonNSBE | 0.001 | 0.003 | 0.006 | 0.001 | 0.001 | 0.002 |
| nonNSBE vs. TOTAL | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| NSBE vs. TOTAL | 0.933 | 0.443 | 0.102 | 0.308 | 0.125 | 0.078 |

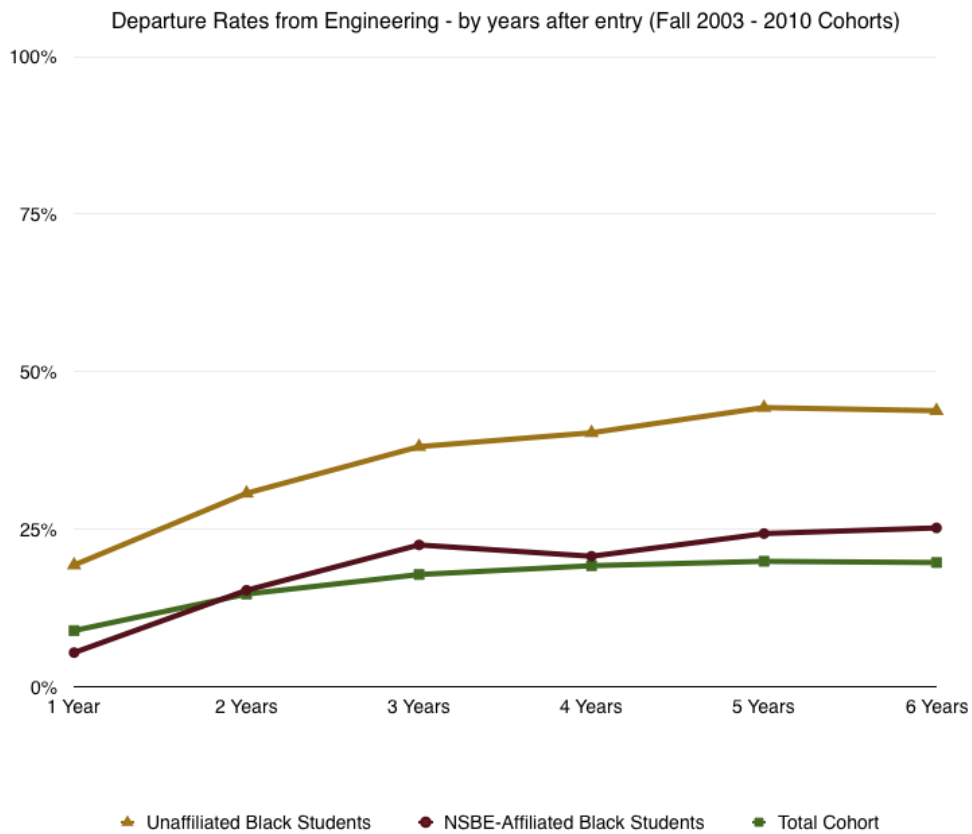


Figure 5: Departure Rates from Engineering

Discussion

There is evidence to suggest that involvement in NSBE is associated with more equitable student success outcomes for Black students in terms of higher graduation rates and lower departure rates from the college of engineering at a large, Midwestern, public university. Specifically, there were statistically significant differences ($p < 0.001$) between 5-year and 6-year graduation rates of Black engineering students involved in NSBE and those not involved. Black students that participated in NSBE had a 5-year and 6-year graduation rate that met or exceeded that of the total student population ranging from 53% - 60%. Although there is a relatively small number of Black students in engineering, a stark contrast is seen between those involved in NSBE and those that are not. These trends support anecdotal observations from Minority Engineering Program (MEP) Staff that serve in an advisory capacity to the NSBE Chapter. The association between NSBE participation and a higher graduation rate was also found in another study of a NSBE Chapter at a small, Midwestern private PWI [14]. Studies that explore graduation rates are likely limited due to the access required to both NSBE membership and institutional data but are important to help characterize academic success outcomes associated with NSBE participation, especially as many NSBE chapter activities are designed to impact not only GPA but retention and graduation rates [22],

One of the key distinctions between this study context and the previously referenced small, Midwestern, private PWI [14] is the existence of the MEP and a strong relationship between the MEP and the NSBE Chapter. This institutional support with complementary aims shapes the role of the NSBE Chapter and some NSBE members are also active participants in MEP programs. The interaction of MEPs and cultural engineering student organizations such as NSBE and the combined impact of their programs, activities, and services warrants further investigation [16], [18], [19].

Future studies will be conducted to explore how and why the associations present in this study occur at this particular chapter. However, elements that have been identified in the literature such as participation in social, academic, and professional activities of the chapter, as well as regional and national conferences, may contribute to outcomes that support persistence such as fostering a strong sense of community or “family”, increased self-efficacy, increased confidence in technical and non-technical skills and abilities, and a strong social and professional network [11], [13], [14], [22], [23], [8], [24]. More granularity in quantitative data and additional qualitative data will also help explain volatility in the trends beyond the small sample size, such as the data from the Fall 2007 cohort which is the one year where the graduation rate of Black engineering students involved in NSBE does not meet or exceed the graduation rates of those that do not participate. Understanding the potential factors at play behind the differences observed can inform future interventions as well evaluation efforts.

Limitations

The goal of this study was to provide preliminary descriptive data of involvement with a NSBE chapter at a PWI. While an association between NSBE involvement and student success outcomes of graduation and departure rates was found, this does not provide evidence that participation in NSBE predicts these outcomes for this institution. Other relevant characteristics such as years of involvement in NSBE, levels of involvement (e.g. general member, chapter leader, national leader), amount of time dedicated to NSBE, specific NSBE activity involvement, and participation in other types of extracurricular activities were not considered in this initial

review but will likely provide more nuanced insights into the association. For consistency, this data set was limited to full-time students who were admitted into Engineering during the Fall admission cycle and does not include those who may have transferred into Engineering from other majors or part time students.

Future Research

The positive association between NSBE membership and student success outcomes supports further quantitative and qualitative investigation of the impact of NSBE participation from a collegiate chapter perspective. Exploring the chapter experience at different institutions and institution types will allow the research community, university administrators, and the national organization to better characterize the impact of participation in NSBE as well as positive and negative trends to be supported or addressed. While the mission of NSBE is to increase the number of Black Engineers, membership is not restricted to individuals who only identify as Black. The research questions of this study focused on Black engineering student participation but the association with success outcomes for non-Black student members is also a future area of interest.

Additional insights into quantitative relationships can be gained by graded categorization of NSBE membership that accounts for factors such as number of years of involvement, when they first joined the organization (e.g. freshman vs later years), level of involvement, and other student success outcomes (e.g. GPA). Exploring how and why particular associations exist can also be supported by more rigorous qualitative explorations of NSBE members decisions to persist or leave engineering and/or the organization and what unique role NSBE played in these decisions.

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