

A Preliminary Assessment Examining Factors Impacting the Persistence of African-American Undergraduates in Chemical Engineering

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ABSTRACT

This presentation presents the preliminary results of a survey administered to Chemical Engineering students aimed at identifying and characterizing factors that contribute to the persistence and attrition of African-American students, particularly females majoring in Chemical Engineering and related degree programs. A preliminary analysis of survey data is provided examining engineering persistence. Data was collected from African American students currently in their third year or beyond using the Assessing Women in Engineering (AWE) *Student persisting in engineering survey*. The factors examined include high school preparation, confidence in completing current degree program, faculty and peer interactions, and career outlook.

INTRODUCTION & BACKGROUND

Traditionally, the field of chemical engineering has been one of the smaller branches of engineering. The emergence of the newer technologies, many of which are steeped deeply in chemical engineering principles, increases the decline in the number of chemical engineers being produced and emphasized the need for training that focuses chemical engineers on new areas of need. In 2001, The Engineering Workforce Commission reported a 12.1% decline in enrollment in chemical engineering (ChE) curricula. In the report, Dr. Ron Darby stated: "The disconcerting drop in chemical engineering enrollment may be due to a perception among students entering engineering curricula that the traditional chemical and petrochemical industry is staid and limited in the opportunities it offers," But by-in and large, the growth of bioengineering and biomedical engineering - and the lure of studying these "exotic" disciplines has taken the greatest toll on ChE enrollment [1].

The recruitment and retention of females and minorities in the fields of science, technology, engineering, and mathematics (STEM) continues to be a critical issue of concern for the United States. This issue is particularly acute for engineering and technology disciplines and may have more intense consequences for students of color. Institutions ranging from community colleges to research intensive universities have undertaken activities to increase the recruitment and retention of students of color in engineering and technical degree programs. Despite increases in baccalaureate degree production in engineering students of color, their overall representation is still quite low [2]. A 2002 National Science Foundation (NSF) report indicated that, Blacks earned less than 5% of the baccalaureate degrees awarded in engineering and roughly 10% in Computer Science [3]. Consequentially, the number of minorities entering the engineering and technology workforce is limited. As the US workforce becomes more diverse, increasing the participation of US citizens that are typically underrepresented in STEM disciplines is essential to the vitality of the country's future workforce. The National Science Foundation and the National Science Board have issued

strong warnings regarding the loss of U.S. dominance in critical areas of science and innovation [4]. Additionally, the Department of Labor projects Information Technology (IT) job growth will exceed IT degree production for the current decade [4].

Current recruitment and retention efforts in engineering and each sub-discipline must be examined with regard to the effectiveness on specific student populations so that successful strategies can be expanded and replicated. Whereas a number of strategies have been implemented (i.e. new pedagogy, learning communities, success centers, etc.), the persistence rates of minorities still remain low. An examination of the current body of engineering education literature reveals limited data on the experiences of African-American females in engineering degree programs and the effect of retention activities designed to increase their persistence and promote their career success.

This study aims to examine and identify factors that affect the persistence of African-American students in chemical engineering. This study is a sub-component of a broader study aimed at identifying factors that impact the academic success of STEM students at HBCUs [5-6]. The study is being conducted to provide a portrait of the experiences of African American Engineering students in an effort to identify any unique obstacles they may encounter during their matriculation in a chemical engineering program (or engineering program in general). Additionally, the study seeks to identify specific reasons that impede the persistence of African American students in Chemical Engineering. In examining the following questions, descriptive and frequency results are provided.

Research Questions

1. What factors influence African-American students to major in chemical engineering?
2. Do students feel their high school education adequately prepared them to be successful in a chemical engineering degree program?
3. What are the predominant factors that influence African-American students' decisions to persist in a chemical engineering degree program?

METHODOLOGY

Participants and Procedure

A survey was administered to 130 thirty African-American students enrolled in their third year or beyond in an engineering or technology degree program (5-6). The participant pool included African American students attending PVAMU, a Historically Black University, and African American undergraduate students attending the 2007 Annual National Society of Black Engineers (NSBE) Conference. Sixty percent (n=78) of the survey participants were undergraduate students enrolled at PVAMU, while 40% (n=52) were students pursuing engineering or technology degree programs at other U.S. institutions. Fifty-one percent of the participants were males (n=66) and 49% (n=64) were females. Table 1 details the gender distribution and institutional affiliation of participants. Survey participants represent all the core engineering and technology disciplines with the largest percentages from Chemical Engineering (16.9%) and Electrical Engineering (16.2%). The average self reported grade point average was 3.1/4.0 (SD= 0.41) and 2.9/4.0 (SD=0.39) for females and males respectively.

This paper re-examines the analysis of the survey data for African American students enrolled in Chemical Engineering degree programs. Twenty-four of the African-American students who participated in this study were enrolled in their second year or beyond in a chemical engineering degree program. Seventy-nine percent (n=19) of the survey participants were undergraduate students enrolled at PVAMU and 21% (n=5) are pursuing chemical engineering degrees at other U.S. institutions. Forty-six percent of the participants were males (n=11) and 54% (n=13) were females. Table 1 also shows the gender distribution and institutional affiliation for Chemical Engineering participants. Fifty percent of the students surveyed were first-time incoming freshman when they entered their program. The average self-reported grade point average for chemical engineering participants was 3.02/4.0 (SD= 0.48).

Table 1: Survey Participants

	Gender (All Participants)		Totals (All participants)	Gender (Chemical Engr. Participants)		Totals (Chemical Engr. Participants)
	Males	Females		Males	Females	
PVAMU	48	30	78	10	9	19
Other	18	34	52	1	4	5
Totals	66	64	130	11	13	24

Survey Instrument

The Student Persisting in Engineering (SPE) instrument developed by the Assessing Women (AWE) in Engineering Project [14] was used to collect the data. This instrument was chosen because it measured the variables that were hypothesized as being critical to the persistence for African-American students. The factors measured included confidence, high-school preparation, academic advising and mentoring, university and departmental environment, participation in extracurricular activities and student organizations, household demographics, family support, financial assistance (e.g., grants, scholarships) and financial motivation. These factors are not unique in that they have been the focus of prior studies on engineering persistence [7-16]. However, the findings of this study will contribute to understanding of these issues for African-American students. The SPE instrument was designed to measure a number of the aforementioned variables including participant demographics (e.g., ethnicity, gender, classification, etc.), initial commitment and preparation for studying engineering, the impact of several factors on student persistence (e.g., course workload, institutional climate, academic advising, finances, peer relationships, etc.), participation in academic and extra-curricular activities, confidence in complete engineering degree program, and post graduation plans of subjects [17].

Results

Factors influencing students' decision to majoring in Chemical Engineering

Disaggregating the data by major reveals, the most significant reasons why students initially choose to major in chemical engineering was (1) they felt they were good at math and science (92% of females versus 55% of males), attracted by the challenge of a difficult curriculum (31% females versus 64% of males), liked to solve problems (39% of females versus 46% of males) and wanted to be able to get a well-paying job after graduation (31% of females versus 73% of males) as shown in Table 2. The top reasons for majoring in chemical

engineering are similar to those reported by all engineering students surveyed [5-6]. It is interesting to note that 0% of the male participant were influenced by a counselor or teacher nor did they major in the field to address social ills yet high-earning potential was the most significant reason for majoring in chemical engineering. In a subsequent question, 90.5% (n= 19) participants reported their parents were very supportive of their decision to study engineering.

Table 2: Surveys Results – Reasons for majoring in Degree Program

Question: Why did you initially decide to major in engineering? (Check all that apply)	Females (n = 13)	Males (n = 11)
	Percentages %	Percentages %
Attracted by the challenge of a difficult curriculum	31	64
Good at math or science	92	55
High school adviser or teacher recommended it	15	0
Like the design work that engineers do	31	18
Like to solve problems	39	46
Parents, other relatives or friend is an engineer	8	18
Parents, siblings or other relatives recommended it	8	9
Participated in engineering camp or workshop that influenced me	8	9
Received or anticipated possibility of good college scholarship	0	9
Wanted to be able to get a well-paying job after I graduate	31	73
Wanted to use engineering solutions to address social problems	8	0
Not Sure	0	9
Other	8	0

High School Preparation for studying Chemical Engineering

Participants were asked if they felt their high school coursework adequately prepared them to be successful in an engineering curriculum. Of the 24 participants that answered this question, 37.5% (n=9) of the participants, 25% (n=6) attended an urban school, and 16.7% (n=4) attend a magnet school. Ninety-one percent of the participants reported having access to honors or advanced placement courses. In a subsequent question revealed that 65-82% of the students completed honors or advanced courses (e.g. physics (71%, n=15), pre-calculus (82%, n=18), calculus (65%, n=13), chemistry (91%, n=21)). 79% (n=19) of the participants answered responded “yes” when asked if they felt they were adequately prepared by their high school curriculum. Comparatively, 59% (n=82) of all participants surveyed reported feeling adequately prepared. We asked participants in an open-ended question to explain their response. Example responses for the participants who answered “no” included:

- *“I feel that wee could have been challenged more in some of the science course.”*
- *“I feel like although I was introduced to the subjects, I was not prepared for college level work.”*

- *“I feel that more emphasis was based on the actual grade rather than the material. High school students get babied on a lot of things.”*

A large percentage of participants reported that they felt confident that they would complete their degree when they began their program (see table 3). Additionally, most participants reported they were presently confident they would complete their degree program at their current institution (63.6% males versus 84.6% females).

Predominant factors affecting persistence

Participants responded to a 26 item question regarding factors affecting their persistence. The items addressed a variety of factors related to confidence, academic advising and mentoring, academic performance, university and departmental environment, family support, financial assistance, and financial motivation. Participants rated the items on a scale from 0 to 4 where 0 corresponds to “Not a Factor” and 4 equate to a “Significant Factor”. We report here only the top factors rated by males and females. As shown in Table 4, females reported “having a fulfilling career”, “having satisfactory grades” and “having quality engineering, math, and science teachers” as the factors most significant to their persistence. As shown in Table 5, males reported “having a fulfilling career”, “belonging in engineering”, “engineering positions after graduation”, and “having quality international teachers” as the factors most significant to their persistence.

Table 3: Surveys Results – Confidence in completing degree

Question: When you began your engineering degree, how confident were you that you would complete it? (Check one)	Males (n = 11)	Females (n = 13)
	Percentages %	
Not at all confident; I was already unsure of my plan to study engineering	0	0
I felt there was about a 50% chance that I would complete a degree in engineering	0	7.7
I was fairly confident that I would complete a degree in engineering	36.4	15.4
I was very confident that I would complete a degree in engineering	63.6	76.9
Other	0	0

Table 4: Survey Results – Predominant Reported Persistence Factors for Females

Question: The following are factors that may be associated with you persisting in your engineering education. For each factor choose a column ranging from Not a Factor (left most) to a Significant Factor (right most) to indicate the degree to which that factor influences your persistence in engineering.						
	Not a factor	Somewhat a Factor	A Factor But Not Significant	A Somewhat Significant Factor	A Significant Factor	Rating Mean/ Frequency
Having a fulfilling career						
Females	0%	9.1%	0%	0%	90.9%	3.73
Having satisfactory grades						
Females	9.1	0	0	18.2	72.7	3.45
Having quality engineering /math/science faculty						
Females	0%	0%	0%	27.3%	72.7%	3.73

Table 5: Survey Results – Predominant Reported Persistence Factors for Males

Question: The following are factors that may be associated with you persisting in your engineering education. For each factor choose a column ranging from Not a Factor (left most) to a Significant Factor (right most) to indicate the degree to which that factor influences your persistence in engineering.						
	Not a factor	Somewhat a Factor	A Factor But Not Significant	A Somewhat Significant Factor	A Significant Factor	Rating Mean/ Frequency
Having a fulfilling career						
Males	0	0.0%	0	27.3	72.7	3.73
Belonging in engineering						
Males	0	0	0	45.5	54.5	3.55
Engineering positions after graduation						
Males	0	0.0%	0	27.3	72.7	3.73
Quality of international						
Males	0	0	0	45.5	54.5	3.55

CONCLUSIONS

The results presented here are a preliminary analysis that re-examines data from phase 1 of the study [5-6] and provide only descriptive and frequency results of survey data. Additional data analysis and collection is planned, which will provide detailed results on any statistical difference for factors impacting the persistence of African American Chemical Engineering students.

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