AC 2008-1856: AN EXAMINATION OF THE USE OF SOCIAL COGNITIVE CAREER THEORY TO EXPLORE FACTORS INFLUENCING THE POST BACCALAUREATE DECISIONS OF HIGH ACHIEVING ENGINEERING STUDENTS

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Abstract

The literature indicates that the representation of minority science, technology, engineering, and mathematics (STEM) professionals is significantly disproportionate to minority representation in the U.S. general population and workforce, thereby impacting the current pool of primarily White male STEM professionals' ability to meet the rapidly changing demands facing the engineering industry. The need to increase the numbers of science and engineering degrees conferred to ethnic minorities at the baccalaureate level and beyond is evident. This paper shares data from the first phase of a multi method longitudinal study conducted at a Historically Black College/University (HBCU) in fall 2006 and spring 2007 using a sample of 51 high achieving (GPA > 3.0) Black STEM students. The Social Cognitive Career Theory (SCCT) was used as a theoretical framework to provide insight regarding factors influencing the post baccalaureate decisions of high achieving Black STEM students. Survey findings revealed a statistically significant association between STEM discipline and post baccalaureate plans. Qualitative data from a focus group will shed light on factors influencing the aforementioned finding.

Introduction

The literature indicates that the representation of minority science, technology, engineering, and mathematics (STEM) professionals is significantly disproportionate to minority representation in the U.S. general population and workforce, thereby impacting the current pool of primarily White male STEM professionals' ability to meet the rapidly changing demands facing the engineering industry. Instead, the U.S. must increase the numbers of women and minorities (defined for the purpose of this study as African Americans, Hispanics, and Native Americans) that earn degrees in STEM fields not just at the baccalaureate level, but at all levels[1].

Minorities, particularly African Americans, are showing an increase in enrollment and subsequent degree attainment in science and engineering (S&E)[1]. Data from 1987 and 2000 show an increase in the percentage of S&E degrees awarded at the baccalaureate level (5.0% to 8.0%), the masters level (2.7% to 4.7%) and the doctoral level (1.6% to 2.8%)[2]. These numbers can be misleading for two reasons. First, the increase in psychology and social science degree attainment are the bulk of the observed increase in S&E degrees at all levels. Natural sciences, mathematics and engineering show little to no increase. Secondly despite the increase, the actual number of degrees earned is still only a very small percentage of the total U.S. S&E degrees conferred. For example, African Americans in 1996 earned only 674 master's degrees in engineering as compared to 13,573 earned by Whites. The numbers are similar for the natural sciences and for doctorate degrees awarded[3]. This disparity is also seen in 2004 data. In 2004, Whites represented 45.9% of science and engineering master's degrees conferred while underrepresented minorities (i.e. Native Americans, Blacks, and Hispanics) represented 11% of science and engineering master's degrees conferred[4].

This paper utilizes the Social Cognitive Career Theory (SCCT) as a theoretical framework to provide insight regarding factors influencing the post baccalaureate decisions of high achieving Black STEM students. The following research questions were examined:

1. What is the association between STEM discipline (Science and Mathematics versus Engineering and Computer Science) and post baccalaureate plans (Industry or Graduate/Professional School) among High Achieving Black STEM students?
2. What are the factors influencing the post baccalaureate decisions of students in the sample?

Overall, study findings will seek to provide engineering educators and higher education administrators with information that can be helpful in providing services to minority students.

Overview of Social Cognitive Career Theory

The theoretical framework guiding this study is Social Cognitive Career Theory. An extension of Bandura's general social cognitive theory[5], this theory postulates that three social cognitive mechanisms are essential to career development: self efficacy beliefs, outcome expectations, and goal mechanisms[6]. The quantitative portion of this paper examines goal mechanisms while the qualitative portion examines self efficacy beliefs and outcome expectations. Bandura asserts that self efficacy beliefs are "concerned not with the skills one has but with the judgments of what one can do with whatever skills one possess"[7]. Thus, among the sample in this study, self efficacy plays a crucial role in one's confidence in his/her ability to pursue a post baccalaureate degree, despite the various barriers and obstacles. Focus group data examined the role of self efficacy by exploring the impact of a variety of internal and external factors on the study participants' post baccalaureate plans. Outcome expectations refer to beliefs regarding the long term consequences of success in specific educational or career decision making behaviors[8 9]. Outcome expectations for pursuing a career in industry or completing a graduate or professional degree were explored during the focus groups. Finally, goal mechanisms refer to the determination to engage in a particular behavior or activity or to affect a particular future outcome[10]. For the purpose of this study, goal mechanism is the post baccalaureate plan of either pursuing a career in industry or obtaining a graduate or professional degree. This paper will discuss the impact of STEM discipline on post baccalaureate educational and career plans.

Methodology

This paper shares data from the first phase of a multi method National Science Foundation funded longitudinal study conducted at a HBCU in fall 2006 using a sample of 51 high achieving Black STEM senior students. The criteria for participation included:

1. Grade point average >3.0
2. Senior status (intended graduate date of May 2007)
3. STEM major (Biology, Chemistry, Physics, Mathematics, Chemical Engineering, Electrical Engineering, Civil Engineering, Mechanical Engineering, and Systems and Computer Science); and
4. Black (African American, African, Afro-Caribbean and Indo-Caribbean and Other)

Although the primary racial make-up of the study sample included Black students, there was one student that identified herself as Asian; however, this represents less than 2% of the study sample. The study participants were U.S. citizens, permanent residents and international students. For the purpose of conducting analyses, students that identified themselves as permanent residents were categorized with the U.S. citizens (as permanent residents represented less than 4% of the study sample).

A stratified random sampling technique was utilized to select the study sample. The sample was recruited via formal letters of invitation and promotional materials that were posted throughout the campus. After interested students were identified as potential participants, they were divided into three subgroups—(1) physical sciences and mathematics, (2) engineering and computer science, and (3) biological sciences. Students from each group were then randomly selected to participate. Efforts were made to ensure the percentage of the students selected for each group was representative of the population for that major; however, not surprisingly, there was an overrepresentation of students within the biological sciences. Further, efforts were made to include an equal number of males and females while retaining a randomized sample.

The sample consisted of 51 students (61% female and 39% male) and was divided into 2 groups: Engineering and Computer Science (ECS) (31%) and Science and Mathematics (SM) (69%) (as illustrated in Figure 1). Women represented 31% of the sample for the ECS group and 74% of the sample for the SM group (as illustrated in Figure 2). Fifty-five percent were United States citizens and 45% were international students. More than half were African American (55%), 33% were Afro-Caribbean, 4% were African, 2% were Asian, and 6% classified themselves as Other. The age of the participants ranged from 19 to 28 and the mean age was 22. All of the participants were either single or never married and none of the participants reported having children. Finally, in regards to the specific STEM discipline, more than half were from the biological sciences (51%), 3.9% were from physics and mathematics, respectively, 9.8% were chemistry, 2% were systems and computer science, 2% were chemical engineering, 6% were civil engineering, 12% were electrical engineering, and 9.8% were Mechanical Engineering.

Figure 1: Gender and STEM Discipline of Study Participants

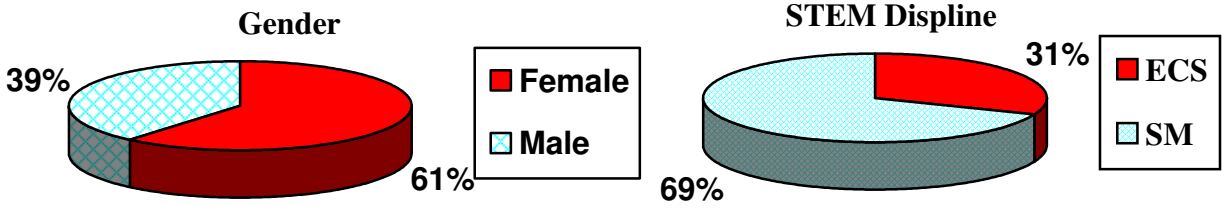
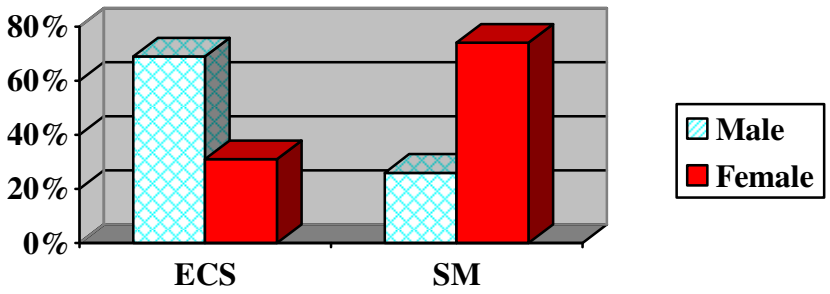


Figure 2: Gender Distribution by Academic Discipline



Data was collected during three occasions in the fall of 2006 and spring of 2007 via an electronically administered survey, one on one semi-structured interviews and focus groups respectively. This paper will report on findings gleamed from the surveys and focus groups. The electronically administered survey was quantitative and sought to obtain information regarding participants' post baccalaureate decisions. It was important that this survey be administered via this method for it allowed students to respond anonymously and thus candidly to questions without fear of judgment. The focus group included a subset of the population from the electronically administered survey and was divided into two groups based on post baccalaureate plans: industry and graduate or professional school. Focus group research sought to obtain qualitative information regarding the specific factors influencing the post baccalaureate decisions of the sample.

Data Analysis and Findings

A Chi Square analysis was conducted to examine the association between STEM discipline and post baccalaureate plans. Survey findings revealed a statistically significant association between STEM discipline and post baccalaureate plans ($\chi^2_{(df=1)} = 17.141$, $p<.05$) (as illustrated in Table 1). Among ECS students, 63% plan to enter industry immediately upon graduation while less than 19% plan to attend graduate or professional school, and less than 19% selected other. Conversely, 60% of SM students plan to attend graduate or professional school, 9% plan to enter industry and close to 31% selected other.

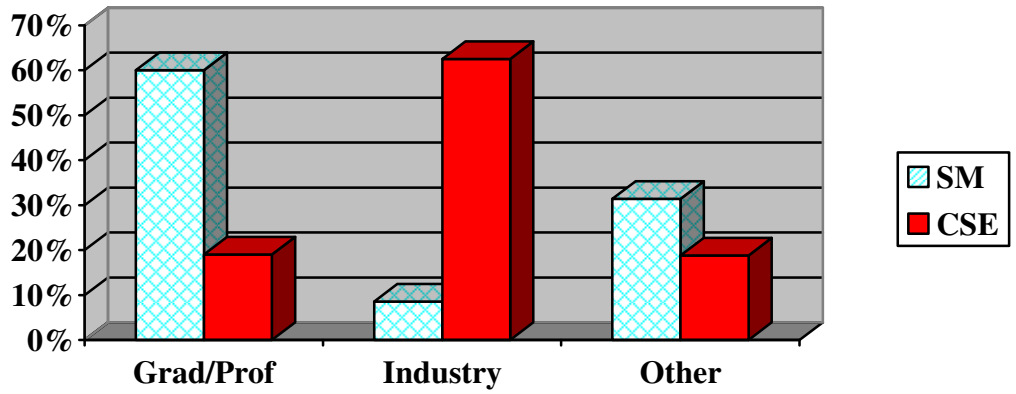
Table 1: The Results of the Chi Square (χ^2) Test:
Post Baccalaureate Plans by STEM Discipline (N=51)

	Grad/Prof		**Industry**		**Other**				
	N	%	N	%	N	%	Total	χ^2	P
STEM Discipline									
SM	21	60	3	8.6	11	31.4	35	17.141	.0000*
ECS	3	19	10	62.5	3	18.8	16		
TOTAL	24		13		14				

*One tailed

Thus, Black ECS students are more likely to enter the industry upon graduation while Black SM students are more likely to pursue higher education immediately upon completing the baccalaureate degree (as illustrated in Figure 3). The association between STEM discipline and post baccalaureate plans based on gender was not examined in this paper; however, future research may seek to examine this important topic.

Figure 3: Post Baccalaureate Plans by STEM Discipline (N=51)



The qualitative data collected from participants assisted researchers in answering, "Why?" Why do high achieving students make the decisions that they do. Focus group data was analyzed to determine the factors influencing the aforementioned post baccalaureate decisions. ECS students revealed that mentorship played a significant role in their decisions. However, it was their undergraduate internship experiences that yielded the greatest connection to pursuing industry employment. In fact, many students reported obtaining mentorship during their internship experience. For example, a male mechanical engineering student reported *"I initially wanted to pursue a career in aerospace engineering but changed my mind after an undergraduate internship. I now plan to work for a large energy company and subsequently pursue a graduate degree in the future."* A male computer science student indicated *"I obtained a summer internship at a large computer software company and I knew that I wanted to work there after graduation. I will like to work there for at least 5 years or so. I may pursue graduate school later."* Financial gains associated with immediate employment were also frequently mentioned. In fact, some students mentioned that a career in industry will provide both work experience and tuition assistance for graduate school. A female electrical engineering student stated *"I plan to work for a large automobile company while pursuing a graduate degree in engineering part-time. My company will pay for my degree. This will allow me to gain hands on exposure while completing my degree."* A male civil engineering student reported *"I will like to gain experience as an environmental engineer and then open up my own company. I may pursue graduate school in the future but right now I will like to focus on obtaining employment so that I can pay my bills."*

Conversely, SM students pursuing a graduate or professional degree reported that mentorship was important but an undergraduate research experience greatly influenced their decision. Some

students indicated that mentorship was particularly important when applying to graduate schools. A male chemistry major stated *"I will be pursuing my Ph.D. in chemistry at a northeastern ivy league institution. I often sought the help of a professor in my department when making this decision."* Furthermore, several students received an undergraduate research experience through a program that exposes high achieving minority STEM students to research and scholarship in STEM areas. A male chemistry major with plans of pursuing a Ph.D. upon graduation reported *"I received a summer internship at a midwestern institution and I have been working with a professor in my department as his undergraduate research assistant. This influenced my decision to pursue graduate school."* A female biology student reported *"I was initially exposed to research during the summer of my junior year. After this experience I realized that I love research with a passion. I feel like I can help millions more in the lab! I will like to pursue my Ph.D. in human genetics. Although I applied to several schools I have not been accepted. I plan to work at the National Institute of Health and then reapply to graduate school for a fall 2009 entrance."* Another female biology student with aspirations to attend medical school stated *"I always wanted to be a doctor. I participated in a summer research experience at a southwestern university and I become undecided regarding medical school or graduate school. I later met with professionals and decided to pursue a medical degree first, and then pursue research."* Overall, mentorship was largely informal, self-pursued and external to the university, although there was a hope to have more mentor relationships with faculty.

Finally, the path toward the post baccalaureate decision was often mixed. Some students reported that they knew of their post baccalaureate plans prior to entering college while others changed their decision along the way. A female biology major reported "I have always wanted to be a dentist. In fact, I knew that I wanted to be a dentist since the age of 3. *I plan to attend a dental school at a northeastern historically black university immediately upon graduation. I will begin my program during the summer."* Another female biology student stated *"Prior to entering college I planned to pursue a medical degree; however, after a summer research experience I decided that I love working in a lab and made the decision to pursue a Ph.D. in human genetics. I feel that I can help millions of people by doing lab research."*

Study Observations

Overall, findings revealed a variety of factors significantly impacted the post baccalaureate decisions of high achieving Black STEM students. Overall, those pursuing graduate school were largely impacted by mentorship, research experiences, research intensive internships, and faculty encouragement. Mentorship and faculty encouragement was often obtained either at the University or during the undergraduate research experience. The decision to pursue graduate school was often made during the junior and/or senior year. Finally, students pursuing industry (most often ECS students) also made their decision during their junior or senior year and their decision was often based on both financial gains as well as a desire to obtain employment experience prior to pursuing a graduate degree.

It became noticeable that the exposure of undergraduate research experiences of Science and Mathematics students impacted the students' decisions to pursue graduate work in the SM fields. However, in this study we found that Engineering students are more likely to have industrial internships rather than research experiences. It is not surprising that many engineering students

are foregoing or perhaps delaying graduate school for other options. Traditionally, the BS in Engineering has been considered the professional degree for entering industry. However, in recent years there has been a movement in a number of disciplines (most noticeably civil engineering) to make a master's degree the first professional degree of entry. This may serve as the key explanation as to why a larger percentage of engineering students are pursuing industry and shall serve as evidence for why there is a need for additional programs to encourage engineering students to pursue graduate degrees.

Overall, findings from this study shall serve to inform academicians in STEM areas about how the various trajectories (i.e. mentorship, summer research and internship experiences) can influence the pipeline of the engineers and scientists that pursue advanced degrees. As articulated through the Social Cognitive Career Theory, an evolutionary process beginning in early childhood and continuing throughout adulthood narrows the scope to successful endeavors to focus on and form a career goal/choice. The contextual factors come into play by influencing the individual's perception of the probability of success. We are reminded of the importance of the impact of undergraduate experiences outside of the classroom to the pathways that our students pursue. More than likely if students are exposed to research in their undergraduate careers, there becomes an interest in the pursuit of graduate school. Conversely, if students participate in summer internships or cooperative experiences, they are more likely to pursue a career within the industry immediately after graduation. Adopting a developmental democracy model, introduced by John Dewey, would allow for a wider of exploration of interests during this very vulnerable stage of their education[11]. Dewey's pragmatic approach to education promoted learning by doing. Very few educators would disagree with this approach. However, before one can learn through those experiences, there must first be exposure and access to those experiences. The fundamental question becomes, "are students choosing their career paths based on an inherent or intrinsic interest or solely from indiscriminate exposure?"

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[1] [2] United States Census Bureau, "Educational Statistics", Washington, DC, 2006.

[3] Berger, J, B, & Milem, J, F, "Exploring the impact of historically Black colleges in promoting the development of undergraduates' self-concept". *Journal of College Student Development,* 41, 2000, 381-394.

[4] Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey.

[5] Bandura, A. (1986). *Social foundations of thoughts and actions: A social cognitive approach.* Englewood Cliffs, NJ: Prentice Hall.

[6] Lent, R.W., Brown, S.D., & Hackett, G. (1994). Toward a unified social cognitive theory of career/academic interest, choice, and performance. *Journal of Vocational Behavior,*45,79-122.

[7] Bandura, A. (1986). *Social foundations of thoughts and actions: A social cognitive approach.* Englewood Cliffs, NJ: Prentice Hall.

[8] Betz, N.E. & Voyten, K.K. (1997). Efficacy and outcome expectations influence career exploration and decideness. *Career Development Quarterly,* 46, 179-189.

[9] Ochs, L.A. & Roessler, R.T. (2004). Predictors of career exploration intentions: A social cognitive theory perspective. *Rehabilitation Counseling Bulletin,* 47(4), 224-233.

[10] Albert, K.A. & Luzzo, D.A. (1999). The role of perceived barriers in career development: A social cognitive perspective. *Journal of Counseling and Development,* 77, 431-436.

[11]Hickman, L., (Ed). Alexander, T. &Dewey, J. (1998). The Essential Dewey, Volume 1: Pragmatism, Education, Democracy. Bloomington, IN: Indiana University Press.