

AC 2008-1920: VARIANCES IN COPING EFFICACY AMONG WOMEN STEM STUDENTS: IS GENDER OR DISCIPLINE MORE INFLUENTIAL?

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**Variances in Coping Efficacy Among Women STEM Students:
Is Gender or Discipline More Influential?**

Variations in Coping Efficacy among Women STEM Students: Is Gender or Discipline More Influential?

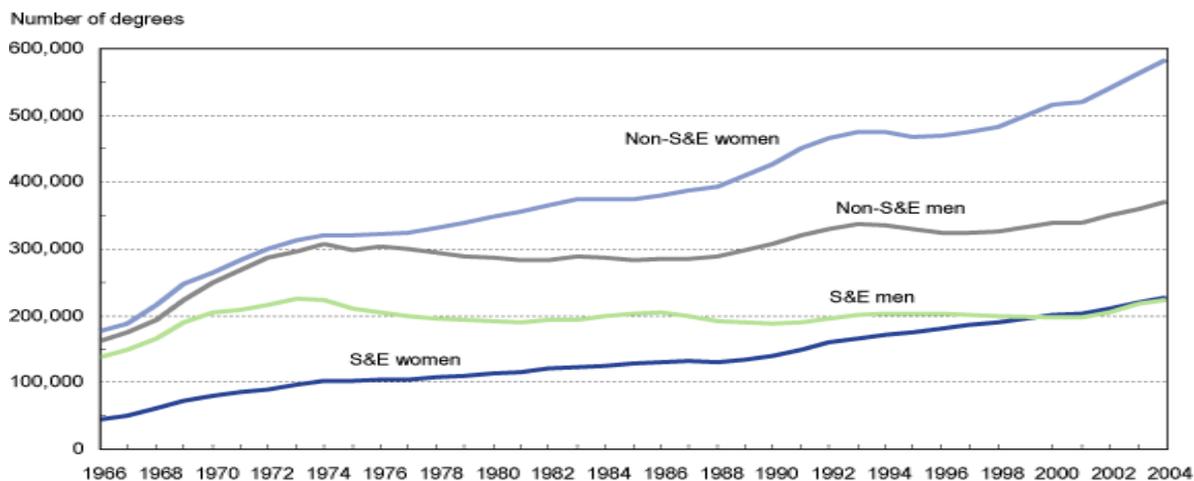
Abstract

This study uses Social Cognitive Career Theory (SCCT) to examine the coping efficacy of high achieving women STEM students as it relates to their post baccalaureate career decisions. Differences between male and female students were examined to answer the following question: Is gender or academic discipline most influential in students' perception of their ability to cope with the challenges associated with pursuing a post baccalaureate degree. Quantitative data was obtained via the first phase of a multi method longitudinal study conducted at a HBCU in fall 2006 using a sample of 51 high achieving (GPA>3.0) Black STEM students. Findings revealed that when compared to men, women are more likely to pursue professional or graduate school upon graduation; however, there were no statistically significant differences in coping efficacy. Overall, study findings provide insights about the role that academic climate plays on the post baccalaureate decision making process.

Introduction

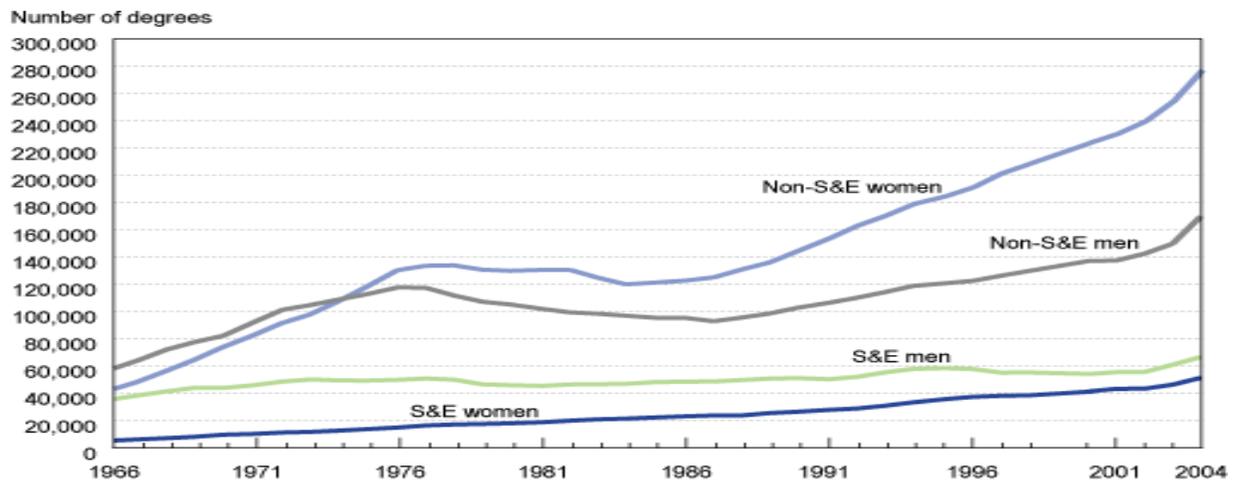
Research suggest that the number of women earning baccalaureate degrees in science and engineering has increased every year since 1966 (excluding 1988) and by 2004 women earned 44% of master's degrees in science and engineering (as illustrated in Figures 1 and 2)¹. Although the number of baccalaureate degrees for men in science and engineering reached over 224,000 in 2004, the number of master's degrees earned by men in the sciences and engineering declined during the 1990s (as illustrated in Figures 1 and 2)².

Figure 1. Bachelor's degrees awarded in S&E and non-S&E fields
by sex: 1966–2004



Source: National Science Foundation, Division of Science Resources Statistics, special tabulations of U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 1966–2001.

Figure 2. Master's degrees awarded in S&E and non-S&E fields by sex: 1966–2004



Source: National Science Foundation, Division of Science Resources Statistics, special tabulations of U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 1966–2001.

The literature also suggests that there are gender differences in the conferment of baccalaureate degrees in certain technical fields among African Americans. For example, African American women earned 47% of baccalaureate degrees conferred in computer and information sciences and 36% of the degrees in engineering³. Finally, although women lag behind in the conferment of doctoral degrees in engineering and computer and information sciences (17 and 18 percent respectively), the percentage of women earning doctoral degrees in the biological and life sciences increased to 44%⁴. Further, in 2004, 9.3% of individuals completing master's degrees in science and engineering were Black women⁵. Although it is evident that women are pursuing master's and doctoral degrees in the sciences and mathematics, there is limited data that examines how women cope with the barriers of pursuing a post baccalaureate degree. Using Social Cognitive Career Theory as a theoretical lens, this study examines the coping efficacy of women STEM students particularly as it relates to their post baccalaureate decisions. STEM disciplines were divided into two groups: Science and Mathematics (SM) and Engineering and Computer Science (ECS). The following research questions were examined:

1. Is there a statistically significant association between gender and post baccalaureate plans?
2. Is there a statistically significant association between academic discipline (SM versus ECS) and post baccalaureate plans?
3. What is the association between gender and post baccalaureate plans among students pursuing a degree in Engineering or Computer Science (ECS)?
4. What is the association between gender and post baccalaureate plans among students pursuing a degree in the Sciences or Mathematics (SM)?
5. Are there statistically significant differences in coping efficacy based on discipline (ECS versus SM)?
6. Are there statistically significant differences in coping efficacy based on gender?

This paper explores the differences between male and female students and primarily seeks to understand: Is gender or academic discipline most influential in students' perception of their ability to cope with the challenges associated with pursuing a post baccalaureate degree?

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 theory⁶, this theory postulates that three social cognitive mechanisms are essential to career development: self efficacy beliefs, outcome expectations, and goal mechanisms⁷. This paper utilizes 2 major concepts of this theory: self efficacy beliefs and goal mechanisms. 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 possesses"⁸. 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. Goal mechanisms refer to the determination to engage in a particular behavior or activity or to affect a particular future outcome⁹. For the purpose of this study, goal mechanism is the post baccalaureate plans of either pursuing a career in industry or obtaining a graduate or professional degree.

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 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)

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 3). Women represented 31% of the sample for the ECS group and 74% of the sample for the SM group (as illustrated in Figure 4). 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 with the mean age being 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 3: Gender and STEM Discipline of Study Participants

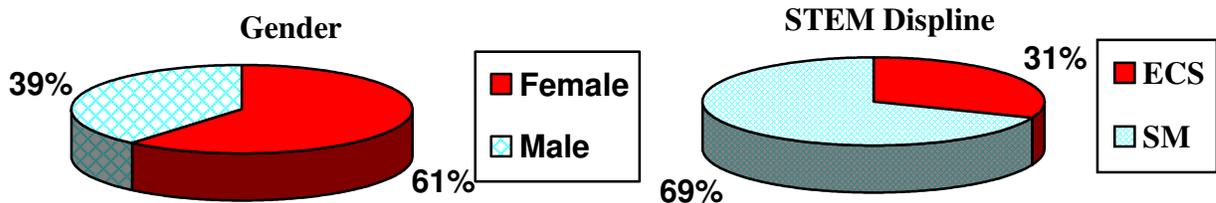
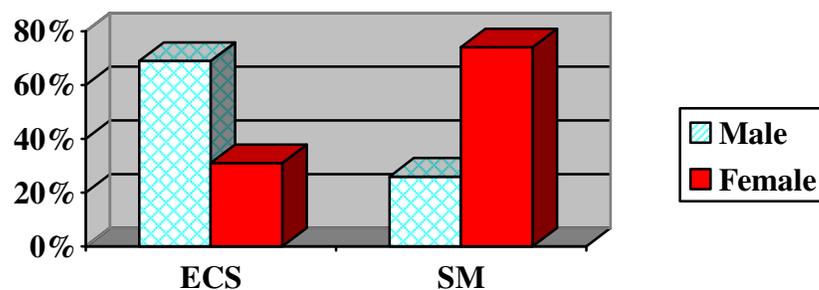


Figure 4: Gender Distribution by Academic Discipline



Instrumentation

The data used to answer the aforementioned research questions and inform this paper was collected during the fall of 2006 via an electronically administered survey. 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 electronically administered survey was hosted through a reputable online survey site. The host site for the survey has a positive reputation and is often used by professionals and researchers for conducting marketing and social research. One of the major limitations of this paper is that qualitative information is not yet available to shed light on the specific reasons for the disparities. Since this is part of a multi method longitudinal study, qualitative findings will be available at a later date.

The survey was composed of the following components: sample demographics, influences on post baccalaureate plans, immediate plans after graduation, and coping efficacy for pursuing a post baccalaureate degree. Students were asked to provide information on their immediate plans after graduation. Their response options included attending graduate school, enrolling in professional school, entering the global marketplace or other. Participants were instructed to select "other" only if they were unsure of their post baccalaureate plans or if they could not be categorized into the other groups. Coping efficacy for pursuing a post baccalaureate degree was a particular interest of the researchers. This part of the survey addressed participants' confidence in their ability to cope with a variety of barriers or problems that students may encounter when pursuing a post baccalaureate degree.

The coping efficacy measure used a nine point Likert scale with 0 indicating no confidence at all and nine indicating complete confidence. Participants reported their confidence with managing several barriers or problems that may occur when pursuing a post baccalaureate degree (e.g. "a lack of support from professors or advisors, completing a post baccalaureate degree despite financial pressures, balancing studying with other activities, etc"). This scale was a modified version of the coping efficacy scale developed by Robert Lent¹⁰.

Data Analysis

Inferential statistics was used to make inferences about the sample population and answer the research questions. A Chi Square analysis was performed to answer research questions 1-4. This is a non parametric statistic used to examine the association between 2 nominal level variables. Separate independent t tests were used to examine the final 2 research questions. Independent t test is a parametric test used to examine differences between the means of 2 independent groups observed at the same time. For the purpose of this study, separate independent t tests were performed to examine differences in coping efficacy based on STEM discipline (Engineering and Computer Science versus Science and Mathematics) and gender (males versus females).

Findings

Using quantitative data from electronically administered surveys, inferential analyses were conducted to describe the post baccalaureate decisions of high achieving Black women in engineering and to explore differences in coping efficacy based on gender and discipline. Findings revealed a statistically significant association between gender and post baccalaureate plans ($\chi^2_{(df=1)} = 4.480, p < .05$) (as illustrated in Table 1).

Table 1: The Results of the Chi Square (χ^2) Test:
Post Baccalaureate Plans by Gender (N=48)

	Grad/Prof		Industry		Total	χ^2	P
	N	%	N	%			
Gender							
Males	4	78	16	80	20	4.480	.00152*
Females	14	22	14	20	28		
TOTAL	18		30				

*One tailed

Close to 78% of participants pursuing a professional or graduate degree were women (as illustrated in Figure 5). On the other hand, 80% of men plan to pursue a career in industry (as illustrated in Figure 6). Thus, women are more likely to pursue professional or graduate school while men are more likely to pursue a career in industry immediately upon graduation.

Figure 5: Post Baccalaureate Plans by Gender

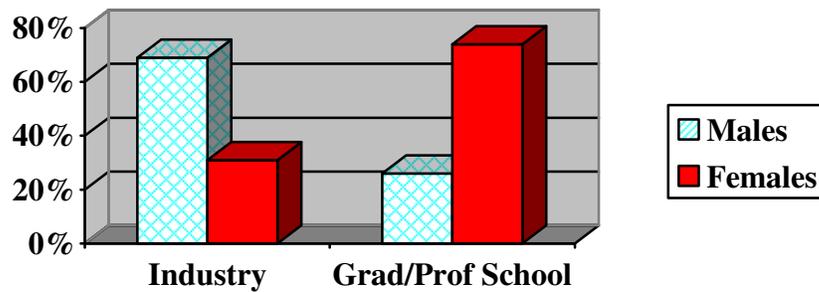
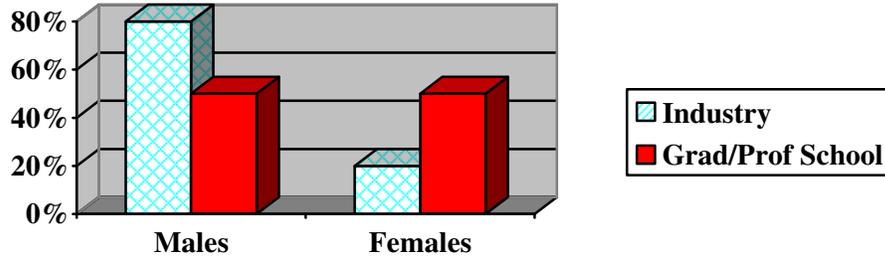


Figure 6: Post Baccalaureate Plans within Gender



However, when determining the association based on discipline, findings revealed that ECS students are more likely to go into industry while SM students are more likely to pursue graduate or professional school ($\chi^2_{(df=1)} = 6.4, p < .05$) (as illustrated in Table 2). Close to 90% of students that pursue graduate or professional school are SM (as illustrated in Figure 7). Conversely, close to 90% of ECS students pursue a career in industry immediately after graduation (as illustrated in Figure 8). There were no statistically significant findings in examining the association between academic discipline (ECS versus SM) and post baccalaureate decisions (professional/graduate school versus industry) for women only ($\chi^2_{(df=1)} = 2.191, p > .05$). Therefore, the post baccalaureate plans of ECS women do not differ from SM women.

Table 2: The Results of the Chi Square (χ^2) Test:
Post Baccalaureate Plans by Academic Discipline (N=48)

Discipline	Grad/Prof		Industry		Total	χ^2	P
	N	%	N	%			
SM	16	88.9	16	53.3	32	6.400	.0055*
ECS	2	12.5	14	46.7	16		
TOTAL	18		30				

*One tailed

Figure 7: Post Baccalaureate Plans by STEM discipline

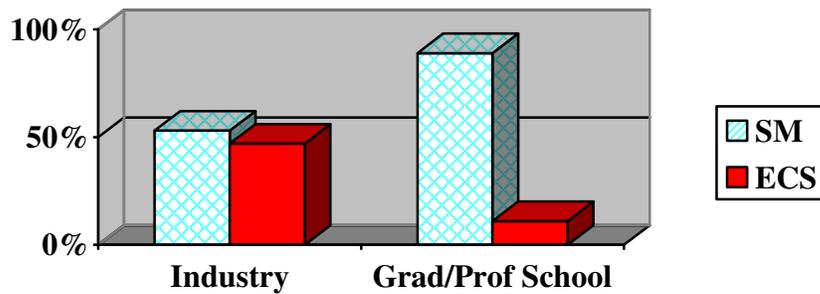
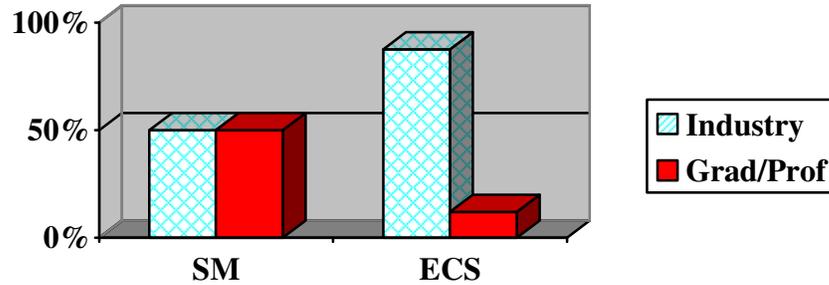


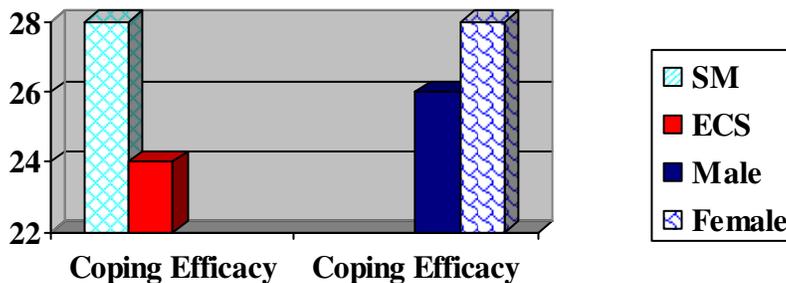
Figure 8: Post Baccalaureate Plans within STEM discipline



Although findings revealed statistical significance when examining the association between gender and post baccalaureate plans as well as academic discipline and post baccalaureate plans, it is important to understand differences between gender and post baccalaureate plans within the specific disciplines. Thus, is there a significant association between gender and post baccalaureate plans among SM students only and ECS students only? Separate Chi Square analyses were conducted to answer these research questions. Findings revealed no statistically significant association between gender and post baccalaureate plans among SM students ($\chi^2_{(df=1)} = 1.391, p > .05$). Similar findings were found when examining the association between gender and post baccalaureate plans for ECS students. Findings revealed no statistically significant association between gender and post baccalaureate plans among ECS students ($\chi^2_{(df=1)} = .374, p > .05$)

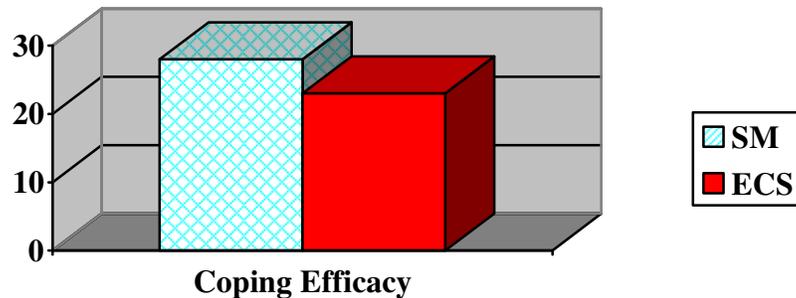
Finally, coping efficacy, or confidence in one's ability to cope with the barriers or problems associated with pursuing a graduate or professional degree was examined to determine differences based on gender and discipline. As stated previously, Bandura asserts that self efficacy beliefs are "concerned not with the skills one has but with the judgments of what one can do with whatever skills one possesses"¹¹. Thus, this theory was crucial in answering the final 2 research questions. Findings revealed there are differences in coping efficacy based on discipline ($t_{(df=49)} = -3.892, p < .05$), but not based on gender ($t_{(df=49)} = -1.113, p > .05$). ECS students indicated lower levels of coping efficacy ($\bar{x} = 23.9$) than SM students ($\bar{x} = 28$); however, males and females indicated similar levels of coping efficacy ($\bar{x} = 26$ and 28 , respectively) (as illustrated in Figure 9).

Figure 9: Coping Efficacy based on STEM discipline and Gender



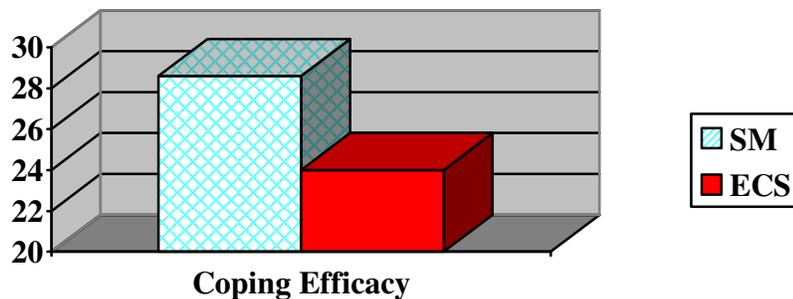
Furthermore, there are no gender differences within the discipline (coping efficacy for ECS women did not differ from men) ($t_{(df=49)}=-.388, p>.05$). Finally, when comparing coping efficacy for ECS women to SM women, findings revealed that ECS women indicated lower levels of coping efficacy ($t_{(df=29)}=-2.681, p<.05$). The mean coping efficacy score for ECS women was 23.2 while the mean coping efficacy score for SM women was 28.4 (as illustrated in Figure 10).

Figure 10: Coping Efficacy based on STEM discipline for Women Only



Similar findings were observed when comparing the coping efficacy score for ECS men and SM men. ECS men indicated significantly lower levels of coping efficacy than SM men ($t_{(df=18)}=-.243, p<.05$). The mean coping efficacy score for ECS men was 24 while the mean coping efficacy score for SM men was 28.6 (as illustrated in Figure 11). These statistically significant findings can be further explained by the academic climate that persists in the respective disciplines of ECS and SM.

Figure 11: Coping Efficacy based on STEM discipline for Men Only



Conclusions and Recommendations

Based on study findings, it is safe to conclude that academic discipline played a greater role than gender in post baccalaureate decisions. Science and mathematics students were more likely to

pursue professional or graduate school while computer science and engineering students were more likely to pursue industry. However, science and mathematics students indicated higher levels of coping efficacy, or confidence in one's ability to cope with the barriers associated with pursuing a post baccalaureate degree, than computer science and engineering, students. This could be one explanation for why more SM students plan to pursue a post baccalaureate degree than ECS students.

Another explanation could be related to the academic climate of engineering education. Irregardless of gender, coping efficacy was reportedly lower within the Engineering and Computer Science academic disciplines. This new observation prompted the researchers to inquire further along these lines in the next phase of data collection.

Next, when examining the role of gender, findings revealed that there is a statistically significant association between gender and post baccalaureate decisions. Females are more likely to pursue professional or graduate school while men are more likely to pursue industry; however, there was no statistically significant association between gender and post baccalaureate decisions within each discipline (e.g. the post baccalaureate plans of female SM students did not differ from male SM students). Not surprisingly, there were statistically significant differences in coping efficacy for men and women.

Overall, study findings shed light on the importance of developing educational interventions and programs that seek to increase confidence in pursuing a post baccalaureate degree, particularly among Black women in ECS areas. Examining climatic issues in the university, and more specifically in the engineering programs, will seek to increase the number of minority women in graduate education and ultimately further diversify the current workforce in the Sciences and Engineering.

Acknowledgements

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