First-Generation College Students and Non-First-Generation College Students Enrolled in A Science, Technology, Engineering, and Mathematics (STEM) Discipline: A Comparison of their Academic College Activities (Conference Proceedings for International Conference on Urban Education in Jamaica)

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First-Generation College Students and Non-First-Generation College Students Enrolled in a Science, Technology, Engineering, and Mathematics (STEM) Discipline: A Comparison of their Academic College Activities

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Introduction

There is extensive research literature that attests to the uniqueness of Historically Black Colleges and Universities (HBCUs) relative to the academic performance not only of African-American students but other minority students (Bonner, Alfred, Lewis, Nave, & Frizzell, 2009; Owens, E.W., Shelton, Bloom, & Cavil, 2012). On average, HBCUs attract less than 15% of all African-American college students but consistently award undergraduate degrees to African-American college students at a higher rate than Predominately White Institutions (PWIs) (Bonner et al., 2009). In a recent study, the nurturing and supportive learning environment, the visibility of African-American role models, and the positive influence from peer groups were several reasons cited by research findings for better academic outcomes at HBCUs (Palmer, Davis, & Maramba, 2010). Over the past decade, HBCUs were also instrumental in producing greater numbers of STEM professionals than PWIs (Williams, 2010). Indeed, from 2001 to 2009, HBCUs awarded an average of 39% of all undergraduate degrees in STEM disciplines with the most degrees awarded in 2004 (Owens, E.W. et al., 2012). Unfortunately, recent data indicates a decline in the number of African-American students interested in STEM disciplines and a decline in the number of degrees awarded by HBCUs in STEM disciplines (Owens, E.W. et al., 2012) Given that a relatively large percentage of African-Americans entering college are first-generation students (Murphy & Hicks, 2006) and considering the low completion rate among this group in the STEM discipline, it is of importance to explore innovative strategies to improve college outcomes. Therefore, the purpose of this study was to determine the differences in the levels of college academic activities between first-generation and non-first generation college students enrolled in a STEM discipline at a HBCU.

Method

Research Design

A two-group ex post facto research design using a single questionnaire was used for this study. Ex post facto designs are used when the researcher is not able to randomly assign participants into experimental groups; rather by a pre-existing or naturally occurring condition (Breakwell, Hammond, Fife-Schaw, & Smith, 2006; Schenker & Rumrill, 2004). In this study, the predetermined group variable was parental level of education. A group of college students enrolled in a STEM discipline was surveyed and divided into groups based on their parental level of education. The categories were: no college; yes, both parents; yes, father only; yes, mother only; and don’t know. The researcher made an effort to recruit a sufficient number of participants to represent each group rather than simply operationalizing parental level of education as a dichotomous variable. Quantitative data was obtained from the College Student Experiences Questionnaire. This study surveyed both students whose parents graduated from a 4-year college (other college students) and students whose parents who did not graduate from a 4-year college (first-generation).

Instrumentation

College Student Experiences Questionnaire (CSEQ). Robert Pace developed the CSEQ at the University of California Los Angeles in the 1970s and introduced it as a multi-institutional survey tool in 1979. It has been revised three times since. The fourth edition of the CSEQ (Pace & Kuh, 1998) is
designed for students attending four-year colleges and universities and gathers information about students' background (age, major field, and so forth) and their experiences. With over 150 items, the CSEQ provides colleges and universities with a comprehensive inventory of the student experience. For this study, two areas of CSEQ were used. The first area is the amount of studying, reading, and writing students do and the time and energy (quality of effort) they devote to various activities measured by items contributing to 13 Activities Scales. One of these scales, Computer and Information Technology (C&IT), is composed of nine items describing various forms and uses of computers and information technology. The response options for all Activities items are: 4 = "very often, 3 = "often," 2 =" occasionally, "and "1 = "never."

The second area used includes 10 Environment items representing student perceptions of the extent to which their institution emphasizes important conditions for learning and personal development. Student responses are scored on a 7 point scale ranging from "strong emphasis" = 7 to a "weak emphasis" = 1.

Since its inception, the CSEQ has been administered to over 300,000 students attending more than 400 different colleges and universities in the United States making it the third largest national database on college student experiences. Over 100,000 students at 200 different institutions have completed the fourth edition alone. The CSEQ data have been cited in over 250 articles, books, and dissertations, and probably an equal number of institutional reports. The CSEQ remains one of the few national assessment instruments that inventories both the processes of learning (e.g., interactions with faculty, collaboration with peers, and writing experiences) and progress toward desired outcomes of college (e.g., intellectual skills, interpersonal competence, and personal values).

Demographic Survey. This scale was created for the purposes of this study. The scale contains 12 questions that ask participants about their age, gender, race, living conditions, residency, classification at the university, parental educational achievement, source of income during the university year, educational or employment goals. In addition, two questions ask the participant to list a person (by relationship, not name) of who either supported or not supported their educational plans. These two questions relate to parental involvement and the background contextual influences of being the first in the family to attend college.

Participant Demographics

Examining the parent college education status in this study, 52.2% had parents with no college degree, 24.4% had both parents that had a college degree, and 23.4% had at least 1 college educated parent. At all degree levels, more mothers earned degrees than fathers. This finding is consistent with another study of African American college freshmen where African-American students' mothers were slightly more likely than their fathers to be college graduates (Astin, 1990). The majority of the participants (72%) were college students between the ages of 20 and 29 years, and most were African Americans (59%). The first-generation gender compositions and ethnicity of students in this study are consistent with other studies (Hicks, 2003; Tinto, 1993). Fifty-seven percent of the sample was female. National data demonstrates that African-American women outnumber African-American men on college campuses. In 2000 (Hoffman, Llagas, & Snyder, 2003), 63% of the African-American population on college campus were female and 37% was male. The participants in the study were comprised of 3.3% sophomores, 22.2% juniors, 72.2% seniors and 2.2% other. Forty-five percent of the study participants indicated that they had plans of attending a graduate school.

Procedures

Data collection. Permission to use and administer the College Student Experiences Questionnaire was obtained from the Institutional Review Board (IRB) of the participating institution. In the spring 2012 semester, a stratified random sampling process was used to survey students enrolled in a STEM course. Stratified sampling is most likely to be used when the researcher is convinced that a
particular variable is of such importance that the researcher wants to ensure that it is represented as it would be in the population. The strata for the sample were first-generation status: first-generation college student and other college student. A sample of students was selected from 300 and 400 level STEM courses from the biological sciences, chemistry and physics and mathematics and computer sciences. After selecting the courses, the course professors were contacted to seek permission to administer the questionnaires and to determine the most desirable time for administering the questionnaire to the study participants. Before administering the questionnaire, students were informed that they were being asked to voluntarily participate in research that will examine their college experiences. Students were also informed that their participation would be both anonymous and confidential as no identifying information would be disclosed. Students in attendance were given the opportunity to voluntarily participate in the study or they could elect to decline participation without penalty or question. After completion of the questionnaire, they were returned to the researcher by each participant. Data collection was conducted during the first four weeks of the spring 2012 semester.

**Data analysis.** To ensure that the sample size was big enough, a power analysis calculation was conducted to determine what size sample was needed. For any power calculation, one needs to identify the statistical test being used, the alpha value or significance level, the expected effect size, and the sample size.

There were 121 students who originally completed the CSEQ. Thirty-seven percent (45) of the 121 college students were classified as other college students and 76 of the study participants were classified as first-generation college students. For ANOVA, the Cohen’s G power analysis concluded that using a low effect size of ($f^2 = .33$) with 80% power that the sample size required is 38 per group. To determine the low effect size of ($f^2 = .33$) for this study on STEM college students, a preliminary meta-analysis conducted on STEM subjects was reviewed. Becker and Park (2011) synthesized the findings from existing research on the effects of integrative approaches among STEM subjects on students’ learning. Twenty-eight studies were selected and thirty-three effect sizes were calculated. With respect to grade levels, the smallest effect size was presented at the college level. As seen in Table 1, Becker and Park (2011) examined four college level studies with five different effect sizes.

Table 1
Major features of Four College Level Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Grade Levels</th>
<th>Effect Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crates (1994)</td>
<td>32</td>
<td>College</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-0.58</td>
</tr>
<tr>
<td>Dantley (1999)</td>
<td>25</td>
<td>College</td>
<td>0.65</td>
</tr>
<tr>
<td>Elliot et al. (2001)</td>
<td>143</td>
<td>College</td>
<td>0.31</td>
</tr>
<tr>
<td>Su (2006)</td>
<td>257</td>
<td>College</td>
<td>1.18</td>
</tr>
</tbody>
</table>

*Note: Effect size determine for this study was an average of the four studies/five effect sizes above = ($f^2 = .33$)*

The data for the research question was analyzed using descriptive and inferential statistics based upon the subscales of the College Student Experiences Questionnaire with the sample size set at $N = 45$ for the first-generation college student group and $N = 45$ for the other college student group. Therefore, the sample consisted of 90 college students enrolled in a STEM discipline at a HBCU. Data analysis was conducted on the mean scores for the first-generation and other college student groups using the Statistical Package for the Social Sciences (SPSS), Version 19.0 to determine if there were differences on each of the dependent variables.

To answer the research question, a one-way Analysis of Variance (ANOVA) was used to examine the differences between first-generation and other college students enrolled in a STEM discipline.
and their levels of academic engagement. The independent variables for this question consisted of first-generation and other college students. The dependent variables consisted of questions listed under the "college activities" academic category. The academic categories consisted of library, computer and information technology course learning, writing experiences, experiences with faculty and art, music, theater and scientific and quantitative experiences. An example of a question listed under the "library" category was, "Found something interesting while browsing in the library. "and a "computer and information technology question was "Searched the World Wide Web or Internet for information related to a course."

Results

Using the College Student Experiences Questionnaire, the study focused on the following research question: What differences exist in the level of college academic activities between first generation and non-first generation college students enrolled in a STEM discipline at a HBCU? This analysis helped to determine if there were any differences in the perceptions and beliefs concerning college academic experiences between first-generation and other college students enrolled in a STEM discipline at a Historically Black College and University.

Academic engagement by first-generation and other college student status. As can be seen in Table 2, a one-way ANOVA comparing the mean scores of the first-generation and other college student groups found a statistically significant difference ($F(1,88) = 4.108, p = .044, \eta^2 = .045$) between the means of the two groups for item, "used a computer to analyze data (statistics, forecasting, etc.)." The strength of the relationship between the dependent variable was moderate with 5% of the variability in the dependent variable is accounted for. This analysis revealed that the mean score for the first-generation college students was significantly higher ($M = 2.13, SD = 1.160, 95% CI = [1.843, 2.424]$) than the mean of the other college students ($M = 1.71, SD = .757, 95% CI = [1.421, 2.001]$). First-generation college students felt that they "very often" used a computer to analyze data, whereas the other college students felt that they "often" used a computer to analyze data. For item, "talked about art (painting, sculpture, artists, etc.) or the theater (plays, musicians, dance, etc.) with other students, friends, or family members," a statistically significant difference ($F(1, 88) = 4.183, p = .044, \eta^2 = .045$) was found between the means of the two groups. The strength of the relationship between the dependent variable was moderate with 5% of the variability in the dependent variable accounted for. The mean score for the first-generation college students was significantly higher ($M = 3.20, SD = .991, 95% CI = [2.895, 3.505]$) than the mean score of the other college students ($M = 2.76, SD = 1.069, 95% CI = [2.450, 3.061]$). First-generation college students felt that they "occasionally" talked about art or the theater with other students, friends, or family members. The other college students felt that they "often" talked about art or the theater with other students, friends, or family members.

It was interesting to note that for item, "talked about music or musicians (classical, popular, etc.) with other students, friends, or family members," a statistically significant difference ($F(1, 88) = 9.383, p = .003, \eta^2 = .096$) existed between the mean score of the two groups. The strength of the relationship between the dependent variable was large with 10% of the variability in the dependent variable accounted for. The mean score for the first-generation college students was significantly higher ($M = 2.71, SD = .815, 95% CI = [2.446, 2.976]$) than the mean of the other college students ($M = 2.13, SD = .968, 95% CI = [1.868, 2.398]$). Both first-generation and other college students felt that they "often" talked about music or musicians with other students, friends, or family members.

Table 2

Means and Standard Deviations for Academic Engagement by First-generation and Other college students Status

<table>
<thead>
<tr>
<th>Group</th>
<th>First-generation</th>
<th>Other students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n = 45$</td>
<td>$n = 45$</td>
</tr>
</tbody>
</table>

294
<table>
<thead>
<tr>
<th></th>
<th>M/SD</th>
<th>M/SD</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used a computer to analyze data</td>
<td>2.13/1.160</td>
<td>1.71/.757</td>
<td>.044*</td>
</tr>
<tr>
<td>Talked about art or theater</td>
<td>3.20/.991</td>
<td>2.76/1.069</td>
<td>.044*</td>
</tr>
<tr>
<td>Talked about music or musicians</td>
<td>2.71/8.15</td>
<td>2.13/9.68</td>
<td>.003**</td>
</tr>
</tbody>
</table>

*Note:* *significant at .05; **significant at .01

**Discussion**

The goal of this study was to document the differences in college academic activities between first generation and non-first generation college students enrolled in STEM disciplines at a HBCU. Previous studies over the past five years addressed the role of HBCUs in supporting and retaining STEM students (Jett, 2011; Owens, E.W. et al., 2012; Palmer et al., 2010). However, very few research studies focused specifically on first generation college students in STEM disciplines at HBCUs. In light of the unique role of HBCUs in producing STEM graduates, this study attempted to highlight for college administrators and faculty impediments to academic performance faced by first generation college students at HBCUs.

Statistically significant differences between first generation college students and other college students were found in three areas on the CSEQ. The first two were, “used a computer to analyze data,” and “talked about art or theater.” Initially the former appeared counterintuitive. After all, smartphones, tablets and handheld communication devices are readily available to college students. However, first generation college students may not know how to maximize the use of those communication devices for academic purposes, a probability that is supported in the research literature (Murphy & Hicks, 2006; Ramos-Sanchez & Nichols, 2007; Soria & Stebleton, 2012). The other category that indicated statistical significance, “talked about music or musicians with other students, friends, or family members” may infer the cultural capital of non-first generation college students includes more exposure to fine arts than their peers (Lundberg, 2007; Tanner, 2013).

This study employed an ex-post facto research design and since all studies are vulnerable to some limitations, a few will be noted. While this study was restricted to students enrolled in STEM disciplines at one HBCU, a larger study comprised of three to four HBCUs in a particular region could have impacted the results. Furthermore, the present study was conducted using quantitative methods. A qualitative research study would have undoubtedly provided broader insight from study participants.

According to Engstrom and Tinto (2008), the level of access a student has to higher education does not equate with the quality of opportunities. In other words, the emphasis of college administrators and faculty should reflect a commitment to measures with demonstrable results. The consensus of research studies on this population is that first generation college students face barriers that greatly impede college completion (Engstrom & Tinto, 2008; Owens, D., Lacey, Rawls, & Holbert-Quince, 2010). Possible solutions to address the importance of improving academic engagement have been recommended by other scholars such as providing greater access to resources not realized by first generation students (Owens, D. et al., 2010) the establishment of learning communities (Engstrom & Tinto, 2008; Hicks, Heastie, Allen, Ford, & Taylor, 2013) , development of specific programs aimed at student retention (Murphy & Hicks, 2006; Petty, 2014).

Multiple studies have been conducted on first generation college students, represented in large measure by minorities and specifically, African-Americans. Furthermore, studies have been conducted on African-American college students enrolled in STEM disciplines. However, the literature is void of longitudinal studies on first generation African-American students enrolled in STEM disciplines. Such a
study would allow for comparisons to be made between first generation college students and their peers. Additionally, as mentioned above, a qualitative study could examine the perspectives of first generation college students' experiences and perceptions of the academic challenges they face.

Conclusion

Research indicates first generation college students are particularly at high risk for academic and social challenges that impede college completion (Hicks et al., 2013; Murphy & Hicks, 2006; Rame-Sanchez & Nichols, 2007). Research further indicates that the declining participation of first generation African-American students in STEM disciplines is occurring when there is critical shortage of professionals in these areas (Bonner et al., 2009; Owens, E.W. et al., 2012). Historically, HBCUs have provided the kind of nurturing and supportive environment that contributed to the steady production of graduates in STEM disciplines (Jett, 2011). However, the findings from this study suggest there is more for these institutions to do.

References


