

DIFFERENCES IN STEM BACCALAUREATE ATTAINMENT BY ETHNICITY*

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Abstract

In this study, we examined the extent to which differences were present in the science, technology, engineering, and math (STEM) baccalaureate attainment of Black students and of Hispanic students at 82 Texas 4-year colleges from 2008 to 2009. A custom download of data files was conducted on the Integrated Postsecondary Education Data System in which Texas 4-year colleges, baccalaureate granting, STEM majors, and 2008 and 2009 were used as filters to create two reports. The number of STEM degrees attained by Black students and by Hispanic students at Texas four-year colleges did not increase from 2008 to 2009. In actuality, the mean number of Black graduates and the mean number of Hispanic graduates decreased by 0.39 and by 2.90 during the specified time period, respectively. Implications of our findings are discussed.



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1 Sumario en español

En este estudio, nosotros revisamos el punto hasta que diferencias fueron presentes en la ciencia, en la tecnología, en la ingeniería, y en las matemáticas (TALLO) logro de bachillerato de estudiantes Negros y de estudiantes hispanos en 82 Tejas los colegios de 4 años de 2008 a 2009. Una descarga personalizada de archivos de datos fue realizada en el Postsecondary Educación Datos Sistema Integrado en El que Tejas los colegios de 4 años, el bachillerato que otorga, DERIVA a mayores, y 2008 y 2009 fueron utilizados como filtros para crear dos informes. El número de grados de TALLO alcanzados por estudiantes Negros y por estudiantes hispanos en colegios de cuatro-año de Tejas no aumentó de 2008 a 2009. En la realidad, el número malo de egresados Negros y el número malo de egresados hispanos disminuidos por 0,39 y por 2,90 durante el período de tiempo especificado, respectivamente. Las implicaciones de nuestras conclusiones son discutidas.

NOTE: Esta es una traducción por computadora de la página web original. Se suministra como información general y no debe considerarse completa ni exacta.

2 Introduction

To compete and contribute internationally, the United States needs citizens who are highly trained in science, technology, engineering, and mathematics (Kuenzi, 2008). The National Academies' report, *Rising Above the Gathering Storm, Revisited* (2010), revealed that only 15% of all undergraduates in the U.S. receive their degrees in natural science or engineering, compared with 67% of undergraduates in Singapore, 50% in China, 47% in France, and 38% in South Korea. During the next decade, the U.S. demand for engineers and other scientists is expected to increase at four times the rate for all other occupations (STEM Education Coalition, 2011). As such, science, technology, engineering, and math (STEM) education is a growing area of concern to the U.S. government (Kuenzi, 2008).

In 2005, the Program for International Student Assessment reported that of 15-year-old students, the United States ranked 28th in math literacy and 24th in science literacy (Kuenzi, 2008). In comparison to other nations, the math and science achievement of U.S. students and the rate of STEM degree attainment appear inconsistent, especially for the nation considered to be the world leader in scientific innovation (Kuenzi, 2008). Furthermore, the United States ranked 20th among all nations in the proportion of 24-year-olds who earned degrees in natural science and engineering. The U.S. government sought to improve these statistics from 2006-2007 by releasing the American Competitiveness Initiative, by signing into law three modest STEM education programs, and by combining some of the major STEM education legislative proposals, into the America COMPETES Act of 2007 (Kuenzi, 2008).

Of those individuals who choose to enter a STEM field, too many students fail to complete their degrees in a timely manner, choose to leave STEM programs for other majors, or drop out of college completely (Hurtado & Garcia, 2011). Low graduation rates among science and math students not only affects how the United States competes globally but mean fewer doctors and engineers to serve the needs of the population (Hurtado & Garcia, 2011). Thirty-six percent of White, 21% of Black, and 22% of Hispanic undergraduate STEM students finished their bachelor's degree within five years but nearly 22% of all students dropped out of college by the fifth year (Hurtado & Garcia, 2011). Only 24% of underrepresented minorities who begin college as a STEM major complete a bachelor's degree within six years of college entry, as compared to 40% of White students (Center for Institutional Data Exchange and Analysis, 2000). In contrast, of those individuals who major in the liberal arts or business fields, 73% of White students and 63% of Black and Hispanic students finish degrees within five years (Hurtado, 2010). One of the most interesting and disturbing facts is that since 1985, Black college students specified a STEM major at a higher rate than that of their White peers but due to a high attrition rate from both the STEM major and from college, lagged far below their White and other minority peers in completion (Sasso, 2008). Sasso (2008) also noted that although the attrition rate of Black students is high in all fields, the attrition rate is especially high in science and engineering.

Having students from a variety of backgrounds who successfully complete the STEM degree programs can increase the likelihood of new innovations and problem solving. Recent increases in the general population and college enrollment of minority students in STEM programs provide encouraging signs that the United States has made progress in diversifying the STEM workforce and educational pipeline (National Science Board, 2008). Therefore, we contend that it is of paramount importance for the students, the nation, and the world that diverse populations enter STEM fields.

The disparity between underrepresented minorities in STEM areas in comparison to the White majority in these fields has been apparent for decades (Callender, 2006). Professionals in these occupations have recognized this problem and are striving to recruit and retain underrepresented minorities through a variety of methods (Callender, 2006). Researchers and those persons responsible for implementing STEM programs of various types have identified and utilized several methods to recruit and retain underrepresented minorities in STEM fields. The most common methods included financial and social support, academic support, and specialized recruitment (American Council on Education, 2006). Several colleges and universities have utilized one, several, or all of the aforementioned strategies in the attempt to recruit and retain underrepresented minorities in STEM fields.

3 Financial Support

Researchers (e.g., Gilmer, 2007; Nnedu, 2009; Maton & Hrabowski, 2004) have documented that many underrepresented minorities need financial support throughout their collegiate careers (ACE, 2006). This support is provided through stipends, scholarships, and grants. Nnedu (2009) reported that qualified underrepresented minorities involved in the nursing program at Tuskegee University were given monthly payments of \$200.00. Maton and Hrabowski (2004) also discussed financial support given to underrepresented minorities enrolled in the University of Maryland, Baltimore County's Meyerhoff program. Gilmer (2007) stated that members of the AIMS program at Bowling Green State University not only received \$1000 stipends after completing the summer-bridge program but also received a minimum of \$1500 in scholarship money annually. All of the aforementioned financial awards were given to help reduce the financial stress associated with college and reduce the need to work while in college, thus allowing students to focus on their studies (Gilmer, 2007; Maton & Hrabowski, 2004; Nnedu, 2009).

4 Social Support

Enrollment in STEM majors, becoming acclimated to the demands of the STEM disciplines, and adjusting to the STEM culture are areas of concern for researchers. Accordingly, numerous researchers (e.g., Callender, 2006; Gilmer, 2007; Nnedu, 2009; Maton & Hrabowski, 2004) have noted that students were given social support to offset these pressures. Programs on a variety of campuses have been created in attempts to provide a means of interaction for underrepresented minorities. Callender (2006) commented that several chiropractic colleges held social events for underrepresented minorities. Gilmer (2007), Maton and Hrabowski (2004), and Nnedu (2009) described programs requiring underrepresented minorities to attend some type of socialization activity. The attention given to this matter by the majority of the aforementioned studies can support the belief that social activities and other opportunities for engagement are important means of STEM program retention for underrepresented minorities. Hailed as a model program, the University of Maryland, Baltimore County Meyerhoff Scholars Program has successfully focused on combating cultural isolation, low expectations that erode morale, unsupportive peers, and discrimination that lead to undergraduate STEM student drop out (Sasso, 2008).

5 Academic Support

Academic preparedness is an area worth addressing by those persons who work to improve the enrollment and success of underrepresented minorities in STEM fields. Gilmer (2007), Carmichael and Sevanair (1991), Nnedu (2009), and Maton and Hrabowski (2004) documented the existence of various academic support

initiatives for students before entry into their respective programs and during their respective programs. Summer bridge programs were required for entry to all of the programs. These authors also stated that students received tutoring throughout their collegiate careers. This tutoring was provided not only by trained professionals, but also by peers in the programs. The Pre-Accelerated Curriculum program is a 6-week intensive summer bridge program for pre-engineering minority students who have yet to take any college level engineering courses at a Mid-Atlantic Historically Black College. The Pre-Accelerated Curriculum has helped students strengthen their math and critical thinking skills to avoid testing into developmental mathematics when they take the university's entrance exam (Palmer, Davis, & Thompson, 2010). The students are also exposed to high level mathematics, English courses, and introduced to the engineering curriculum. The program continues as the students enter their freshman year with peer and faculty tutoring in addition to self-efficacy development. Pascarella and Terenzini (2005) contended that programs structured in the manner described enhance students' collegiate preparedness. These programs may have assisted in the social acclimation to the programs as well as assisted in academic preparation.

6 Specialized Recruiting

Several researchers mentioned recruiting measures that targeted underrepresented minorities. Callender (2006), Nnedu (2009), and Maton and Hrabowski (2004) all promoted using various resources to attract and recruit underrepresented minority students to STEM. Nnedu (2009) ventured into the community and met with counselors and students. Program developers at the Tuskegee University program also conducted follow-up calls and sent correspondence to potential applicants. Callender (2006) determined that several of the chiropractic colleges she surveyed specifically recruited minorities. Maton and Hrabowski (2004) explained how not only the underrepresented minority students but also the parents of applicants of the UMBC Meyerhoff Scholars Program were hosted for a recruiting weekend on the campus of the University of Maryland, Baltimore County. These reports could bring specialized recruiting to the forefront of colleges' efforts to increase the number of underrepresented minority members in STEM fields.

7 Texas URM to STEM Recruitment Efforts

The Houston-Louis Stokes Alliance for Minority Participation (H-LSAMP) program is a National Science Foundation funded collaborative effort among numerous Houston and surrounding area colleges and schools including Houston Independent School District, Houston Community College, University of Houston Central and Downtown, and Texas State University at San Marcos (Francisco, 2005). Utilized in this program are specialized recruitment, mentoring, scholarships, and ongoing professional development to increase underrepresented minority participation in STEM fields. The University of Houston Downtown tripled the number of underrepresented minority STEM graduates, and the University of Houston and Texas State University-San Marcos doubled the number of underrepresented minority STEM graduates in the first five years of the program (Francisco, 2005). Texas A&M University (TAMU) has invested millions of dollars to attract minority students through programs such as the Very Important Prospects program that transports minorities from their neighborhoods to TAMU for college visits, scholarships, and mentoring and tutoring programs for students in sciences (Tresaugue, 2005)

8 Theoretical Framework

The American Council on Education (2006) conducted research in which they determined the negative factors that affect the recruitment and retention of underrepresented minorities in STEM fields: (a) lack of adequate high school preparation, (b) working more than 15 hours a week, and (c) not consistently enrolling full time. Colleges and universities could utilize this information as a guide to develop programs, in addition to other components they deem valuable as well. Theories informing the current study are Astin's theory of involvement (1984) and Tinto's persistence theory (Milem & Berger, 1997). Astin (1984) posited that students learn more the more they are involved in both the academic and social aspects of the collegiate experience.

Tinto (1993) stated, "There appears to be an important link between learning and persistence that arises from the interplay of involvement and the quality of student effort" (p. 71). Students who enroll part-time do so mainly due to work and other obligations. They are less likely to be involved in campus activities and are not engaged with their classmates in academic work outside of the classroom. If a minority member or any student is working due to economic necessity, s/he is spending less time on campus and does not take advantage of opportunities that contribute to academic success. If the student is also the individual who carries the burden of inadequate preparation in high school, the combination of these factors most assuredly impacts persistence in the STEM disciplines.

9 Purpose of the Study

The purpose of this study was to determine the extent to which a difference was present in the STEM baccalaureate attainment of Black and Hispanic students at Texas 4-year colleges from 2008 to 2009. According to the U.S. Department of Education (2009), the increased enrollment of minority students in higher education institutions has been substantial over the past several years: minority enrollment has increased from 15% in 1976 to 32% in 2007. When reviewing the national data, it would seem reasonable that a corresponding increase in minority enrollment in the STEM fields would follow. Texas is a state with both a sizable population and a sizable Hispanic and Black minority population, 32% and 12% respectively (U.S. Census Bureau, n.d.). Therefore, the study of Texas minority student STEM baccalaureate attainment is noteworthy.

10 Research Questions

Research questions addressed in this study were: (a) What is the difference in the STEM baccalaureate attainment of Black students at Texas 4-year colleges from 2008 to 2009?; and (b) What is the difference in the STEM baccalaureate attainment of Hispanic students at Texas 4-year colleges from 2008 to 2009?

11 Method

11.1 Participants

Participants in this study constituted Texas 4-year colleges and universities on whom data were available, as this number was fewer than 100 institutions; the entire sample of 82 institutions was utilized. Specific ethnic groups of interest were Black and Hispanic students at these institutions. Texas 2-year colleges were excluded from this study due to their inability to grant baccalaureate degrees. Baccalaureate attainment, the focus of several studies in this field (Kuenzi, 2008), is the focus of this study.

11.2 Procedures and Instrumentation

The Integrated Postsecondary Education Data System (National Center of Education Statistics, 2010) was the source of the information analyzed in this study. A custom download of data files was conducted on the Integrated Postsecondary Education Data System. Texas 4-year colleges, baccalaureate granting, STEM majors, and 2008 and 2009 were used as filters to create two reports. Once the reports were created they were then downloaded into SPSS version 18 for analysis. Two separate reports were created by year and were therefore separate in the SPSS system. A merging procedure was used to create one data set. Once this set was created it was downloaded into an Excel file and aggregated to calculate all of the STEM degrees awarded by each institution into single rows, which would later become cases in SPSS. Data were then downloaded and converted back into an SPSS data file.

12 Results

Black and Hispanic student baccalaureate attainment in STEM fields was the focus of the two research questions in this study. The means of both groups (i.e., Black and Hispanic students) ranged from 1 to 48 during the specified time period. Further descriptive statistics of the variables investigated in this study are presented in Table 1. Prior to conducting inferential statistics to establish whether a statistically significant change had occurred in the number of Black and Hispanic students at Texas 4-year colleges, checks were conducted to identify the extent to which the data were normally distributed. Of the standardized skewness coefficients and the standardized kurtosis coefficients (i.e., the skewness value divided by the standard error of skewness and the kurtosis value divided by the standard error of kurtosis), all were calculated and determined to be far outside the range of normality ± 3 (Onwuegbuzie & Daniel, 2002). Due to these findings, nonparametric Wilcoxon's dependent samples t -tests were the statistical procedures used to answer the aforementioned research questions.

Descriptive Statistics of Texas 4-Year College STEM Baccalaureate Attainment by Student Ethnicity, 2008 to 2009

Ethnicity and Year	<i>n</i> of colleges	<i>M</i>	<i>SD</i>
Black			
2008	82	20.48	35.54
2009	82	20.09	43.92
Hispanic			
2008	82	48.99	97.57
2009	82	46.09	99.90

Table 1

The Wilcoxon's dependent samples t -test did not yield a statistically significant difference in the number of STEM baccalaureate degrees attained by Black students from 2008 to 2009, $z = -0.74$, $p = .46$. The number of STEM degrees attained by Black students at Texas four-year colleges did not increase from 2008 to 2009. In actuality, the mean number of graduates actually decreased by 0.39 during the specified time period. The Wilcoxon's dependent samples t -test also did not yield a statistically significant difference in the number of STEM baccalaureate degrees attained by Hispanic students from 2008 to 2009, $z = -0.90$, $p = .37$. The number of STEM degrees attained by Hispanic students at Texas 4-year colleges did not increase from 2008 to 2009. In actuality, the mean number of graduates decreased for this group as well by 2.9 during the specified time period.

13 Discussion

In this study, we documented that the baccalaureate attainment numbers of underrepresented minorities in STEM majors changed from 2008 to 2009 in a negative manner. Although these changes were modest, they showed a slight decline in both groups, a decline that could possibly worsen over time. The enrollment in Texas 4-year colleges has increased over the specified time period though as evident, the number of graduates in the majors associated with this study has decreased. Because Texas has a large minority student population, any decrease is cause for concern. As noted in the theoretical framework of Tinto's persistence theory (1997) and Astin's involvement theory (1993) merely being enrolled in college does not ensure eventual graduation. Involving underrepresented minorities in academic support could be a method to increase this involvement. The apparent link between learning and persistence has the ability to become edified through the dedication of staff and students in the tutoring and mentoring process.

As indicated in the research literature, the methods needed to increase the number of underrepresented minorities in STEM majors have been identified. The literature is clear, prepare underrepresented minorities more adequately in high school, provide financial assistance to reduce work hours, and find ways to keep underrepresented minorities consistently enrolled full-time (American Council on Education, 2006). Both Hispanic and Black students, as compared to White students, are less academically prepared for STEM fields, have more financial concerns, take fewer math and science courses in high school, and have lower aspirations for pursuing a career as a scientist (Hurtado & Garcia, 2011). Numerous colleges across the nation have created programs based upon those methods and have experienced success. Though several Texas colleges have implemented some of these suggestions by creating programs, only a small number have successfully implemented these programs. Addressing these areas can increase the baccalaureate attainment of underrepresented minorities in STEM fields. At present, the Texas Higher Education Coordinating Board has addressed some of this issue in the goals of the Closing the Gaps 2015 campaign (Texas Higher Education Coordinating Board & Richard T. Ingram Center for Public Trusteeship and Governance of the Association of Governing Boards of Universities and Colleges, 2008). As the population of Texas grows to be more diverse and the demand for more innovative technological and scientific advances increase in the coming years; these populations could become more of a concern for higher education in Texas.

Two substantial limitations occurred in this study, the inability to access data for all private 4-year colleges in Texas which might influence the results and the complete demographic information of the student populations of each campus included in the studies. Further research pertaining to this topic could assess the change in underrepresented minorities STEM baccalaureate attainment in Texas 4-year colleges from the implementation of the America Competes Act of 2007 to the present. Inclusion of female STEM baccalaureate attainment in Texas 4-year colleges might be a useful addition to the data, as females are considered underrepresented minorities in STEM fields as well. An examination of the factors that impact the students' decision to pursue a STEM degree may also reveal important data for planning and recruiting. Research of successful programs that confront the problems of STEM degree completion by minority students may also provide some implications for improved practice. This study invites a mixed methods approach. A survey could be distributed to the institutions analyzed in this study to determine what methods are being employed at the colleges that are most successful in graduating underrepresented minority members in STEM majors. Such areas of research may include: gatekeeper courses, focus interventions at points of loss, financial innovations such as debt forgiveness, stipends and book grants, mentoring and faculty relationships, the impact of research activities, and other non-cognitive predictors of persistence such as participation in clubs and organizations, sense of belonging, and cross-racial interactions.

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