A Comparative Study of Variables that Predict the Retention of Black Pre-Engineering Students and White Pre-Engineering Students at a Majority University

by

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Abstract

The persistence of Black engineering students to graduation from college continues to be of concern as the nation moves into a more globally diverse environment. Institutions have a large role to play to ensure that there is a large pool of diverse and talented students trained to work in a technological environment. While our population has become increasingly diverse, the educational institutions have not kept pace with the growth by providing educational opportunities that tap into the diverse human resources that correlate with the increase in the U.S. population. Even though there has been progress made over the years to improve the recruitment of Black engineering students, there still is a lack of awareness in identifying the factors that impede Black engineering students in their persistence to graduation with a degree in engineering.

The purpose of this study was to determine whether the same nine dependent variables−knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal−used to predict the academic success and persistence of White pre-engineering should be used to predict the academic success and persistence of Black pre-engineering students. The research questions were these: Is race related to the nine dependent variables? Is status of students related to the nine dependent variables? Is the relationship between the status of students and the nine dependent variables different for Black pre-engineering students and White pre-engineering students?

The participants, all pre-engineering students, were selected from 3,570 students who were enrolled for classes during the fall semesters 2000-2003. All incoming freshmen enrolled as pre-engineering students in the College of Engineering were required to complete the College Freshman Survey (Halpin & Halpin, 1996). After filtering, the number consisted of 386 Black students and 3,184 White students. Student status included 1,742 students who were admitted into their engineering major with an overall GPA $\geq$ 2.2, 939 students who were unsuccessful in advancing into their engineering major because they did not achieve an overall GPA 2.2, and 889 students who voluntarily left engineering with an overall GPA $\geq$ 2.2.

MANOVA results revealed significant race differences on the set of nine dependent variables and significant status differences on the set of the nine dependent variables. ANOVA results revealed significant race differences on seven of the dependent variables and significant status differences on six of the dependent variables. A significant Race x Status interaction also resulted. For Black pre-engineering students, the results revealed no significant status differences for eight of the dependent variables. Academic self-concept was the only dependent variable for which there were significant status differences. For White pre-engineering students, significant status differences were found for all of the dependent variables.

Based on the findings of the study, the same measures used to predict the academic success of White pre-engineering students should not be used to predict the academic success of Black pre-engineering students. The findings are useful for administrators, counselors, and teachers who are serious about using the most effective measures to predict the academic performance of Black pre-engineering students.

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I. Introduction

For those students who decide to remain in engineering and persist to graduation, the college road will be a journey of discovery and challenges. The journey to college and the matriculation process for Black students may be quite different than the journey and matriculation process for the traditional college student. Even more so, if the Black student decides to major in engineering, the journey may be much more arduous for him or her as compared to the journey of the traditional engineering student. Rowser (1997) argued that most of the proactive retention efforts for Black students are based on what others perceive their needs to be. She approached her research by focusing on identifying key factors that freshman Black college students perceived to be their needs as entering freshmen.

The first year of college presents numerous challenges and opportunities for the freshman students as they embark on the second phase of a life-long journey that may take them to places they never imagined. These new college students will need to make some key decisions at this juncture in their lives that are critical to their success as college students. Some of the key concerns the students will face are these:

1. Which college to attend?
2. How will the cost of college be financed?
3. Which major is appropriate for the student's skills and knowledge level?

4. What kind of support and encouragement will the student expect and receive from parents, peers, and friends?
5. Will the student experience isolation at being exposed to new and unfamiliar environments?
6. Will the student live in campus housing, an apartment, or at home?
7. Will the student have difficulty developing new relationships?
8. Should the student break neighborhood ties with old friends?
9. Are the college expectations for the new college student different from the high school expectations?

These are just a few concerns new college students will face.

Astin (1975) surmised that environmental circumstances significantly influence the chance of students completing college and indicated some of the measures used as predictors of college attrition. He stated:

> A substantial body of research has shown clearly that the student's academic performance in secondary school is a major predictor of attrition. The measures used in most studies have included the student's average high school grade, rank in high school graduating class, and academic ability as measured by college admissions tests scores. (p. 30)

In Astin's analyses, using four groups−White students in White colleges, White students in Black colleges, Black students in Black colleges, and Black students in White colleges−students' chances of dropping out of college increased consistently as their high school grades decreased. The students' rank in high school class, specifically for Black students attending White colleges, was a strong predictor of dropping out as opposed to

their average high school grade. For Black students the predictive strength of the SAT and ACT scores was consistently smaller than that of high school grades, and in comparison to White students, the test scores contributed marginally to the prediction of attrition. The academic rating of high school attended added significantly to the predictive strength of dropout proneness for all groups.

If students decide to major in engineering, they will become part of an academic community that requires them to complete a rigorous curriculum that is substantially more challenging than some of the other non-technical majors. At Auburn University, a predominately majority institution located in southeast U.S., pre-engineering students are required to complete all courses in the pre-engineering curriculum, accumulate 31 credit hours, and attain an overall 2.2 GPA to matriculate into their desired engineering major. The actual pre-engineering curriculum consists of two semesters of calculus, two semesters of science−either physics or chemistry, one computer programming class, one engineering orientation course, and one introduction to engineering course that is major-specific.

For many traditional students, the journey to college is oftentimes paved at birth with assertive and educated parents who provided the student with perpetual guidance and encouraged the student to maximize all available educational opportunities. These parents were astute in mapping out the best possible academic route to ensure that their son or daughter remained on the academic road to success. For example, traditional students may have attended a high quality high school, with counselors and administrators who formed a supportive and encouraging network that ensured that these traditional students were prepared for college. This kind of supportive and

knowledgeable network helps these students to overcome many seen and unforeseen obstacles that may interfere with attaining a college degree.

The Black engineering students will need to discern the academic difficulty associated with engineering, how they will handle the perceived difficulties of their course work, and the level of support that they will need from parents, peers, and college administrators. The journey to college for the Black students may lead down a more rugged road. They may have the same high aspirations and expectations as the White students in terms of their ability to succeed at college but may not be familiar with all pre-college preparation requirements. Additionally, Black students may not have attended a high caliber high school that includes a supportive and encouraging network of counselors and administrators to guide them in the college preparatory process. Consequently, the kind of environment that does not respond to the needs of the Black students may shatter their aspirations and expectations. This kind of environment, in fact, may have a detrimental effect on whether these students attend college and persist to graduation.

The academic difficulties the Black engineering students may experience are further compounded if they are first-generation college students. Their parents may not have the available financial resources to make college affordable and accessible. More than likely, the parents of first-generation students are not familiar with a multitude of obstacles and barriers, including these:

1. Pre-college admissions requirements. These Black students may not know how to complete the application process and how to work with high school counselors

to make sure they have taken the appropriate courses required for a particular major, e.g., math and science courses for engineering.

2. Standardize testing requirements. Parents are not familiar with the testing strategies to ensure that their son or daughter receives an acceptable score to be admitted into college.
3. Meeting admissions deadlines. Parents are not familiar with the time frames to make sure that paper work is submitted to the college in a timely manner, for review, so that the students are included in the pool of applicants.
4. Financial assistance. Parents are not familiar with the required financial aid forms to complete to increase available financial options for the student.
5. Enrollment process. Parents are not familiar with the procedures to obtain assistance from college admissions personnel and college advisors whose role is to assist prospective students in the enrollment process.

As the Black pre-engineering students progress along key paths on the academic road, they will be faced with difficult circumstances and consequences that will determine whether or not they are admitted into the engineering program, transfer into a non-technical major, transfer to another university, or drop out of college. These are key factors of retention college administrators should be concerned with when considering recruitment and retention for Black pre-engineering students.

In spite of the growing concern regarding diversity on college campuses, and the concerns for filling the future engineering void in the work force, institutions must be able to address recruitment and retention issues that are unique to Black engineering students. Currently, there is a lack of literature that focuses on the critical issues that

specifically impact the academic performance and persistence to graduation for Black engineering students. Much of the literature suggests that Black students' chances of graduating depend on a number of factors. Some of the factors include how well they integrate into college life, their standardized test scores, the mathematics courses they completed while in high school, and their high school GPA. These same factors are used to predict the academic success of White engineering students. However, unlike White students, integration into college for the Black students may entail a different set of factors that may go beyond the cognitive variables that are so often used to predict their academic success. In other words, there may be another set of variables that should be considered when predicting the academic success for Black engineering students.

Purpose of the Study

The research was focused on the effectiveness of select variables in predicting academic success and persistence for Black pre-engineering students and White pre-engineering students. The more specific purpose of this study was to examine whether the same variables that are used to predict the academic success and persistence of White pre-engineering students should be used to predict the academic success and persistence of Black pre-engineering students. Used in this study was a set of nine variables from the College Freshman Survey (Halpin & Halpin, 1996): knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal.

Research Questions

This comparative study of variables related to the academic success and persistence of Black pre-engineering students and White pre-engineering students at a majority university tested three research questions.

1. Is race related to the nine dependent variables which include knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal, when the variables are analyzed collectively or analyzed individually?
2. Is status of students related to the nine dependent variables which include knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal, when the variables are analyzed collectively or analyzed individually?
3. Is the relationship between the status of students and the nine dependent variables which include knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal different for Black pre-engineering students and White pre-engineering students?

Definition of Terms

Status

The term *status* refers to three groups of students: students who were admitted into their respective engineering major with an overall GPA ≥ 2.2, students who were unsuccessful in advancing into their respective engineering major with an overall GPA < 2.2, and students who voluntarily left engineering with an overall GPA ≥ 2.2.

Black students

In this study, the term *Black students* will be used to refer to the Black or African American students. The terms *underrepresented minorities* and *minority students*, which include Black students, will be used only when referring to cited material.

Traditional students

The term *traditional students* refers to White students, majority students, and non-Black students.

Predictors of persistence

The term *predictors of persistence* in this study are variables associated with how students personally feel about their ability to succeed at college: The students' perception of their knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal.

Persistence

The term *persistence* refers to the student's perseverance to matriculate through the pre-engineering and engineering curriculum.

Pre-engineering

The term *pre-engineering* refers to the time frame in which freshman students are required to complete a series of prescribed courses that are prerequisites to advancing into their desired engineering major. The requirements for the pre-engineering curriculum are two calculus courses, two science courses, one engineering orientation course, one introduction to engineering course, and one programming course. In addition to the pre-engineering curriculum students must complete to advance into their major, they must earn 31 credit hours and maintain an overall 2.2 GPA.

GPA

The term *GPA* refers to the overall or cumulative grade point average (GPA) and not the GPA for one semester. Included in the GPA are grades that students repeated in accordance to Auburn University's Grade Adjustment Policy which allows undergraduate students to delete a maximum of 3 course grades of D or F from the computation of their cumulative grade-point average. Students who delete course grades must repeat the courses at Auburn University before they graduate.

Significance of the Study

A comparative study that examines the predictors of academic success for Black students and White students is significant as institutions put forth efforts to address the retention problems of Black engineering students. In most comparative research that deals with the recruitment and retention of Black and White engineering students based on a set of variables that predicts the students' persistence to graduation with an engineering degree, the research is generalized and dominated with studies that suggest that White engineering students outperform Black engineering students. On the other

hand, there is limited research consideration given to the fact that the variables used to predict the persistence to graduation for Black engineering students and White engineering students may drastically differ.

This study, used in a broader context, will assist college administrators and high school and middle school counselors in developing more accurate approaches to identify and address the academic attrition of Black engineering students, as well as other students with characteristics that are similar to Black engineering students.

II. Literature Review

There is a substantial amount of literature that compares the academic performance of Black engineering students to that of White engineering students using the same measures. However, the literature that focuses specifically on the measurements that predict the academic performance and persistence of Black engineering students is limited. This literature review is outlined as follows: A General Perspective on College Retention, Retention Studies Focused on Black Students, Mathematics Readiness, Knowledge and Confidence, Help Networks for Students, Self-Appraisal and Self-Concept, Academic Difficulties Black Students Face, the Social Community of Black Students, and Summary.

A General Perspective on College Retention

There are numerous studies that focused on the various predictors of college persistence and graduation. Astin (1975) and Bernard, Spurlin, and Anson (2007) indicated that family background, religion, parental education, income, race, and type of home town are predictors of academic success. The researchers also asserted that to succeed one must have a strong sense of personal efficacy. Further, to better understand student attrition, researchers must examine how prior academic performance, socioeconomic status, and study habits interact with each other.

Tinto (1993), a renowned author and researcher that has influenced the study of student retention for a numerous years, advanced several reasons most students leave

college before completing their degrees. These reasons are generalized statements that pertain to freshman students. For instance, many freshman students have difficulty caring for themselves when they arrive at college because they have not learned how to function in a more demanding environment compared to the less demanding environment of high school. Tinto further surmised that many students are not comfortable with separating themselves from their past associations in order to start the process of making new friends at college. He also suggested that students with lower abilities and lower socioeconomic status are more likely not to complete a 4-year degree within 6 years and that expectations, support, feedback, involvement, and learning are some reasons why students remain in college and persist to graduation.

Retention Studies Focused on Black Students

Rowser (1997) advocated that most of the proactive retention efforts for Black students are based on what others perceive their needs to be. Not relying on the critique of others regarding the retention efforts for Black students, she approached her research by focusing on what new Black students perceived their own needs to be as entering freshmen. In a survey, the Black students were asked to indicate (a) how well they believed they were academically prepared for college, (b) what their expected GPA would be, (c) their expected graduation year, (d) how well they were prepared personally and socially to adapt to a new environment, and (e) the areas in which they believed they would need help to succeed. The results showed that 90% of the students felt that they were adequately prepared for college, while only 1% of the students believed that their GPAs would be < 2.0. Results further showed that 56% of the males expected to graduate in 5 years, 40% of the females expected to graduate in 4 years, and 47% of both

males and females expected to graduate in either 4 or 5 years. In the areas of personal and social preparation, 52% of the males and 48% of the females believed that they would not have any problems adapting to their new environment, and almost three times as many females, compared to the males, felt that they would need tutoring. Males felt that they would need 50% more help in exercising self-discipline than the females, whereas both males and females felt they needed much help in goal setting. Both groups, however, did not differ in identifying their need for help with making friends. None of the males indicated that they would be homesick, whereas 3% of the females believed they would be homesick.

Rower further indicated that, even though the Black students had positive outlooks regarding their academic performance and graduation, the data are disturbing because most of the students needed to start college in remedial courses that did not count toward their credits for graduation. The perception for 95% of the Black students, consistent with the White students, was that they could adapt to the new environment and make friends however. She advocated that using predictors that are unique to Black students will assist them to develop realistic expectations, to eliminate unnecessary frustrations, and to improve persistence to graduation rates.

Graham (1994) has also conducted extensive research on some of the predictors that influence the persistence of Black students in college. She asserted that empirical literature, spanning over 30 years, supports the notion that the self-concept of Black students does not support the general perspective that they have negative self-views. Quite the contrary, she advocated that comparative racial studies consistently report Black students to be the same or higher than White students on multiple self-concept

measures. Interestingly, the literature Graham studied was so racially-compared that she concluded:

> With literature so heavily race-comparative the question of socio-economic status of subjects becomes particularly important. . . . Because African Americans are overrepresented among economically disadvantaged groups in this society, researchers who make Black and White comparisons need to incorporate socioeconomic status in their designs in order to disentangle race and social class effects. (p. 59)

Predictors of Student Persistence to Graduation

The Nation at Risk, the Nation's Report Card, and Alexander Astin, a noted researcher on student retention, gave a brief prospectus of what students need to be successful in college.

The 1983 Nation at Risk report, still relevant after 26 years, pointed out benchmarks that high school graduates and college graduates should have in terms of knowledge content, abilities, and skills that are required to succeed academically. To succeed it takes time, hard work, self-discipline, and motivation on behalf of the student. Contrary to the success strategy benchmarks that are required to succeed academically, the report also indicated that, when the teacher does not demand a lot of homework from the student or when the teacher gives grades for less work, the classroom expectations, along with the average student achievement, are diminished.

The Nation's Report Card Educational Progress assessment for mathematics and science further showed that, as with other studies, an important predictor of persistence in college is whether or not the parents finished high school and attended college and

graduated from college. The percentage of students who reported that neither parent finished high school was 7%, and the percentage that reported one parent graduated from college was 34% (NCES, 2007).

Astin (1975) found that first generation students are more apt to leave college because they are not academically prepared for the strenuous curriculum of college. In predicting which freshmen will drop out of college, he indicated that self-concept−which includes a student's ability, whether or not the student graduated from high school, the student's socioeconomic status, and the student's educational aspirations−are predictors of academic success once the student arrived at college.

In his longitudinal and multidimensional dropout study that covered a 4-year period, from 1968 to the summer and fall of 1972, Astin (1975) investigated several conditions that were attributed to student persistence to graduation. The students in the study were selected from a national sample of 358 2- and 4-year colleges and universities in the Cooperative Institutional Research Program, conducted by the Laboratory for Research on Higher Education at the University of California, Los Angeles and the American Council on Education. The results highlighted variables as predictors that either increased or decreased students' chances for stopping or dropping out of college.

1. High school grades. As high school grades decreased so did the chance of students either stopping or dropping out of college.
2. High school rating or the academic quality of the high school. Schools that are considered high quality are more often able to provide quality resources to their students.

3. Student aspiration. If students set realistic goals to earn an advanced degree, more than likely they will persist to graduation as undergraduate students in college.

4. Study habits. If students were bored with high school, had difficulty concentrating on their homework, studied with outside distractions, and seldom completed homework, the chance of their stopping or dropping out of college increased.

5. Financial aid. The sources of financial aid to pay for college costs−whether from parents, spouse, scholarships, loans, savings or work−increased or decreased the chance of students stopping or dropping out of college.

6. Housing. Where students live, i.e., in a college dormitory, off campus housing, or at home, either increased or decreased their chance of stopping or dropping out of college. The study indicated that students' chances of success increased if they lived in a college dormitory.

Cognitive Variables Used to Predict Persistence to Graduation

A few of the studies that emphasize GPA, mathematic grades, admission scores, and standardized tests scores as predictors of academic success are highlighted here. For instance, Ohland and Zhang (2002) and Zhang, Anderson, Ohland, and Thorndyke (2004) ascertained that a common measure of students' academic ability is their high school GPAs. In 2006, the American College Testing (ACT) Program reported that approximately 48% of students enrolled in 2-year colleges left during the first year and that more than 25% of the students left during the first year from a 4-year college or university (Braxton, Brier, & Steele, 2007).

House (2000) highlighted several studies that used standardized test scores to predict academic success:

> For instance, Scholastic Aptitude Test (SAT) scores have been found to be significant predictors of grades in college algebra (Bridgeman, 1982) and finite mathematics (Troutman, 1978). Similarly, American College Testing (ACT) scores have been shown to be significantly correlated with student achievement in college algebra (Kohler, 1973), finite mathematics (House, 1995b), and calculus (Edge & Friedberg, 1984; Keeley, Hurst, & House, 1994). Other researchers have evaluated the relationship between admissions test scores and grade performance in college science courses. (p. 270)

Zhang et al. (2004) also examined pre-existing factors that were quantitatively evaluated to emphasize the impact on engineering students' success. A database was used to report the graduation rate, as a function of the years to matriculate, that determined the typical time-to-graduation. The database consisted of 87,167 engineering students at nine institutions from the time frame 1987 through 2002. A multiple logistic regression model was fitted to each institution's data to explore the relationship between graduation and demographic and academic characteristics. High School GPAs, gender, ethnicity, quantitative and verbal SAT scores, and citizenship variables had a significant impact on graduation. While the high school GPAs and quantitative SAT scores for engineering students' success were significant for all models tested, the significance of other predictors varied among the institutions. These studies add to the existing body of research about factors affecting the success of engineering students.

Gainor and Lent (1998) summarized several studies that shared commonality regarding the math performance of Black students.

> African Americans have, historically, enjoyed many successes in math, science, and technology (Bailey, 1990; Pearson and Bechtel, 1989). However, African American high school and college students currently enroll in fewer math and science courses than do their White peers (Powell, 1990). Hall and Post-Kammer (1987) considered several general factors that may help explain Blacks' underrepresented in math and science majors, including educational factors (e.g., early interest and academic preparation), social-psychological factors (e.g., role models), and career opportunity and economic incentive factors (e.g., job ceilings). (p. 403)

In addition, Gainor and Lent investigated the courses students choose as a predictor of academic success. The students' beliefs about their math abilities and the consequences of taking a particular math course influenced whether they would take the course. If they thought the course was difficult, they would not take it if they believed they would fail. Counter to avoiding a course because of its difficulty and the possibility of failure, if students believed that they could pass the course, they would take it. Consequently, achievement was most strongly related to the students' perceived level of mathematical ability. The results suggested that their interest in mathematics, measured at the beginning of high school, was a significant and independent predictor of how far students progressed by the end of school (Jones, 1984).

The notion that some students take courses based on whether they believe they will pass or fail ties directly into the theory of self-efficacy. Wigfield and Eccles (2002) reiterated that self-efficacy involves how students' beliefs about their capabilities to learn or perform behaviors at designated levels influences their persistence level. In addition, Schunk and Zimmerman (1997) stated, "Compared with students who doubt their learning capabilities, those with high self-efficacy for acquiring a skill or performing a task participate more readily, work harder, persist longer when they encounter difficulties, and achieve at a higher level" (p. 198).

Additionally, in line with the concept of self-efficacy, Gainor and Lent (1998) found that Black students' math self-efficacy and outcome expectations were jointly an indicator of their math-related interests. Since math-related courses are under the umbrella of engineering and if Black students shy away from taking math-related courses, they lower their potential of taking engineering courses.

On a national level, fewer Black students take advanced mathematics and science courses than White students (May & Chubin, 2003). The fact that fewer Black students take advanced mathematics and science courses than White students is quite discerning in today's academic environment, especially if students are allowed to pick and choose what courses they would like to take as opposed to what courses they need to take. As a link to the statement made by Gainor and Lent (1998) that students will only take courses they believe they will do well in does not serve Black students well, especially if they are allowed to pick and choose their math courses.

For instance, the Nation at Risk (1983) report showed that intermediate algebra was offered, but only 31% of the high school graduates completed it. While calculus, a

gateway course to the study of engineering, was available in schools enrolling about 60% of all students, only about 6% of all students completed it.

The NSF Indicators (2002) reported that more than 20% of students who wanted to major in a science or engineering field self-reported that they needed remedial work in mathematics. Alting and Walser (2006) found that as much as 39% of freshman engineering students began their mathematics studies with algebra and college algebra. Unfortunately, in the engineering curriculum, algebra and college algebra are not counted towards fulfilling the math course requirements for the engineering curriculum. If students needed to take algebra courses, it would cause them to remain in their pre-engineering curriculum longer than students who started their college pre-engineering curriculum with calculus.

Burtner (2005) used discriminant analysis to investigate the influences of non-cognitive factors on students' decision to persistence in engineering school. He reported that students' self-reported confidence in college-level math and science ability and the belief that an engineering degree would enhance their career security were found to be significant predictors of persistence in engineering. While some students remain in engineering, approximately half of the students entering college with a desire to major in science, math, or engineering change their majors within the first 2 years (Center for Institutional Data Exchange and Analysis, 2000). Students switch majors because they lack the basic science and mathematics skills to persist (May & Chubin, 2003).

Knowledge and Confidence

A student's ability to learn comes from his or her pre-existing knowledge, domain-specific attitude, general intelligence, and self-regulatory tendencies (Jones &

Byrnes, 2006). Even though engineering students began their college education with a set of attitudes and beliefs about engineering and their abilities to be successful, changes that occurred as they learned new technical skills and acquired knowledge during their first year has been shown to have had a profound influence on the students' motivation, academic performance, and retention in engineering (Besterfield-Sacre, Atman, & Shuman, 1997). Hirsch, Gibbons, Kimmell, Rockland, and Bloom (2003) conducted a study to assess high school students' attitudes and knowledge about engineering. They developed a survey that asked students how much they knew about engineering and engineering careers. Surprisingly, over 80% of the students indicated that engineering requires flexibility in thinking and good problem-solving skills. However, the students did not have a good grasp of what engineering entails. It appeared that, even though the students had an abundance of self-confidence in the math and science subjects, they had very little knowledge about engineering. The authors attributed students' lack of knowledge about engineering to their high school counselors and asserted that this lack of knowledge may explain why students, even though they were seniors, had not taken a physics or chemistry class.

Help Networks for Students

Students who share common classes provide a support network that makes uncomfortable students feel comfortable in those common classes. Students tend to build a network of peers that functions as an academic and social support system by providing study partners, sharing of class information, and helping with homework and class assignments (Tinto & Goodsell-Love, 1993).

Seidman (2005) noted that support from parents and friends was helpful to students during pre-college as well as while the students were in college. Another support network within the academic setting is collaborative learning groups. Tinto and Goodsell-Love (1993) stated that collaborative groups provide important peer support by helping students to balance the many strategies they experience at college.

Benefield, Walker, Halpin, Halpin, and Trentham (1996) reported on issues relating to Black students' retention with the level of academic potential measured by ACT scores. In the 1991-92 academic years, the Black engineering freshmen had a mean ACT of 21.8, compared to a mean of 25.6 for the university's traditional White engineering freshmen.

At the end of the first year of a study, Good, Halpin, and Halpin (2002) stated that the Black students' achievement increased as a result of the students' involvement in an academic support program. The results showed that 24% of the non-participants left for academic reasons, with grade point averages less than 2.2, with 14% of the non-participants also opting to leave in spite of their strong academic standing.

In a qualitative study, Lee (2000) found that public research universities that fostered a competitive culture within a learning community tended to create a competitive, isolated environment that prohibited or made it difficult for students to form natural mentoring relationships. The competitive culture, which is fostered within a learning community, may be particularly true for Black students who felt marginalized from the traditional college population.

Self-Appraisal and Self-Concept

Sedlacek (1996) also conducted a qualitative study in which he investigated variables that he felt influenced the self-appraisal of Black students. If students had a high score on self-appraisal, it meant they appreciated and accepted rewards for their good performance as well as accepted the consequences of their poor performance. The students understood that reinforcement was imperfect and they did not overreact to positive or negative feedback. Further, the students developed a system of using feedback to change their behavior. On the other hand, if students had a low score on self-appraisal, it meant that they were not sure how the evaluations were done in school. The students overreacted to most reinforcement (positive or negative), rather than conceptualizing it in a larger context. Additionally, the students did not know how they were performing until the grades were out, nor did the students know how their peers would rate their performance.

Observing how some students succeed can raise other students' efficacy and motivate them to try harder at a task because they believe that if someone else can succeed they also can succeed. On the other hand, if students observed how another student handled difficult tasks and failed, the students observing may also doubt their own capabilities and, as a result, lack the motivation to try a task (Schunk & Zimmerman, 1997).

Comparison of Black and White Students in Engineering

NSF (2008) Chapter 1 of the 2008 Science and Engineering Indicators provided a more recent summary of what occurred in the engineering and science field between 1985 and 2005. Highlights of the report showed that science and

engineering degrees awarded to White students declined from 82% to 65% from 1985 and 2005. On the other hand, the science and engineering degrees that were awarded to Black students increased from 5% to 8% between 1985 and 2005.The differences in the completion of bachelor's degrees in science and engineering by race and ethnicity reflected the differences that occurred in the students' high school completion rates, college enrollment, persistence and attainment rates.

Even though the 2005 overall national mathematics assessment for both Black and White students was not encouraging, the White students consistently outperformed the Black students. The assessment showed the 29% of White students were at or above proficient level and 6% of Black students were at or above the proficient level (NCES, 2007).

Georges (2002), then president of National Action Council for Minorities in Engineering (NACME), acknowledged that extensive progress has been made in the last 15 years in making engineering accessible to today's Black students. In an ongoing study, funded by NACME on the performance of engineering institutions in retaining Black freshmen through graduation, he surmised that while current and previous research has confirmed that Black students performed extremely well at top engineering schools, only half were likely to graduate with an engineering degree. Georges concluded that there is a widening in the disparity of Black students in engineering since 1995 when the retention rate was 59.1%. The retention rate for Black freshmen in 2002 was 32.2%.

Black Students' Perception of Academic Success in Engineering

In a qualitative study by Signer, Beasley, and Bauer (1997), the focus was on the educational aspirations of high school Black students with regard to their ability classification. Several classifications were created that positively assessed how the students felt about their mathematics ability in statements such as, "I learn math easy.", "It comes easy to me.", and "I think there's a math blockage." These findings suggested that Black students who enrolled in a 2-year less rigorous mathematics course were approximately six times more likely to attend college than Whites students who were enrolled in a 2-year less rigorous mathematics course. The White students who were enrolled in the more demanding mathematics courses were approximately two times more likely to see themselves attending college than the Black students who were enrolled in the same demanding mathematics courses.

The Nation's 2007 Report Card indicated that, according to the 2005 mathematics assessment, nationally 61% of students performed at or above the basic achievement in 2005, and 23% performed at or above proficient on the 12th-grade mathematics assessment. The average proficiency for White students was 31 points higher than the proficiency for Black students (NCES, 2007).

Pajares and Kranzler (1995) completed extensive research on the study of mathematics self-efficacy between Black and White students. Pajares and Kranzler noted that Black students reported a positive math self-concept even though their mathematics

self-efficacy was lower than that of the White students. Over time, as the Black students recognized their lower expectation level, their self-concept to achieve may diminish, may lead to limited educational success, and may affect their desire to remain in school.

Brynes (2003) posited that the aptitude for Black students is lower than that of White students. He indicated that, since it takes time to gain math proficiency, Black students may enter college more disadvantaged than White students because they lack the aptitude to learn math skills. The Black students would therefore get less out of a math course than the White students who are farther along the proficiency continuum. In his analysis, he found that Black students, on average, exhibited a mastery of arithmetic competency and some skills with measure, geometric figures, and simple logical relations. In contrast, the White students had the same skills as the Black students, plus some mastery competency of algebra, simple data interpretation, and rational numbers. He asserted further that, in addition to the average math proficiency differences between Black and White students, Black students were also more likely to attend schools that are located in disadvantaged urban areas.

Finally, he surmised that the best predictors of math performance in his study were the education of the parent, the high school program, coursework, calculator, worksheet frequency, ability and liking math, and the beliefs about the nature of math.

Similar to the socioeconomic data that are prevalent in several comparative studies between Black and White students, Wigfield and Eccles (2002) indicated that it is important to consider the quality of the schools that Black students attend when comparing their academic performance to that of White students. In addition, teachers that are not adequately prepared to teach in schools that also lack quality resources and

acceptable instruction to students may contribute to the perceived difficulty that Black students experienced when they begin college.

Pajares and Miller (1994) defined self-concept as beliefs of self-worth that are associated with an individual's competence−in other words, how a person views his or her capabilities. In conjunction with self-concept, studies in the late 1950s began to emerge that compared Black and White students' aspirations (Graham, 1994). In opposition to some of the earlier studies regarding the academic achievement of Black students, Graham posited that, from a self-concept perspective, Black students do, in fact, have high aspirations regarding their abilities and capabilities. She indicated that the Black students erred in the direction of overestimating their likely performance and, even in the face of escalating obstacles, they remained optimistic. It is also well documented that two obvious measures of success in college, GPA and academic ability, are not always good predictors of retention. It should also be noted that some students who left engineering with passing grades were not fully committed to engineering for reasons other than receiving failing grades (Bernold et al., 2007).

Tinto (1993) mentioned that more students leave their college or university before graduating than those that stay. Further, he asserted that White students were almost twice as likely to earn a 4-year degree by 1986 as were Black students, and the differences in the rates of graduation for the Black students and the White students can be attributed to the differences between the average measures of their tested abilities and their socioeconomic background.

Sanchez (2002) stated that researchers hypothesized that Black students reported lower aspirations than White students. In academic settings, the Black students may be

aware that there is a lower expectation of their academic performance, and over time, their self-concept may decline as well as their potential to do better.

Witherspoon, Speight, and Thomas (1997) posited that Black students have a history of inferior academic achievement. To intensify the dilemma that Black students face with a history of inferior academic achievement, Stovall (2000) added that Black students often face greater challenges than their White peers in becoming integrated into the college environment.

Academic Difficulties Black Students Face

In a similar study by French, Immekus, Oakes, and William (2005), which highlighted the indicators of engineering students' success and persistence to graduation, the participation in a first-year engineering seminar, academic motivation, and institutional integration were hypothesized to have significant positive effects on the students' persistence. After eight and six academic semesters for two of the cohorts, the persistence rate at the university was 80.9% for Cohort One and 85.2% for Cohort Two.

Noble, Flynn, Lee, and Hilton (2007) looked at some of the disadvantages that Black students faced with regards to achieving academic success. They concluded:

> Second, we also expected that disadvantaged minorities would have less academic success. Fortunately, this received only partial support in our analyses. While underrepresented minority students did have lower GPAs than White students and Asian-American students, they are equally likely as White and Asian Americans, once we controlled for ACT, to graduate from South. Their likelihood of not graduating is cut in half when controlling for ACT score and GPA. Our findings

suggest that academic preparation is lower for this group (as indicated by ACT score) which then explains much of why their average GPA is lower. (p. 56-57)

Additionally, using SAT as a criterion for academic preparation, Raftery (2004) highlighted the 2003 average SAT scores for Black and White students. The 2003 SAT average scores for Black students either improved slightly or remained unchanged from the 2002 SAT scores. The average combined score for Black students remained at 857, reflecting a decrease of one point on the verbal section and a gain of one point in math. The White students' 2003 SAT averaged 1026 which is a drop of one point on the verbal section and three points on the math from the 2002 SAT.

Similarly, Reichert and Abscher (1997) indicated that high early college GPAs are a significant predictor of persistence in science and engineering. Seidman (2005) suggested that high school grades are the best predictor of success in college, while French et al. (2005) asserted that GPAs, the only significant variable in their study, showed high correct classification rates for students' persistence. The authors claimed GPAs should not be ignored when examining persistence within an engineering major.

One of the best pre-college engineering persistence predictor is grades in math (Moller-Wong & Eide, 1997). The NCES (2007) reported that the kinds of courses taken in high school impacted the persistence for students who are interested in a science, technology, engineering, and mathematics field. Fifteen percent of students in high school reported that they had taken Advanced Placement mathematics courses, whereas 55% of the students reported that they had never taken an Advanced Placement mathematics course. Minority students, the most rapidly growing portion of our school-age population and the students most likely not to have taken an Advanced Placement

mathematics course, are the students that are generally left out of science and mathematics (Clark, 1999).

Several studies on the persistence of Black students in engineering share a consensus on the predicament of Black students that persist to graduate. According to Chubin, May, and Babco (2005), the graduation rates for Black students are at 41.8 % in comparison to other U.S. students. This is a substantially lower rate and the only rate that is less than 50%. The researchers agreed that Blacks have been and continue to be underrepresented in the engineering majors. The 2002 NSF Indicators provided a bleak outlook for Black engineering students at 119 college and universities. The report showed that about 25% of all entering first-time freshmen in 1992 declared their intention to major in a science and engineering field. By their second year, 33% of the students who declared their intention to major in a science and engineering field had dropped out of their engineering program. Underrepresented minorities dropped out of their science and engineering programs at a higher rate than non-minority students.

In light of the 2002 indications, the 2006 Indicators did not provide much improvement over the previous years. The Indicators reported, again, that a disparity between the persistence of Black and White engineering students existed. The disparity between the persistence of Black engineering students and White engineering students suggested that Black students did not enroll or complete college at the same rate as White students, whereas the enrollment between 1983 and 2004 showed a slow trickle in the enrollment for Black engineering students.

Positive Perceptions of Black Students' Success in Engineering

Contrary to this dismal perspective, Reichert and Abscher (1997) posited that the best predictors to graduation for science and engineering non-minority and minority students were the students who scored 550 or above on the math SAT, the nature of the college environment, and the perceived quality of instruction of the math, science, and engineering courses. In identifying variables to predict the persistence to graduation for Black engineering students, the report stated:

> Ethnicity, however, did not significantly predict persistence in these students; in fact, black students persisted to an S/E bachelor's degree at a slightly higher rate (53%) than did White students (52%). This study simply suggests the obvious: when minority students have the opportunity to acquire the skills (as indicated by high math SAT scores), and have the interest to succeed (as determined via interviews), then they will persist in S/E at the same rate as non-minority students. Black students persisted in an science and engineering bachelor's degree at a slightly higher rate (53%) than did White students (52%). (p. 248)

Wigfield and Eccles (2002) reiterated an interesting finding by Graham (1994) in their research. Graham showed that Black students may say they are doing well in their courses to protect their self-esteem. As an example, Black students will say that they don't like a subject, instead of admitting that the course may be too difficult for them. She asserted that this explanation has not been adequately tested and questions that if Black students' competence-related beliefs do not predict their school performance, then questions should be raised about how relevant the theories are that focus on competence-related beliefs in understanding the motivation of Black students.

Rowser (1997) acknowledged that Black students have had to deal with numerous societal disadvantages in terms of college persistence. When there are differences in skill level, lack of adequate academic preparation, and socioeconomic disadvantages between Black and White students, the Black students do not perform as well during their first year of college.

Seidman (2005) challenged Tinto's 1975 retention model by asserting that it does not appropriately represent the persistence to graduation for Black students. His challenge stated that Tinto's model posited that the explanation for students leaving college was the interaction between the college and the students. This is the most widely accepted and emulated model of student retention in higher education. While widely accepted, one of the criticism of the model is that it is designed for the traditional-age, largely White group of students who are newly graduated from high school.

In addition, Guiffrida (2006) argued that Tinto's theory does not recognize differences in some of the cultural variables that are applicable to Black students. He asserted that the more that students are academically integrated into the university environment, the greater their commitment to complete their degree becomes. The differences in cultural variables is particularly important to consider when describing minority student academic achievement and persistence.

The canvas of the United States is speckled with a diverse population. The Census 2000 showed that the United States population on April 1, 2000, was 281.4 million. Out the total 281.4 million, 34.7 million or 12.3% of the population was reported as Black. What this means is the Black population increased faster than the total population between 1990, when it was 30.0 million, and in 2000, when it was 34.7 million. This

increase was 4.7 million or 15.6% of the total Black population. As the population increased, it was predicted that the Black population would account for 2.1 million of the nation's 16 million college students in 2015, compared to 1.7 million out of the 13.3 million undergraduates in 1995. This predicted increase of 2.1 million in the Black population will account for an increase of 400,000 Black undergraduates (Carnevale & Fry, 2000).

Numerous studies agree with Raymond Landis, the noted father of Minority Engineering Programs (MEPs), in his stance regarding the academic difficulties experienced by Black students in college. Landis (2005) posited that academic performance is a serious problem for Black students, and their performance is significantly below that of White students who have similar backgrounds.

Jones (2001) noted that since the late 1990s Black students have forged ahead in college attendance. Over a 9-year period, Black students' overall college enrollment increased to 57.2%. Even though there has been an increased effort to recruit and retain Black engineering students, there seems to be a general consensus among researchers that Black engineering students are inadequately prepared for college-level mathematics (Hall & Ponton, 2005). Students developed an unstable foundation for the study of engineering when they exhibited a lack of interest in early grades, failed courses in mathematics, and enrolled in lower level mathematics courses (Zamani, 2000). On a positive note, if Black students are adequately prepared in science and mathematics, they will be able to integrate fully into a technological field (Clark, 1999).

Failing lower level math courses is a major obstacle for Black students who need to progress into higher level mathematics courses that are required for the engineering

curriculum. Failing lower level math courses is one reason why Black students do not perform better in progressively higher math courses early in high school (Riegle-Crumb, 2006).

Some researchers and theorists may be underestimating the resilience of some Black students by reporting that the traditional deficiency view of Black students' educational achievement is not accurate, at least for the Black students who are characterized as high achievers and college bound. Based on research from the 1970s and 1908s, the traditional deficiency view stated that Black students more often have difficulty in long-term educational achievement than traditional students (Trusty, 2002).

Black students often lack an understanding of the expected conventions of the academic culture. Black students are concerned about their academic preparation, just as White students are concerned, but they are often unaware of the skills needed to balance the multiple demands of the academic environment, the social aspects of college, and the cultural differences of the student body, the professors, and the staff (Jones, 2001). The Black students can experience culture shock with regard to the faculty, the lack of diversity, and a curriculum that is based on a limited understanding caused by the their lack of exposure and experience in higher education (Swail, 2006). Tinto (1993) admitted that Black students often come from disadvantaged backgrounds, have experienced inferior schools prior to college, and are more likely to have serious academic deficiencies when they enter college.

Sanchez's (2000) study may shed some light on what happens to students from disadvantaged background, especially when there is a disconnection between what the high school teachers expect and what the Black students expect:

> Lower expectations result in limited opportunities for some students. Thus, student motivation and the effort students devote to academic tasks can be circumscribed by teacher expectations. Students recognize the lower expectation level and, over time, their self-concept and motivation may decline until the potential to achieve is diminished. This may lead to limited educational success, which in turn affects the desire to remain in school. (p. 36)

The Social Community of Black Students

Guiffrida (2006) noted that Black college students perceived that their families and members of their home communities were essential in providing the connections and nourishment that helped them deal with racism, cultural isolation, and other adversities at college. These findings suggest that cultural connections play a large part in Black college student persistence than just navigating through the social integration of college. Other researchers have made similar comments. It appears that healthy attachment to parents can support students' development of social and interpersonal competence (Taub, 2008). Astin (1975) asserted that relying on parental support has a statistically significant positive effect on college persistence. Black students depended less, only 33%, on parental support than White students.

Good, Halpin, and Halpin (2002) asserted that administrators in higher education have initiated numerous support programs intended to foster academic success and encourage a sense of community among Black students. These efforts are targeted to retain Black students in the engineering, technical, and mathematics fields. The results of their study indicated that, even though the students felt when they first arrived at the university that they were not prepared academically for college, 92% indicated that they

improved their study habits during their first and second year in order to survive. Initiation of support programs would suggest that students' retention appeared to be affected by program involvement.

Stovall (2000) found that many Black students believed that they did not fit in at college because they felt a lack of support from other students and from the faculty members. Black students suffered on predominantly White campuses because they often had to study alone. These students were less likely to integrate themselves into a subgroup or into the institution (Swail, 2006). Lee (2000) noted how important it is for Black students to be academically and socially integrated into college. Not becoming academically and socially integrated into college is problematic because many Black students are either first-generation college students or would be the first person in their household to complete a degree. On the other hand, when parents have attended college, they are able to share their college experiences with their son or daughter, provide psychological support, and offer suggestions on how to maneuver through the system.

Using a noncognitive questionnaire they developed, Sedlacek and Brooks (1976) assessed the confidence level of Black students persisting to graduation based on the low and high profiles of non-cognitive variables. The variables included motivation, experiences, and background variables. Sedlacek (1996) demonstrated that students with high scores on knowledge and skills classifications made positive self-statements about themselves, expected to do well academically, and felt able to handle new situations and challenges. Students with low scores, on the other hand, expressed reasons for possibly having to leave school, felt other students were more capable, and expected grades to be marginal.

While the percentage and number of Black students earning degrees in science, technology, engineering, and mathematics fields have increased over the years, the reality is that there are still daunting obstacles that policy makers and educators encounter in attempting to increase the diversity of graduate students, professors, and scientists in private industry who made it through the pipeline. Guess (2008) noted that only a fraction of the underrepresented minorities that graduated from high school were eligible to seriously pursue engineering at the college level. This is a reality he reported as the 4% problem.

Vest (2005), President Emeritus, Massachusetts of Technology, highlighted some of the issues that he has witnessed for the past 35 years. He stated that, from the U.S. perspective, globalization is not a choice but a reality. He further reiterated that the United States awards approximately 220,000 first degrees in science and engineering but stated, "In the future, American engineers will constitute a smaller and smaller fraction of the profession as more and more engineers are educated and work in other nations, especially in Asia and South Asia" (p. 2). Black students, in order to be counted in the national statistics of engineering professionals, need to understand that early involvement with science and mathematics opens doors to other domains of knowledge (Clark, 1999).

NACME is a premier research organization on minority representation in engineering and is best known for tracking national trends in engineering education since 1974. A NACME report showed that U.S. institutions enrolled 8,552 Black engineering freshmen in 2001, an increase of 4.4% from 8,192 in 2000. Daryl Chubin, Senior Vice President of NACME, said the enrollment of Black engineering students should be a lot higher, indicating that the outlook is far worse when the graduation rates are considered.

In 2001, the retention rate for Black students who earned bachelor's degrees in engineering was just under 39% compared to 62% for White students (Walsh, 2003).

In spite of the upward trend in the Black population, there is still a shortage of Black skilled workers. Research shows that there is a small number of Blacks wanting to pursue an engineering degree. McSherry (2005) shared this information regarding projections in engineering:

> The National Academy of Engineering suggests many reasons why we must do a better job of encouraging women and minorities to consider a career in engineering. Among them: there is a shortage of skilled workers. Polls of business leaders indicate that the shortage is still their number one barrier to growth. Current projections show that unless women and minorities are attracted to science, technology, and engineering, the U.S. won't have the trained personnel necessary to meet its needs and remain competitive in a global economy. (p. 60)

Brown, Morning, and Watkins (2005), in a study to determine how the personal and social campus climate influenced the academic performance and institutional graduation rates of Black students, reported that:

> The graduation rates for underrepresented minorities are substantially lower than the 73.1 percent rate for other U.S. students. Particularly interesting is the African American engineering graduation rate of 41.8 percent, which is the lowest of any group and also the only rate less than 50 percent. (p. 263)

Brown et al. (2005) further reported that 31% of the HBCU students in their sample had GPAs in the 3.00-3.49 range compared to approximately 13% of students in each of the designated three institutional categories: Category 1, Category 2, Category 3,

and HBCUs. Category 1 included GPA scores that ranged from 83 to 99, high selective to very selective schools (50.1% graduation rate); Category 2 had GPA scores that ranged from 75 to 82, selective schools (45% graduation rate); Category 3 had GPA scores that ranged from 60 to 74, less selective to non-selective schools (28% graduation rate); HBCU, regardless of range (36% graduation rate). Chi-square analysis of associations between students' self-reported GPA range and institutional category found that there were significant differences in the GPAs of African Americans in the same group by institutional category.

Pre-college measures like SAT and ACT scores, high school rank, and the number of semesters of math, English, and other courses were also summarized in a report (Moller-Wong & Eide, 1997) that showed Black students were at a higher risk of attrition. Also, students with very high ACT composite scores (35-36) were more likely to leave engineering as were students with a greater than average number of semesters of high school English and art.

Summary

Vest (2005) suggested that the engineering students who are prepared for 2020 and beyond must be excited by their freshman year and must have an understanding of what engineers actually do. They must be able to write and communicate well and they must appreciate and draw on the richness of American diversity. Further, they must think clearly about ethics and their social responsibility, and they must be prepared to live and work as global citizens.

Jones (2001) asserted that a review of literature is needed to explore some of the critical issues that affect the performance, persistence, and the graduation rates of Black

students in college. The literature suggested that students' chances of remaining through graduation depend on the level of social and academic integration into college life. Social and academic integration depends on a number of cognitive and non-cognitive factors shared by many Black students. Some other important issues that emerged from the literature that affect the persistence of Black students in engineering were that students needed to adjust to their new environment and develop a support network that will prohibit students from experiencing isolation. Jones reiterated that research has only begun to examine the subtle effects of Black students' experiences when they are separated from their cultural heritage and identity. The influence of the campus climate on the persistence of Black students at predominantly White institutions is replete in the literature. Black students attending predominantly White campuses experience more stress, racism, and isolation and are less likely to persist than their counterparts at historically Black colleges.

Rowser (1997) conducted a retention study at a midwestern university on Black students at predominantly White institutions and found that more than 90% of the students surveyed perceived their academic preparation for college as adequate. More than one third of students in the study expected to earn a 3.0 or greater grade point average during their first year in college, while more than 90% of the students expected to graduate in 5 years or less. These same students felt that they would not have any problems making new friends or adjusting to college and believed they were at least adequate in their personal and social preparation for college.

As indicated earlier, the purpose of this literature was to examine the variables that predict the persistence to graduation from college for all students, the variables that

predict the persistence to graduation from college for engineering students, and the variables that predict the persistence to graduation from college that are unique to Black pre-engineering students.

In order for institutions to be successful in retaining Black engineering students, it is important to realize that there may be variables that are repeatedly used to predict the persistence of Black engineering students that may not appropriately predict their academic success. It is important that institutions establish programs to assist the Black engineering student to develop realistic expectations about the college environment and their own skills and abilities to succeed.

This literature review focused on presenting several perspectives on the variables that attribute to the success of Black pre-engineering students to form a framework to enhance students' retention.

III. Methodology

This is a quantitative ex post facto study that examined the differences in nine dependent variables that were used to predict the academic success and persistence to graduate for Black and White engineering students. The chapter is outlined as follows: (a) Review of the Problem, (b) Participants in the Study, (c) Procedures, (d) Data Sources, (e) Independent and Dependable Variables, (f) Data Preparation and Analysis, (g) Statistical Treatment of the Data, (h) Statistical Analysis, and (i) Limitations.

Review of the Problem

Fifty-five years after the decision of the United States Supreme Court Case *Brown v. Board of Education* (1954*)*, it would be injudicious to believe that all is well in academia, when it comes to the academic success of Black students who have a desire to attend college and to graduate with an engineering degree. *Brown v. the Board of Education* opened the door of awareness and was instrumental in building the steps toward integration that would finally ensure equality as well equity in educational opportunities for all students. The plaintiffs in the case argued that separated educational facilities are not equal. Yet, many Black students are still subjected to substandard educational facilities. In addition to substandard facilities, the teachers, counselors, and administrators are ill-equipped to teach or to prepare the students for entrance into college. How far have we come as a society in recognizing that the educational experiences of Black pre-engineering students may be quite different from the educational experiences of White pre-engineering students?

A quote from the *Knight and Sims vs. Alabama* court case resonates why a study that compares the variables related to the academic success and persistence to graduation for Black pre-engineering students and White pre-engineering is still relevant in a post Civil Rights era. It states:

> The court's principal decrees in 1991 and 1995 mandate a wide variety of reforms affecting all the historically white and historically black universities and the citizens of Alabama in general.
>
> These institutional reforms range from efforts to increase the representation of African Americans on the faculties and administrations of the historically white universities, to providing new academic programs, new and improved facilities and endowment funds for the historically black universities, to unification of the agricultural extension and research functions of Alabama's historically white land grant college, Auburn University, and the state's historically black land grant college, Alabama A&M University. (p. 1)

Investigated in this study are the differences in the dependent variables that were used to examine the academic success of Black pre-engineering students and White pre-engineering students. The results of this study should offer insight as to whether the same variables that relate to the academic success of White pre-engineering students also relate to the academic success of Black pre-engineering students. Additionally, the results should assist administrators in facilitating better interventions for Black engineering students in their quest to persist to graduate in the field of engineering.

Participants in the Study

The participants in this study were selected from a population of 3,570 pre-engineering students who were enrolled for classes during one of the four fall semesters from 2000-2003. All entering freshman students enrolled in the College of Engineering as pre-engineering students were required to complete the College Freshman Survey (Halpin & Halpin, 1996). The results of the survey are used to assess, advise, and monitor the academic progress of the engineering students enrolled in the College of Engineering.

The participants for this study were selected by filtering the data that included only Black pre-engineering students and White pre-engineering students who completed the College Freshman Survey (Halpin & Halpin, 1996). The number of participants in this study consisted of 386 Black pre-engineering students and 3,184 White pre-engineering students. Student classification status included 1,742 pre-engineering students who were admitted into an engineering major with an overall GPA $\geq$ 2.2, 939 pre-engineering students who were unsuccessful in advancing into an engineering major because they did not achieve an overall 2.2 GPA, and 889 pre-engineering students who voluntarily left engineering with an overall GPA $\geq$ 2.2.

Karcher (2008), in his dissertation, examined some of the same variables from the College Freshman Survey (Halpin & Halpin, 1996) that were used in this study. His study dealt with at-risk pre-engineering students. He reported that, after filtering, he came up with 582 cases that could be categorized into one of the two groups that he was studying. From his data, he surmised that 370 (64%) of the students departed from the engineering program unsuccessfully, with a GPA < 2.2, and 212 (36%) were admitted into an engineering major. The unsuccessful students are typically the students who are

placed on academic warning and eventually dismissed from the university. Some of the Black pre-engineering students in this study were included as a subgroup of the at-risk students in his study.

Procedures

Data were collected on pre-engineering students before the first day of class. As part of a longitudinal study, the College of Engineering requires that all freshman students who enter college for the preceding fall semester complete the College Freshman Survey (Halpin & Halpin, 1996). This instrument measures dependent cognitive and non-cognitive measures. The survey is administered to incoming freshman students during the first day of their scheduled orientation session. The survey is proctored by staff in the Engineering Student Services Department, faculty from the College of Education, and graduate assistants.

A university staff person greeted the students when they first arrived. They were then escorted to a large auditorium-style classroom to await instructions. After the students were seated, they were introduced to members of the university by a staff person from Engineering Student Services. The students were then explained the purpose of the survey and given instructions on how to complete it. Each student was handed one survey booklet, one scantron for recording the answers, and two pencils. The estimated time to complete all the items on the survey was 1 hour. The survey consisted of a multiple-choice format and all the responses were recorded on the scantron. When the student completed the survey, before exiting, the booklet and the scantron were given to a university staff person, who reviewed the scantron while the student waited. If all the fields were completed, the student was allowed to leave the testing area. If the scantron

had incomplete information, the student was asked to supply the missing data. Once the missing data were added, the scantron was reviewed a second time. After all of the fields were completed, the student left the testing area.

Data Sources

Pre-existing data from the longitudinal study within the College of Engineering were used in the study. The instrument used for this study, as well as the resulting data, were developed and managed by faculty members in the Educational Foundations, Leadership, and Technology (EFLT) Department. Grade point averages and classification status were retrieved from the university's Student Information System to determine which students advanced into an engineering major, which students were unsuccessful in advancing into an engineering major, and which students had the required grade point average to advance but were still classified as pre-engineering. These students were typically the students that were classified as inactive. They were not included as part of the study.

Independent and Dependent Variables

Nine dependent variables measured by the College Freshman Survey (Halpin & Halpin, 1996) were considered the non-cognitive dependent variables. The nine dependent variables were labeled as knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal. These variables were used to measure the students' perception of their attitudes, opinions, and beliefs about their ability to succeed academically and their persistence to graduate with an engineering degree. Two independent variables were used in the study,

race and status. Race was comprised of two groups: Black pre-engineering students and White pre-engineering students. Status was comprised of three groups: students who were admitted into engineering with an overall GPA ≥ 2.2, students who were unsuccessful in attaining an overall GPA of 2.2, and students who voluntarily left engineering with an overall GPA ≥ 2.2. The students who were not able to attain an overall GPA of 2.2 were not admitted into an engineering major. These students are involuntarily transferred into another college. The students with an overall GPA ≥ 2.2 are either the students who advanced into engineering or the students who voluntarily transferred to another college or left college altogether.

Data Preparation and Analysis

All of the student information was examined to identify missing data. All of the cases with missing data were eliminated from the study. SPSS version 17 for Windows was used to analyze the independent and nine dependent variables.

Statistical Treatment of the Data

The following steps were employed to explore answers to three research questions:

1. Is race related to the nine dependent variables which include knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal, when the variables are analyzed collectively or analyzed individually?
2. Is status of students related to the nine dependent variables which include knowledge and confidence, need help, academic success in engineering,

likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal, when the variables are analyzed collectively or analyzed individually?

3. Is the relationship between the status of the students and the nine dependent variables which include knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal different for Black pre-engineering students and White pre-engineering students?

Statistical Analysis

Reliability tests were conducted for the Black pre-engineering students and the White pre-engineering students on the nine dependent variables. After the reliability tests, descriptive statistics were computed.

A multivariate analysis of variance analysis (MANOVA) was conducted to assess the impact of the independent variables, race and status, on the nine dependent variables which include knowledge and confidence, need help, academic success, likelihood of leaving engineering, likelihood of leaving Auburn, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal.

The purpose of the MANOVA was to see if there was a significant main effect of race, a significant main effect of status, and an interaction of status and race across the nine dependent variables. An analysis of variance analysis (ANOVA) was conducted to individually test the nine dependent variables for the Black pre-engineering students across the three status groups and the White pre-engineering students across the three

status groups. A significant effect indicated that a post hoc analysis needed to be completed. To isolate the differences, an LSD post hoc comparison was performed.

Limitations

There are several limitations to this study. When self-reported responses are used, there is a possibility that the participants may not have responded honestly due to self-report bias. This study included only non-cognitive variables. While the focus of this study was on the predictive attributes of non-cognitive variables, the predictive attributes of cognitive variables may have provided additional insight into the study. This study did not provide case studies which would have provided insight into the students' perspective regarding their personal beliefs about their potential for academic success based on their own experiences.

IV. Results

This chapter describes the results of the MANOVA and ANOVA. The sections of are divided as follows: (a) Selection of the Variables, (b) Description of the Variables, (c) Reliability, (d) MANOVA for Status and Race Groups, (e) Tests of Between-Subjects Effects for Status, (f) Tests of Between-Subjects Effects for Race, (g) Tests of Between-Subjects Effects for Race x Status Interaction, (h) MANOVA for Status and Black Group, (i) Tests of Between-Subjects Effects for Black Group Across Status, (j) LSD Post Hoc Comparisons for Black Group Across Status, (k) MANOVA for Status and White Group, (l) Tests of Between-Subjects Effects for White Group Across Status, and (m) LSD Post Hoc Comparisons for White Group Across Status.

Selection of the Variables

The dependent variables were nine constructs that characterize attributes that the pre-engineering students' possess to a certain degree for persistence to graduate with an engineering degree. The dependent variables selected for this study were knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal. These variables were identified in the College Freshman Survey (Halpin & Halpin, 1996).

Two independent variable groups were selected for this study, race and student classification status. The two category variables within the race group were (a) Black

pre-engineering students and (b) White pre-engineering students. The independent variable, student classification status, was categorized into three groups: (a) students who were admitted into their respective engineering major with an overall < 2.2 GPA, (b) students who were unsuccessful in advancing into their respective engineering major because they did not attain an overall < 2.2 GPA, and (c) those students who voluntarily left engineering with an overall GPA ≥ 2.2.

Description of the Variables

The following is a description of the two independent variables and the nine dependent variables that were used in the study.

Independent Variables

Race. The race group was comprised of two categories: Black pre-engineering students and White pre-engineering students.

Student classification status. Student classification status throughout this study is referred to as status. Status was categorized into three groups: students who were admitted into their respective engineering major with an overall GPA ≥ 2.2, students who were unsuccessful in advancing into their engineering because their overall GPA was < 2.2, and students who voluntarily left engineering with an overall GPA ≥ 2.2.

Dependent Variables

Variable 1: Knowledge and confidence. The students' level of confidence about choosing engineering, the comfort they have with making this choice, and their level of decisiveness about selecting engineering.

Variable 2: Need help. The degree of help that the students' perceive they will need from family, friends, peers, and administrators.

Variable 3: Academic success in engineering. This variable signifies the degree of persistence the students possess to graduate with an engineering degree and their perception as to how well they will succeed throughout the collegiate process.

Variable 4: Likelihood of leaving engineering. The students' perception as to how successful they will be in advancing into their respective engineering major.

Variable 5: Likelihood of leaving Auburn University. The students' beliefs about the likelihood of having to leave Auburn University before graduating for personal, academic, or financial reasons.

Variable 6: Academic difficulty. The students' beliefs about the likelihood of not performing satisfactorily in their pre-engineering studies and not meeting their academic expectations.

Variable 7: Perceived difficulty. The students' sense of anxiety over coping with difficult and unanticipated events, and how well they will manage their time and handle problems.

Variable 8: Academic self-concept. The students' self-concept of how well they believe they are prepared to meet the rigors of engineering studies and to adapt to the campus environment.

Variable 9: Self-appraisal. The students' beliefs about their abilities to honestly assess their strengths and weaknesses in handling personal, social, and academic problems.

Reliability

The number of items measuring the dependent variables ranged from 3 to 11. Cronbach's alpha was used to assess the internal consistency of the measures of each dependent variable, respectively, for the independent variable of race, categorized as Black pre-engineering students and White pre-engineering students. The reliability results are shown in Table 1.

Table 1

Alpha Coefficients for Dependent Variable Measures: Black Students and White Students

Dependent variables	Number of items	Black students		White students	
		N	A	N	A
Knowledge and Confidence	10	374	.847*	3151	.922*
Need Help	6	382	.629*	3171	.625*
Academic Success in Engineering	9	382	.686*	3163	.638*
Likelihood of Leaving Engineering	5	382	.732*	3167	.810*
Likelihood of Leaving AU	3	386	.434	3181	.423
Academic Difficulty	5	386	.585*	3170	.609*
Perceived Difficulty	11	382	.701*	3159	.714*
Academic Self-Concept	4	382	.660*	3179	.719*
Self-Appraisal	6	380	.639*	3174	.675*

* Meets the established level of reliability

All variables, with the exception of the likelihood of leaving Auburn University, met the predetermined Cronbach alpha (.50) criterion for internal consistency. The

dependent variable, likelihood of leaving Auburn University, for the Black pre-engineering students was .43 and for the White pre-engineering students was .42. Both measures were close to the internal consistency criterion. Further, because much of this study was targeted at the students' beliefs as to whether or not they would persist to graduate from Auburn University with an engineering degree, the dependent variable likelihood of leaving Auburn University was not removed. Therefore, all nine of the dependent variables were used throughout this study.

MANOVA for Status and Race Groups

A MANOVA was conducted to determine if differences existed among the status groups and between the race groups on a linear combination of the nine dependent variables. The results of the MANOVA test, using Wilks' Lambda, were significant for status, $F(1,7112) = 8.03$, $p < .05$, $\eta^2 = .02$, small effect size. MANOVA results were also significant for race, $F(1, 3556) = 34.14$, $p < .05$, $\eta^2 = .08$, medium effect size, and there was a significant status by race interaction, $F(1, 7112) = 2.55$, $p < .05$, $\eta^2 = .006$, small effect size. To further examine the effect of status within race on each of the dependent variables, tests of between-subjects effects were examined.

Tests of Between-Subjects Effects for Status

The results of the between-subjects analysis for status across the individual dependent variables were statistically significant for knowledge and confidence, $F(2, 3564) = 10.52$, $p < .05$, $\eta^2 = .006$, small effect size; need help, $F(2, 3564) = 6.54$, $p < .05$, $\eta^2 = .004$, small effect size; academic success in engineering, $F(2, 3564) = 6.27$, $p < .05$, $\eta^2 = .004$, small effect size; likelihood of leaving engineering, $F(2, 3564) = 8.88$, $p < .05$, $\eta^2 = .005$, small effect size; perceived difficulty, $F(2, 3564) = 5.45$, $p < .05$, $\eta^2 = .003$,

small effect size, and academic self-concept, $F(2, 3564) = 43.67$, $p < .05$, $\eta^2 = .024$, small effect size.

The results that were not statistically significant were self-appraisal, $F(2, 3564) = .41$, $p > .05$, $\eta^2 = .000$, likelihood of leaving Auburn University, $F(2, 3564) = .411$, $p > .05$, $\eta^2 = .000$, and academic difficulty, $F(2, 3564) = 2.19$, $p > .05$, $\eta^2 = .001$. Table 2 depicts the means and standard deviations across the nine dependent variables for status.

Table 2

Means and Standard Deviations for the Status Groups

Dependent variables	Admitted to engineering N = 1742		Unsuccessful GPA < 2.2 N = 939		Left with GPA ≥ 2.2 N = 889	
	M	*SD*	*M*	*SD*	*M*	*SD*
Knowledge and Confidence	32.19	4.95	31.40	5.16	29.42	5.92
Need Help	13.29	2.83	14.45	2.82	13.97	2.85
Academic Success in Engineering	28.37	2.95	27.44	3.14	27.47	3.12
Likelihood of Leaving Engineering	8.96	2.43	9.25	2.60	10.19	2.93
Likelihood of Leaving AU	4.06	1.09	4.28	1.17	4.16	1.18
Academic Difficulty	10.43	2.10	10.71	2.17	10.89	2.12
Perceived Difficulty	24.60	3.72	25.64	3.78	25.55	3.85
Academic Self-Concept	16.58	2.09	15.14	2.22	15.74	2.20
Self-Appraisal	18.70	1.85	18.40	1.95	18.62	1.89

Tests of Between-Subjects Effects for Race

Results of the between-subjects analysis for race were statistically significant for seven of the dependent variables. These variables were knowledge and confidence, $F(1, 3564) = 13.01$, $p < .05$, $\eta^2 = .004$, small effect size; need help, $F(1, 3564) = 162.76$, $p < .05$, $\eta^2 = .044$, small effect size; academic success in engineering, $F(1, 3564) = 53.89$, $p < .05$, $\eta^2 = .015$, small effect size; likelihood of leaving engineering, $F(1, 3564) = 7.29$, $p < .05$, $\eta^2 = .002$, small effect size; likelihood of leaving Auburn University, $F(1, 3564) = 20.01$, $p < .05$, $\eta^2 = .006$, small effect size; perceived difficulty, $F(1, 3564) = 6.63$, $p < .05$, $\eta^2 = .002$, small effect size, and self-appraisal, $F(1, 3564) = 5.79$, $p < .05$, $\eta^2 = .002$, small effect size.

Academic self-concept was the only dependent for which results were not statistically significant, $F(1, 3564) = 2.40$, $p > .05$, $\eta^2 = .001$. For academic difficulty the results were $F(1, 3564) = 3.84$, $p = .05$, $\eta^2 = .001$. Table 3 depicts the means and standard deviations across the nine dependent variables for race.

Table 3

Means and Standard Deviations for Race

Dependent variables	Black students N = 386		White students N = 3184	
	M	SD	M	SD
Knowledge and Confidence	32.18	4.44	31.18	5.48
Need Help	15.82	3.00	13.52	2.76
Academic Success in Engineering	29.01	3.18	27.77	3.04
Likelihood of Leaving Engineering	9.00	2.48	9.38	2.67
Likelihood of Leaving AU	4.45	1.28	4.11	1.11
Academic Difficulty	10.40	2.31	10.64	2.11
Perceived Difficulty	25.61	3.99	25.04	3.77
Academic Self-Concept	16.00	2.16	15.99	2.25
Self-Appraisal	18.82	2.07	18.57	1.87

Tests of Between-Subjects Effects for Race x Status Interaction

Results of the between-subjects analysis for Race x Status interaction were statistically significant for all of the dependent variables. These variables were knowledge and confidence, $F(2, 3564) = 4.78$, $p < .05$, $\eta^2 = .003$, small effect size; need help, $F(2, 3564) = 4.94$, $p < .05$, $\eta^2 = .003$, small effect size; academic success in engineering, $F(2, 3564) = 9.85$, $p < .05$, $\eta^2 = .005$, small effect size; likelihood of leaving engineering, $F(2, 3564) = 6.08$, $p < .05$, $\eta^2 = .003$, small effect size; likelihood of leaving Auburn University, $F(2, 3564) = 4.98$, $p < .05$, $\eta^2 = .003$, small effect size; academic

difficulty, $F(2, 3564) = 6.69$, $p < .05$, $\eta^2 = .004$, small effect size; perceived difficulty, $F(2, 3564) = 6.28$, $p < .05$, $\eta^2 = .004$, small effect size; academic self-concept, $F(2, 3564) = 4.41$, $p < .05$, $\eta^2 = .002$, small effect size; and self-appraisal, $F(2, 3564) = 4.22$, $p < .05$, $\eta^2 = .002$, small effect size.

MANOVA for Status and Black Group

The results of the Wilks' Lambda revealed that the dependent variables across the three status groups for the Black pre-engineering students were statistically significant, $F(1, 750) = 2.39$, $p < .05$, $\eta^2 = .054$, small effect size.

Tests of Between-Subjects Effects for Black Group Across Status

Results of the between-subjects effects for Black pre-engineering students across the status groups revealed that eight of the nine dependent variables did not significantly differ.

The variables that did not significantly differ across the status groups were knowledge and confidence, $F(2, 383) = 1.98$, $p > .05$, $\eta^2 = .010$, small effect size; need help, $F(2, 383) = 4.54$, $p > .05$, $\eta^2 = .003$, small effect size; academic success in engineering, $F(2, 383) = 1.49$, $p > .05$, $\eta^2 = 008$, small effect size; likelihood of leaving engineering, $F(2, 383) = 2.88$, $p > .05$, $\eta^2 = .015$, small effect size; likelihood of leaving Auburn University, $F(2, 383) = .99$, $p > .05$, $\eta^2 = .005$, small effect size; academic difficulty, $F(2, 383) = 2.56$, $p > .05$, $\eta^2 = .013$, small effect size; perceived difficulty, $F(2, 383) = 2.06$, $p > .05$, $\eta^2 = .011$, small effect size; self-appraisal, $F(2, 383) = .48$, $p > .05 = \eta^2 = .003$, small effect size.

Academic self-concept was the only variable on which Black students differed significantly across the three status groups, $F(2, 383) = 6.46$, $p < .05$, $\eta^2 = .033$, small

effect size. Table 4 shows the means and standard deviation for Black pre-engineering students across the status groups.

Table 4

Means and Standard Deviations for Black Group Across Status

Dependent variables	Admitted to engineering N = 148		Unsuccessful GPA < 2.2 N = 175		Left with GPA ≥ 2.2 N = 63	
	M	SD	M	SD	M	SD
Knowledge and Confidence	32.07	4.49	32.59	4.01	31.31	5.34
Need Help	15.80	3.07	15.95	2.84	15.49	3.30
Academic Success in Engineering	28.97	3.05	29.25	3.25	28.44	3.27
Likelihood of Leaving Engineering	9.20	2.41	8.68	2.26	9.43	3.09
Likelihood of Leaving AU	4.57	1.37	4.39	1.24	4.35	1.14
Academic Difficulty	10.60	2.44	10.11	2.19	10.71	2.26
Perceived Difficulty	25.59	4.13	25.31	3.91	26.50	3.78
Academic Self-Concept	16.49	2.08	15.66	2.20	15.79	2.05
Self-Appraisal	18.72	2.09	18.93	2.04	18.74	2.13

LSD Post Hoc Comparisons for Black Group Across Status

Knowledge and confidence, need help, academic success in engineering, likelihood of leaving Auburn University, academic difficulty, and self-appraisal were the variables on which the Black pre-engineering students did not significantly differ, $p > .05$, across the three status groups in the post hoc analysis.

Likelihood of leaving engineering, perceived difficulty, and academic self-concept were the variables on which the Black pre-engineering students differed significantly, $p < .05$, across the three status groups in the post hoc analysis. However, given the nonsignificant results from the between-subjects analysis for likelihood of leaving engineering and perceived difficulty, only status differences for academic self-concept are considered to be significant.

Academic Self-Concept

Academic self-concept for Black students who were unsuccessful in advancing into engineering with overall GPA < 2.2 and Black students who voluntarily left engineering with overall GPA ≥ 2.2 did not differ significantly, $p > .05$. The mean difference was .11. These students shared similar beliefs as to how well they were prepared to meet the rigors of engineering studies and to adapt to the campus environment.

Black students who were admitted into engineering and Black students who were unsuccessful in advancing into engineering with overall GPA < 2.2 differed significantly, $p < .05$. The mean difference was .83. Additionally, Black students who were admitted into engineering and Black students who voluntarily left engineering with overall GPA ≥ 2.2 differed significantly, $p < .05$. The mean difference was .72.

MANOVA for Status and White Group

Results of the Wilks' Lambda revealed that the dependent variables across the three status groups for the White pre-engineering students were statistically significant, $F(1, 3181) = 26.86$, $p < .05$, $\eta 2 = .071$, medium effect size.

Tests of Between Subjects Effects for White Group Across Status

Results of the between-subjects analysis for White pre-engineering students across the status groups revealed significant differences for all of the variables. The variables were knowledge and confidence, $F(2, 3181) = 81.68$, $p < .05$, $\eta^2 = .049$, small effect size; need help, $F(2, 3181) = 46.27$, $p < .05$, $\eta^2 = .028$, small effect size; academic success in engineering, $F(2, 3181) = 56.88$, $p < .05$, $\eta^2 = .035$, small effect size; likelihood of leaving engineering, $F(2, 3181) = 68.58$, $p < .05$, $\eta^2 = .041$, small effect size; likelihood of leaving Auburn University, $F(2, 3181) = 12.62$, $p < .05$, $\eta^2 = .008$, small effect size; academic difficulty, $F(2, 3181) = 19.66$, $p < .05$, $\eta^2 = .012$, small effect size; perceived difficulty, $F(2, 3181) = 34.38$, $p < .05$, $\eta^2 = .021$, small effect size; academic self-concept, $F(2, 3181) = 144.69$, $p < .05$, $\eta^2 = .083$, medium effect size; and self-appraisal, $F(2, 3181) = 13.20$, $p < .05$, $\eta^2 = .008$, small effect size.

Table 5 depicts the means and standard deviations for White pre-engineering students in the three status groups across the nine dependent variables.

Table 5

Means and Standard Deviations for White Group Across Status

Dependent variables	Admitted to engineering N = 1594		Unsuccessful with GPA < 2.2 N = 764		Left with GPA ≥ 2.2 N = 826	
	M	SD	M	SD	M	SD
Knowledge and Confidence	32.20	5.00	31.13	5.36	29.28	5.94
Need Help	13.06	2.70	14.10	2.70	13.85	2.78
Academic Success in Engineering	28.32	2.93	27.02	2.96	27.40	3.10
Likelihood of Leaving Engineering	8.93	2.43	9.38	2.66	10.28	2.91
Likelihood of Leaving AU	4.02	1.05	4.25	1.16	4.14	1.18
Academic Difficulty	10.41	2.06	10.85	2.15	10.90	2.11
Perceived Difficulty	24.50	3.67	25.71	3.74	25.47	3.85
Academic Self-Concept	16.59	2.10	15.02	2.20	15.74	2.21
Self-Appraisal	18.69	1.83	18.28	1.91	18.61	1.87

LSD Post Hoc Comparisons for White Group Across Status

Results of the post hoc comparisons for White pre-engineering students across status for the dependent variables knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal are discussed as follows:

Knowledge and Confidence

White students who were admitted into engineering had a significant ($p < .05$) mean difference of 1.08 from White students who were unsuccessful in advancing into engineering with overall GPA < 2.2. White students who were admitted into engineering had a significant ($p < .05$) mean difference of 2.93 from White students who voluntarily left engineering with overall GPA ≥ 2.2. White students who were unsuccessful in advancing into engineering with overall GPA < 2.2 had a significant ($p < .05$) mean difference of 1.85 from White students who voluntarily left engineering with overall GPA ≥ 2.2. The results signified the students' level of confidence about choosing engineering, the comfort they had when making this choice, and their level of decisiveness about selecting engineering as their major. White students who were admitted into engineering had higher knowledge and confidence levels than White students who voluntarily left engineering with overall GPA ≥ 2.2 and White students who were unsuccessful in advancing into engineering with overall GPA < 2.2.

Need Help

The dependent variable of need help for White students who were unsuccessful in advancing into engineering with overall GPA < 2.2 and White students who voluntarily left engineering with overall GPA ≥ 2.2 did not differ significantly, $p > .05$. The mean difference was .25. These students were alike in the degree that they perceived they would need help from family, friends, peers, and administrators.

On the other hand, White students who were admitted into engineering had a significant ($p < .05$) mean difference of 1.04 from White students who were unsuccessful in advancing in engineering with overall GPA < 2.2. White students who voluntarily left

engineering with overall GPA ≥ 2.2 had a significant ($p < .05$) mean difference of .79. White students who were admitted into engineering, White students who voluntarily left engineering with an overall GPA ≥ 2.2, and White students who were unsuccessful in advancing into engineering did not share the same views as to the amount of help they would need from family, friends, peers, and administrators.

Academic Success in Engineering

White students who were admitted into engineering had a significant ($p < .05$) mean difference of 1.29 from White students who were unsuccessful in advancing into engineering with overall GPA < 2.2. White students who were admitted into engineering had a significant ($p < .05$) mean difference of .92 from White students who voluntarily left engineering with overall GPA ≥ 2.2. White students who were unsuccessful in advancing into engineering with overall GPA < 2.2 had a significant ($p < .05$) mean difference of .37 from White students who voluntarily left engineering with overall GPA ≥ 2.2. These students held different perceptions as to the degree of persistence they possessed to graduate with an engineering degree and how well they would succeed throughout their collegiate process.

Likelihood of Leaving Engineering

White students who were admitted into engineering had a significant ($p < .05$) mean difference of .45 from White students who were unsuccessful in advancing into engineering with overall GPA < 2.2. White students who were admitted into engineering had a significant ($p < .05$) mean difference of 1.31 from White students who voluntarily left engineering with overall GPA ≥ 2.2. White students who were unsuccessful in advancing into engineering with overall GPA < 2.2 had a significant ($p < .05$) mean

difference of .86 from White students who voluntarily left engineering with overall GPA ≥ 2.2. The likelihood of leaving engineering for White students who were admitted into engineering showed that their perception of success in advancing into their respective engineering major was higher than White students who were unsuccessful in advancing into engineering with overall GPA < 2.2 and White students who voluntarily left engineering with overall GPA ≥ 2.2.

Likelihood of Leaving Auburn University

White students who were admitted into engineering had a significant ($p < .05$) mean difference of .24 from White students who were unsuccessful in advancing into engineering with overall GPA < 2.2. White students who were admitted into engineering had a significant ($p < .05$) mean difference of .13 from White students who voluntarily left engineering with overall GPA ≥ 2.2. White students who were unsuccessful in advancing into engineering with overall GPA < 2.2 had a significant ($p < .05$) mean difference of .11 from White students who voluntarily left engineering with overall GPA ≥ 2.2. The higher mean score of White students who were admitted into engineering signified that they held higher beliefs about the likelihood of not having to leave Auburn University due to personal, academic, or financial reasons than White students who were unsuccessful in advancing into engineering with overall GPA < 2.2 and White students who voluntarily left engineering with overall GPA ≥ 2.2.

Academic Difficulty

Academic difficulty for White students who were unsuccessful in advancing into engineering with overall GPA < 2.2 and students who voluntarily left engineering with overall GPA ≥ 2.2 did not differ significantly, $p > .05$. The mean difference was .06.

These White students had similar beliefs about the likelihood of not performing satisfactory in their pre-engineering studies and not meeting their academic expectations.

However, White students who were admitted into engineering and White students who were unsuccessful in advancing into engineering with overall GPA < 2.2 had a significant ($p < .05$) mean difference of .43. Further, White students who were admitted into engineering and the students who voluntarily left engineering with overall GPA ≥ 2.2 had a significant ($p < .05$) mean difference of .49. This finding implied that White students who were admitted into engineering did not share the same beliefs as to the level of difficulty they would experience compared to White students who were unsuccessful in advancing into engineering with overall GPA < 2.2 and White students who voluntarily left engineering with overall GPA ≥ 2.2.

Perceived Difficulty

On the perceived difficulty variable, students who were unsuccessful in advancing into engineering with overall GPA < 2.2 and students who voluntarily left engineering with overall GPA ≥ 2.2 did not differ significantly, $p > .05$. The mean difference was .24. These students shared a similar sense of anxiety over how they would cope with difficulties and unanticipated events and how they would effectively manage their time and handle problems.

Further, White students who were admitted into engineering and White students who were unsuccessful in advancing into engineering overall GPA < 2.2 had a significant ($p < .05$) mean difference of 1.21. Similarly, White students who were admitted into engineering and White students who voluntarily left engineering with overall GPA ≥ 2.2 had a significant ($p < .05$) mean difference of .97. This finding implied that White

students who were admitted into engineering viewed their perceived difficulty differently from White students with overall GPA < 2.2 who were not admitted and White students with overall GPA ≥ 2.2 who voluntarily left engineering.

Academic Self-Concept

White students who were admitted into engineering had a significant ($p < .05$) mean difference of 1.57 from White students who were unsuccessful in advancing into engineering with overall GPA < 2.2. White students who were admitted into engineering had a significant ($p < .05$) mean difference of .85 from White students who voluntarily left engineering with overall GPA ≥ 2.2. White students who were unsuccessful in advancing into engineering with overall GPA < 2.2 had a significant ($p < .05$) mean difference of .72 from White students who voluntarily left engineering with overall GPA ≥ 2.2. The academic self-concept for White students who were admitted into engineering indicated that their beliefs in how well they were prepared to meet the rigors of their engineering studies, and to adapt to the campus environment, were higher than the beliefs of White students who were unsuccessful in advancing into engineering and White students who voluntarily left engineering with overall GPA ≥ 2.2.

Self-Appraisal

The self-appraisal variable for White students who were admitted into engineering and White students who voluntarily left engineering with overall GPA ≥ 2.2 had a mean difference of .08, which was not significantly different, $p > .05$. These students held similar beliefs in their abilities to honestly assess their strengths and weaknesses in handling personal, social, and academic problems.

On the other hand, White students who were unsuccessful in advancing into engineering with overall GPA < 2.2 differed significantly, $p < .05$, from White students admitted into engineering with a mean difference of .42 and White students who left engineering with overall GPA ≥ 2.2 with a mean difference of .33. White students who were unsuccessful in advancing into engineering with overall GPA < 2.2 held different beliefs about their abilities to honestly assess their strengths and weaknesses in handling personal, social, and academic problems compared to White students who were admitted into engineering and White students who voluntarily left engineering with overall GPA ≥ 2.2.

V. Summary, Conclusions, and Recommendations

This section includes a summary of the study and conclusions that reflect the results along with recommendations for future studies.

Summary

This study was influenced by limited research associated with comparative studies that deal with the variables that predict the persistence for Black pre-engineering students and White pre-engineering students. The first year of college presents numerous challenges and opportunities for freshman students as they embark on the second phase of a life-long journey that may take them to places they never imagined. Students will need to make some key decisions at this juncture in their lives that are critical to their chances of success. For Black pre-engineering students, the journey to college may pose a completely different set of obstacles and challenges from White pre-engineering students.

The research focused on the effectiveness of select variables that were used to predict academic success and persistence for Black pre-engineering students and White pre-engineering students. The more specific purpose was to examine whether the same variables used to predict the academic success and persistence of White pre-engineering students should be used to predict the academic success and persistence of Black pre-engineering students.

Independent and Dependent Variables

Two independent variable groups were selected for this study, race and classification status. The two categories within the race group were Black pre-engineering students and White pre-engineering students. The classification status was divided into three groups: students who were admitted into their respective engineering major with an overall GPA ≥ 2.2, students who were unsuccessful in advancing into their respective engineering major with an overall GPA < 2.2, and students who voluntarily left engineering with an overall GPA ≥ 2.2. Nine dependent variables were used in the study. They were knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal.

Research Questions

The research questions for this study were:

1. Is race related to the nine dependent variables which include knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal, when the variables are analyzed collectively or analyzed individually?
2. Is status of students related to the dependent variables which include knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal when the variables are analyzed collectively or analyzed individually?

3. Is the relationship between the status of the students and the nine dependent variables which include knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, academic self-concept, and self-appraisal different for Black pre-engineering students and White pre-engineering students?

Participants

The participants in this study were selected from a population of 3,570 pre-engineering students who were enrolled for classes during one of the four fall semesters from 2000-2003. All entering freshman students enrolled in the College of Engineering as pre-engineering students were required to complete the 248-item College Freshman Survey (Halpin & Halpin, 1996). The participants for this study were selected by filtering the data that included only Black pre-engineering students and White pre-engineering students who completed the College Freshman Survey. The number of participants in this study consisted of 386 Black pre-engineering students and 3,184 White pre-engineering students. Student classification status included 1,742 pre-engineering students who were admitted into an engineering major with overall GPA $\geq$ 2.2, 939 pre-engineering students who were unsuccessful in advancing into an engineering major because they did not achieve overall 2.2 GPA, and 889 pre-engineering students who voluntarily left engineering with overall GPA $\geq$ 2.2.

Reliability

Cronach's alpha was used to estimate the internal consistency reliability of the measures. All variables, except the likelihood of leaving engineering, met the

predetermined Cronbach's alpha criterion (.50) for internal consistency. The reliability on this measure for the Black pre-engineering students was .434 and for White pre-engineering students was .423. The likelihood of leaving engineering variable was not removed from the study because the results for the Black pre-engineering students and White pre-engineering students were near the (.50) criterion.

MANOVA and ANOVA Results

Results of the MANOVA revealed significant status differences on the set of the nine dependent variables, $F(2, 7112) = 8.03$, $p < .05$, $\eta^2 = .02$, small effect size. Significant race differences with the set of dependent variables were also found, $F(1, 3556) = 34.14$, $p < .05$, $\eta^2 = .08$, medium effect size, and there was a significant interaction between status and race, $F(1, 7112) = 2.55$, $p < .05$, $\eta^2 = .006$, small effect size. Eta squared was used to show the effect size, the proportion of variance in the weighted combination of the dependent variables accounted for by the independent variables. The ranges were .01 for a small effect size, .06 for a medium effect size, and .15 for a large effect size (Cohen, 1988).

Results of the ANOVA test of between-subjects effects revealed significant status differences on six of the dependent variables: knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, perceived difficulty, and academic self-concept. Not statistically significant were the status groups on the likelihood of leaving Auburn University, academic difficulty, and self-appraisal.

An ANOVA test of between-subjects effects revealed significant race differences on seven of the dependent variables: knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn

University, perceived difficulty, and self-appraisal. Not significantly different were academic difficulty and academic self-concept.

An ANOVA test of between-subjects effects revealed that the Race x Status interaction were statistically significant for all of the dependent variables.

An ANOVA test of between-subjects effects for Black pre-engineering students across status revealed no significant differences on eight dependent variables: knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, and self-appraisal. Statistically significant was academic self-concept.

An ANOVA test of between-subjects effects for White pre-engineering students across status revealed significant effects on all the dependent variables: knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, academic difficulty, perceived difficulty, self-appraisal, and academic self-concept.

Conclusions

The questions in this study were developed to assist administrators and counselors in higher education interested in finding better ways to assist Black pre-engineering students to persist to graduation with an engineering degree.

Status was significantly related to six of the nine dependent variables: knowledge and confidence, need help, academic success in engineering, likelihood of leaving engineering, likelihood of leaving Auburn University, perceived difficulty, and academic self-concept. Race was significantly related to seven of the dependent variables: knowledge and confidence, need help, academic success in engineering, likelihood of

leaving engineering, likelihood of leaving Auburn University, perceived difficulty, and self-appraisal. There was a significant interaction between status and race indicating that the relationship between the status of the engineering students and the nine dependent variables was different for Black pre-engineering students and White pre-engineering students. For Black pre-engineering students, no significant status differences were found on eight dependent variables: knowledge and confidence, need help, academic success in engineering, the likelihood of leaving engineering, the likelihood of leaving Auburn University, academic difficulty, perceived difficulty, and self-appraisal. The results for White pre-engineering students revealed significant status differences on all the dependent variables.

The findings of this study suggest that the same measures used to predict the academic success of White pre-engineering students should not be used to predict the academic success of Black pre-engineering students. Therefore, researchers must realize the seriousness of determining the variables that predict the academic success of Black engineering students. It is important to ascertain the best and most appropriate measures when selecting the variables to predict academic success and persistence for Black engineering students.

The Wikipedia dictionary states that it is widely believed that no two snowflakes are exactly alike. While the snowflakes are not identical, there may be similarities. In a more pragmatic way, it is more likely that the two snowflakes would be identical if their environments were similar enough, either because they grew very near one another or simply by chance. Many Black pre-engineering students, while not identical to White pre-engineering students, have some perceived similarities. Because of the perceived

similarities, the same measures are used to predict their persistence to graduation. Collectively these two groups appear to be similar. However, there may be differences in their characteristics and environments that may have produced factors that would adversely impact the student from successfully matriculating through the engineering curriculum. A cookie-cutter approach to selecting variables may not be the best approach to predict the academic success for Black pre-engineering students. Therefore, identifying variables that would more accurately predict the academic success for Black pre-engineering students would better assist administrators, counselors, and instructors to develop effective success strategies to ensure that Black engineering students move successfully through their engineering curriculum.

A Recap of Black and White Comparative Studies

Research that focuses on the variables that predict the persistence to graduation for Black students in engineering and White students in engineering generally elevate predictive attributes in favor of more positive outcomes for White engineering students and deflate predictive attributes in favor of more negative outcomes for the Black engineering students.

In a broader context, Tinto (2003) advocated five conditions that support the persistence to graduation for new Black students as well as White students. The five conditions are settings that expect the students' to succeed; settings that provide academic, social, and personal support; settings that provide early and frequent feedback on students' performance; settings that include students' as valued members; and settings that foster learning.

Cabera, Nora, Terenzini, Pascarella, and Hagedorn (1999) found that, "the adjustment to college by all students represents a complex process that links a student's motivations, attitudes, and abilities with institutional features" (p. 154).

It is discouraging when the results of research affirm that Black students lack the intellectual capacity to perform as well as White students. For instance, Brynes (2003) posited that the aptitude for Black students is lower than that of White students. Black students were more likely than White students to be viewed as incapable of performing academically as well as White students. The results of this study confirmed Graham's (1994) notion that the self-concept of Black students does not support the general perspective that Black students have negative self-views. In this case, self-concept measures are the same for the Black pre-engineering students as White pre-engineering students.

Graham (1994) noted that African American students maintained overwhelming optimism and positive self-regard in the face of achievement failure. In addition, Pajares and Schunk (2001) stated:

> In studies in which task-specific self-efficacy perceptions are assessed, the self-efficacy of African American students and of Hispanic American students tends to be lower than that of their White peers. Despite differences in self-efficacy, minority students report positive self-concepts (Pajares and Kranzler, 1995; Pajares and Johnson, 1996). Some have posited that beliefs at differing levels of specificity perform different functions for minority students (Edelin and Paris, 1995). (p. 246)

Rower (1997) asserted that the retention for Black students on predominantly White campuses is one of the greatest challenges that many colleges and universities face. Graham (1994), a prolific researcher on Black student retention, advocated that students who felt good about themselves were believed to be more motivated to succeed. She indicated views that Black students have negative self-views. On the contrary, comparative racial studies consistently report Black students to be equal to or higher than White students on a vast array of self-concept measures. She further asserted that if the findings for ability self-concept were found in the larger self-esteem literature, it would be found that Black students have relatively high self-concept abilities.

Witherspoon et al. (1997) indicated that Black students have a history of inferior academic achievement. To intensify the dilemma that Black students encounter with a history of inferior academic achievement, Stovall (2000) added that Black students often face greater challenges than their White peers in becoming integrated into the college environment.

On a positive note, Rowser (1997) indicated that most of the proactive retention efforts for Black students are based on what others perceive their needs to be. Her study asserted that, while there are differences in the perception of what constitutes success for the Black pre-engineering student and White pre-engineering student, perhaps some other measures for academic success would be more appropriate to predicting the Black pre-engineering students' persistence to graduation. Rowser also acknowledged that Black students have had to deal with numerous societal disadvantages in terms of college persistence. When there are differences in the skill levels, lack of adequate academic

preparation, and socioeconomic disadvantages between Black and White students, the Black students do not perform as well during their first year of college.

In contrast to the general views about Black students and their persistence to graduation with a degree in engineering, Graham (1994) supports the notion that, from a self-concept perspective, Black students have high aspirations regarding their abilities and capabilities. She indicated that the Black students erred in the direction of overestimating their likely performance and, even in the face of escalating obstacles, they remained optimistic. It is also well documented that two obvious measures of success in college, GPA and academic ability, are not always good predictors of retention for Black students. Sedlacek (1996) investigated what he believed was important to the self-appraisal of Black students. His research focused on how students learned about self and how they developed from their self-appraisal. He asserted that one of the admission problems of colleges and universities is that a one-measure-for-all approach is used in their admissions policies. The one-measure-for-all-approach assumes that the same measures can work for all applicants. He stated, "It is illogical to assume that a single measure has predictive validity for all applicants and that is can assess the diversity in the backgrounds of students of color. Thus, if schools apply measures such as the ACT and SAT equally to all applicants, traditional students will be favored" (p. 82).

Similar to the socioeconomic data that are prevalent in several comparative studies between Black and White students, Wigfield and Eccles (2002) indicated that it is important to consider the quality of the schools that Black students attend when comparing their academic performance to that of White students.

Seidman (2005) believed that Tinto's 1975 retention model did not appropriately represent the persistence to graduation for the Black students. He explained, that even though Tinto's model is widely accepted, it is designed for the traditional-age, largely White students newly graduated from high school.

Recommendations

This study was conducted to better understand how variables that predict the academic success for White pre-engineering students may not be the ideal variables to use to predict the academic success for Black pre-engineering students. Science and Engineering Indicators (2008) reported that science and engineering degrees awarded to Black students increased from 2007 by 3%, from 5% to 8%. This is positive news. Additionally, completion rates showed an upward trend for each racial/ethnic group between 1975 and 2005. The rates increased faster for Blacks than for Whites, narrowing the gaps between the two groups. It would do well for administrators and counselors to capitalize on the increase in Black engineering student enrollment by developing programs that will help to retain the Black engineering students in college. Good et al. (2002) explained the efforts of administrators in higher education that targeted efforts to retain Black students in the engineering, technical, and mathematics fields. The results of their study articulated that, even though the students felt when they first arrived at university that they did not have good study habits and were not prepared for demanding college work, their study habits improved as a result of participating in the retention program. After becoming involved in a retention program, 92% of the students felt that their study habits had improved during their first and second year. Involvement in a

retention program would suggest that student persistence to graduation appears to be affected by program involvement.

An environment that ensures that the Black engineering student is successful requires a careful examination of what skills the student lacks and what skills the student can acquire through a network that provides support through mentoring, tutoring, and creating a community of students to help each other through difficult adjustment periods.

There are several studies that identify some of the barriers and obstacles that hinder the Black engineering students' chances of persisting to graduation. Swail (2006) listed some specific steps to ensure that students successfully integrate into the campus environment. He used a model that included interaction between the student and the university, depicted on a triangle. The left side of the triangle includes the cognitive factors that the student brings to the campus. The right side of the triangle includes the social factors, and the bottom of the triangle includes the institutional factors that provide support for the student. Each side of the triangle works in balance to address the specific needs of the student. For instance, for the cognitive factors, provide tutoring and mentoring programs. For the institutional factors, provide support through perhaps the initiation of a freshman seminar class to help students to acclimate to the campus environment, to develop good study habits, and to set realistic goals. As far as the social factors, provide opportunities for the students to meet other students in the engineering program by forming collaborative learning groups, joining campus and college organizations, and making sure the student is involved in team-building activities.

While the results in this study are significant, the study does have some limitations because it is a quantitative study that does not explain the actual experiences

of the Black students who completed the College Freshman Survey (Halpin & Halpin, 1996). Having a study that addresses the specific needs of the Black students based on their perception would provide added value to the study. A future study that concentrated on developing a set of cognitive variables that are reflective of the cultural attributes of Black engineering students would be a benefit to the students and the administrators.

This study pointed out that many Black engineering students have a different set of skills from White engineering students that may help them to persist to graduation with a degree in engineering. Rower (1997) indicated that even though the Black students had a positive outlook regarding their academic performance and graduation, the data are disturbing because most of the students needed to start college in remedial courses that do not count toward their credits for graduation. She noted that providing the students with "accurate information about the college experience may help students develop more realistic expectations, may eliminate unnecessary frustrations, and may possibly improve retention and graduation rates of African American students" (p. 725).

Finally, this study should open the doors of understanding to higher education administrators and counselors who are serious about recruiting Black engineering students. If efforts are being made to recruit the best and brightest Black engineering students, serious efforts should, in turn, be made to retain them.

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