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The Impact of Student Engagement, Institutional Environment, College Preparation, and Financial Support on the Persistence of Underrepresented Minority Student in Engineering at a Predominately White Institution: A Perspective from Students

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Abstract

The persistence and attrition of underrepresented minority (URM) students in science, technology, engineering and mathematics (STEM) continues to remain a steadfast problem in education and the workforce. Research has shown that educators, administrators, and policy makers all play a vital role in shaping the future generation of STEM education, programs and the workforce, however, much of the research is deficient in providing URM student perceptions on how key factors such as student engagement, financial support, higher education preparation and institutional environment all impact their persistence in the STEM pipeline. This study employs qualitative research methods, semi-structured interviews and casual conversations to gain insight on common trends for the persistence of four (2 males, 2 females) URM students that were enrolled in a 2012 Summer Bridge Program at Mississippi State University (MSU), a predominately large white institution (PWI). Within this study, emphasis will be placed on the engineering branch of STEM. The research found that small diverse organizations such as NSBE and IMAGE along with financial support in the form of scholarships and alumni waivers, and pre-freshmen summer engineering programs such as Summer Bridge played a major role in URM student persistence in engineering disciplines.

Introduction

Many URM students in science, technology, engineering, and mathematics (STEM) majors are either dropping out of institutions of higher education or changing their majors by their sophomore year due to constraints such as rigorous course loads, institutional and academic barriers, as well as environmental factors. Such constraints induce an attrition of URM students at predominately white institutions (PWIs) in STEM. This phenomenon is quite overwhelming and frightening to minority students seeking to gain STEM degrees from PWIs post their secondary studies. Studies conducted on URM student populations in STEM disciplines at PWIs have consistently established that males dominate the interwoven fields in comparison to their female counterparts, and that URM student groups account for a minute percentage of all the students majoring in STEM disciplines at PWIs when quantifying retention. The National Science Foundation (NSF) has shown that minorities continue to remain stagnant in attaining degrees in general compared to the overall population as shown in Figure 1 and 2. In examining Figure 2 a little closer, many Black students are not obtaining degrees in engineering. For the U.S.'s economy to remain globally competitive, policy makers must make it imperative to expand the nation's scientific, engineering, and technical workforce (Winston, et al., 2008).

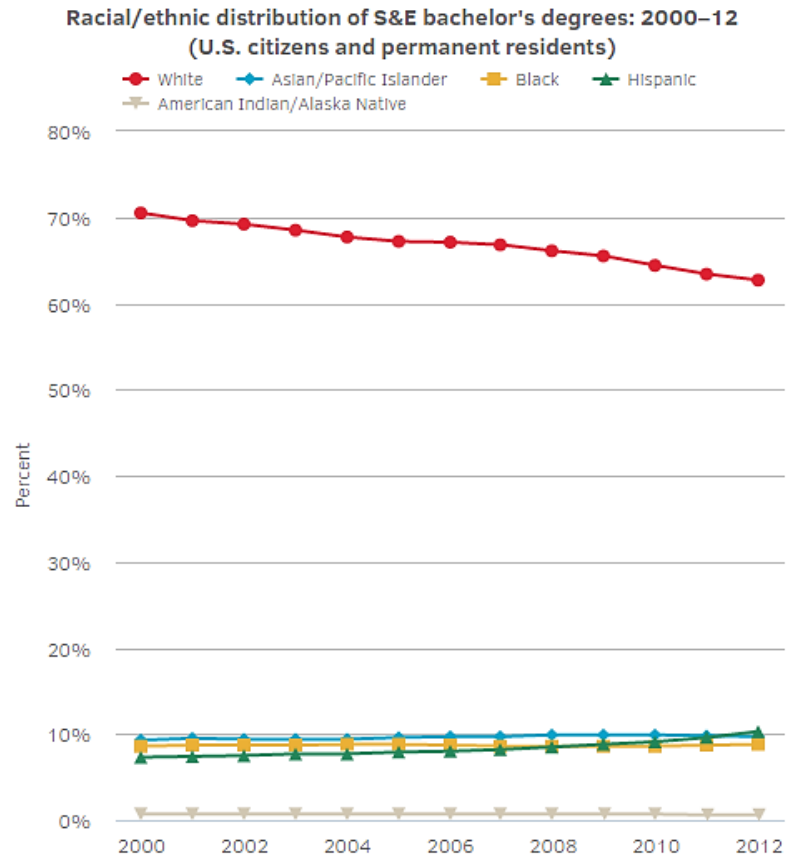


Figure 1. Racial/ethnic distribution of S&E bachelor's degrees: 2000 – 12. Obtained from the National Science Foundation's Science Education Database.

Notes: S&E = Science and Engineering.

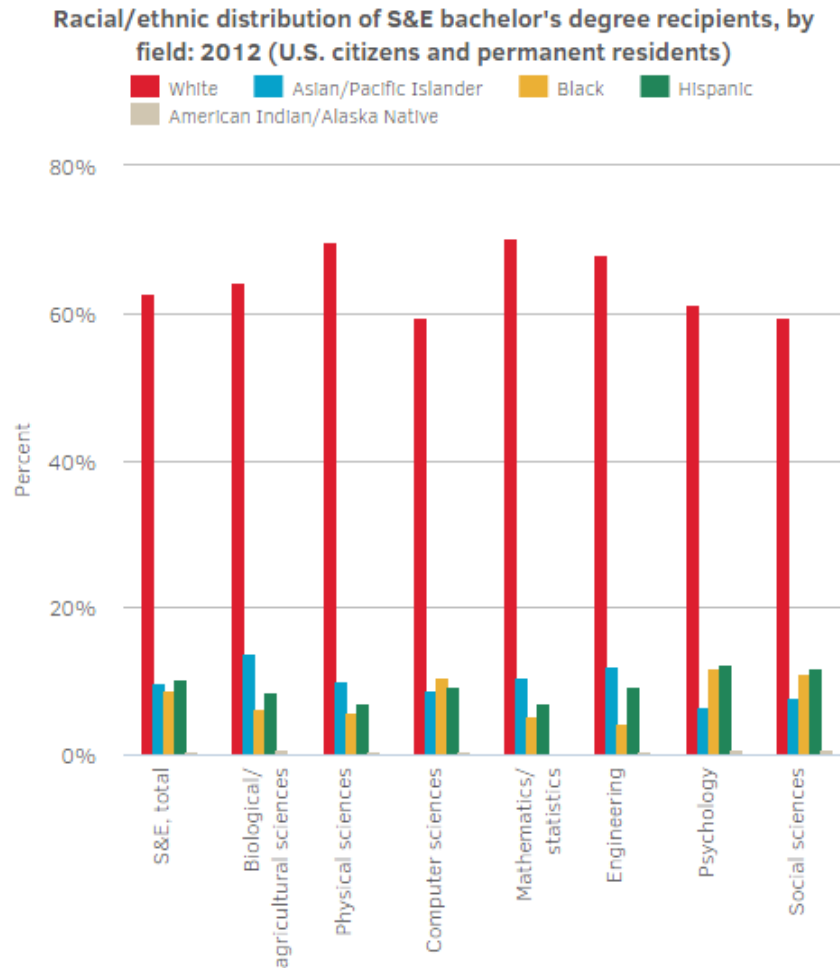


Figure 2. Racial/ethnic distribution of S&E bachelor's degree recipients, by field: 2012. Obtained from National Science Foundation's Science Education Database.

Upon transitioning from high school to college settings, underrepresented minority student groups in general have developed a lack of self-efficacy when it comes to selecting and persisting in engineering disciplines. This alarming transition is a direct result of challenging first year coursework, in-adequate academic preparation, time management, study skills and personal accountability, which all affect the persistence of students in engineering disciplines at PWIs. Many PWI's are currently trying to find methods to improve and enhance their engineering

pipelines in order to lessen the attrition rates of URM students seeking to pursue engineering degrees.

URM student groups are usually challenged by their white counterparts to constantly prove themselves, whether it is in the classroom or working collaboratively on a project. Research indicates that there is a lack of representation in engineering for URM student groups due to the fact that members of the affiliated group can foresee career barriers, while their counterparts foresee career opportunities (Winston et al., 2008). Foreseeing such barriers pose emotional and educational barriers to URM STEM groups. Although URM student groups are faced with many challenges, federal projections indicate that an increase in retention and graduation rates of STEM degrees for URM student groups will lead to a positive impact in the nation's labor force demand for qualified workers (Winston et al., 2008). The ability to overcome many of the challenges and barriers depends upon the improvement of STEM “self-efficacy” within URM students.

This study provides a rich, detailed description of URM students and the factors that stimulated their interests in pursuing an engineering degree from a PWI. More specifically, this study will examine retention and identify key factors that have motivated and aided an URM student population that participated in a 2012 Summer Bridge Program at Mississippi State University with a population of approximately twenty thousand students.

Background on Key Factors Identified within the literature

Student Engagement

Present research on URM student groups has focused mainly on student retention and student involvement. Vincent Tinto's (1993) theoretical base model and Alexander Astin's Theory of Involvement will be used in this study in relation to student engagement. Tinto's

theoretical concept of student retention is a model that identifies factors that influence students to either persist in or depart from a discipline. In this model, Tinto discuss three major sources of why students may not persist in a discipline: academic difficulties, the inability of individuals to resolve their educational and occupational goals, and their failure to become or remain incorporated in the intellectual and social life of the institution (Tinto, 1993).

According to Myers et al. (2012), “Astin’s Theory of Involvement highlights that students who engage in campus clubs, organizations, and dorm activities are more likely to persist at higher statistical rates when compared to students who are not engaged in such campus-based activities” (p.1). Several authors such as Museus & Liverman (2010), Tinto & Pusser (2006) have found that educators and administrators who set fostering and engaging environments for students usually observe high persistence rates. The authors also state that URM student groups in engineering are highly encouraged to interact more closely with faculty, peers, mentors and organizations both inside and outside of the minority arena to experience success. Student engagement plays a vital role in how well students continue through the engineering curriculum.

Tinto’s and Astin’s models are highly effective in fostering student retention across many disciplines. For the purpose of this study, both models will be used in relation to URM student groups, particularly, African Americans majoring in engineering at a PWI.

Financial Support

Students make decisions whether to continue their education beyond a high school diploma by considering the costs and benefits of obtaining a degree in engineering. If students believe that pursuing a bachelor’s degree in engineering will be beneficial in five to six years from now, they more likely will be motivated to persist throughout their studies in engineering.

When financial resources become the underlying factor in choosing to pursue an engineering degree, students must identify what is more important to them and their future. Hurtado et al. (2007, as cited in Slovacek et al., 2011) found that, “underrepresented minority students are frequently impacted by financial and family pressures, and are more likely to become concerned with the ability to finance their college education” (p.6). In a large PWI in northern Mississippi, scholarships for first year URM students are awarded based upon students’ performance on ACT and/or SAT test scores and high school GPA’s.

Inadequate financial support is one of the most outstanding factors for URM students. Of course this plays a major role in whether a student will persist from year to year in engineering and other STEM related disciplines. With increasing tuition cost, cost of attendance, and student loan financial aid packages, it is unlikely that threats to URM student groups’ ability to pay will decrease (ASHE, 2011).

Institutional Environment

In addition to funding opportunities, researchers note the importance of the institutional environmental factors and programs that are geared toward retaining students. When URM student groups step outside of their comfort zone and are placed in a dissimilar environment, relating to the new environment can pose a challenge, especially when coming from a predominately Black high school and transitioning to a PWI. The environment and culture of PWI’s as well as the many engineering departments create challenges for URM students. One aspect of the environment that can affect URM student groups negatively is the individualistic and competitive environment of classes (ASHE, 2011). Courses such as general physics, general chemistry, and calculus eliminate unprepared students from persisting in engineering disciplines (ASHE, 2011).

Pre-College Preparation

One relevant factor that hinders URM students' success in Engineering is their inadequate levels of academic preparation during their primary and secondary educational years. Success in engineering is based on adequate academic preparation for college level work within the discipline, more specifically mathematics and science courses, which are deemed most important in Engineering. According to ASHE (2011), eight factors in K–12 contribute to the inadequate academic preparation of URM students in Engineering. The factors are: “(1) school district funding disparities, (2) trailing into remedial courses, (3) underrepresentation in Advanced Placement courses, (4) unqualified teachers, (5) low teacher expectations, (6) stereotype threat, (7) oppositional culture, and (8) premature departure from high school” (p. 29).

Upon entering college, many students often choose to pursue STEM disciplines, however, a large portion of URM students leave the field before the duration of the second year (Griffith, 2010). This is perplexing, because student interest is present, but the commitment for URM student groups to persist is not; therefore, the trend of underrepresentation continues. Previous research suggests that college preparation and other educational experiences affect these decisions (Griffith, 2010). It is important to identify what these experiences are so that measures can be taken to replicate success for URM student groups in engineering. College experiences, college environments and family background characteristics in regards to persistence, all play a significant role in the ambitions of a student to persist in engineering. The idea of support for URM students is a driving mechanism for pertaining students in engineering.

Nowadays, to get early preparation for college, many URM senior high school students who are seeking to obtain an engineering degree from a PWI, usually participate in a Summer Bridge program experience before entering into their freshmen semester. The Summer Bridge

program is designed to help incoming minority freshman students become more acclimated with the institutional culture as well as expose them to courses within STEM disciplines hosted by university faculty, staff, graduate and undergraduate students. In an article, Slovacek et al. (2011) stated, “The Summer Bridge component for incoming freshman was found to have substantial impact on a student’s academic performance” (p.27).

Methodology

The purpose of this study was to identify factors that influence URM student groups to persist in engineering discipline at a large PWI in Mississippi. This study used a qualitative approach to identify key factors attributed to URM groups’ persistence in engineering. Three research questions were used to guide the interview discussions done within this study:

1. What factors influenced the URM students to persist in an engineering discipline at large PWI in Mississippi?
2. How did academic preparation, financial assistance, and support groups influence URM student groups decisions to remain in engineering at a large PWI in Mississippi?
3. What academic and social factors were attributed to the retention of URM students in engineering at a large PWI in Mississippi?

Transcripts made from the audiotape interviews were checked for accuracy against the original recordings.

Participants

The four participants selected for this study were all African Americans, two males and two females. All participants were students in the 2012 Summer Bridge incoming freshmen group. Summer Bridge exposed the URM students to the institutional environment and gave

them the opportunity to take real college course work such as general physics, chemistry and computer programming. Each participant was given an alias to protect their identity. For the purpose of this study, the participants are referred to as “Debra”, “Patsy”, “Aaron”, and “Cade.” Debra, Patsy, and Aaron went to large high schools located in the city while Cade went to a very small school located in rural Mississippi. Mississippi State University is a large research institution in the southeastern region of Mississippi; it is a PWI with a total population of approximately 20,000 students enrolled. Demographics and attributes of the URM student participants are listed in Table 1.

Table 1. URM student demographics and attributes.

URM Student	Gender	Major	High School	College Preparation/Attributes
Debra	Female	Aerospace Engineering	Attended 6A (2100+ students) high school located in South East Mississippi. ACT score	Excelled in academics and athletics.
Patsy	Female	Industrial Engineering	Attended 5A (1060 – 2099 students) high school located in South Georgia. ACT score	Possessed a strong background in mathematics.
Aaron	Male	Aerospace Engineering	Attended 5A high school located in south Georgia. ACT score	Teachers were great and mentors sparked an interest in him to pursue an engineering degree.
Cade	Male	Mechanical Engineering	Attended 1A high school located in North Mississippi. ACT score	Excelled in athletics and academics.

Parental Influence

Making the transition from high school to college can be overwhelming for students that rely on their parents to make their decisions. Each participant had a parent or grandparent that influenced his or her decision to attend Mississippi State University and major in engineering. Neither one of Debra or Cade’s parents or grandparents attended college, however, they strongly urged Debra and Cade to pursue engineering for it would provide them with a lucrative career

path. Cade stated, “Both of my grandparents were very influential and played a major role in my high school and college decisions” Cade grandparents allowed him to participant in preview days hosted by the university. Cade also participated in an honors study abroad program during his senior year in high school. Debra parents were very engaged during her junior year of high school they allowed her to participant in a Science and Engineering Summer Bridge Program at a local university near their home. Patsy and Aaron, both had parents that were college graduates. Their parents were also influential and made a major impact on their collegiate decisions. Both of Aaron’s parents earned their accounting degrees from the same institution. Patsy father attended law school and would often take her to mock trials.

Institutional programs and environment

At Mississippi State University, student organizations are very popular. Each engineering discipline has an affiliated engineering organizations at the local, regional and national levels. For example, aerospace engineering is affiliated with the American Institute of Aeronautics and Astronautics (AIAA), and Mechanical Engineering is affiliated with the American Society of Mechanical Engineers (ASME). However, at Mississippi State University there are also other student organizations that are geared toward assisting underrepresented student populations. The interviewees all mentioned NSBE and IMAGE, two local student organizations at Mississippi State University that assist URM student groups throughout their engineering studies.

All of the students stated that NSBE and IMAGE provided them with upper class mentors, which made navigating the engineering curricula less frustrating. For instance, Debra stated that having a mentor has been crucial to her success in engineering. Her mentor has provided her with tips on what classes to take, what teachers to avoid, and how to be successful in the field as an African American female in aerospace engineering. Free tutoring provided

through the NSBE and IMAGE organizations by other URM students in various STEM subjects has also played a major role in helping the URM students in this study to persist in engineering. Several students have stated that without the tutoring program in place, they would not have progressed engineering. The students also mentioned that the talks and panels provided by NSBE and IMAGE from engineering faculty, researchers and engineers within and outside of Mississippi State University has helped them to find purpose in seeking an engineering degree. Aside from exposure to several academic and industry leaders, the students mentioned the multiple opportunities they were given to apply for co-ops and internships just from being involved in the organizations.

The impact of academic preparation, financial assistance, and support groups on URM persistence at a PWI

Academic Preparation

For some participants, choosing to major in engineering was a challenge within itself. While in high school, Aaron did not have to study or take notes. He could easily sit in class and retain information. However, Debra, Patsy and Cade took notes, perhaps Debra would re-write her notes in outline form, while Patsy and Cade would re-read their notes several times until they felt comfortable with the information. Each participant had their own unique approach to studying. Even though Debra, Patsy, and Cade took notes they were all over night crammers. Several similarities were found among each participant when asked about their study habits. Debra stated, “Beforehand it was not a habit. I would study when I absolutely needed too or when I did not know the material from the lecture at all.” Likewise Patsy stated, “I find myself doing more memorization versus studying.” It was found that many students mentioned memorization as a common theme throughout each of their interviews.

Financial Assistance

Preparing for college can be a burden for both parents and students. While in middle and high school some students' dream of becoming doctors, lawyers, engineers, or even professors; however, without obtaining a college education these things are impossible. The most challenging question parents and students are faced with are "How much will college costs?" and "Can we afford those costs?" The participants noted the importance of receiving scholarships and application waivers. Patsy was a little overwhelmed because she did not receive any scholarships to offset the cost of tuition. Patsy had to take out student loans and her parents were left to pay the remainder of her tuition so that she could attend Mississippi State University. When Patsy was asked how financial support influenced her decision to attend Mississippi State University she stated, "At first it hindered my decision to attend Mississippi State University because I did not want my parents paying any money, but I recalled when I was little, my dad had always told me that if you don't get a scholarship and it is a school you really want to go to, I will pay your way in order for you to be a success and achieve your dreams and goals."

Debra, Aaron, and Cade admitted that scholarship opportunities influenced their decisions profoundly, both to attend and major in engineering at Mississippi State University. While Patsy had chosen Mississippi State University because it was an institution out of the state of Georgia but close enough to make it back home in a reasonable time-frame during academic breaks and that the school was part of the South Eastern Conference. Patsy also mentioned that she wanted to graduate from a large state institution with a good engineering program post her high school studies.

Due to Debra's outstanding achievement in high school, she received several full scholarships to other institutions in the state of Mississippi, however, most of the schools did not

have the aerospace engineering major she was seeking. Cade also received other scholarship offers, however, he was attracted more to Mississippi State University because of the environment, football games, and the dorms. Aaron on the other hand received the alumni waiver to assist in covering the cost of his tuition. Having financial stability and support played a pivotal role in the four participant's choice of attending Mississippi State University and majoring in engineering.

Support Groups

From this study, several similarities between all four participants were revealed. Each participant stated that having support groups consisting of parents, mentors, and peers has had a positive impact on their persistence in engineering. Engineers usually collaborate with one another when working on projects and when trying to solve problems. Patsy noted that her parents and her NSBE, IMAGE and study support groups are her major sources of motivation to continue on persisting in engineering. In response to having support groups, the four participants believed that being involved in support groups has helped to enhance their self-efficacies, study habits, and networking opportunities. Debra stated, "It's a great bond between the 2012 Summer Bridge cohorts and no one wants to be that student that got left behind or did not make it in engineering." Having a strong and solid support system along with being actively involved in the learning process can make the difference in whether a student regardless of race or socioeconomic status complete the engineering degree program or not.

Summer Bridge

All four participants in this study participated in the 2012 Mississippi State University Summer Bridge Program. The interviewees were similar in that they all mentioned that the program improved their study skills, time management abilities, and provided them with insights

on how to be successful in engineering. In high school, three out of the four participants did not have to study or have a routine for preparing for classes. Summer Bridge not only exposed students to the institutional environment, campus courses, faculty and researchers but required URM students to attend a three hour mandatory structured study hall Sunday through Thursday during the summer of 2012. For Aaron, the summer bridge requirements were a new concept for him due to his lack of taking notes and studying while in high school. Aaron stated, “Summer Bridge was a great experience. I was able to work alongside my cohorts, learn new ideas, theories and concepts, and most of all, how to be a success in engineering. I gained study tips, and developed better study habits.” Summer Bridge provided the four participants lifelong learning skills. Patsy reported that the Summer Bridge Program had a positive influence on her and that it taught her how to manage her time effectively. She noted that, “Summer Bridge helps shape and mold you into becoming a better and more productive student upon entering college your freshmen year. It helps you to gain a better insight and outlook of what is going on around you.”

Student Engagement

After examining how the four participants were engaged during their high school years, it was noted that Debra and Cade were highly engaged in academic programs during the full academic year including the summer. Debra stated that being a part of Mu Alpha Theta, a math club that competed in math and science competitions at local universities made her feel more comfortable with mathematics. She also participated in a Summer Bridge Program at during her junior year of high school. Cade reported his use of computer engineering techniques to develop a web page for his local community, while attending high school. In addition, to creating this web site he participated in a study abroad research program in Australia. He also participated in a

summer engineering camp at North University. In contrast, Patsy and Aaron did not participate in any summer programs or any engineering programs throughout their high school years. One unique characteristic of all four participants was their involvement in athletics and leadership positions held during high school.

During Debra's collegiate years, she participated in NASA's student competition as an intern in Washington DC, studied abroad during her sophomore year, and served in leadership roles for both IMAGE and NSBE. Patsy's collegiate experience has been very challenging due to introductory courses such as physics, calculus, and chemistry. Although Patsy continues to face challenges within engineering curricula, she is still persisting as a junior. Aaron is still persisting as a junior in engineering, however, he has noted that the classes are quite challenging and overwhelming. Cade has been very active on campus. He currently holds leadership roles in several student organizations such as the Men of Excellence, NSBE, and IMAGE. Cade also noted that the engineering curriculum is quite overwhelming at time and that he wishes instructors do a better job of instructing the course material.

Student Interest

Each participant expressed an interest in math. Debra reported an interest in applied math and science because of its relevance to engineering. All engineering students must complete Calculus I-IV, Chemistry I, Chemistry II as well as Physics I & II. A strong mathematical background is key to completing most engineering prerequisite courses. A student's passion for a subject can vary depending on a number of factors. In this case the data revealed that the four participant's high school math teachers influenced them in some way. Cade reported that his math teachers in high school were challenging and made learning math very interesting to him. His teachers used different forms of technology that allowed for interaction among the students.

Cade mentioned that his math teachers made the all of the students compete with other schools using the promethean board. When Aaron was in middle school, he stated that math seemed very easy to him, and mentioned as the years went by, math became more and more complex. Despite the complexity, he mentioned that his love for math continued to grow. Aaron also mentioned that having great math teachers that explained different math concepts in depth, made learning math more meaningful. Patsy stated that math “gets her brain going” because it allows her to keep busy mentally. Her least favorite subjects were reading and English.

Having a career in engineering can lead to a financially stable lifestyle. Each participant expressed a profound interest in the starting salary for engineers. When searching for a career, Debra browsed the internet for jobs, where she found Engineering to be among the top 10 growing job fields and offered a very competitive starting salary. She stated, “I want to live comfortable. I wanting something interesting and money did play a major factor in my final decision.”

Student preparation and college readiness

Elementary, middle, and high schools each have curriculums that they are required to follow. The curriculum varies from state to state; however, some high schools do offer advance courses also known as AP (advanced placement) or IB (international baccalaureate) courses. The notion behind advance courses is that they prepare students for college as well as provide for a more challenging lectures, lesson plans, homework and tests.

Each participant took AP/IB courses during their high school years. More specifically, this study revealed that even though the students took these AP/IB courses, they felt somewhat underprepared before they entered college. Debra reported that her school IB program was very challenging and the courses were rigorous. She took eight IB courses her senior year and yet she

felt unprepared for college. Among the eight courses she was mostly interested in the math and science courses, Debra took a mathematical statistics course which was not a preparatory class for the Calculus class she took in college. Although she scored high enough on the ACT to be placed in Calculus I, she stated that the Summer Bridge Program prepped her more than the IB math course taken in high school. When asked “How well did you do in your Calculus I class,” she explained how grateful she was for attending Summer Bridge and taking Pre-Calculus. Debra reported that over the summer she was able to learn different trigonometry functions that were used in Calculus I. Patsy and Cade took AP Algebra and AP Trigonometry while in high school, however when asked how well did they do in their college Trigonometry course, their responses were “good”. They both said that the College Algebra class they had taken in Summer Bridge played a tremendous role in their preparation for Trigonometry.

None of the four participants took Chemistry or Physics courses while in high school. Aaron reported that by not taking these classes in high school was a huge disadvantage for him since he had decided to major in aerospace engineering. Debra took AP Biology, Patsy took AP Environmental Science while Cade had taken General Science in high school. Although each participant took an AP/IB course, they felt no different than the students who had not taken AP/IB courses in high school.

Conclusions and Implications

This study examined four URM engineering students who participated in Mississippi State University 2012 Summer Bridge Program. The study revealed that the Summer Bridge Program served as a positive stimulus for preparing students for their first year of college. More specifically, these findings provide empirical data support to Vincent Tinto’s theory of student retention. The

Summer Bridge Program helped participants improve their study skills, time management, and improved their abilities to become well-rounded engineering students.

The value of financial support, student engagement, and mentorship were all major factors identified within this study that attributed to student interest and persistence in engineering at a large PWI. In addition, small diversity organizations such as NSBE and IMAGE provided URM students with mentorship, tutoring, networking and potential co-op and internships. A concept map of the factors are shown in Figure 3. It was also revealed that AP/IB high school courses did not have an impact on students to persist in engineering. This study provides insight to university administrators and STEM researchers on URM student group persistence from primary sources.

This study was limited to only African American students who participated in the 2012 Summer Bridge Program; however, future research should include representation of other underrepresented student groups (Latinos/Hispanics, and Native Americans etc.). Expanding the range of ethnic groups will give more insight to understand if findings are consistent with other underrepresented groups. This study should also be expanded to understand what factors influence URM students to pursue a degree in engineering and the factors that impacted their departure from the discipline.

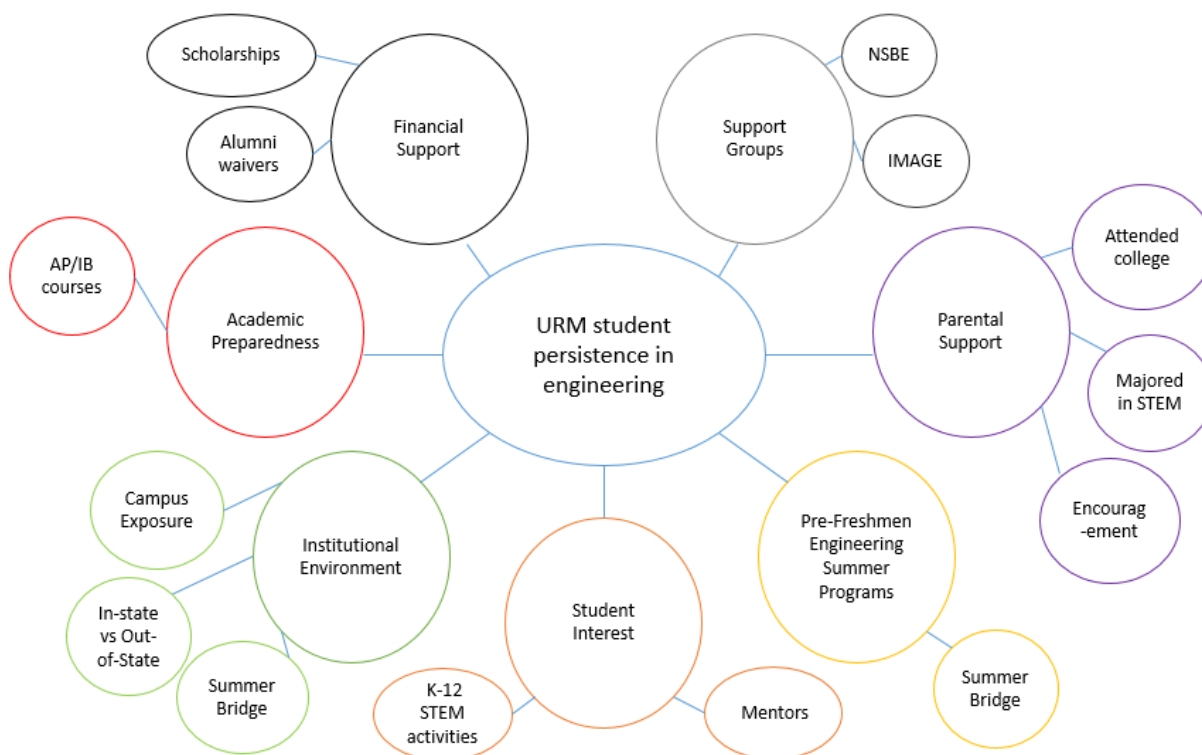


Figure 3. Concept map of factors explored in this study.

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