Best Practices for Underrepresented Minority Students in an Engineering Summer Bridge Program

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Vemitra White, a native of Crawford, Mississippi, is currently a doctoral candidate at Mississippi State University where she will receive her PhD in Instructional Systems and Workforce Development. She received her undergraduate degree in Business Administration from Mississippi State University with concentrations in Finance, Insurance, and Management. Vemitra also received her Master’s of Science degree in Instructional Technology from Mississippi State University. Vemitra has been involved with recruiting under-represented minorities (URMs) students in the Science, Technology, Engineering, and Mathematics (STEM) areas at Mississippi State University since the summer of 2010. Vemitra currently serve as the Director of Educational Outreach and Student Programs in the Bagley Development. Vemitra serves as a city council member in her hometown. She is the youngest member on the board that is responsible for making policies and procedures, as well as ordinances for the town. Her active participation on the city council exhibits her commitment to helping others and building her town both financially and economically. Vemitra is an active member of Columbus Lowndes County Alumni Chapter of Delta Sigma Theta Sorority, Inc., the recent award recipient of the Outstanding Graduate Woman Award from the President’s Commission on the Status of Women, a member of Phi Theta Kappa, Women’s Basketball Collegiate Association, and Mississippi Educators Association. Her active participation in these organizations reveals her passion in helping others succeed. Vemitra is also a former collegiate basketball player where she played 2 years of women’s basketball at Bevill State Community College in Fayette AL and her last 2 years at the University of West Georgia in Carrollton GA. She was a 4 year Academic All American.

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Introduction

The educational achievement gap in STEM (Science, Technology, Engineering and Mathematics) disciplines in America continues to persist among underrepresented groups. As the U.S. competes to remain a world power in the area of technology and innovation, we do so with marginal participation from underrepresented minority groups. As the U.S. faces this point in time, there must be a commitment on behalf of policy makers, practitioners, and researchers to address the issues impacting who pursues engineering majors; who can financially afford to attend college to major in engineering fields; and who is retained and graduate with engineering degrees. One approach that has been implemented to address the gap in retention and graduation rates among underserved populations is the use of summer bridge programs. Summer bridge programs have been used by both predominately white institutions (PWIs) as well as historically black colleges and universities (HBCUs) to promote the inclusion and success of minorities in STEM fields. Some of these programs are purposeful to close the achievement gaps of underrepresented minority (URM) students pursuing engineering degrees as compared to non-minority students. URM in the sciences or engineering is defined as a student who has self-identified as Black or African American, a Hispanic, or American Indian/Alaskan [1]. Summer bridge programs vary per institution and can be structured to offer different types of experiences for participants. Traditional summer bridge programs provide incoming first year URM students the opportunity to participate in an intensive academically enriching programming as a remediation in foundational courses such as mathematics, chemistry, and computer programming. Some universities may offer summer bridge programs for academically prepared students and remediation may not be the need. This model of summer bridge centers programming on establishing support and academic acculturation [2]. The model used in the College of Engineering at Mississippi State University merges both approaches: providing remediation for some participants as well as focusing on student transition from high school.

Among some of the most prevalent hindrances to URMs in engineering are the lack of early K-12 exposure to STEM education, academic preparedness, and financial difficulties [3]. To address these issues the Office of Diversity Programs and Student Development in the College of Engineering has established initiatives to support URMs in engineering including (1) K-12 outreach program for middle school girls; (2) first and second year retention programs; (3) scholarship and stipend awards; (4) a five-week Summer Bridge Program. This paper focuses on the Summer Bridge Program.

Research Motivation

Within the social context of American society, participation in science, technology, engineering and mathematics (STEM) disciplines, has long been dominated by white males. Historically there has been much interest and debate around why this phenomenon is prevalent in American society. The National Academy of Sciences states “without the participation of individuals of all racial/ethnic backgrounds and genders, the increasing demand for workers in these fields will not be met, potentially compromising the position of the United States as a global leader” [4]. This paper will examine the best practices for a Summer Bridge Program to facilitate URM student success in engineering at a predominately white institution (PWI). The analysis will provide
insight into first year retention rates and graduation of students in the Summer Bridge 2010-2013 cohorts. This paper examines the provide best practices and preliminary retention date for implementing a minority engineering summer bridge program and compare the effect of the Summer Bridge Program on the retention rates and graduation rates of (i) URM Summer Bridge students (ii) College of Engineering URM students who did not participate in the Summer Bridge Program and (iii) College of Engineering Non-minority student cohorts for 2010-2013.

The Summer Bridge Program at Mississippi State University, a predominately white institution, is committed to creating an educational environment of inclusiveness and high academic excellence. This environment is fostered to enable students to persist in the engineering curriculum, graduate with an engineering degree, and allow for exposure to research and graduate school opportunities. By promoting a culturally diverse environment, the College of Engineering seeks to increase the participation of minorities and women in the field of engineering and to close the social gaps of underrepresented minority students. In the fall 2013 first-time incoming freshmen in engineering consisted of 637 students with 531 (83%) of students being White American and 87 African American students making up 14%. The remaining 3% self-identified as being either American Indian/Alaskan Native, Asian, Hispanic, Multiracial or a Non-Resident student. African Americans have historically been the largest minority group in the College of Engineering. Historically efforts to increase URM success have been focused on the African American student population, but in recent years an emphasis has been placed on increasing the population of URM participation across all minority groups. Table 1. African American and White American 2010-2013 Cohorts for incoming freshmen provides an overview of the two racial/ethnic groups comprising the majority of incoming freshmen engineering students from 2010-2013.

<table>
<thead>
<tr>
<th>Cohort Year</th>
<th>Total Incoming Freshmen</th>
<th>African American Head Count</th>
<th>Percent of Total Head Count</th>
<th>White American Head Count</th>
<th>Percent of Total Head Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>474</td>
<td>95</td>
<td>20%</td>
<td>368</td>
<td>77%</td>
</tr>
<tr>
<td>2011</td>
<td>530</td>
<td>103</td>
<td>19%</td>
<td>413</td>
<td>77%</td>
</tr>
<tr>
<td>2012</td>
<td>569</td>
<td>91</td>
<td>16%</td>
<td>462</td>
<td>81%</td>
</tr>
<tr>
<td>2013</td>
<td>637</td>
<td>87</td>
<td>14%</td>
<td>531</td>
<td>83%</td>
</tr>
</tbody>
</table>

For first-time student enrollment in the College of Engineering for cohort years 2010-2013, the overall percentage of African American students declined each year as the first-time student enrollment for White American students increased over the same period.
**Summer Bridge Program Overview/ Goals**

In existence for more than twenty years, the MSU Summer Bridge Program is designed to provide incoming URM engineering students five weeks of intensive coursework in Pre-Calculus/College Algebra, Chemistry and Physics. Students also receive instruction in technical communication, personal development, and real world engineering projects, teambuilding, and study skills development. The program is held the summer prior to students’ first semester enrollment. The Summer Bridge Program provides on-campus residence, class instructors, textbook/materials and meal stipends at no cost to each participant and strives to meet the following goals:

1. Increase the recruitment, retention, and graduation rate of minority students in Engineering.
2. Develop a greater sense of community among all URM participants.
3. Establish strong academic performance in foundation courses (math, chemistry, etc.).
4. Interact with professional engineering mentors (speakers, presenters, etc.), engineering department heads, faculty, MSU Human Resources (MHRI), and alumni.
5. Cultivate professional and personal skills needed in the engineering curriculum and profession.
6. Recognize and reward successful program participation through stipend and Dow Academic Distinction Scholarship awards.
7. Provide overall effective programming.

In 2010 the Summer Bridge Program received corporate sponsorship to assist in efforts to increase the recruitment, retention, and graduation rate of underrepresented minority (URM) students in engineering. The Bridge program accounts for roughly 50% of all African American students in the College of Engineering. Despite the program’s longevity and anecdotal observations, quantifiable findings to support the program’s effectiveness has yet to be evaluated.

**Elements of the Summer Bridge Program**

**Target Population and Recruitment**

Incoming freshmen URM students are recruited for the Summer Bridge Program (SB) in several ways. The most common recruitment is via word-of-mouth. Because of the program’s twenty plus year longevity, many of the alumni of the program provide referrals. Through electronic correspondence shared with high school counselors, some students apply to the program via this route while others apply to the program from direct recruiting efforts of the partnership established between the College of Engineering and the university Office of Admissions and Recruitment. Many students are made aware of the program through “cold calls” and emails from current past Bridge participants. Overall, incoming URM freshmen who have been accepted into the College of Engineering are recruited for SB based on demographic attributes (e.g., gender and ethnicity) and incoming metrics (e.g., standardized test scores, high school grade point average). Although high school GPAs and standardized scores are considered as part of the application, the decision for acceptance into SB is a combination of a student’s expressed work ethic, letters of recommendations from high school counselors and teacher, and overall transcript course evaluation. All incoming URM students are encouraged to apply for the program; however, with an average acceptance rate around 90%, not all applicants are accepted.
Summer Bridge Structure
The SB program runs for five weeks and coincides with the second summer session. Students are admitted into the program at no cost as part of the funding provided by the Chevron Corporation, Southern Company, and Louis Stokes Mississippi Alliance for Minority Participation (LSMAMP). Effective 2014 Dow Chemical became the primary Bridge corporate sponsor. The program provides on-campus housing, books and materials, instruction, and travel opportunities. For the five week duration of the SB program students receive intense instruction in engineering foundational courses such as mathematics, chemistry, physics, and computer programming. For some participants, the program rigor is unexpected and unlike their high school experiences, with many students stating “we never studied in high school”. As a result, study skills and time management are critical components of the enrichment seminars presented throughout the program. Students learn in real time how to adjust to the demands of college life as an engineering student. Table 2. Sample Weekly Schedule of the Summer Bridge Program, shows the overall structure of courses and topics experienced by participants. The schedule is very rigid to simulate scheduling demands placed on engineering students throughout the academic year.

In addition to foundational course instruction, like many summer bridge programs, MSU students participate in enrichment seminars to address academic acculturation [2]. These sessions are critical in helping students successfully transition into a university setting as well help them to adjust to academic and social demands experienced by minority students in engineering disciplines at a PWI. Seminar topics such as Campus Orientation and Resources (e.g., Financial Aid, Co-op, Housing, etc.) in some cases provide a point-of-contact for future reference. Time Management and Study Skills along with Personal and Professional Development (e.g., “Presentation of Self”) are provided to increase student academic acculturation and self-efficacy. Coping Skills (e.g., anxiety and stress management, etc.) help students to adjust to the mental workload required of engineering students. Through the use of project based learning, students are introduced to the field of engineering. Participants complete a real world simulated team-based project such as the Southern Company Transmission Line Development. Through this project students were required to conduct virtual land surveys to determine transmission line locations, perform calculations for electricity flow rate, and wattage constraints. Upon completion of the project students were required to complete formal research papers and to give formal presentations to the Southern Company team. This requirement, along with industry tours and the introduction and interaction with engineering Department Heads and College administration, help students to solidify a greater sense of what it means to pursue and achieve engineering degrees.

The MSU Bridge program is overseen by the Director of Diversity Programs and Student Development in the College of Engineering. In addition to Bridge, this office is responsible for diversity efforts of the College and is tasked with supervision of student organizations such as NSBE, SHPE, IMAGE, and LSMAMP. This office is able to leverage university and external resources to provide optimal support for Bridge students. As an additional approach to integrating students into the university and engineering culture, Bridge students are introduced to student organizations during the summer and are encouraged to become actively engaged in the activities of these organizations.
Traditionally URM summer bridge programs offer content designed to close academic performance gaps among participants to result in increased retention and graduation rates. The structure typically will include instruction in mathematics, critical thinking, communication development and academic acculturation [5]. Although the MSU Bridge Program has incorporated many of the traditional bridge components, it is the execution of a holistic approach to accomplishing the mission that is noteworthy. Through the use of many best practices identified by ASEE in its 2012 best practices report the MSU Summer Bridge Program is positioned to positively impact the attrition of URM engineering students [6].
Alliance of Strategic Partnerships

The MSU Summer Bridge Program is heavily dependent on strategic partnerships established to provide effective summer bridge programming. From 1998-2010 the MSU bridge program was primarily self-funded with supplemental funding from the Louis Stokes Mississippi Alliance for Minority Participation (LSMAMP) which is designed to prepare undergraduate underrepresented minority students who major in STEM to be effective and proficient in their respective STEM field, and be prepared for graduate school. The Bridge program managed to enroll an average of 16 students per summer. In 2010 the Chevron Corporation and Southern Company became the first corporate sponsors of the MSU bridge program resulting in a 68% growth of enrollment to reach a maximum capacity of 50 students.

With an established corporate relationship with Chevron and Southern Company, Bridge participants had direct access to professional engineers who offered real world insight on classroom topics. Group projects assigned during the program were created by the corporate sponsor and was heavily tied to real industry needs. By working with corporate mentors students became better acclimated to the engineering profession through the use of engineering acumen, and problem solving techniques. This opportunity allowed students meaningful early exposure to the engineering discipline and helped to shape their understanding of the field. This engagement provided a basis for future skills needed for project based learning such as capstone coursework [7].

Among the major University partners for the Summer Bridge Program are the Math and Chemistry Departments, the Learning Center, University Library, Career Services and the Writing Center. Each of these provide unique services that benefit the program. For instance, the Math Department is key in helping to determine the appropriate math placement for Bridge students. As a condition of the program students must agree to take the appropriate math class during SB as determined by the Math Department. Students will be placed in either the Pre-Calculus or College Algebra course during the five weeks. Upon completion of the program students are enrolled in the appropriate math course for the fall semester based on their summer performance. This allows students to start at the appropriate level of math that will best support a strong math foundation going forward [1]. As a result of strong math performance over the summer, students may earn the opportunity to bypass remediation math courses that may otherwise be dictated by their Math ACT Sub Score. There are also examples where students have been enrolled in lower level math courses for the fall rather than advancing to the math course dictated by their Math ACT Sub Score. For instance, after the completion of the 2010 Bridge program, of all students enrolled in Pre-Calculus during the summer, 22% were placed in Trigonometry in the fall as opposed to Calculus I with the remaining 78% of being placed in Calculus I or higher. Of students enrolled in College Algebra during the summer 26% were placed in a math course lower than College Algebra in the fall, with 74% of students being placed in math courses higher than College Algebra. Appropriate math placement is an important step in helping students develop a strong foundation to be successful in completing the series of math courses required in engineering.

Community Building and Belonging

Many underrepresented minority students are challenged with overcoming negative stereotypes, ethnic isolation, and inadequate support systems when majoring in engineering [8]. This problem can be more profound for minority students at PWI institutions. During the Summer Bridge orientation students and parents are briefed on the program structure and are reminded of all associated requirements and expectations. Students formally sign an agreement committing to
upholding all the goals and objectives of the program. Each year orientation includes the topic of the necessity of students developing a “sense of belonging” and embracing the idea of “Bridge group accountability”. To better understand the concepts, students and parents are familiarized with national and campus URM engineering statistics and how social integration and a sense of belonging must be established to aid in student persistence during the summer and throughout their engineering college experience. Students are challenged and inspired to fully engage over the next five weeks while parents leave encouraged and accountable to the program’s efforts by providing support and reinforcement to students throughout the summer. Students leave orientation motivated to provide academic and social support to help fellow Bridge participants to reach their fullest potential and persist in engineering by agreeing to offer tutoring and reassurance to others when needed [9]. Students quickly learn that as a whole the group benefits by utilizing the different strengths of individuals to better ensure the success of the group as a whole. Through this approach student self-efficacy can be increased and they learn foundation, a growth mindset, and a committed work ethic, they can be successful in engineering.

**Teambuilding**

To further promote community building, on the first Saturday morning of the program students participate in the half day “Big Dawg Challenge” outdoor obstacle course designed by the university Recreational Sports division. The course offers low-ropes workshops designed for groups to engage in problem-solving strategies requiring both mental and physical involvement of each team member. Each challenge pulls on every team members’ input of ideas, efforts and support to achieve the course objective much like that of engineering coursework. Overall students leave with:

- Improved self-confidence
- Improved teamwork
- Enhanced communication skills
- Greater trust
- Enhanced decision-making and problem-solving skills
- Increased individual responsibility & leadership
- Overall increased awareness of community and belonging to the Summer Bridge group

**Financial Support**

Financial support in the form of scholarships and stipends are awarded to participants at the completion of the program. Outstanding and most improved performances are recognized and stipend scholarships are awarded accordingly. Starting in 2014, the multi-year Dow Academic Distinction Scholarships awards for $10,000 include an opportunity for the recipient to pursue a co-op position within the company. In addition to scholarships, stipends are awarded to all participants with award amounts based on academic performance throughout the program. This aspect of the program allow students additional opportunities to secure financial support for the upcoming academic year. Bridge stipends and scholarships help to address financial barriers experienced by many URM students from low socio-economic status (SES) when pursing post-secondary education [3].
Continued Student Oversight
As a condition of the Summer Bridge program, students are required to enroll in the GE-1021 Engineering Success class in the fall semester. The course is taught by the SB director and reinforces many of the skills learned throughout the summer. The course provides an opportunity for continued oversight of student engagement, academic performance, and student overall acculturation. The course offers students more in-depth instruction on topics ranging from self-efficacy, history of engineering, time management, and engineering design process and principles. Studying Engineering: A Road Map to a Rewarding Career (4th Edition) written by Raymond A. Landis, is the textbook adopted for the course. The text provides a systematic approach to improving academic performance and retention rates among engineering students. The course is a one hour class that meets once a week. In addition to the class, students participate in:

- Ongoing one-on-one meetings with staff of the Engineering Office of Diversity Programs.
- Summer Bridge group meetings, roundtable discussions on topics such as “The Importance of Persisting in Engineering”, and social gathering.
- Complete a minimum of 8-10 hours of mandatory study hall Monday through Thursday.

Dow Faculty Fellows
Prior to 2014 faculty mentoring for the Summer Bridge Program was less formalized; however, through corporate sponsorship increased faculty mentoring has been provided to students through the College of Engineering Dow Diversity Faculty Fellows Program. The fellowship provides a $10,000 stipend to each faculty fellow participant. Potential fellows are considered through an application process where the following criteria are used for selecting three faculty members to serve:

- Demonstrate a commitment to enhancing opportunities for academic success in engineering for underrepresented students.
- Provide interactive opportunities for Bridge students to gain an inclusive academic experience with a particular focus on academic preparedness, research exposure and participation, and overall mentorship of Bridge participants.
- Provide a minimum of eight (8) meaningful touch points with students over the academic year.
- Provide periodic updates as well as an annual progress report to the Director of Diversity Programs and Student Development no later than July 1st of each year.
- Must have completed a PhD degree by the start of his/her fellowship term.

The Dow Diversity Fellows Program matches engineering faculty with Bridge students. Students are divided among the three fellows where they meet individually and in small group sessions to receive greater hands-on advising and overall mentoring. The goal of this program is to increase academic preparedness and performance, improve research exposure and/or participation, and provide overall better student engagement and retention. As a result of this initiative, faculty fellows have arranged for students to attend technical conferences, participate in industry tours, and have increased one-on-one sessions with engineering faculty/mentors.
Retention and Summer Bridge Program

Summer Bridge has had noticeable success through offering these experiences to URM and our retention illustrates that success. The data used for this analysis consisted of those students who entered as first-time, full-time engineering and pre-engineering students in the fall semesters for the years 2010-2014. The working definition for a URM student for the purpose of this study shall include those students who have self-identified as Black or African American, a Hispanic or Latino, or Native American. The comparison for this study will consist of the URM African American students as compared to those of White American students in the College of Engineering. The population of African American students is the largest minority group in engineering at a rate close to six times that of the next largest minority groups. Each cohort from 2010-2014 has been classified into three groups for analysis: (i) URM Summer Bridge students (ii) College of Engineering African American students who did not participate in the Summer Bridge Program and (iii) White American students in the College of Engineering. Tables 3 provide cohort measures of college preparedness by overall ACT scores across all three groups.

Participation of African Americans in the Summer Bridge Program accounts for roughly 50% of all URMs in the College of Engineering at Mississippi State University. The outcome of this program has a great impact on the overall inclusion goals for the College. Table 5 shows the retention and graduation rates of Bridge students across 2010-2013 cohorts. The average first year retention rates of across all cohorts for Bridge participants is 76%, with 82% for African Americans not participating in Bridge and 88% for White Americans. Although Summer Bridge is open to all underrepresented minorities, enrollment has historically been African American. In recent years there has also been participation of Hispanic and Asian American students.

<table>
<thead>
<tr>
<th>Cohort Year</th>
<th>SB Total Head Count</th>
<th>Avg. ACT</th>
<th>Non-SB Total Head Count</th>
<th>Avg. ACT</th>
<th>White American Head Count</th>
<th>Avg. ACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>48</td>
<td>24</td>
<td>47</td>
<td>23</td>
<td>368</td>
<td>28</td>
</tr>
<tr>
<td>2011</td>
<td>45</td>
<td>22</td>
<td>58</td>
<td>22</td>
<td>413</td>
<td>28</td>
</tr>
<tr>
<td>2012</td>
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<td>61</td>
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<tr>
<td>2013</td>
<td>37</td>
<td>23</td>
<td>50</td>
<td>23</td>
<td>531</td>
<td>28</td>
</tr>
</tbody>
</table>
Summer Bridge student persistence is less than that of White students across all years; however, the average Bridge Year 3 retention rate of 62% is comparable to the persistence of Non-Bridge African Americans of 66% as compared to an average retention rate across Year 3 of 82% for White students. For the 2010 Bridge cohort, 15% of participants graduated within four years with 44% of students persisting to Year 5. The 2011 Bridge cohort realized a 9% four year graduation
rate and 27% of student persisted to Year 5. Non-Bridge African Americans in 2010 resulted in 13% four year graduation rate and 9% of students graduated within four years from the 2011 cohort. In 2010 Summer Bridge students outperformed Non-Bridge African American students with 15% and 13% four year graduation rates respectively in 2010.

Research Limitations

Findings from this paper are considered preliminary information that will allow for follow-up studies to further understand the impact of the Summer Bridge Program on student achievement. Although it is to be determined the impact of the Summer Bridge Program on increasing recruitment, retention, and graduation rates of minority students engineering, the rigor of the summer program and mandatory study skills development have exposed students to techniques to be successful in achieving higher rates of retention and graduation in engineering at Mississippi State University. Factors impacting the persistence of minority students in engineering such as K-12 factors, socio-economic status, and academic acculturation must also be addressed to understand the influence they may have on student performance and persistence.

To determine the effectiveness of the Summer Bridge Program on development of a greater sense of community among URM participants and improved self-efficacy, time management and study skills, will require the development of a survey tool to access Summer Bridge effectiveness. A tool has been created and was implemented at the completion of the 2015 Summer Bridge Program for future studies; however, for 2010-2013 this tool was not available.

Additionally new program structure started in 2010 shifted the focus of the program from a STEM Summer Bridge Program to one more only focused on engineering. Data captured prior to 2010 includes all STEM majors and not engineering only; therefore, this has hindered the ability to establish longitudinal data.

Conclusion

As the U.S. strives to address the needs of increasing the participation of individuals of all racial/ethnic backgrounds and genders in STEM careers, the MSU Summer Bridge Program remains committed to closing performance gaps among URM students in engineering disciplines. With a four year graduation rate exceeding that of Non-Bridge African American students in 2010, the efforts of the Bridge program are viewed favorably. The MSU Bridge program remains diligent in utilizing the best practices shared in this paper to continue to improve URM student outcomes.
References


