

TAMUS LSAMP Project: 25 Years of Success - Finding and Implementing Best Practices for URM STEM Students

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Dr. Samuel Merriweather currently serves as the Texas A&M University System Louis Stokes Alliance for Minority Participation (TAMUS LSAMP) Associate Director through the Texas A&M Engineering Experiment Station (TEES), a TAMUS member. He obtained bachelor and master of science degrees in industrial engineering at Georgia Institute of Technology and a PhD in industrial engineering at Texas A&M University.

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Shannon D. Walton, PhD, is the Director of Recruiting for the Office of Graduate and Professional Studies and the Director of Educational Achievement for the Dwight Look College of Engineering at Texas A&M University. Holding dual positions, Dr. Walton's responsibilities range from the recruitment and retention of a talented and diverse graduate student population to the management of science, technology, engineering and mathematics (STEM) programs, like the NSF-funded Louis Stokes Alliance for Minority Participation (LSAMP), aiming at increasing the number of underrepresented minority students successfully completing high quality degree programs in STEM disciplines.

A product of one of the very programs that she currently directs, LSAMP, Shannon holds a bachelor's degree in Industrial Engineering, a master's degree in Safety Engineering, and a doctorate in Interdisciplinary Engineering, all from Texas A&M University.

With research interests rooted in engineering education, the learning styles of engineering students in particular, Shannon's tenure at Texas A&M is and has been rooted in the mentoring of both undergraduate and graduate students. Currently an advisor for the Texas A&M National Society of Black Engineers (NSBE) Chapter and an active member of Delta Sigma Theta Sorority, Incorporated, a service organization, Shannon is no stranger to mission and vision of the academic excellence and cultural responsibility.

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Karen Butler-Purry is the Associate Provost for Graduate Studies and Professional Studies as well as a Professor in the Department of Electrical and Computer Engineering at Texas A&M University, College Station, Texas. Her research interests include computer and intelligent systems applications to power distribution systems and engineering education. She can be reached by e-mail at klbutler@tamu.edu.

Judy Kelley, West Texas A&M University

Judy Kelley currently serves as the Executive Director of the West Texas Office of Evaluation and Research. She has a Bachelor of Science degree in Mathematics from Texas Tech University and a Master of Science degree in Statistics from SMU.

Mrs. Krystal E. Thomasson, Texas A&M University-Corpus Christi

Krystal Thomasson was born and raised in Corpus Christi, TX. She earned her Bachelor's Degree in Liberal Arts, with an emphasis in Communication, from Texas A&M University-Corpus Christi in 2007. Krystal worked with the local ABC affiliate news station KIII-TV3 until 2010 when she was hired as a Program Coordinator for the College of Science & Engineering at her Alma Mater. She has coordinated many grant programs, including scholarship programs and undergraduate research programs. She has worked with the Louis Stokes Alliance for Minority Participation (LSAMP) undergraduate research program with the TAMU System from the beginning and currently coordinates the TAMU-CC LSAMP program still. In her free time, Krystal enjoys spending time with her husband and 2 year old son in Corpus Christi.

Dr. John David Rausch Jr., West Texas A&M University

Dr. Rausch is the Teel Bivins Professor of Political Science at West Texas A&M University in Canyon, Texas.

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Received BA in English (1974) and MS in Biological Sciences (1979) from the University of New Orleans, PhD in Zoology from The University of Texas at Austin (1984). Appointed Asst. Professor, Mississippi State University (1984-1987), Asst. Professor - Professor University of Louisiana-Monroe (ULM) (1988-2005); Associate Dean, College of Pure and Applied Sciences, ULM (1998-2002); Curator of Zoology, Museum of Natural History, ULM (1999-2005); Program Director, ULM/Howard Hughes Undergraduate Biological Sciences Education Program, College of Arts and Sciences, ULM (2000-2005); Director, Museum of Natural History, ULM (2002-2005); Research Associate, American Museum of Natural History, NYC, NY (2005-present); Dean and Professor of Biology, College of Science and Engineering, Texas A&M University – Corpus Christi (TAMUCC) (2006-present). More than 50 publications on the diversity and conservation of fishes, PI or co-PI for more than \$16M in external funding including \$14M grants for student and faculty development, and more than 100 professional presentations. Mentored one post-doc, 23 graduate students and 34 undergraduate researchers.

Dr. Kendall T. Harris, Prairie View A&M University

Kendall T. Harris, PhD, P.E., a native of East St. Louis, Ill., was appointed the Dean of the Roy G. Perry College of Engineering at Prairie View A&M University (PVAMU) in the Fall of 2007. Dr. Harris is the sixth dean of the Roy G. Perry College of Engineering at Prairie View A&M University. As Dean of the Roy G. Perry College of Engineering, Dr. Harris serves as the chief administrative officer of the College in all matters related to academic, faculty and student affairs. He is also responsible for fund development, policy compliance, and student recruitment and retention. A licensed professional engineer, Dr. Harris began his tenure at Prairie View A&M University in 2005, as Associate Dean and Professor of Mechanical Engineering. Under his leadership as Associate Dean, the College implemented the College of Engineering Success Center, which focuses on the retention of engineering students by offering supplemental instruction for freshman and sophomore students enrolled in math, science and engineering courses. He also conceptualized and facilitated a program that partners freshman advisors from each academic department within the college with advisors from the university's freshman residence complex, University College. This collaboration works through a new freshman course within the College that introduces fundamental engineering, computer science and technology concepts to first year students. Dr. Harris has consistently held faculty appointments throughout his tenure as an educator. His external research efforts have garnered more than \$10 million in research and program funding. His research interests are in the fields of Heat Transfer, Electronic Package Cooling and Energy Conservation. He has numerous publications and conference proceedings in these areas. Dr. Harris is an active member of the faculty in both academia and in his community. Dr. Harris has worked extensively with youth, encouraging them to pursue college degrees and to major in STEM related fields. He strongly advocates and recognizes that an education is the key factor that separates the "haves" from the "have nots". Prior to joining the faculty at PVAMU, Dr. Harris served as Associate Professor and Associate Chairman for the Department of Mechanical and Aerospace Engineering at the University of Texas at Arlington. In this capacity, he managed the departmental budget, curriculum design, fellowships, and scholarships. He graduated from the Naval Aviation Officer School as a U.S. Naval Officer and Aviator. Dr. Harris received his masters and doctoral degrees in mechanical engineering from the University of Mississippi and he holds bachelor degrees from the University of Kansas.

TAMUS LSAMP PROJECT: 25 YEARS OF SUCCESS – FINDING AND IMPLEMENTING BEST PRACTICES FOR URM STEM STUDENTS

Introduction

The Texas A&M University System (TAMUS) Louis Stokes Alliance for Minority Participation (LSAMP) program, funded by the National Science Foundation (NSF), through implementation of best practices is now in its fifth phase of encouraging and supporting the program's underrepresented minority (URM) science, technology, engineering, and mathematics (STEM) majors at the three Alliance members. Since 1991, the Alliance has supported over 8,700 undergraduates for one or more semesters of their undergraduate studies. Alliance institutions have awarded over 15,000 STEM degrees to URM students.

Formally called TX LSAMP, the Alliance was one of the first six LSAMPs funded by NSF. It has functioned as a key vehicle in enhancing retention, degree completion, and advancement to graduate school for URM students in STEM fields. Using a carefully conceived suite of opportunities specially designed for URM undergraduate (UG) students (such as using participation in research and motivation to enroll in graduate school enrollment [1-5]), the Alliance has demonstrated its impact across a range of academic success indicators.

The Alliance is now composed of three of the five original universities from the TAMUS and is focused on increasing the participation of STEM URM students who successfully complete a Bachelor of Science (BS) degree and who are prepared and ready to matriculate into doctoral programs. The foci of this paper are the remaining three Alliance institutions which are

- Texas A&M University (TAMU): Highest Research Activity (R1) University and Lead Institution
- Prairie View A&M University (PVAMU): Moderate Research Activity (R3) University and Historically Black College and University (HBCU)
- Texas A&M University-Corpus Christi (TAMUCC): Moderate Research Activity (R3) University and Hispanic Serving Institution (HSI)

Moreover, the Alliance's program became a catalyst and cornerstone for innovative strategies aimed at enriching the learning experiences for URM STEM students. These strategies were later adopted by other programs, universalized, and institutionalized for all STEM students within each of the three institutions. PVAMU was listed as 4th top producer of African American engineers from 1998-2002 while TAMU was the 5th top producer of Hispanic engineers during the same time period [6]. During Fall 2014, PVAMU was ranked 7th among HBCUs with the highest Latino/Latina populations [7]. These URM strategies have proven to be critically important in Texas following the Hopwood decision, as the provision of benefits and program services to students targeted by race or ethnicity became "illegal" [8]. The LSAMP program brought forth minority issues in education and addressed them through URM STEM student recruitment and support.

The Alliance, as well as the other LSAMP programs throughout the country, has contributed significantly to the number of URM students who have graduated with STEM BS degrees creating a substantial pool of potential URM STEM graduate students within the Alliance and nationally. Universal institutionalization of these largely retention- and persistence-enhancing measures at TAMU was the primary means by which the ratio of URM to non-URM STEM majors was maintained at a higher level than the same ratio in non-STEM majors. During the same period, the ratio of URM to non-URM students enrolled in STEM majors at TAMUCC increased more rapidly than the same ratio in non-STEM majors, despite the fact that the representation of URM students remains higher in non-STEM fields.

At PVAMU and TAMU, the LSAMP project supported and encouraged persistence and degree attainment for many STEM students who would otherwise not have demonstrated resilience and achievement. The TAMUCC campus, established in 1947, is a considerably smaller and much younger university than PVAMU and TAMU (both founded in 1876). The Alliance provided models for practices and policies that TAMUCC LSAMP created and implemented at formative junctures in the development of TAMUCC and its College of Science and Engineering.

Undergraduate research (UGR) has been a major strategy used to encourage UGs to enroll in graduate school [1-3]. There are indications that being able to self-identify as having conducted research has strengthened the student's ability to visualize being an engineer and researcher [4, 5]. The UGR experiences provided the impetus for continuation to graduate school [8]. Prior TAMU LSAMP research and national findings [9-13], including that by the National Academies [14], indicate that peer-supported learning efforts targeting barrier or gatekeeping STEM courses at each of the Alliance institutions resulted in greater URM student retention and matriculation to graduation.

LSAMP's STEM program priorities have morphed over the 25 years from focusing on increasing the number of enrolled STEM majors to increasing the number of STEM baccalaureate degrees and the number of STEM graduates who attend and complete graduate level work. All of the LSAMP projects nationwide changed to address NSF's priority areas through adjustments in their goals and objectives. Some projects changed more quickly than others, but all emerged with similar revised priorities. Due to comparable goals and objectives, all the projects have presented similar results with most slightly refining to best align with their specific goals, objectives, and institutions.

Two major metrics that NSF has used to judge individual LSAMP alliances by are URM STEM enrollment and URM STEM BS degree production numbers. The TAMU LSAMP Alliance has been successful in increasing both metrics over the past 25 years.

Figure 1 depicts the URM STEM enrollment numbers for the three Alliance institutions from the 1992-93 academic year through the 2015-16 academic year. The top line in the figure is the overall sum of Alliance enrollment numbers. Examination of each institution's UG enrollment totals in Figure 1 shows the expected cyclic tendencies experienced by all institutions. The cycles are influenced by various factors including economic concerns and family responsibilities. Growth appears to be slow for TAMUCC, the smallest of the three institutions, in the early years. This can be explained in part by the fact that TAMUCC was a junior- and senior-level

college for many years before becoming a four-year university in 1994. Overall, the Alliance as a group, and individually, has maintained a continued total growth in URM STEM enrollment.

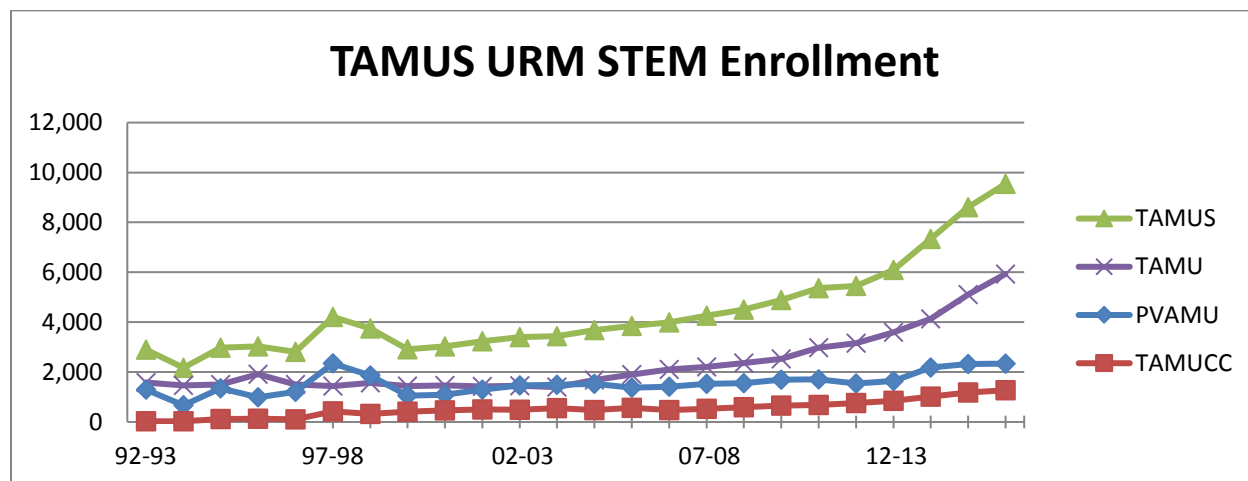


Figure 1. TAMUS URM STEM Enrollment from Fall 1992-2016. Data taken from NSF WebAMP survey.

As with the URM STEM enrollment data, the URM STEM BS degree data in Figure 2 are also cyclic as a reflection of the student pool of eligible majors. With few exceptions, growth has continued as enrollment has continued to increase. The degree data appear to have more dips since the time to degree completion varies according to how quickly the students move through their degree plans. Some students may postpone their studies for a year or two and then return to complete their degrees once they experience the benefit of a degree in the workforce.

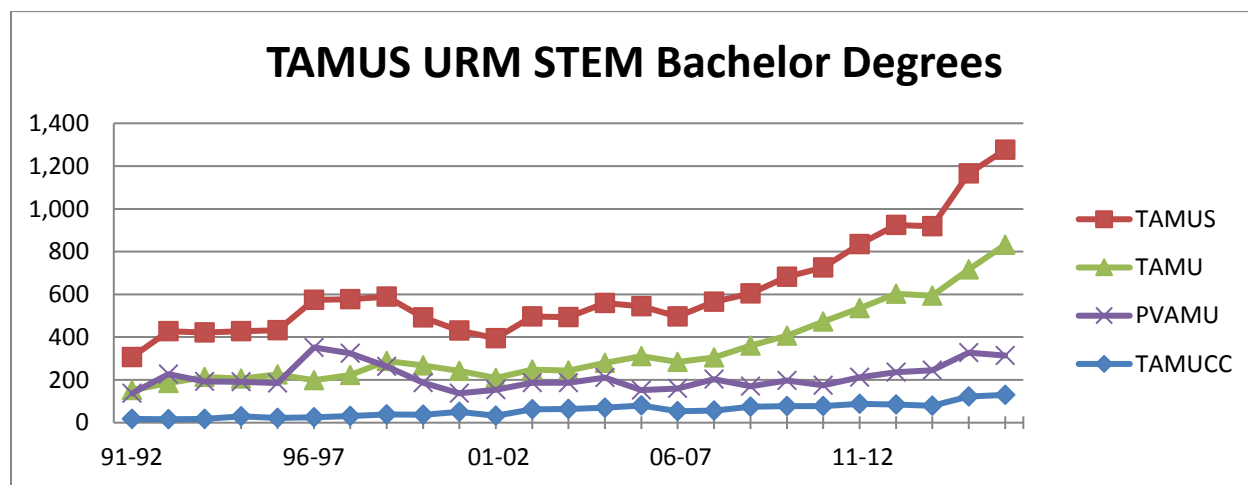


Figure 2. TAMUS URM STEM Bachelor Degree 1991-2016. Data taken from NSF WebAMP survey.

The Alliance's activities and best practices have influenced the increases in the URM STEM enrollment and bachelor degree metrics at each partner institution. These activities and best practices include interventions to address increasing recruitment and retention, increasing and incorporating undergraduate research opportunities (to increase interest in graduate school), and providing outreach opportunities to K-12 schools and community colleges. These address

LSAMP's overall goals to (1) increase significantly the number and quality of URM who gain STEM BS degrees and (2) to increase the number of URM STEM students who attend graduate school. Due to size and demographic characteristics inherent to each institution, the Alliance quickly found that all goals could not be implemented in the same ways at each institution. Best practices from the Alliance's program have yielded five themes that can be institutionalized at different sized campuses with diverse demographics. The themes that have emerged include (1) pre-college (K-12) outreach and recruitment efforts, (2) undergraduate research, (3) learning communities, (4) international research experiences, and (5) community college recruitment, transfers, and retention. Since these five areas are closely interwoven, they have been condensed to (A) recruitment, (B) retention, and (C) continuation and recruitment to graduate school. The following sections highlight these areas and best practices employed on each Alliance institution.

Recruitment

Recruitment to STEM majors was the first focal point for the NSF LSAMP program solicitations. The emphasis was placed on increasing the number of URM STEM majors. It involved the engagement of feeder community colleges and recruitment of transfer students to the universities. The focus also included pre-college (K-12) outreach and recruitment efforts. Teacher preparation was included in this effort as an indirect way to engage the K-12 population in pursuing STEM degrees.

Pre-College Outreach

It became apparent during the first two phases of the project that involving pre-college and community college interests was an effective recruitment process while creating and building productive, cooperative partnerships with these institutions. K-12 outreach activities have taken place throughout the life of the project either in the form of K-12 teacher workshops or summer programs for K-12 students in the various STEM disciplines. Each Alliance member has worked with K-12 outreach. Thus, the types of outreach programs offered varied to provide for the specific needs of the surrounding K-12 schools.

Each institution began working in pre-college (K-12) settings through outreach efforts to enhance teacher preparation and to provide continuing discipline-specific workshops and training with applications which met state-mandated K-12 instructional objectives. Exposing students to STEM fields through easy to understand exercises provided teachers with tools to excite and engage the young learners. These efforts were institutionalized within the colleges through the teacher preparation programs and meetings with school districts to maintain student interest through engagement activities rather than passive listening lectures. These institutionalized efforts at TAMU, PVAMU, and TAMUCC became part of the teacher preparation programs.

TAMUCC LSAMP leaders played key roles in two NSF-funded projects, the Texas Rural Systemic Initiative and the South Texas Rural Systemic Initiative, focused on improving mathematics and science education in K-12 schools through teacher professional development, and in the NSF-funded Texas Collaborative for Excellence in Teacher Preparation. These partnerships provided a network of educators who worked together to improve mathematics and science teacher preparation across the Alliance.

The Enrichment Experiences in Engineering Teacher Summer Research Program (E³ RET) at TAMU offered secondary school science and math teachers and pre-service teachers a four-week summer residential engineering experience on campus. This program provided participants with the knowledge necessary to introduce engineering concepts to their students and the information to promote math and science as skills necessary to succeed in engineering. E³ RET participants were empowered to excite, empower, and educate their students about the field while encouraging the consideration of engineering as a career choice.

PVAMU worked with teachers through summer workshops and opportunities for teachers to visit campus and STEM classes to experience the background needed by students for STEM majors.

Pre-college and bridge programs were developed to bring high school students, college student peer mentors, and college faculty and staff together to facilitate the transition to college and prepare students for the rigors of college math and science courses prior to their freshman year. Phase I at TAMU provide a residential, five-week program with students enrolled in pre-calculus and Engineering 289 for course credit. Seminars, tutorials, studying techniques, and group study sessions were provided to promote student success.

Summer Bridge Programs and Camps

During Phase III (2007), TAMU began the Learning to Excel in Engineering through Preparation (LEEP) summer bridge program and summer camps to continue this early engagement and to ease the transition from secondary to post-secondary education. The LEEP program was offered during the second summer five-week session to incoming freshman as a way to introduce them to campus and life as a college student through instruction in engineering, math, physics, and study skills. Another program introduced was an Engineering Insights (EI) summer camp targeting high school students. EI was a four-day summer program focused on promoting engineering to underrepresented minorities. Participants stayed on campus and experienced special classes while visiting and participating in engineering classes. PVAMU began in 2002 with the Engineering and Science Concepts Institute (ESCI) to introduce to recently graduated high school senior to careers in engineering and computer science while receiving course credits. Advancing Careers in Engineering (ACE) program, sponsored jointly by LSAMP and the Society of Hispanic Professional Engineers (SHPE) to promote engineering, was an outreach activity to high school students. Women Explore Engineering (WEE) focused on female high school students to provide those with interests in science and mathematics an opportunity to explore engineering as a career. E-12 Exploring Engineering Program (E-12 EE) targeted a small group of high schools to provide students interested in STEM the opportunity to explore engineering during a four-day workshop. E-12 EE participants stayed on campus during the workshop in order to experience college life and participate in engineering related activities.

Summer STEM camps have continued to be offered to teachers and their students at all the Alliance institutions. These programs were adapted to fit the different disciplines to best serve the needs of the student populations. These activities served as effective recruitment activities for teachers to continue their education as well as to recruit secondary students who attended the summer programs and camps at the Alliance institutions.

Community College Recruitment and Transfer Programs

Community colleges received more focus as the phases progressed due to the realization that they were the “feeder” sources for the universities and that the relationships needed to be cultivated to yield more transfers in the STEM disciplines. Alliance institutions began thinking of community colleges as their sources for students, thus resulting in the cultivation of collaborations with these two-year institutions.

Transfer Day and other TAMUS LSAMP- initiated community college outreach efforts, identified two areas as being necessary for success of transfer students, cultural articulation and course articulation. Cultural articulation refers to a “transfer-receptive culture,” which includes the establishment of an institutional voice for transfer students. One example of cultural articulation involved a transfer orientation program that paralleled those provided for entering freshmen. These orientation programs addressed issues such as a lack of adequate transfer information or the financial aid process. Course articulation guarantees that certain courses are transferable from one institution to another, saving students and programs time and money by eliminating the need to repeat courses and decreasing time to graduation. These models were instituted at TAMU, PVAMU and TAMUCC. Collaborations between administrators and faculty formed from these interactions. Funding provided to URM students at participating community colleges allowed the students to continue their STEM education with more efficient and less traumatic transitions from the community colleges to the four-year universities. The support removed some stress related to transferring and increased retention for these students as they became more acclimated to the larger institutions. All Alliance institutions established collaborations with their area feeder community colleges, which have continued to provide STEM students to the four-year STEM programs.

In 2009, LSAMP at TAMU hosted community college students interested in STEM majors at TAMU and community college representatives interested in building relationships for their students to transfer into STEM majors at TAMU. The STEM Conference program included resource roundtables for students and one-on-one sessions with faculty and staff for representatives.

Other activities such as the NSF Scholarship in Science, Technology, Engineering, and Mathematics (S-STEM) were used as both recruitment and retention strategies. The S-STEMs provided community college transfer students research opportunities, academic and professional development seminars, scholarship money to assist in funding students’ education without them having work commitments, and establishment of cohorts and the resulting social community to help ease the transition from the community college to the four-year university. The concept of “cohorting” has been evaluated for success and sustainability and has been shown to build community and improve student retention [15-22]. Articulation agreements between community colleges and bachelor degree-granting institutions facilitated students’ transfer process, further enticing students to pursue BS degrees. More information about S-STEMs and other retention efforts are in the next section.

Retention

As enrollment increased, the project focus shifted from a sole emphasis on recruitment to incorporate URM STEM student retention and strategies to increase the number of STEM baccalaureate degree recipients. This shift in focus led to reallocating funds to encourage first-time-in-college and community college transfer students to pursue BS degrees. Scholarship funding allowed students to focus on their education instead of finances. As a result, retention and persistence-to-completion rates increased at each of the Alliance institutions. While progressing in their degree plans, TAMUS LSAMP participants were exposed to seminars, conferences, and other professional development and training to gain networking experience and to learn about employment opportunities in their fields of study. These experiences provided UGs with examples of the benefits of completing the BS requirements and continuing to graduate school. Surveys and focus group participants at Alliance institutions have shown the value of this funding which reduced participants' financial stress and allowed them to participate in undergraduate research. The undergraduate research also increased interest in graduate school. Some of the strategies employed to increase retention are detailed below.

Learning Communities

One retention strategy that TAMUS LSAMP employed in its earliest phases and continues to promote is the creation of learning communities. Learning communities emerged from recruitment efforts and the support provided to first-time-in-college and transfer students throughout their gateway and other STEM courses. Cohorts were also a product of the learning communities as the students built support networks within their major fields. The Bridge to the Doctorate (BTD) component of LSAMP introduced cohorting and provided details of the value of this concept. See more about the BTD program in the **Continuation and Recruitment to Graduate School** section below. Cohorting provided a different grouping of participants as most were majoring in the same disciplines.

In the 1990s, TAMU LSAMP developed programs that demonstrated learning communities and scholarships can effectively lead to retaining URM STEM students to graduation. Based on the successful programs piloted by TAMU LSAMP, the Regent's Scholars and Century Scholars programs arose at TAMU. The Regent's Scholars and Century Scholars programs feature learning communities as a support system. Communities are established early in students' undergraduate programs and continue through degree completion and beyond graduation.

The Regents' Scholars program began in 2003 and targeted first-generation undergraduates. These students met specific financial eligibility criteria to become Regents' Scholars. They receive financial support and academic and social assistance as they become the first in their families to obtain college degrees.

The Century Scholars program is a learning community partnership, formed during 1999-2000, between TAMU and 110 Texas high schools located in targeted regions throughout the state. Its focus is to provide an academic scholarship and retention program for the Scholars. The program is a recruitment and retention effort that provides academic, financial, and social assistance to the

participants while they gain the life skills necessary to become productive members of academia and/or the professional workforce upon completion of their degrees.

NSF Scholarship in Science, Technology, Engineering, and Mathematics (S-STEM)

In addition to recruitment (see **Recruitment** section above), S-STEMs aided retention.

TAMU's College of Engineering applied for and received a NSF S-STEM, named the Engineering Transfer Scholars (ETS) Program, during 2009-2013. The purpose was to increase the quantity, quality, and diversity of the engineering workforce through enabling academically talented students who had considerable financial need to transfer to TAMU to continue their pursuit of a BS in engineering. These students attended select LSAMP seminars and workshops focused on graduate school.

The College of Science at TAMU and Palo Alto College (PAC), a predominately-Hispanic two-year college, received an S-STEM that began in Fall 2008. The project provided scholarships and supported activities to address retention to graduation for UG students majoring in biology, chemistry, mathematics, or physics. Participants began their studies at PAC and transferred to TAMU for completion of their BS degrees.

In 2012 TAMUCC received an S-STEM which was named "Expanding the STEM Pool with Transfer Scholarships" (ESP) which established the ESP Scholar up to three years of funding toward the completion of a BS to twenty-six college students selected from regional community colleges with large Hispanic student populations. A learning-community cohort experience with support student services and mentors was provided to retain this group of students through the completion of their degrees. The project is ongoing with its final year of funding approaching.

Another currently funded S-STEM at TAMUCC is the Supporting Undergraduates for Careers in Computing and Engineering with Scholarships and Supervision (SUCCESS) program. SUCCESS focuses on recruitment by providing up to four years of scholarship funding for entering freshmen or transferring regional community college students in engineering and computer science disciplines. Retention strategies for the SUCCESS program include learning communities, research opportunities, internships, mentoring, and other support activities.

Other past S-STEMs awarded at TAMUCC included the Computer Science, Engineering Technology, and Mathematics Scholarship Program; Attacking the Gathering Storm in Computer Sciences and Mathematics (STORM); Scholarships to Enhance Life Sciences (STELS); CCLI Phase 2: Increasing Attractiveness of Computing: The Design and Evaluation of Introductory Computing Coursework that Elicits Creativity; and Scholarships to Enhance Physical Sciences (STEPS). Each S-STEM employed various retention strategies.

PVAMU just received an S-STEM in 2016 that will provide scholarships to a cohort of fifteen students in year 1 and a second cohort of fifteen students in year 2. These scholarships will reduce the financial burden experienced by many URM students and will provide support structures which will ensure student success to degree completion. Students will receive the

academic support they need through the cohorts, learning community, mentoring, and individual advisory teams.

Leveraging with Other Projects

Alliance members' STEM colleges and departments have become actively engaged in transfer days, S-STEMs, and other STEM related funding opportunities within their respective institutions and area community colleges to better leverage funding. Leveraging of resources and support staff between these projects and LSAMP allowed advancements in recruitment, engagement, and retention which have changed the outlook of the involved departments and have become a part of the departments' budgeted activities as S-STEM funding ends. TAMU and TAMUCC continue to hold community college STEM conferences on their campuses as a recruitment tool. PVAMU has several Research Experiences for Undergraduates (REUs) and summer bridge programs through its College of Engineering.

PVAMU has expanded the UGR programs by leveraging with other STEM-related federal programs to support students. The NSF Centers of Research Excellence in Science and Technology (CREST) program provides support to enhance the research capabilities of minority-serving institutions (MSI) through the establishment of centers that effectively integrate education and research. CREST promotes the development of new knowledge, enhancements of the research productivity of individual faculty, and an expanded presence of students historically underrepresented in STEM disciplines. The HBCU Research Infrastructure for Science and Engineering (HBCU-RISE) program specifically targets HBCUs to support the expansion of institutional research capacity and the production of doctoral students especially from URM STEM students. The HBCU Undergraduate Program (HBCU-UP) program focuses on enhancing the HBCU's UG STEM educational quality as a way to increase the STEM workforce participants. PVAMU's LSAMP has also leveraged efforts with the Eisenhower Transportation Fellowship (ETF) program. This program funds transportation-related research for upper-level undergraduate and graduate students who demonstrate a strong interest in pursuing careers in the transportation profession.

TAMUCC's LSAMP partners with the NSF Computing Alliance for Hispanic Serving Institutions (CAHSI). CAHSI funds UGR students in computer science and encourages Hispanic students to enter the professoriate or the workforce in computing areas with advanced degrees.

TAMUCC has worked with the Title V funded STEM Outreach, Access, and Retention (SOAR) program since 2012 offering many services exclusively for STEM students. These services include supplemental instruction, a lending library program, career and professional development workshops, travel funding for conferences (Hispanics in STEM Career Expo and Hispanics in Higher Ed: Inside Edition), and undergraduate research experiences.

Undergraduate Research

Undergraduate research has become a part of more STEM courses at all Alliance members. Results have shown an increase in retention of STEM majors due to active involvement in research. These experiences have introduced students to academic research and professionalism

within their disciplines through mentoring from faculty members and graduate students. Industry and business professionals are engaged in the presentations for the students at professional organization conferences and student conferences where many industry members provide opportunities for students to interview for summer internships and future employment.

Inclusion of academic and summer undergraduate research experiences provided opportunities for students to experience the application of their knowledge to real-life situations and to see what graduate school could offer as a way to improve their success in academia or the work force. Students who experienced research opportunities during summers became more involved in and dedicated to their education. Based on feedback to the external evaluator about these experiences, more exposure to research-based opportunities have been included as part of an increasing number of UG STEM courses. Students indicated in focus groups the value of being an active participant in a research project, even if only for part of a semester. The experiences emphasized the importance of content from courses taken by the participants.

Beginning in Fall 2010, LSAMP participating students completed surveys almost every year on which they were asked questions about the impact of their research experiences, and the findings from all surveys were similar. On a Fall 2012 survey, sixty-five (65) students from all three Alliance institutions responded about the impact of their LSAMP-supported research experiences. Figure 3 summarizes the results of the survey.

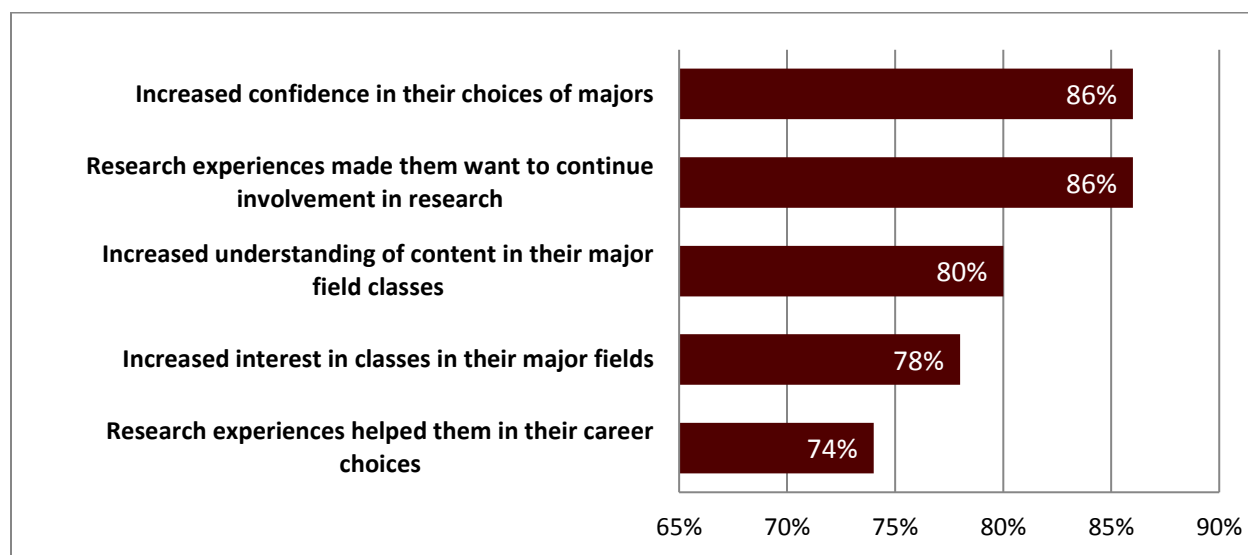


Figure 3: Results of Fall 2012 undergraduate research survey

These results demonstrate that research experiences are influential in familiarizing students to their professions and solidifying students' major choices. Research experiences also motivate UG students to consider graduate school as a viable option.

The next section describes efforts for encouraging URM STEM UGs to continue to graduate school.

Continuation and Recruitment to Graduate School

Continuation and recruitment to graduate school emerged as the next major focal point for the LSAMP program once the numbers of STEM majors and degrees were on a steady increase for participating institutions. The introduction of the LSAMP Bridge to the Doctorate (BTD) program in 2003 provided a unique opportunity for URM STEM LSAMP participants to consider graduate school as an option. The BTD activity provides participants two years of graduate school funding without a work requirement. BTD Fellows can focus on their courses and immediately begin conducting research when they start graduate school. This provides BTD Fellows an advantage over their peers, due to the amount of time required to complete a graduate degree. The removal of financial stress has allowed many graduate students to attain their master's and doctoral degrees as LSAMP BTD program participants. BTD Fellows have been extremely valuable as recruiters for UGs. Fellows share their graduate program experiences with UGs through panel discussions and seminars.

Research was a major motivator for LSAMP participants who pursued and completed graduate degree programs [23]. Many UG courses have increasingly added research components to motivate students. The research projects have provided and continue to provide participants in courses with a research component an incentive to complete the baccalaureate and higher degrees. Research motivates students to be active learners, increasing their opportunities for success in academia or the work force. Research is one of the main recruitment strategies highlighted below.

International Research Experiences

The international research experiences provided opportunities for students to leave their “comfort zones” of home to venture to other countries to conduct research on topics not found at their home universities. These experiences introduced participants to other cultures, situations, and topics not found at their home institutions.

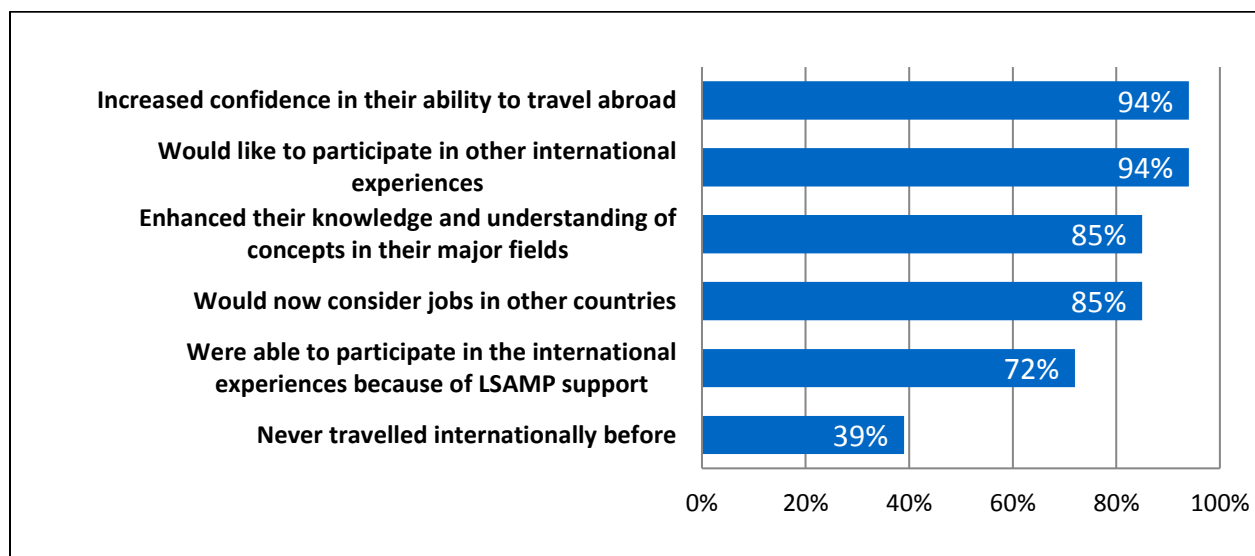


Figure 4. Results of international experience surveys conducted from 2010-2016

Students experienced a broadening of their view and knowledge of what was outside of the comfort zones and former experiences. Surveys completed by fifty-four (54) students after their LSAMP-supported international experiences from 2010-2016 provided the following findings shown in Figure 4. For 39% of participants, their LSAMP-sponsored international experiences were the first time they travelled abroad. These experiences positively affected participants, as 94% increased their confidence in travelling internationally. Similar to the research experiences highlighted from the Fall 2012 survey (see Figure 3), these international experiences enhanced participants' understanding of concepts in their disciplines.

The TAMU College of Engineering began the Engineering Learning Community Introduction to Research (ELCIR) program with funding from LSAMP. This program targeted first-generation undergraduate engineering Regents' Scholars. The ELCIR program provided research projects during a summer session with research faculty mentors from the university and from the collaborating university in the Yucatan. This activity has continued annually and allows students the opportunity to experience another culture while conducting research.

ELCIR participants in 2015 and 2016 were asked on surveys to rate their awareness about and interest in graduate school *Before* and *After* their international experiences. Of the 28 survey respondents, 64% indicated some level of increased awareness about graduate school, and 64% also pointed to increased interest in graduate school. In further analysis of comparison of these *Before* and *After* data, paired t-tests indicated statistically significant increase in awareness about graduate school ($t=5.73$, $p=.0000$) and interest in graduate school ($t=5.65$, $p=.0000$) after ELCIR participation.

LSAMP Academic and Professional Seminar and Workshop Offerings

LSAMP funded activities for the UG students on all campuses throughout the academic year. Seminars were provided to participants on research experiences, professional development, time management, financial management, graduate school, and how to handle stress. Learning communities were established with like-minded individuals and disciplines and mentoring opportunities from upper-classmen, BTD participants, and other graduate students were all part of the LSAMP seminars and efforts to support, engage, and retain these STEM majors. Opportunities to attend numerous STEM professional conferences such as the Black Engineer of the Year Awards (BEYA), the National Society of Black Engineers (NSBE), the Society of Advancing Hispanics/ Chicanos and Native Americans in Science (SACNAS), the Society of Hispanic Professional Engineers (SHPE), Minorities in Agriculture, Natural Resources, and Related Sciences (MANRRS), and the National Organization for the Professional Advancement of Chemists and Chemical Engineers (NOBCCChE), as well as the TAMUS LSAMP Symposium, were provided to participants. Many students presented their research at these meetings and conferences and were able to network with students, faculty members, and other professionals in their disciplines. Constructive feedback and networking with fellow students (UG and graduate) are benefits of participation in the TAMUS LSAMP Symposium.

Efforts for graduate school recruitment include NSF Research Experiences for Undergraduates (REUs) (summer research experiences on or away from campus), the MIT Summer Research

Program, the Louisiana Alliance for Simulation-Guided Materials Application (LA-SIGMA), and the Undergraduate Summer Research Grant (USRG) at TAMU.

TAMUS LSAMP Symposium Experience Survey Results

Over the years, the TAMUS LSAMP has held eleven Symposia during which students from the participating universities have opportunities to network with LSAMP leaders and students engaged in research at other universities. Invited speakers and graduate students mentor and share with undergraduate students about graduate school, career opportunities, and various professional development skills. Students present their own research and view their colleagues' research presentations. Symposia student participants were usually provided opportunities to evaluate the Symposia through surveys completed at the close of those events. Findings from those surveys provided similar positive impressions about the Symposia and their value. For example, at the 2014 Symposium, fifty-nine (59) participants provided responses to survey questions. Figure 5 shows some of those findings.

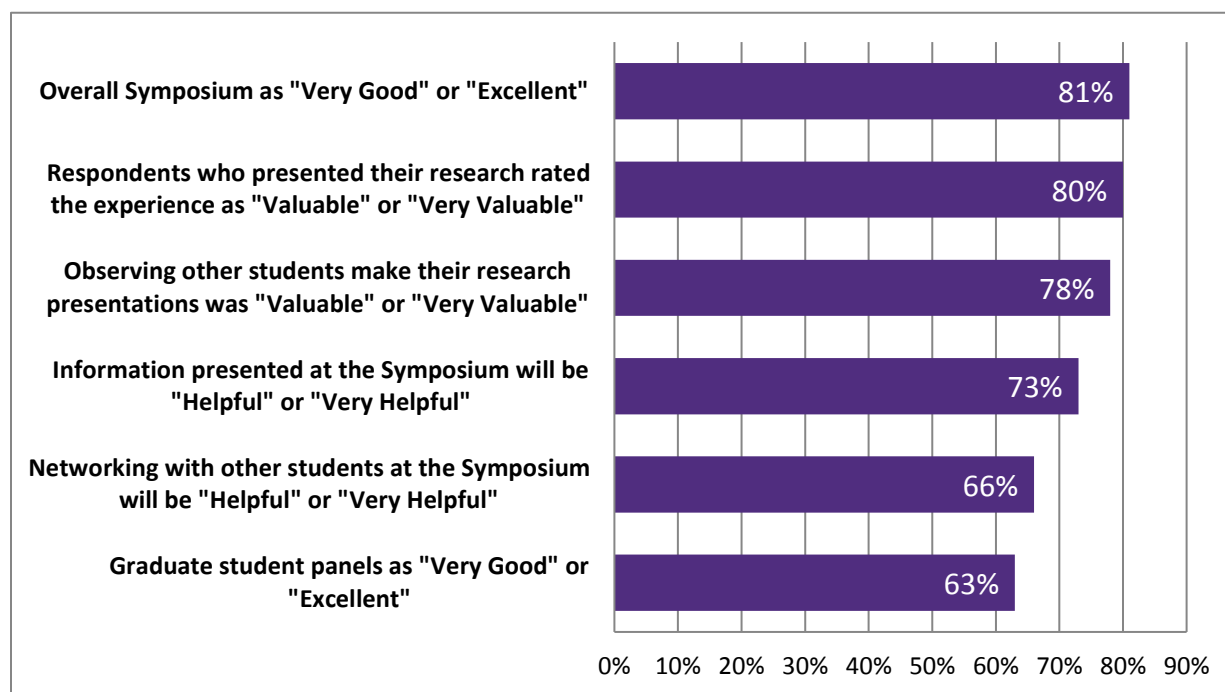


Figure 5. Selected results from the 2014 TAMUS LSAMP Symposium survey

National GEM Consortium and Participants Feedback

The National GEM Consortium (GEM), formerly the National Consortium for Graduate Degrees for Minorities in Engineering and Science, sponsors the Getting Ready for Advanced Degrees (GRAD) Lab event. GEM GRAD Lab is a partnership between GEM, industry partners, and the Alliance universities. Sponsored students attend a one to two day conference on graduate school where they learn about the motivation to attend, how to apply, and how to fund their graduate school experience. Current graduate students serve on a panel and share their experiences and insight with the undergraduate attendees.

LSAMP provided support for students to participate in the GEM GRAD Lab at TAMU in Fall 2015 and at the University of Houston in Fall 2016. After the event, these students were asked to participate in a follow-up survey. A total of forty-five (45) students completed the survey. However, each student did not respond to each survey question.

The TAMUS LSAMP external evaluator provided findings from data collected concerning students' GEM GRAD Lab experiences. When students were asked to give their overall rating of the GEM GRAD Lab, 36 of the 45 respondents (80%) responded *Excellent* (20 respondents) or *Very Good* (16 respondents). They were also asked about the amount of their gains as a result of their GEM GRAD Lab experiences in their understanding in three areas related to graduate school. Figure 6 summarizes findings from the 45 GEM GRAD lab participants' responses.

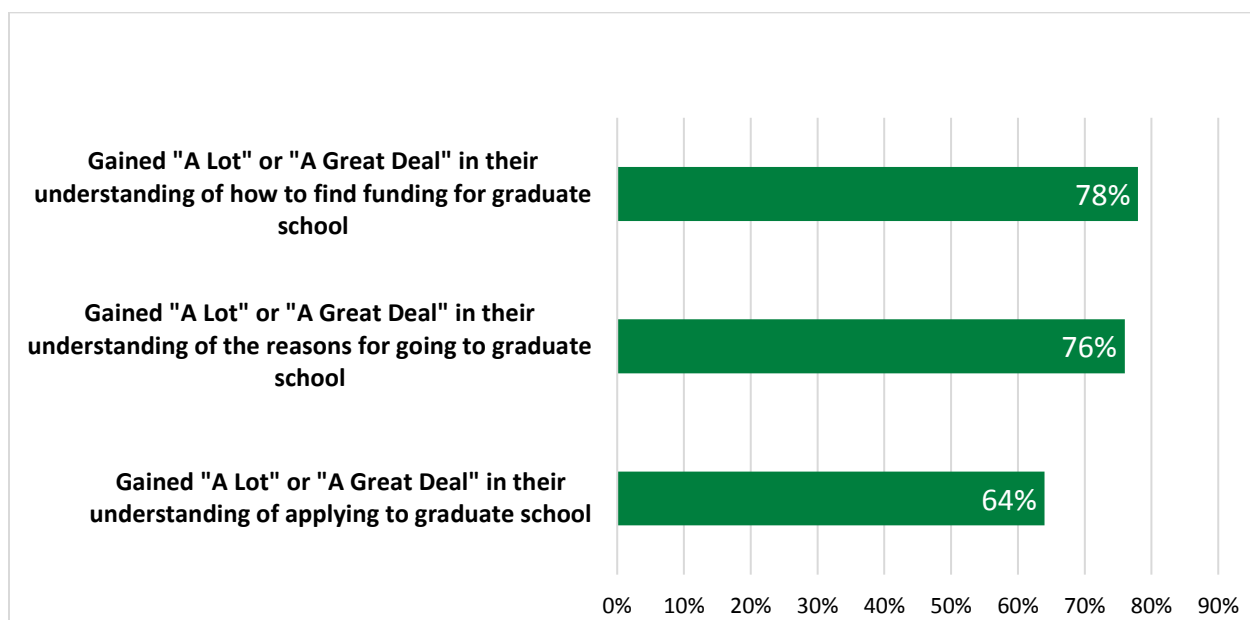


Figure 6. Students' gains in understanding about graduate school after their Fall 2015 and Fall 2016 GEM GRAD Lab experiences

Four retrospective pre-test questions were used to address students' perspectives related to graduate school at two points in time—BEFORE and AFTER their GEM GRAD Lab participation. One question asked them to identify the best descriptor about their plans for graduate school at both points in time. Figure 7 displays the responses of forty-three (43) students. There were 19 of the 43 students (44%) who indicated BEFORE their GEM GRAD Lab experiences that they planned to continue to graduate school right after completing their bachelor degrees, but that increased to 32 (74%) AFTER their workshop participation.

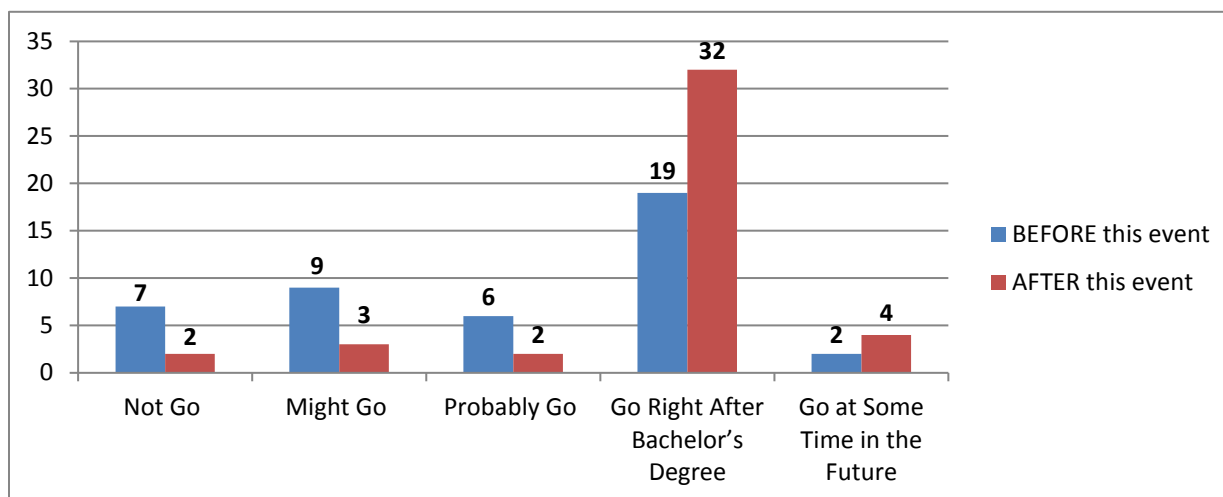


Figure 7. Students' plans for graduate school, before and after their Fall 2015 and Fall 2016 GEM GRAD Lab experiences

Another retrospective pre-test question addressed the highest degrees students planned to obtain. Figure 8 provides the responses of the 43 Fall 2016 GEM GRAD Lab participants. Now, 14 of the 43 students (33%) indicated BEFORE the workshop that they planned to attain PhDs, but that increased to 29 students (67%) AFTER their workshop participation.

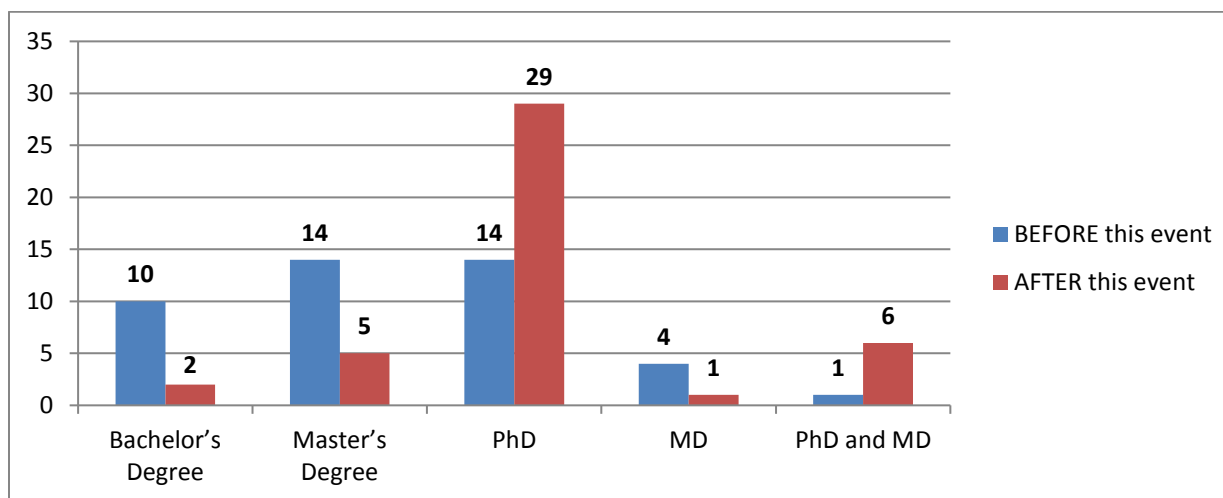


Figure 8. Highest degrees students plan to obtain, before and after their Fall 2015 and Fall 2016 GEM GRAD Lab experiences

Graduate Interest Group

Graduate Interest Group (GIG) at TAMU encourages URM students to pursue graduate school in STEM fields. Partnering with campus student organizations, the group reaches out to the URM STEM populations. The goal is to provide students with accurate information about graduate school to make it a viable option after graduation with a BS. Incentives such as Graduate Record Examination (GRE) and graduate application fee reimbursements are provided to students who attend and participate in GIG events.

Survey Responses

TAMUS LSAMP students were surveyed almost every year beginning in 2010 about the impact of their LSAMP participation, and findings from all surveys were similar. For example, when the seventy-two (72) survey respondents in 2012 were asked to rate their awareness about and their interest in graduate school *Before* and *After* their LSAMP participation, 81% reported some level of *increased awareness* about graduate school and 65% reported some level of *increased interest* in graduate school. In further comparison analysis of these *Before* and *After* data, paired t-tests indicated statistically significant increases in *awareness* about graduate school ($t=10.68$, $p=.0000$) and *interest* in graduate school ($t=7.81$, $p=.0000$).

From 2011-2016, when fifty-seven (57) seniors participating in LSAMP during their last fall or spring semesters prior to graduation were asked on a survey about their plans for graduate school, 86% indicated that they planned to go to graduate school, with 46% continuing right after completing their bachelor degrees and 40% at some point after getting a job. On surveys completed by forty-four (44) LSAMP graduating seniors from 2011 through 2014 when asked about the likelihood of attainment of master's degrees, 45% responded *Definitely* and 18% *Probably* but only 7% *Definitely Not*. When asked about the likelihood of attainment of PhDs, 27% responded *Definitely* and 18% *Probably* but only 11% *Definitely Not*.

Conclusion

Institutionalization of best practices has been a slow process on some campuses while quickly evolving on others. At TAMU one of the activities that has become institutionalized as a result of LSAMP involvement with URM populations is the learning communities (the Regents' Scholars which continues to provide funding for first generation graduates and for students from URM high schools in the state). Peer teaching in freshman level courses has resulted from the LSAMP pilot program and spread to most STEM fields at all Alliance institutions. Supplemental instruction (SI), an academic assistance program designed to improve academic performance and increase retention, has become a part of traditionally difficult core curriculum or high risk courses on all Alliance campuses. TAMUCC began an honors ceremony for graduating LSAMP research students throughout the College of Science and Engineering. PVAMU has institutionalized a summer international experience into its College of Engineering program. Inclusion of research projects or participation in on-going faculty research projects in STEM undergraduate courses has provided participants with real-world applications of their course work and increased interest in graduate school.

At TAMU, the STEM colleges now have administrators who are focused specifically on URM issues. LSAMP has partnered with the TAMU STEM colleges to share best practices so the colleges can implement successfully tested strategies to recruit and retain their college URM populations. Phase V (2014) at TAMU has integrated cohorting into the UG program in five of its colleges to assist them in building programs to increase recruitment and retention through international experiences and summer research experiences both on campus and internationally in collaboration with international university STEM faculty and their research projects. Each year the number of participants in these programs has increased resulting in the individual

colleges providing funding for those over the number currently supported by the project. This has resulted in the institutionalization of the research and in some cases the international experience components of the project.

The overall enrollment numbers and BS degree production have been increasing in the URM STEM field. This degree production has provided a larger pool of candidates available for graduate school from all Alliance institutions.

Over the years, the evaluation processes (data collection forms, surveys, focus groups, etc.) have adapted and been revised to provide more accurate and informative quantitative and qualitative data. Involvement in the LSAMP program has brought other changes to each campus as a result of the bulk data reporting requirements of NSF. A more structured approach to how data is gathered and what factors are needed have been merged into the reports now being generated by the institutional research offices at each institution. These changes have provided more accurate data being reported than in the beginning years of the project.

The project staff and the majority of the management team have been role models and mentors for the LSAMP URM program participants. One specific success story on the TAMU campus involves a former LSAMP and BTD participant who completed her master's and doctoral degrees. She joined the project staff and over the years has moved up into a management position as the project director.

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References

1. National Science Foundation, *Research Experiences for Undergraduates (REU) in the Directorate for Engineering: 2003-2006 participant survey*, ed. M.P. Hancock and S.H. Russell. 2008, Arlington, VA: SRI International. 132.
2. Russell, S.H., *Evaluation of NSF support for undergraduate research opportunities*, ed. SRI International. 2006, Menlo Park, CA: SRI International.
3. Goonatilake, R. and R. Bachnak, *Engaging STEM students in research and presentation activities*. International Journal of Mathematical Science Education, 2009. 2(2): p. 11-23.
4. Watson, K. and J. Froyd, *Diversifying the U.S. engineering workforce: A new model*. Journal of Engineering Education, 2007. 96(1): p. 19-32.
5. Bowman, M.H. and F.K. Stage, *Personalizing the Goals of Undergraduate Research: Implementing Three Types of Goals*. Journal of College Science Teaching, 2002. 32(2): p. 120-125.
6. Chubin, D.E., May, G.S., and Babco, E.L. *Diversifying the engineering workforce*. Journal of Engineering Education, 2005, 94(1), 73-86.
7. Prairie View A&M University. Office of Institutional Research and Effectiveness. Fact Book 2011-2015, Recent Events. Prairie View, TX. Available from: <http://www.pvamu.edu/ir/wp-content/uploads/sites/98/General-Information1.pdf>.
8. Schmidt, P. *The stakes for minority groups in the Supreme Court's review of affirmative action*. Chronicle of Higher Education, 2003, 49(39): A20, Religion and Philosophy Collection, Retrieved from web 21 Jan 2015.
9. Center for Community College Student Engagement, *A matter of degrees: Promising practices for community college student success (a first look)*, 2012, The University of Texas at Austin, Community College Leadership Program: Austin, TX.
10. Froyd, J., *White paper on promising practices in undergraduate STEM education*, 2008, p.22. Texas A&M University: College Station, TX.
11. Bonner, F.A., et al., *"Historically Black Colleges and Universities (HBCUs) and academically gifted black students in science, technology, engineering and mathematics (STEM): Discovering the alchemy for success,"*. Journal of Urban Education: Focus on Enrichment, 2009. 6: 122-135.
12. Chubin, D., et al., *Educating generation net - Can U.S. engineering woo and win the competition for talent*. Journal of Engineering Education, 2008. 97(3): 245-257.
13. Villarejo, M., et al., *Encouraging minority undergraduates to choose science careers: Career paths survey results*. CBE Life Sciences Education, 2008. 7(4): 394-409.
14. The Study Group. *The National Academies' summit on community colleges in the evolving STEM education*. 2011; Available from: <http://nas-sites.org/communitycollegessummit/files/2011/12/SynthesisofSummitparticipantchallengesbigideas.pdf>.
15. Tinto, V., *Classrooms as communities: Exploring the educational character of student persistence*. Journal of Higher Education, 1997. 68(6): 599-623.
16. Engstrom, C. and V. Tinto, *Pathways to student success: The impact of learning communities on the success of academically under-prepared college students*, 2007, 126. Syracuse University: Syracuse, NY.
17. Bewley, J.L., *Living-learning communities and ethnicity: A study on closing the achievement gap at regional university*, 2010, ProQuest LLC.
18. Engstrom, C.M. and V. Tinto, *Learning better together: The impact of learning communities on the persistence of low-income students*. Opportunity Matters: A Journal of Research Informing Educational Opportunity Practice and Programs (Pell Institute), 2008. June 2008: 5-21.
19. Springer, T., K.G. Callam, and Kellogg Foundation, *ENLACE Connection: What Makes a Difference in the Education of Latino U.S. Students--Learning from the Experience of 13ENLACE Partnerships*, 2007, W. K. Kellogg Foundation: Battle Creek, MI.
20. Walsh, M., et al., *The campus lake learning community: Promoting a multidisciplinary approach to environmental problem solving*. Journal of College Science Teaching, 2005. 34(5): 24-27.
21. Froyd, J. and M. Ohland, *Integrated engineering curricula*. Journal of Engineering Education, 2005. 94(1):147-164.
22. Stassen, M.L.A., *Student outcomes: The impact of varying living-learning community models*. Research in Higher Education, 2003. 44(5): 581.
23. Clewell, B.C., Clemencia Cosentino de Cohen, Lisa Tsui and Nicole Deterding. 2006. *Revitalizing the Nation's Talent Pool in STEM*. Urban Institute. Washington, D.C.