



A Proposed Survey-based Student-centered Framework for Evaluation of Undergraduate Research Awareness in Minority-serving Institutions

Dr. Mahmoud Khasawneh, Texas A&M International University

Mahmoud T. Khasawneh is as an Associate Professor of Systems Engineering at Texas A&M International University. Dr. Khasawneh got his Ph.D. in Engineering Management in the Department of Engineering Management and Systems Engineering at Old Dominion University in August, 2012. He received an M.E. degree in Systems Engineering from the same department in May, 2009. He received a B.S. degree in Management Information Systems (MIS) from the department of Business Administration at the Faculty of Economics and Administrative Sciences at the Hashemite University, in Zarqa, Jordan, in 2007. His research interest are focused on Engineering management and systems engineering applications in healthcare, manufacturing, operations management, business, and other industries, modeling and simulation of complex systems, distributed networked operations, and Engineering Education.

Dr. John C. Kilburn Jr, Texas A&M International University

John C. Kilburn Jr. is Associate Vice President for Research and Sponsored Projects and Professor of Sociology at Texas A&M International University. He has been awarded grant funds from the NSF, NIH, Department of Defense and the US Department of Education. One of his primary research interests is studying the productivity of research labs.

Dr. Jared Romeo Dmello, Texas A&M International University

Jared R. Dmello, Ph.D., is an Assistant Professor of Criminal Justice at Texas A&M International University. His work primarily focuses on collective violence, ranging from criminal street gangs to terrorist activity, and applying advanced quantitative approaches to criminological and political science research. His work has been published in top-ranked peer-reviewed journals, including *Criminal Justice and Behavior*, *Crime & Delinquency*, and the *Journal of Interpersonal Violence*. Dr. Dmello also has expertise in program evaluation, having conducted this work both in the governmental and academic sectors. He currently partners with TAMIU's Office of Research and Sponsored Programs to evaluate the institution's sub-award of the Texas A&M University System Louis Stokes STEM Pathways and Research Alliance (LSAMP) Grant.

Daphne Elizabeth Sanchez, Texas A&M International University

Daphne E. Sanchez is a Program Specialist for the Louis Stokes Alliance for Minority Participation at Texas A&M International University. She received her M.S in Pharmacology from Tulane School of Medicine in May, 2019. She also received her B.S.A in Biology from the University of Texas at Austin in May, 2017. Her research interest are focused on underrepresented minorities in higher education, mental health, and memory.

Alicia Segovia, Texas A&M International University

Alicia Segovia is a Program Specialist for the Louis Stokes Alliance for Minority Participation program at Texas A&M International University. She received her B.S. in Biology from Texas A&M International University on May, 2019. She is currently finishing her Master of Science in Biomedical Informatics at the University of Texas Health Science Center Houston-School of Biomedical Informatics. Her research interests include underrepresented minorities in higher education, healthcare acquired infections, unintended consequences of electronic health records, and public health surveillance.

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Abstract

The purpose of this work in progress study is to present a survey-based framework to evaluate the awareness of and participation in undergraduate research experiences (URE) by students in science, technology, engineering, and mathematics (STEM) majors in Minority-Serving Institutions (MSIs). MSIs, which include historically black colleges and universities (HBCU) and Hispanic serving institutions (HSI), recruit and admit underserved, low income, minority students in various disciplines, including STEM. While MSIs attempt to bridge educational gaps seen in these students with pre-college resources, first year mentoring, and tutoring sessions, awareness and participation in URE is not prevalent at a MSI. Participation in such activities, however, has been linked to improved career prospects and an increase in the number of students seeking graduate degrees. Past studies [1],[2],[9] have suggested that an initial interest in STEM does not necessarily continue throughout undergraduate education with a higher number of students requesting major changes and/or prolonging their graduation timeline. This paper proposes to identify current notions and perceptions surrounding undergraduate research of STEM students at a mid-sized MSI along the U.S.- Mexico border. The proposed design for this study will include an online survey to identify which students are more likely to be aware of and participate in undergraduate research and which students are not. Our model will focus on remediation to increase participation in URE, retention in STEM majors, and progression towards career prospects and graduate study.

Introduction

As time progresses, the emphasis of seeking higher post-secondary education has become more common, especially within the STEM workforce. Most, if not all, require at least a bachelor's degree with more careers having preference for graduate degrees [11]. However, while the number of bachelor's degree holders rise, the number of postgraduate education attainments have remained relatively stagnant. In 2017, 9% of young adults aged 25-29 held a Master's or Doctoral degree [8]. Of those individuals, only 8% were attained by Hispanic or Black individuals, and just 8% of these degrees attained were within the STEM field [8]. Despite Blacks and Hispanics making up for 12.3% and 17% of the U.S. population, respectively, only 6% of each make up the STEM workforce [2]. However, regardless of current efforts to improve educational attainment for minority students, there still remains a significant gap between them and their majority peers [2].

Additional perceptions of an unwelcoming academic culture in Mathematics and Science departments may often lead to exacerbation of challenges and potentially lead

to students changing to non-STEM majors [9]. Institutions should be aware of these student perceptions as a welcoming environment in STEM departments may ultimately increase the interest students develop in STEM careers and their willingness to pursue post-secondary degrees. As an example, Black students in STEM have a higher rate of success when enrolled at historically Black colleges and universities (HBCUs) and are more likely to pursue graduate and doctoral degrees than other Black students at predominantly White institutions [10]. Evidence has also shown that research experiences, both in the classroom and in co-curricular programs, are significant contributors to develop and to retain interest in STEM careers for undergraduate students [5].

The objective of this research study is to evaluate the awareness of and participation in undergraduate research experiences (URE) by students in STEM majors in Minority-Serving Institutions (MSIs) by presenting a survey-based framework. This study will highlight current notions and perceptions surrounding undergraduate research of STEM students at Texas A&M International University (TAMIU), a mid-sized regional university along the U.S.-Mexico border. Presenting a survey-based framework will help recognize students who are aware of research opportunities from those who are not. Finally, we will place focus on remediation in efforts to increase participation in URE, retention in STEM majors, and progression towards career prospects and graduate studies.

Literature Review

The longitudinal study conducted by Estrada, Hernandez, and Schultz [5] determined that it takes more than one semester of undergraduate research experience to predict student overall science efficacy. Their study confirmed scientific identity as a positive predictor of STEM careers and a negative predictor for non-STEM careers. Aikens et al. [1] aimed to identify how participation in undergraduate research with faculty mentorship guarantees that minority students will continue careers in science, finding that men and underrepresented minority (URM) students report a more direct tie to their faculty mentors in a closed triad, than did women, white, and Asian students. Additionally, the type of mentoring structure is in fact associated with the different research student outcomes.

Capri, Ronan, Falconer, and Lents [2] developed the Program for Research Initiatives in Science and Math (PRISM) at a large public minority serving college. They found that student participants experienced a deeper mentorship with faculty in addressing their personal needs, abilities, and demands of other commitments. More students participated in undergraduate research during the PRISM program than in prior years. Additionally, students in PRISM contributed to large volumes of scholarly works including conferences and publications. Toven- Lindsey, Levis-Fitzgerald, Barber, and Hasson [9] aimed to examine

academic achievement and persistence of underrepresented undergraduate students enrolled in the Program for Excellence in Education and Research in the Sciences (PEERS). The results demonstrate that participation in the PEERS program helped students perform significantly better in gatekeeper science courses. PEERS students also had significantly higher-grade point averages when compared to control students. Student persistence for science majors was measured by examining the students' declared academic major at the beginning of their third year in undergrad. After 2 years, about 90% of PEERS students retained declared science majors compared to 70% in the control group.

Methodology

Data Collection

Following IRB approval, a 5-minute online survey will be distributed and administered to all STEM students at TAMU. STEM faculty members will be contacted prior to the distribution in hopes of having them either provide a link to the survey on the Blackboard home page of their course or have the survey forwarded by e-mail to each student in their class. Moreover, with faculty approval, a representative of the research study may conduct a short presentation in each STEM introductory course to provide more insight on the survey for the students and faculty. This method will allow students to understand the concepts being presented in the survey and identify any misconstrued information between the student reader and survey. The research team seeks a sample inclusive of all STEM fields represented at the university (Engineering, Mathematics, Physics, Biology, and Chemistry). Because of the College of Arts and Sciences relatively smaller size (an undergraduate student population of approximately 3700), a quota sampling technique is not necessary to achieve saturation. The targeted response rate for the survey is 60% of STEM only majors ($n = 800$).¹

The survey will consist of 12 questions, including demographic information such as students ID numbers, gender, classification, and major. The survey was modeled after similar questions presented in the Tykot et al. [12] study at University of South Florida (USF). This study attempted to identify which type of students were most likely to participate in URE, what they expected to gain from their mentor, and their reasoning for participation (i.e. course credit/volunteer/both). Survey questions are outlined in Table 1. This information will allow linking for longitudinal data collection and observation of these student cohorts throughout their undergraduate and postgraduate careers. Following demographics, participants will include whether they are members of the University Honors program, have an interest in research, and whether they are currently partaking in research. Students who are not interested or are not partaking in research will indicate one of five choices for their reasoning: 1) I do not find

¹ We would like to note a large forecast representation of males is expected as there are higher number of male engineering majors compared to females.

research interesting, 2) I am unaware of opportunities in undergraduate research, 3) I do not know how to get started in undergraduate research, 4) I do not have time for undergraduate research due to work, or 5) I do not have time for undergraduate research due to extracurricular activities. Students who express interest and/or are partaking in current research will be asked if their research has led to publications and/or presentations (poster or conference), how many hours a week they participate in research, and the name of their faculty advisor. Faculty mentor and participation hours will be noted as means of providing insight on which professors are more invested in mentorship and preparing students for publication/conferences.

Undergraduate Research Survey Intake			
1.	Institution ID: A _____	7.	If YES to #6, are you currently participating in undergraduate research?
2.	Gender (male, female, other)	8.	If NO to #6, please select the most relevant reason: a) I do not find undergraduate research interesting b) I am unaware of the opportunities in undergraduate research c) I do not know how to get started in undergraduate research d) I do not have time for undergraduate research due to work and/or extracurricular activities
3.	Student Classification (freshman, sophomore, junior, senior) a) Freshman: 0-29 hours b) Sophomore: 30-59 hours c) Junior: 60-89 hours d) Senior: 90+ hours	9.	If answered YES to #7, with which faculty member do you conduct undergraduate research with?
4.	What is your major?	10.	If answered YES to #7 (shows up with #9), approximately how many hours a week do you spend participating in undergraduate research?
5.	Are you part of the University Honors Program?	11.	If answered YES to #7 (shows up with #9), have you had the opportunity to present your research findings at conferences or in publications?
6.	Are you interested in undergraduate research?	12.	If answered NO to #7, please select the most relevant reason: a) I am unaware of the opportunities in undergraduate research b) I do not know how to get started in undergraduate research c) I do not have time for undergraduate research due to work and/or extracurricular activities d) Other

Table 1. Undergraduate Research Survey questions. The 12-question survey will provide insight on current student perceptions of URE at TAMIU, a mid-sized regional university along the U.S-Mexico border.

Data Analysis

The first survey will provide information on current student perceptions of undergraduate research at TAMIU, a MSI along the US-Mexico Border. We will identify relationships between variables from the student responses. For example, we will be able to determine whether there is a statistical association among membership of University Honors Program with participation of undergraduate research.

Moreover, we can assess which factors tend to be aware of and participate in URE and

whether these individuals are choosing to apply to graduate schools. Additionally, analysis will help determine whether awareness of URE is homogenous among STEM majors.

Results from bivariate analyses have direct implications for institutional/educational policy. The data from the initial proposed survey will also allow for the implementation of, and study the impact of, various programs ranging from mentorship to increasing faculty outreach as well as the impact of student extracurricular involvement. Following the implementation of these programs, a follow-up survey will be conducted using the same questions from the initial survey to determine whether challenges initially mentioned have been remediated and to statistically assess the effectiveness of campus efforts to improve student participation in URE. The full methodology is described in Figure 1.

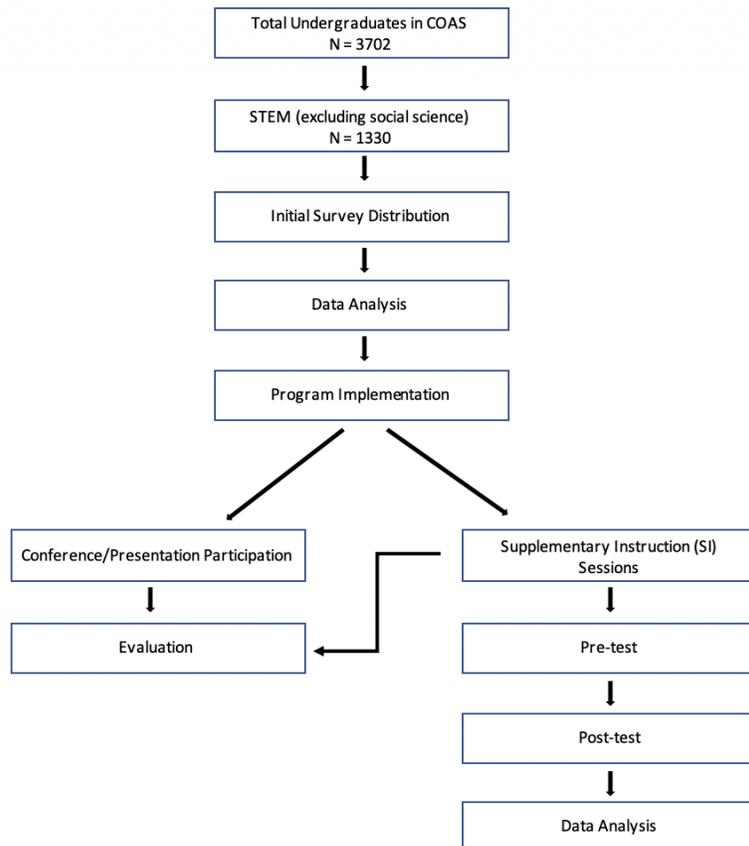


Figure 1. Flowchart demonstrating methodology. The institution has a current enrolled student population of 3,702 undergraduate students in the College of Arts and Sciences (COAS) of which N=1,330 are identified as STEM students. These students will be provided with the initial 12-question survey. Data analysis will identify student perceptions and will allow for implementation of programs ranging from faculty mentorship to faculty outreach.

To further assess relationships identified, the research team plans to organize focus groups with student participants. For example, if lack of awareness is the greatest issue preventing students from participating in URE, then steps to remediate this can be taken, such as the need for greater publicizing of campus research opportunities. Once we know more about time usage, we will address time management in terms of studying and participation in external activities. Specifically, this study will provide new insight into how the research to publication pipeline can be strengthened for undergraduate students in the STEM fields, increasing mastery of disciplinary concepts and workforce preparation in our students. These relationships can be demonstrated in the conceptual model (Figure 2).

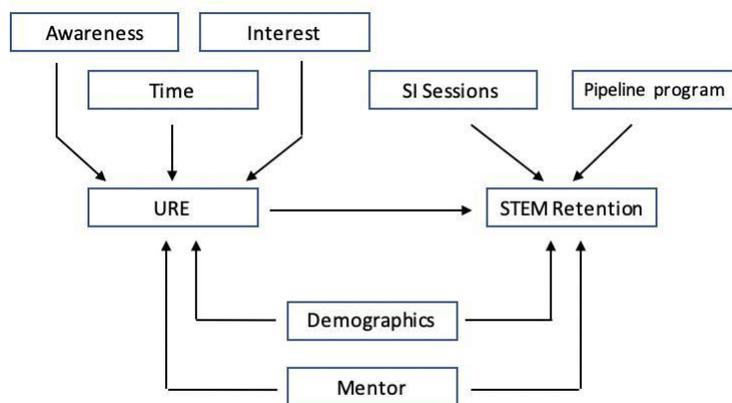


Figure 2. Conceptual model. The relationship between awareness, interest, and time of undergraduate research and how this affects STEM retention is demonstrated. Other factors believed to influence STEM retention are also included.

Discussion and Conclusion

Participation in undergraduate research increases the pipeline in STEM educational attainment and career prospects for underrepresented minorities. As past studies [1], [3] have confirmed, active involvement between students and faculty within an institution promotes growth and development in students needed to persist in the educational endeavors. Additionally, studies [2], [9] demonstrate that student participation in programs like PRISM and PEERS improves their motivation and participation in undergraduate research. This study provides further guidance in the deficiencies in awareness, participation, and involvement surrounding an HSI. The identification of these deficiencies will provide a clear framework with solutions to increase participation and involvement of underrepresented minorities thus elevating their level of educational attainment. To achieve further educational attainment, Supplemental Instruction (SI) sessions will be provided weekly. Supplemental Instruction focuses on assisting students taking traditionally difficult courses at the college level. As opposed to traditional tutoring, SI

sessions are course-specific and demonstrate study strategies for concepts presented in the actual course. The SI leader is an individual who has previously excelled in the course and attends the course lectures to structure SI sessions very similar to them. By implementing SI sessions, we hope to improve STEM retention and consequently, STEM educational attainment and career prospects for underrepresented minorities. A pre-test and post-test will be provided during the first and last SI sessions, respectively. These will serve to determine the level of confidence in the course prior to and after attending SI sessions. Data analysis will help determine if there exists a positive correlation between STEM major retention rates and SI student attendance.

The purpose of this research study is to identify the primary reason as to why students at Texas A&M International University, the mid-sized MSI of study, do not participate in research. Once this reason is known, the institution can therefore make changes (e.g. put up flyers around campus to increase research opportunity awareness) or implement programs similar to the programs in [2] and [9] in efforts to improve research participation in years to come. We hope by increasing research participation, students will be more likely to develop interest in STEM careers and consequently, improve STEM major retention rates.

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