

WIP: Hands-On Learning in a Summer Bridge Program Targeting Underclassmen and Transfer Students at an HSI

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Work-in-Progress: Hands-on Learning in a Summer Bridge Program Targeting Underclassmen and Transfer Students at an HSI

Introduction

In summer 2020, faculty in the College of Engineering at Texas A&M University-Kingsville developed and implemented a virtual Summer Bridge Program (SBP) as part of an NSF Improving Undergraduate STEM Education (IUSE) grant. Texas A&M University-Kingsville is a Hispanic-Serving Institution (HSI). The primary objective of the SBP was to improve academic motivation, retention, and success of underclassmen and transfer students in the college by implementing a co-curricular summer program that included several high-impact enrichment activities. The aim of this work is to share the approach developed for this SBP to obtain feedback from other undergraduate engineering education experts. Many universities have identified bridging programs for STEM students as a means of ensuring greater success and retention of freshman and sophomores majoring in STEM fields [1,2,3], and this was one impetus for the SBP.

Texas A&M University-Kingsville (TAMUK) is located in a region of south Texas where many counties have Hispanic/Latinx majority populations [4]. As a result, TAMUK has a high percentage of undergraduates that identify as Hispanic/Latinx, 75% in fall of 2020 [5]. Research in higher education has identified challenges for Hispanic students at all levels, community colleges [6,7], universities [8,9], and in graduate study [10,11]. Recently completed research has affirmed that these challenges exist for Texas A&M University-Kingsville students [12,13,14]. Rendón et al.'s report of perceived challenges to Latinx student success in STEM (based on the NSF award # 1759134 to Laredo College) provides a succinct summary: “(1) Lack of culture of support, (2) Lack of educational resources, (3) Academic deficiencies, (4) Poor sense of belonging, (5) Lack of faculty support for Latinx STEM students, (6) Lack of STEM information to enter STEM fields, and (7) Limited utility of standardized test scores” [12]. These served as a second impetus for the SBP as it addressed a number of these concerns.

A third impetus for the SBP was encouraging participants to form or reinforce an identity as a student engineer, which has been shown to positively impact student persistence in undergraduate degree attainment [15,16,17,18]. This combination of impetuses (building on existing research; addressing challenges for Latinx students; and creation of a student-engineer identity) informed the SBP structure. The SBP provided opportunities for students to become more comfortable interacting with faculty, learn critical baseline engineering content, encounter experiential learning that would motivate them in multiple areas, and, ultimately, to contribute to

motivation to complete a degree and to consider the prospect of post-graduate education [16,17,19].

The participants recruited for the SBP were underclassmen (freshmen and sophomore) engineering or computer science majors from the TAMUK College of Engineering (COE), current STEM students from regional community colleges, and students transferring from regional community colleges to the TAMUK COE. A total of 37 students enrolled in the SBP. Half of the students were current students at the university, while the remainder were predominantly area community college students or students at other regional universities. Eighteen of the participants identified as female and 19 as male. Twenty-seven participants thought of themselves as Hispanic, while the remaining ten classified themselves as non-Hispanic. The Hispanic students conceived of their racial identity predominantly as Hispanic/Latinx (n= 22), but four saw themselves as White and three others as both Hispanic/Latinx and White (one did not respond to this query). Non-Hispanics were predominantly White (n = 7), with three African-Americans, one of whom also identified as multi-racial. These patterns are similar to the general student population of Texas A&M University-Kingsville, which is 75% Hispanic, 4.6% African-American, and approximately 15% White [5]. The participants were also asked to state whether they were a first-generation college student. Twenty-six indicated that they were, 14 that they were not, and one did not reply. The distribution of gender, ethnicity, and racial identities within these two groups was similar to that for the entire cohort.

Program Implementation

The SBP was a 3-week program conducted virtually with 2-hour sessions each day. The organizing faculty decided to conduct the program virtually because of the COVID-19 conditions at the time the SBP was conducted in July of 2020. The virtual platform utilized for the entire program was the Collaborate platform within the Blackboard learning management system. Participants received weekly stipend payments of \$555 after every week of attendance in the program, as an inducement to continue in attendance and complete the program.

The organizing faculty decided the program would consist of a mix of engineering presentations, guest lectures, and activities intended to engage participants with engineering principles, similar to previous summer bridge programs [1,3,16]. To allow for interest in different engineering disciplines and to facilitate group activities, participants were assigned to student teams. Cohorts were formed based on participants' current or anticipated engineering discipline, while a few team members were placed outside their field to balance the sizes of the teams. Cohorts were formed for the following disciplines: Chemical Engineering; Civil and Architectural

Engineering; Electrical Engineering and Computer Science; and Mechanical Engineering. While not an exhaustive list of undergraduate majors offered by the COE, these four broad cohorts enabled the SBP to cover major areas of interest to participants.

Engineering presentations by Texas A&M University-Kingsville faculty addressed introductory engineering topics such as the design process, importance of math for engineers, use of computer programs, professional registration and public safety, engineering ethics, and engineering career paths. These were distributed throughout the 3-week period. The organizing faculty decided that working or retired engineers from the community and alumni from the COE would be invited to speak individually or as group panelists about their experiences as engineers, as other programs have done [3]. Three other panels presented for the benefit of the participants, one panel per week of the SBP. The first panel consisted of persons who were recent engineering graduates of Texas A&M University-Kingsville. They were asked to speak about the transition from an academic to professional work environment. The second panel consisted of engineering graduates who worked in other professions outside of engineering, and they discussed how they used their engineering skills in performing non-engineering jobs. The third panel consisted of seasoned or retired engineers, who spoke about the variety of things each had accomplished over the course of their careers. There were 16 guest speakers. Of these, five were Hispanics and four were females, both categories of individuals who are underrepresented in the field of engineering [20,21]. Given the high percentage of participants who were female (48.6%) and Hispanic (73.0%), the presence of these speakers was important to encourage student understanding that engineers come from a wide variety of backgrounds. Several of the panelists also identified as first-generation students and were able to discuss this aspect of their student experience.

The engineering lectures by Texas A&M University-Kingsville faculty members supplemented and expanded on the engineering information participants generally receive in freshmen introduction to engineering courses, or served as a surrogate for an introduction to the engineering field if they had not completed such a course. At Texas A&M University-Kingsville, freshmen entering the engineering program are allowed to take the freshmen introduction to engineering course only if they are calculus ready, defined as having completed the pre-requisite courses or met performance standards on the mathematics portion of the SAT or ACT. Texas A&M University-Kingsville freshmen who are not calculus ready are required to take a freshmen college success course which has virtually no engineering-oriented content. Additionally, there are introduction to engineering courses at only some, but not all, of the community colleges that feed students into our engineering program. Therefore, the faculty lectures served to bring all participants to the same level of understanding about the field of engineering.

Design-related Activities

The two experiential learning activities included in the SBP were a 1-day basic engineering challenge, conducted on the second day of the program, and a design project conducted over a 2½ week period. Both the design project and 1-day challenge were completed by discipline cohorts interacting in a virtual environment. The experiential learning activities introduced the participants to the problem-solving approach that represents the core of engineering design. The engineering challenge included topics such as toxic popcorn challenge, tall tower challenge, and marshmallow challenge, from the IEEE Try Engineering website [22]. Activity supply kits for the introductory challenge were mailed to participants the week before the SBP started and served as a team-building exercise. The 2 ½ week design project introduced the underclassmen to more advanced concepts than commonly presented at their academic level and provided initial exposure to concepts they will encounter in the junior and senior years of their undergraduate engineering studies.

Participants in the Chemical Engineering cohort participated in the toxic popcorn challenge, adapted from IEEE's Try Engineering activity [22]. Participants were challenged to come up with a method to remove a cup of toxic popcorn from a 30-inch circular safety-zone area without touching it or allowing their hands or arms to enter the safety zone, using only a bicycle inner tube and short pieces of rope to contact the cup. The participants discussed a few strategies and then began experimenting with ways to utilize the tube and rope to move the toxic popcorn cup. Since all participants were attending virtually rather than being physically in the same setting and the challenge required at least two persons working together to lift the cup with the supplies provided, most participants asked a family member to assist with testing their solution. The groups took several tries to refine their technique for using the rope and tube to lift and move the cup out of the circle without spilling the toxic popcorn from the cup. The toxic popcorn challenge was a good introduction to the challenge of working towards a solution with only a limited set of tools and some restrictive constraints, conditions common to many engineering problems.

Participants in the Civil and Architectural Engineering cohort completed the tall tower challenge, adapted from IEEE's Try Engineering activities [22]. Participants were challenged to create the tallest possible tower from straws, paper clips, and pipe cleaners; the tower was required to support the weight of a golf ball placed at or near the top for two minutes. After a group discussion of strategies, participants completed the challenge individually before regrouping for a demonstration of final products. While participants successfully created towers that ranged in height from 6 to 24 inches, the manipulation and construction nature of the project was not well-suited to virtual implementation from a team-building perspective, since everyone had to produce their own tower. Additionally, one participant who joined the program late was unable to actively engage in the task due to a delay in receiving materials.

For the Electrical Engineering and Computer Science cohort, the cartographer's dilemma challenge focused on the area of graph coloring. After receiving an introduction and overview of the graph-coloring problem, each team was asked to examine and analyze a series of blank maps and determine the minimum number of colors that could be used for a valid coloring of each. The maps varied considerably in their complexity. For some maps, it was relatively straightforward to determine a minimal color assignment, while others required detailed analysis to find the minimum number of colors needed. Throughout the challenge, participants were encouraged to identify map characteristics that influence and can predict the minimum number of colors that a valid color assignment must include. The challenge concluded with a discussion session led by the instructor in which all teams participated and described their solutions and findings.

Participants in the Mechanical Engineering cohort completed the marshmallow challenge. They were asked to build the tallest freestanding tower using a marshmallow, one yard of string, one yard of tape, and 20 spaghetti sticks. A group discussion of ideas for the design occupied the first 5 to 10 minutes and then students were given 20 minutes to build the tower. Participants were able to successfully complete the tower. After the challenge, the group discussed what was the best design and how the tallest freestanding tower was constructed.

The 2½ week design projects included municipal water supply and demand analyses for the Chemical Engineering cohort, app-based game programming for the Electrical Engineering and Computer Science cohort, truss bridge design and analysis for the Civil and Architectural Engineering cohort, and plastic part design and 3-D printing for the Mechanical Engineering cohort. In each of these engineering discipline areas, two teams of participants were formed for the project, with each team consisting of three to six participants each. On the final day of the SBP, each team gave a presentation of their work and submitted a final report documenting their efforts.

The Chemical Engineering cohort included two participant teams that analyzed the supply and demand aspects of potable water for a medium or large municipality (data used was for communities in the same region as the university). The participants determined the total demand for a municipal water supply based on individual personal demand and population numbers, along with industrial demands. The participants also investigated the sources of water supply currently used by their chosen municipality, as well as the roles that water conservation and recycling can play in the supply and demand equation. The learning objective of this study was to introduce the participants to the application of mass balance concepts, and resource sustainability concepts. The participants found the necessary information they needed from

sources such as the city water utility websites, Texas Water Development Board websites, and regional water planning groups. At the conclusion of the summer program, each of the groups submitted a final report and gave a group presentation on their findings.

The Civil and Architectural Engineering cohort completed an introduction to steel bridge design project. In this project, participants worked in two teams of three. Each team was tasked with using structural analysis software to design a steel truss bridge. Teams selected their own truss topology subject to constraints on bottom chord node placement, overall bridge length, and maximum bridge height. Additional constraints included a limit on bridge weight and specification of material properties. Participants used axial stress as the failure criterion. The learning objectives for this design project included introducing the concept of structural modeling, reinforcing participants' understanding of structural load paths, and introducing preliminary concepts in structural design. In addition to preparing a report and presentation about the truss bridges they designed, each group performed some additional background research on one type of bridge structure (truss, plate girder, or cable-stay).

In the Electrical Engineering and Computer Science cohort project, participants learned about computational thinking through the study of coding design principles and techniques. At the start of the project, participants were provided with an overview of some of the important elements of program design including data representation, problem decomposition, algorithm design, and abstraction. Participants were also given a series of basic programming tasks to complete to reinforce learning regarding the elements of program design. A block-based program development platform for mobile computing applications was utilized as a programming environment in which participants designed and developed solutions. Once participants gained familiarity with basic concepts and techniques, each team selected a specific mobile app on which to focus their efforts for the remainder of the project. At the conclusion of the project, each team delivered a completed implementation of their chosen app along with a report that documented the design of their algorithmic solution.

The Mechanical Engineering cohort worked on a 3D printing project. Participants were asked to select a product with a mechanism and at least three individual parts. The students were instructed to disassemble the selected product and review each part of the product assembly. Later, they brainstormed possible design changes to improve product function. This was followed by designing the same product on 3D modeling software. The 3D modeling software used by the participants was SolidWorks. During the design process, students worked to rectify the design and assembly errors or look for an alternative design. The final step was to simulate use of the

product in SolidWorks to check if the mechanism worked the way it should. All the student teams were able to complete the project and gain some experience working as a team.

All SBD participants received a certificate of completion at the conclusion of the program. This step was taken to provide recognition to the students and document successful participation should they list the program on a future graduate school or job application.

Results

The students participating in the SBP were asked to complete a pre- and post-participation survey. They responded to demographic questions and provided ratings regarding their level of experience or capability with 21 topics/tasks on the pre-participation instrument. The topics/tasks represented the instructional goals of the sessions presented by Texas A&M University-Kingsville faculty and the ideas reinforced in the activities. The demographic questions were replaced by an overall rating question on the post-participation instrument and three queries about awareness, interest, and receiving information were added as was a question about the impact of the SBP stipend. Responses regarding the 21 topics/tasks were also sought. Students were asked to use a five-point scale (poor, fair, good, very good, excellent) for their overall rating of the SBP. The awareness, interest, and receipt of information questions employed a ten-point scale with students instructed to use a rating of zero (0) for no impact, five (5) for moderate impact, and ten (10) for a very large change. The question about the stipend used a three-point scale (no, maybe, yes). Rating of personal understanding or ability with the 21 topics/tasks employed a ten-point scale. Informants were instructed to use the lowest rating for topics with which they had no experience or tasks they would not be able to complete and the highest rating for being well-informed regarding the topic or being very capable of completing the task. The last three questions on the post-participation survey were open-ended queries regarding the most valuable learning achieved, the most valuable activity, and any other comment the informant would like to make about their experience in the SBP.

All 37 of the registered participants remained through the entire three-week period of programming. This, in and of itself, is a notable result given the virtual environment and potential for drop off in participation. It should be noted, though, that the weekly stipend payments made to each student participant may have impacted this outcome even though most students ($n = 26$) felt post-participation that they would have participated without receiving a stipend. Eight others felt they might have participated. Two felt they would not have participated, and one did not respond. Several students addressed this topic in written responses indicating that the stipend had made it possible for them to forgo or decrease work commitments during the SBP.

Of 37 respondents to the post-participation survey, 34 indicated an overall rating of very good or excellent for the program, two others submitted ratings of good, and one chose not to respond to the question. The participants also reported high mean scores for an increased awareness of engineering opportunities (8.83/10), increased interest in engineering (8.69/10) and receiving information relevant to career decisions (8.46/10) on the post-participation survey. For each of these queries, the average rating from female respondents was higher than that from males but only the responses for “awareness of the variety of opportunities available to people who study engineering” had a statistically significant difference ($p = 0.03$) between average ratings provided by females and males (Table 1). This is a positive outcome as the cohort’s responses was strongly positive but female cohort members tended to submit the highest ratings.

The same pattern occurred when comparing responses from Hispanic and non-Hispanic informants and parties who were first-generation college students to those who were not, although the differences in means for these comparisons were not statistically significant. For ethnicity, response means were over eight and less than or equal to nine with the difference in means approximately 0.7 in each case. Persons identifying as Hispanic indicated greater change in perspective. First-generation college students also reported a greater change in perspective. The means were similar to those for females and males in Table 1 as was the stair step pattern in differences in means, for the first-generation comparison differences of approximately 0.9 for the first question, 0.65 for the second, and 0.40 for the third.

TABLE 1. Engineering Awareness, Interest, and Career Decision Response Patterns by Gender

<u>Survey Prompts</u>	<u>Ratings</u>		<u>Sign.</u>
	<u>Females</u>	<u>Males</u>	
The presentations and activities increased my awareness of the variety of opportunities available to people who study engineering.	9.41	8.28	$p = 0.03$
The presentations and activities increased my interest in studying engineering.	9.18	8.22	$p = 0.07$
The presentations and activities helped me refine my career goals.	8.59	8.33	$p = 0.38$
Note: a <i>t</i> test was completed to assess significance.			

The pre- and post-participation surveys asked students to provide ratings of their understanding or capacity in respect to 21 statements. The queries occurred in the following content domains (Table 2): (1) the field of engineering, (2) engineering design and materials, (3) engineering licensure, (4) calculus and basic statistics, (5) computer science concepts, (6) Excel functions, (7)

3D modeling, and (8) data science. Wilcoxon analysis indicated a statistically significant increase in ratings of $p \leq .001$ from pre- to post-participation for all 21 of the survey prompts. While one might expect substantial increases in understanding for early career undergraduates in a targeted SBP, strongly significant findings in all 21 topic areas demonstrates substantial efficacy across a broad set of constructs. Like with the questions about awareness of engineering opportunities, interest in studying engineering, and refining career goals, it was possible to disaggregate the responses by gender, ethnicity, and first-generation college student status. It was not possible, though, to complete significance testing. Some students did not submit ratings for all 21 statements, the missing responses did not occur at random, and, as a result, there were cells with too few cases for the calculations to be completed. However, graphing of the responses showed that the main effect, an increase in ratings pre- to post-participation, was consistent across all questions and with each group.

TABLE 2. Survey Prompts Sorted by Content Domain

Domain	Survey Prompts
Field of Engineering	<ul style="list-style-type: none"> - I can explain how engineering is different than science and mathematics. - I know several types of jobs or projects in which engineers in each of the major disciplines might be involved.
Engineering Design and Materials	<ul style="list-style-type: none"> - I have been taught a design process specific to engineering. - I have used an engineering design process to complete a project. - I can explain how the types of material that could be used in a structure impact the way the structure can be designed and built.
Engineering Licensure	<ul style="list-style-type: none"> - I can describe the relationship of licensure for engineers and public safety in the use of products designed by engineers.
Calculus and Basic Statistics	<ul style="list-style-type: none"> - I can explain how calculus is important in creating technological solutions to human problems or needs. - I can explain how simultaneous equations apply in engineering. - I can correctly use the phrases statically determinate and statically indeterminate when describing engineering analysis.
Computer Science Concepts	<ul style="list-style-type: none"> - I can define computer science. - I can describe what people who work in computer science do. - I can give accurate examples of the types of projects and problems on which computer scientists work. - I can describe the use of algorithms in computer science.

	<ul style="list-style-type: none"> - I could explain to a friend what it means to solve a computer science problem at the conceptual level. - I can describe how geographic information systems relate to spatial data, attribute tables, and temporal data.
Excel Functions	<ul style="list-style-type: none"> - I can write a formula in Excel. - I know several options for visualizing data in Excel. - I know how to nest formulas in Excel.
3D Modeling	<ul style="list-style-type: none"> - I have seen how 3D modeling software can be used in engineering design and analysis. - I can explain how 3D modeling software serves as a communication tool for designers, manufacturers, and end users.
Data Science	<ul style="list-style-type: none"> - I know the data science life cycle.

Three open-ended questions were included in the post-participation survey. These asked what the informant considered to be the “most valuable form of learning in the summer program,” “the most valuable activity,” and whether the student had any other comments to share with the project team and faculty members. The responses to the first question can be sorted into eight primary topic areas. The most valuable forms of learning noted were the:

- Multiple perspectives shared regarding work experiences and careers.
- Information about the variety of opportunities in the engineering field.
- Information provided by guest presenters about their experiences.
- Engineering ethics material.
- Opportunity to work on a team toward a shared goal/ the group projects.
- Learning to use software applications.
- Interacting with and being able to ask questions of engineers.
- Learning from peers.

These responses support the findings from comparison of pre- and post-participation ratings. The variety in responses confirms that content provided, while covering a variety of topic areas and practical experiences, had the intended impacts, increasing understanding and sense of capability in those topic areas.

The query about the most valuable activity also elicited a broad range of replies including a response that the entire “program [was] extremely valuable and informative.” Members of the cohort rated various activities as the most valuable which is likely related to personal background and varied levels of experience or interest in respect to the topics covered. The most frequent response was that the group activity was the most valuable. And, up to a third of the informants

provided lists of three or more things they found “most valuable.” Summarizing examples of the submissions are listed below.

- “Work on coding”
- “The introduction activity because it showed a simplified version of a real-life situation.”
- “...the group project to design a steel truss bridge. I was able to learn Visual Analysis, the role of material and member selection in engineering design, and fundamental understanding of load paths in structures.”
- Guest presentations about “job experiences and work.”
- Learning “how to use visual analysis software and utilize it to construct a design relative to my major.”
- “The team building project that we participated in the beginning that helped us break the ice with our group.”
- “The group project;” “Doing the group project while having the daily sessions with engineers and running into and experiencing the things they spoke about while working in groups, allowing us to adhere to their advice and practice our team skills;” “...it required a lot of learning to achieve and troubleshooting to solve problems.”
- The report and presentation.
- “...the numerous group sessions with an advisor. This helped with keeping the focus of the students on the right track.”

Like the responses to the most valuable form of learning, these comments affirm that the material covered was varied and broad but the approach taken proved effective.

The final short-answer question was: “Is there anything else you would like the project team and faculty members to know about your experience this summer?” The responses were primarily expressions of praise and thankfulness with additional details regarding specific areas of benefit like: (1) learning from guided use of software packages; (2) learning more about topics mentioned but not expanded upon in past classes; (3) greater understanding of possible career path information, (4) interacting in small groups with faculty and active engineers, and (5) refining academic and career plans. One student noted that gaining familiarity with TAMUK personnel made him more likely to consider TAMUK as his next step in higher education and another that he would be transferring to TAMUK.

Participants in the Texas A&M University-Kingsville SBP reported increased awareness of engineering opportunities, increased interest in engineering, and receiving information relevant to career decisions as well as statistically significant increases in knowledge or capability in all measured topic areas. The replies provided as ratings were supported by responses to open-ended queries in which references were made to the same areas of advancement. Most participants (70.3%) indicated they would have participated even if a stipend had not been offered yet several stated in written responses that the stipend had allowed them to cut back on or even forgo work commitments during the SBP.

Conclusions and Future Direction

The engineering faculty who presented this SBP concurred after the conclusion of the program that the mix of activities presented to the students was appropriate and that guest speakers were well received by the participants, including the use of both individual guest speakers and guest panels. Student survey responses confirm a similar perspective on the part of the participants. Several faculty expressed the desire to also include a presentation on teamwork so the participants would have tools or techniques they might use should intra-team conflicts arise during the program. Participant comments noted a need for and learning regarding teamwork and associated problem-solving/conflict-resolution skills which align with the interest expressed by the faculty sponsors.

The virtual platform utilized for the entire program was the Collaborate platform within the Blackboard learning management system. Use of this platform led to some accessibility challenges that were problematic for a group of participants as they were a mix of our university students and students not yet enrolled at our university. In the next offering of this SBP in summer 2021, virtual presentation will be retained, and a different web meeting platform such as Zoom or Microsoft Teams will be evaluated for use.

Most of the group activities proved possible even though conditions required virtual completion. The tall tower challenge is an example of a good introductory activity choice in situations where face-to-face processes are possible but, in this instance, the participating faculty concluded that an alternative should be considered for future virtual SBPs. However, the virtual format of the SBP also offered unexpected advantages, such as the flexibility for guest speakers who did not have to make travel arrangements to connect with SBP participants. This flexibility allowed for broader guest speaker recruitment than would be valuable for face-to-face events.

The desired patterns of student learning and change in perspective were achieved. That the programming enacted appeared to have a stronger impact on female participant awareness “of the variety of opportunities available to people who study engineering” is an important finding as females are significantly underrepresented in engineering fields [20]. Another important finding was the statistically significant advancement reported by the participants in learning and perceived capability for all topic areas measured. This is especially notable as 73% of participants identified as Hispanic another segment of the U.S. population underrepresented in engineering fields [20,21] and 70% of them were first-generation college students who are often less informed about and prepared for college [23,24]. The ability of a virtual SBP to increase awareness of and interest, understanding, and perceived capability regarding engineering content

and careers with students from these groups represents a valuable recruiting and, potentially, persistence encouraging tool. While the evidence gathered suggests the program, as planned and implemented, precipitated these outcomes, further study is required. Similar results from a replication of the same process with a similar audience would solidify the case for efficacy.

Teamwork, team building, and learning from peers were mentioned in open-ended responses by informants. The references included both affirmation that these patterns existed and, in several cases, suggestions that some guidance be provided in these areas. This material was insufficient to determine whether the project had an impact on student identification with the group or sense of belonging at Texas A&M University-Kingsville, although several students indicated an increased sense of comfort with the faculty and willingness to attend the institution. Further study is warranted in this topic area.

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References

1. Khasawneh, M., Bachnak, R., Goonatilake, R., Lin, R., Biswas, P., Maldonado, S.C., (2014) “Promoting STEM Education and Careers among Hispanics and Other Minorities through Programs, Enrichment, and other Activities.” ASEE Annual Conference and Exposition, Conference Proceedings, 2014.
2. Martinez, D., Jacks, J., Jones, D., Faulkner, B. (2010). “Work In Progress – Recruiting Initiatives for Hispanic, First-Generation Students.” 40th ASEE/IEEE Frontiers in Education Conference, 2010.
3. Enriquez, A., Langhoff, N., Dunmire, E., Rebold, T., Pong, W. (2018). “Strategies for Developing, Expanding, and Strengthening Community College Engineering Transfer Programs.” ASEE Annual Conference and Exposition, Conference Proceedings, 2018.
4. US Census Bureau. (2019). QuickFacts: Texas. <https://www.census.gov/quickfacts/TX>
5. Texas A&M University – Kingsville. Interactive campus data. <https://www.tamuk.edu/oira/institutional-data/Interactive-Campus-Data.html>
6. Acevedo-Gil, N., Santos, R. E., & Solorzano, D. G. (2014). Examining a rupture in the Latina/o college pipeline: Developmental Education in California community colleges. *Issues in Higher Education Policy and Practice*, 3, 1-19.
7. Vasquez Urais, M. C. (2014). *Predictors of sense of belonging among Latino men in community college*. [Doctoral dissertation, San Diego State University]. <https://digitallibrary.sdsu.edu/islandora/object/sdsu%3A2500>
8. Garcia, G. A., Patron, O. E., Ramirez, J. J. & Hudson, L. T. (2016). Identity salience for Latino male collegians at Hispanic Serving Institutions (HSIs), emerging HSIs, and non-HSIs. *Journal of Hispanic Higher Education*, 17(3), 171-186.
9. Sibila, C. E. (2015). Factors effecting intent to persist among Hispanic/Latino students attending a private non-profit nonresidential university.[Doctoral dissertation, University of Miami]. https://scholarship.miami.edu/discovery/fulldisplay/alma991031447934602976/01UOML_INST:ResearchRepository
10. Mireles-Rios, R. & Garcia, N. M. (2018). What would your ideal graduate mentoring program look like?: Latina/o student success in higher education. *Journal of Latinos and Education*, 18(4), 376-386.
11. Preuss, M. D., Merriweather, S. P., Walton, S.D. & Butler-Purry, K. L. (2020). Minority student preparation for STEM PhD study: Impact of NSF Bridge to the Doctorate programming. *International Journal of Technology in Education and Science*, 4(3), 168-187.
12. Rendón, L. I., Nora A., Ray, J. M., and Cabrales, J., “Realizing the PROMISE for Latinx STEM students,” 2018, Laredo, Texas: Laredo Community College.

13. Preuss, M. D., Rodin, J. C., Sosa, E. M., Ramos, J. D., Dorsett, C. R. & Burlison, C. R. (2019). Hispanic-Serving Institutions in the South-Central United States: A Research Report for Los Barrios de Amarillo. Canyon, TX: West Texas Office of Evaluation and Research.
14. Preuss, M., Sosa, E., Rodin, J., Ramos, J., Dorsett, C. & Burlison, C. (2020). Competence of faculty, staff, and administrators in Hispanic culture: Evidence from three surveys of personnel and students at Hispanic-Serving Institutions. *International Journal of Research in Education and Science*, 6(2), 202-230.
15. Kendall, M. R., Choe, N.H., Denton, M., Borrego, M., (2018). "Engineering Identity Development of Hispanic Students." ASEE Annual Conference and Exposition, Conference Proceedings, 2018.
16. Strayhorn, T.L. (2010). "Work in progress: Diversifying STEM: Underrepresented students' experience in undergraduate research programs." 40th ASEE/IEEE Frontiers in Education Conference.
17. Carpi, A., Ronan, D.M., Falconer, H.M., and Lents, N.H. (2017). "Cultivating minority scientists: undergraduate research increases self-efficacy and career ambitions for underrepresented students in STEM." *J. Research in Science Teaching*, 54(2), 169-194.
18. Wao, H. O., Lee, R. S. & Borman, K. (2010). Climate for retention to graduation: A mixed methods investigation of student perceptions of Engineering departments and programs. *Journal of Women and Minorities in Science and Engineering*, 16, 293-318.
19. Perrin, J., "Features of Engaging and Empowering Experiential Learning Programs for College Students," *Journal of University Teaching and Learning Practice*, 11(2), 2014, article 2. <https://ro.uow.edu.au/jutlp/vol11/iss2/2/>.
20. National Center for Education Statistics. (2019). Fast facts: Degrees conferred by race and sex. Retrieved from <https://nces.ed.gov/fastfacts/display.asp?id=72>
21. Pew Research Center. (2019). 7 Facts about the STEM Workforce. Retrieved from: <https://www.pewresearch.org/fact-tank/2018/01/09/7-facts-about-the-stem-workforce/>.
22. "IEEE Try Engineering," <https://tryengineering.org/>. Accessed May 31 and June 16, 2020.
23. Engle, J. (2007). Postsecondary access and success for first-generation college students. *American Academic*, 3, 25-48. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.296.7903&rep=rep1&type=pdf>
24. Tim, C., McMillion, R., Barone, S. & Webster, J. (2004). First-generation college students: A literature review. Round Rock, TX: Texas Guaranteed Student Loan Corporation. <https://files.eric.ed.gov/fulltext/ED542505.pdf>