The Future of Engineering Education
2024 Annual Conference & Exposition
Oregon Convention Center
Portland, OR . June 23 - 26, 2024
ASEE
Paper ID #41837

Outcomes from a Multi-Year Design-Oriented Summer Engineering Program at a Hispanic-Majority Institution

Dr. Matthew Lucian Alexander P.E., Texas A&M University, Kingsville

Dr. Alexander graduated with a BS in Engineering Science from Trinity University, a MS in Chemical Engineering from Georgia Tech, and a PhD in Chemical Engineering from Purdue University. He worked for 25 years in environmental engineering consulting bef

Dr. Michael Preuss, Exquiri Consulting, LLC

Michael Preuss, EdD, is the Co-founder and Lead Consultant for Exquiri Consulting, LLC. His primary focus is providing assistance to grant project teams in planning and development, through external evaluation, and as publication support. Most of his work

Dr. David Hicks

David Hicks is an Associate Professor in the Electrical Engineering and Computer Science Department at Texas A&M University-Kingsville. Before joining TAMU-K he served as Associate Professor and Department Head at Aalborg University in Esbjerg, Denmark. He has also held positions in research labs in the U.S. as well as Europe, and spent time as a researcher in the software industry.

Dr. Breanna Michelle Weir Bailey P.E., Texas A&M University, Kingsville

I am a licensed Professional Engineer in the State of Texas. I currently serve as the chair for the Department of Civil and Architectural Engineering at Texas A&M University-Kingsville.

Mr. Rajashekar Reddy Mogiligidda, Texas A&M University, Kingsville

Rajashekar Mogiligidda is working as a Lecturer in the department of Mechanical and Industrial Engineering at Texas A&M University-Kingsville since 2016. He graduated from Texas A&M University-Kingsville with a Master's in Mechanical Engineering in 2016 and currently working on his PhD in Engineering at Texas A&M University-Kingsville.

Lihua Zuo, Texas A&M University, Kingsville
Dr. Mahesh Hosur

Mahesh Hosur, PhD Associate Dean, Research and Graduate Affairs Mahesh Hosur received his education from India with a Bachelor of Engineering (B.E.) degree in Civil Engineering from Karnatak University (1985), Master of Technology (M. Tech.) degree in A

Outcomes from a Multi-Year Design-Oriented Summer Engineering Program at a Hispanic-Majority Institution

Introduction

An engineering-oriented Summer Bridge Program (SBP) has been conducted in each of the past four years within the Frank H. Dotterweich College of Engineering (COE) at Texas A&M University-Kingsville. The intent has been to provide freshman and sophomore engineering, computer science, and industrial technology students with activities in a 3-week summer program that will increase their skills relevant to and perseverance and motivation to complete baccalaureate studies in an engineering-oriented field. The SBP has enrolled freshman and sophomore level students from TAMUK, as well as community colleges and other universities within the south Texas region. Team-based design projects were one of the major components included in each year of the SBP. These short design projects centered around the disciplines of the participating faculty, chemical, civil, mechanical, electrical, industrial engineering, computer science, and industrial technology. This paper presents the outcomes for students based on their participation in one of the SBPs held during the past four years at our Hispanic-majority institution [1].

The first two years of this SBP (2020 and 2021) were conducted in a virtual modality due to COVID-19 restrictions; thereafter, the program was implemented in a hybrid modality (participants could attend either virtually or in person in 2022 and 2023). The effectiveness of the SBP implemented in different modalities is an important result for wider sharing with the engineering education research community. The ability to determine whether there were differences in learning and other outcomes for students based on personal background and in each of the instructional modalities is an addition to the engineering literature regarding SBP activity and the use of team-based design projects.

This SBP was developed as component of an NSF Hispanic-Serving Institution (HSI) 5-year grant awarded to the COE at TAMUK, a regional university located in south Texas, an area of Hispanic/Latinx majority population [2]. The continuation of this summer program after the end of the NSF grant period has not yet been decided. Engineering-oriented programs such as this can be important tools for enhancing undergraduate student success, as demonstrated by other researchers [3-5]. Numerous challenges in the post-secondary education environment exist for Hispanic/Latinx students attending community colleges [6, 7], universities [8, 9], and in graduate study [10, 11]. Challenges that Hispanics/Latinx face in their academic careers include a poor sense of belonging at the university level, cultural support deficiencies, and challenges in overcoming secondary education academic deficiencies [12]. Therefore, another goal of the SBP was to help the freshman and sophomore attendees more fully identify as engineering students, which is recognized as positively impacting student retention [13-15].

The four years of programming involved a substantial number of students, 182 in all. In the 2020 SBP, a total of 37 students attended virtually, while in the 2021 SBP, 50 students attended virtually. A total of 46 students were enrolled in the 2022 SBP, with 22 of them attending virtually and 24 attending on-site. A total of 49 students were enrolled in the 2023 SBP, with 35 of them attending virtually and 14 attending on-site.

Design Rationale/Theoretical Framework

As part of TAMUK's NSF Improving Undergraduate STEM Education (IUSE) HSI grant, the SBP objectives were to (1) increase motivation for engineering academic study, (2) reinforce personal commitment among students early in their engineering academic career to aid retention, (3) increase skill in areas with relevance to the study of Engineering, and (4) ensure effectiveness of programming to achieve these objectives amongst a primarily Hispanic/Latinx student population. In order to achieve these objectives, the program then selected the following elements for implementation in the SBP:

1) Introduce key skills necessary for engineering academic study.

2) Introduce engineering design activities/skills, and a guided experience in a group design project as a precursor to student's future capstone engineering design experience.

3) Provide a venue for peer and older engineers to relate their academic and career development practices to the SBP participants.

4) Introduce shared experiences of other Hispanic/Latinx / minority (female) engineers.

The SBP program each year consisted of 2 to 4-hour afternoon sessions held each weekday in virtual only or hybrid mode over the three-week program in July. A Zoom platform was used to conduct the virtual portion of the daily SBP sessions. A weekly stipend was provided to each participant as an incentive for continued attendance, paid after each week. For the on-site participants of the SBP, additional activities centered around either student success or engineering lab tours were held each morning. The student success topics presented to the on-site students included time management, GPA calculation, resume building and internship opportunities, library services, and personal learning styles [16-18].

Faculty lectures delivered during the SPB covered topics on the engineering design process; engineering disciplines; importance of mathematics, chemistry and computational tools in engineering; lean manufacturing; engineering mechanics; data analysis and visualization; ethics; professional licensure; and career searches. Content varied from material that would be included in freshmen engineering courses to introducing advanced (upper-level) engineering courses [16-18].

The primary experiential learning activity incorporated into the SBP was a group-based engineering project that students performed during the majority of the program. The project activity was directed by an individual faculty member, and exposed participants to realistic engineering challenges or problems. For the group projects (group sizes typically 3 to 5 students), participants were assigned to discipline-specific teams to align with students' interests or declared engineering major. For the 2023 SBP, a total of 12 teams were formed amongst the 49 SBP participates, and these teams fell into the following discipline-related cohorts: Chemical and Environmental Engineering (3 teams of 2 to 4 students), Civil and Architectural Engineering (2 teams of 4 or 5 students), Electrical Engineering and Computer Science (1 team of 4 students), Mechanical and Industrial Engineering (3 teams of 4 or 5 students), and Industrial Technology (3 teams of 4 students). Project team distribution in preceding years has been described in previous publications about this undertaking [16-18].

In the 2023 SBP, the engineering design projects that were assigned to the student teams included (a) solar-powered pump system, desalination, and municipal water supply alternatives, for three Chemical and Environmental Engineering groups, (b) computational design of a truss bridge for two Civil and Architectural Engineering groups, (c) building and programming a line-following robot for one Electrical Engineering and Computer Science group, (d) plastic part design and 3-D printing for three Mechanical and Industrial Engineering groups, and (e) an engineering optimization coding study for three Computer Science and Industrial Technology groups. All teams gave a presentation of their project work and submitted a final report on the final day of the SBP. Design project descriptions for the first three SBPs are provided in prior publications [16-18].

Finally, each SBP also included an array of industry professionals as guest speakers, consisting of three panel discussions and three or four presentations by individuals. The three panel discussions for the 2023 SBP invited guests from different career stages as follows: (a) a recent winning senior design team from the TAMUK COE, (b) early career professionals, and (c) seasoned engineers. Panels and speakers in preceding years were described in prior publications [16-18]. Each panel had four to six speakers. With stand-alone presentations and panel discussions, a total of 15 industry professionals participated in the 2023 SBP, ten of whom were Hispanic/Latinx and three of whom were female (one of females was bi-racial, African American and white). Thus, speakers included persons from multiple groups that are underrepresented in engineering [19-20]. Guest speaker diversity was a program priority, since a high percentage of participants were female (approximately one-third) and Hispanic/Latinx (nearly two-thirds). The diversity of SBP speakers was intended to allow the participants to recognize and relate to engineers who shared their background and characteristics.

Assessment Methods

Students participating in the SBP were asked to complete pre- and post-participation surveys and the outcomes from the first three years of programming, 2020, 2021 and 2022, have been discussed in prior publications [16-18]. This article adds 2023 outcomes and discusses results from the four years of programming.

As noted above, the original project plan was disrupted by the COVID-19 pandemic. Moving the SBP online during that period and maintaining optional online attendance after introduced a new investigative opportunity. In addition to the original interest in understanding the impact the programming had on participant knowledge, interest in study of Engineering, interest is opportunities in Engineering, career goals, and student retention, it became possible to consider whether outcomes were different for parties participating exclusively online or in person. The number of participants also made it possible to disaggregate and check for differences in outcomes by gender, ethnicity, first-generation college student status, perceived skill in mathematics, and prior experience in advanced courses (i.e., dual enrollment and Advance Placement classes).

The surveys employed "sought insight into the backgrounds of the students and responses that would allow assessment of the impact of the programming. The intent was to ascertain whether participation resulted in perceived increases in student understanding and skill and awareness of and interest in engineering and whether impacts differed for subsets of participants" [18]. The last topic is of particular importance given the underrepresentation of females and some ethnic groups in the engineering workforce [20, 21] and studies that have found impacts of instructional innovations in Engineering differing by race/ethnicity or gender [22, 23, 24].

The surveys were constructed based on the SBP learning objectives identified by the participating faculty for each activity. The questions were generated by the evaluator, who holds a doctorate in Education and taught graduate level assessment and research courses for six years, using the learning objectives. The queries were reviewed multiple times by the evaluator and faculty from the participating disciplines to arrive at face and construct validity. The COVID-19 pandemic disrupted and ultimately prevented reliability testing of the questions due to the immediate, intense, and time-consuming efforts needed to move all instruction online in the spring semester of 2020. Reliability concerns are, though, unlikely as the prompts are statements of fact (e.g., I know..., I have used..., I can define…), employ specific and unambiguous but commonly understood terms (e.g., 3D modeling software, formula in Excel, algorithm), do not address patterns that evolve or vary across time (e.g., personal sense of safety or well-being), and were presented to the same parties in the same order and format three to four weeks apart. Multiple items were not developed to address each topic queried for two reasons, the items were all dichotomous statements of fact (e.g., know versus do not know, have used versus have not used) so the only option was a positive and negative statement for each and to avoid survey fatigue on the part of respondents when encountering clearly repetitive questions.

"Adjustments to programming were made for 2021 based on the faculty and students' experiences in the [2020] pilot program and for 2022 due to additions to the programming. This involved addition of material about chemistry and ethics in engineering in 2021. The additions in 2022 covered lean manufacturing, a new topic in the summer offering, and the presentations for on-site participants regarding time management, GPA calculation, resume building and internship opportunities, library services, and personal learning styles" [18]. As was the case for preceding publications, "Survey questions asked and analysis of data related to the student support services and library presentations, while not discussed herein, are available from the authors upon request" [18].

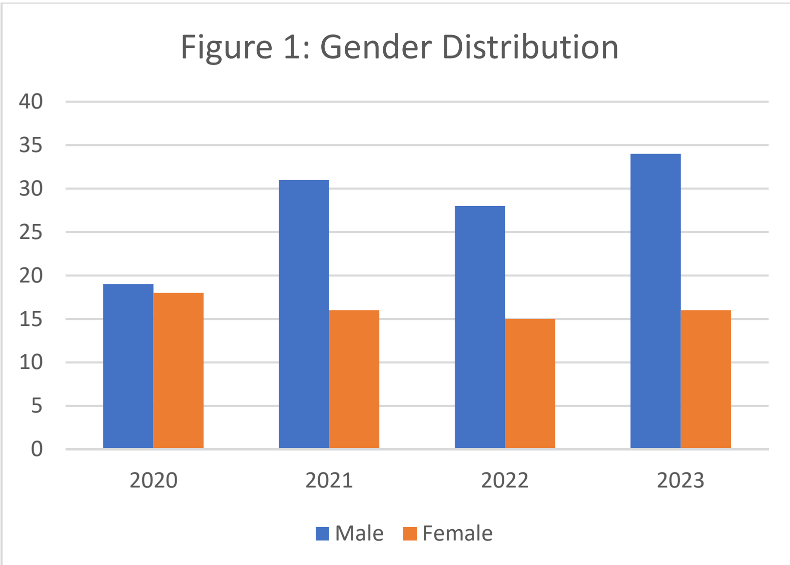
The pre- and post-participation surveys were completed using the Qualtrics platform. The pre-participation questions were made available to the participants on the first day of programming via an emailed individualized link and they were encouraged to complete it at that time. Those who did not were reminded of the request by email several times in the first week of programming and general verbal reminders were also made in project sessions. The pre-participation survey was closed within a week to ten days. Access to the post-participation survey was also provided via individualized links emailed to all participants on the last or second to last day of programming. Like with the pre-participation survey, reminders were sent to parties who did not respond. Post-participation responses were solicited for two to three weeks before the survey was closed.

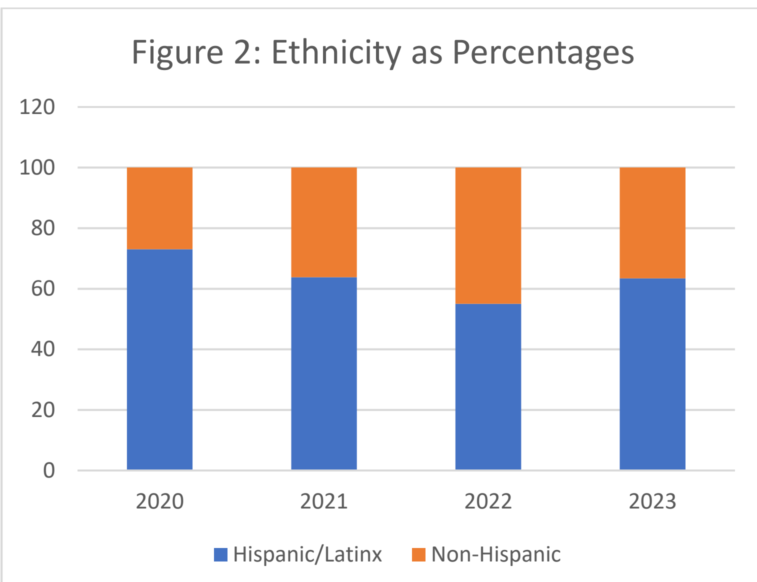
Survey data were downloaded as cumulative listings of submissions for the year in the form of numeric ratings on a ten-point scale, Likert scale ratings, nominal scale responses, and short texted responses. Descriptive statistics, tabular representation, and inferential statistics, when applicable, were used to analyze the quantitative data. This included Wilcox Wilcoxon, Mann Whitney U, paired *t* tests, a randomized test, and regression analysis, as applicable [17-18]. Qualitative input was processed using the constant comparison method [25]. Steps taken in analysis to address the high volume of comparisons made and resulting potential for false positive or negative findings [26] were annual assessments of the data, use of alpha correction, and effect size calculations. Analysis of the data year-by-year demonstrated consistent patterns (Table A1) whereas false positives or false negatives would have appeared as isolated or exaggerated findings in a year. Even using an adjusted alpha value of 0.01, only three of the 102 comparisons in Table A1 and the 24 with the lowest p values of the 196 comparisons in Tables A3 through A8 would be suspect. Eliminating them from consideration does not alter the general findings. Finally, effect sizes were calculated (*r* values in Tables A3 to A8). These "measure…the closeness of association of the points in a scatter plot to a linear regression line" [27] and are associated with a scale categorizing the closeness of association (e.g., no association, very weak, weak, etc.) [27, 28]. While findings are discussed using p values, a common practice in presentation of pre- and post-instruction measures of educational interventions, it is the *r* values that were used to interpret the patterns and arrive at the study's conclusions.

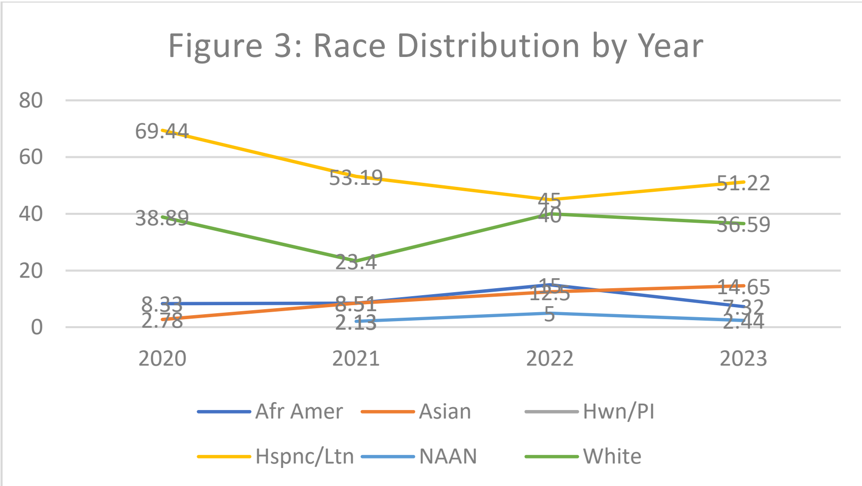
Persistence and graduation rates of native students and those who transferred to the institution who had completed one of the SBP offerings was developed by review of individual TAMUK student academic records. While this resulted in retention outcomes for a part of the cohort rather than the entire cohort, there was no verifiable means of tracking persistence and graduation for students who did not attend the University. The retention data requested was persistence in an engineering degree track and graduation rates for cohorts for which sufficient time had transpired to facilitate degree completion. These data were analyzed using descriptive statistics.

Description of the Cohort

Figure 1 graphs the counts of females and males who participated in the four years of programming (none of the participants identified as non-binary). "The count of females participating stayed relatively constant with 18 females in 2020, 16 in 2021…15 in 2022" [18], and 16 in 2023. "Yet, the total participant count was higher" [18] in each year after 2020, 50 students in 2021, 46 in 2022, and 49 in 2023. Thus, "the net gain in participants occurred among males who were 51.4% of the 2020 cohort, 63.3% in 2021, 65.1% in 2022" [18], and 68.0% in 2023.



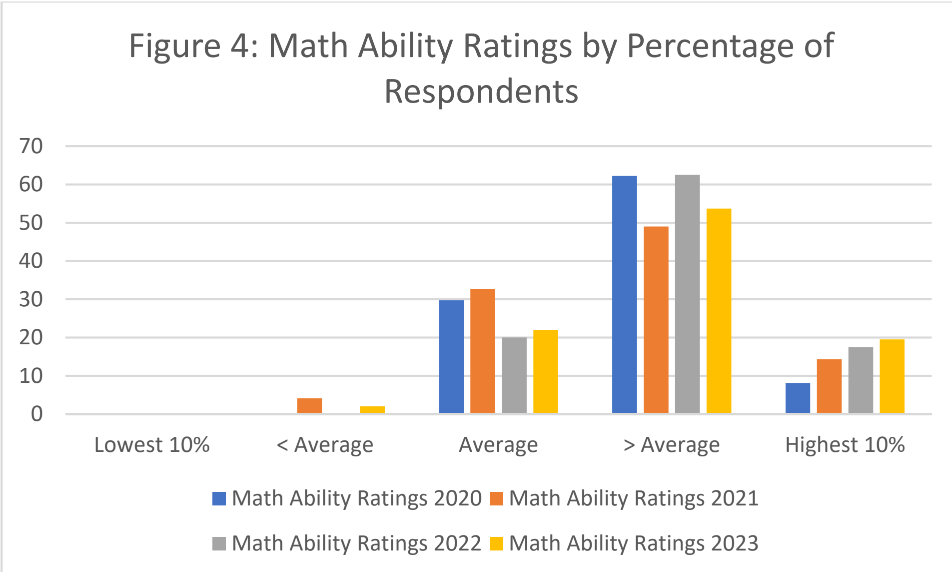


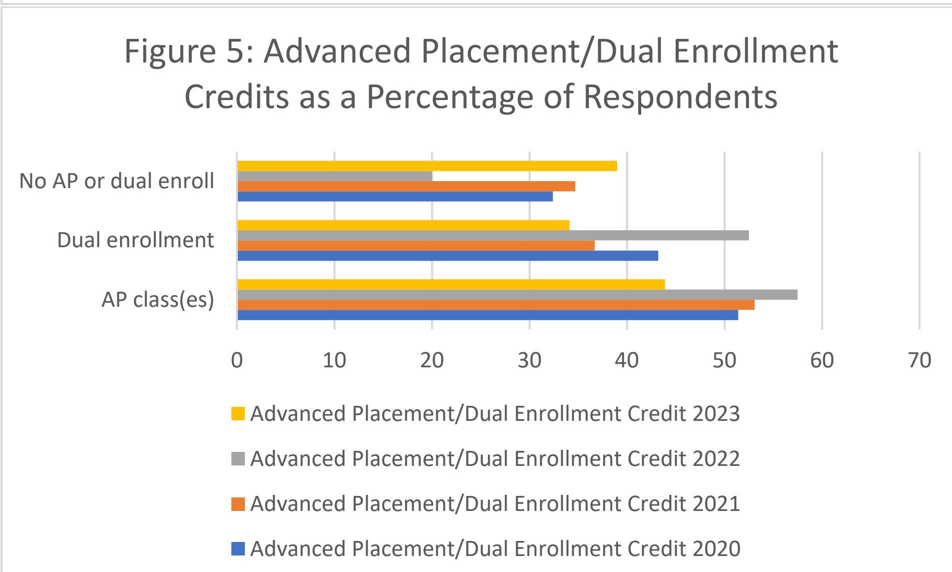


The cohorts exhibited ethnic and racial diversity. The primary ethnic group in each year was persons who identified as Hispanic/Latinx (Figure 2). There was also diversity within that group with Hispanic/Latinx students selecting more than one racial category, most frequently Hispanic/Latinx (Hspnc/Ltn) followed by white but also African American/Black (Afr Amer), Asian, and Native American/Alaska Native (NAAN). Other multi-racial combinations reported were African American/Black and white, Native American/Alaska Native and white, and African American/Black Asian. Figure 3 presents the percentage of participants who identified with various racial categories in the four years of programming. The total percentages exceed 100% in each year due to individuals reporting multiple racial identities.

The ethnic/racial composition of the program cohorts was similar year-to-year to that of general student population of the institution [29], which likely is a product of general population in the area served by the University.

Another characteristic common to each of the cohorts was many of the participants classifying themselves as first generation college students by indicating "neither of my parents/guardians possesses a college degree" [16]. The levels, as noted in prior publications [16-18], were 62.2% first-generation college students in 2020, 57.4% in 2021, 48.8% in 2022 (although three additional students [7.5%] did not know whether they were first-generation college students), and 41.0% for the 2023 cohort.





Summer bridge program participants were asked to rate their math skills and note whether they had completed dual enrollment or advanced placement classes in high school (Figures 4 and 5). This was done to identify whether the students attracted to the SBP exhibited a particular set of skills or prior experiences and to ascertain whether existing math skill impacted student perspective of or outcomes from the programming. The queries did not, though, ask for information that would have facilitated greater specificity like the number or type of mathematics or physics courses completed. Students could rate themselves as below average, average, above average, or in the upper 10% in math skills. Between 64.6%, in 2021, and 80.0%, in 2022, rated their skill in mathematics as above average or in the highest 10% of their peers, indicating most of the students should have been well positioned, based on estimated skill in mathematics, to learn the proposed content. The volume of Advanced Placement and dual enrollment experience in the cohorts support this conclusion (Figure 5). Over 60% of participants had completed classes of these types each year. That “volume of Advanced Placement and dual enrollment experience in the cohorts provided further support of academic preparation” [17].

"The demographics outlined for the…cohorts indicate several differences existed year-to-year. These were the gender distribution, the percentage of first-generation college students, and percent with dual enrollment credit and those not having participated in Advanced Placement or dual enrollment courses. This variation, as well as the different forms of program presentation (online and hybrid), make the data set valuable. [Four] groups that departed from each other in several important ways have been instructed using the same curriculum but that curriculum was presented in two different ways. As a result, any statistically significant patterns reoccurring would represent a strong case that the cause was the curriculum" [18].

Online and On-Site Presentation

The SBP programming was originally intended to be an on-site offering. The international COVID-19 pandemic and resulting restrictions on in person gatherings forced the 2020 and 2021 SBPs to be completed at a distance. The 2022 and 2023 versions, following the success of the first two offerings [16, 17], maintained an online option, but also offered on-site participation. This allows assessment of success as online and in person programming and comparison of the two modalities.

Response Rates

The number of participants and the survey response rates varied from summer to summer. Table 1 summarizes participation and response by year. Response rates were generally high, at or above 89% for all but one survey. In 2020 and 2023, there were minors in the cohort. They were not permitted to respond to the survey as no provision had been made for acquiring informed consent from their parents. The response rates in Table 1 exclude them as potential informants.

Table 1

Student Response Rates for the Pre- and Post-Participation Survey

Year	**Pre-Participation**			**Post-Participation**		
	Count	***Percentage***	***Interval***	***Count***	***Percentage***	***Interval***
2020	32 of 36*	88.9%	5.86	37 of 37**	100.0%	0.00
2021	48 of 50	96.0%	2.86	49 of 50	98.0%	2.00
2022	45 of 46	97.8%	2.18	41 of 46	89.1%	5.10
2023	35 of 46*	76.1%	8.19	42 of 46*	91.3%	4.51

* One or more persons under the age of 18 was blocked from completing the survey. ** Underage party turned 18 while in the program and could complete the post-participation survey.

The interval column in Table 1 records the confidence interval for each survey calculated at the 95% level of confidence. The confidence interval for the combined sets of pre- and post-participation surveys are 2.47 and 1.79 respectively. Thus, interpretation of results can be conducted with reasonable confidence as the response rates were sufficiently high for the data to be representative and to have small confidence intervals.

Learning Achieved

The pre-participation response sets facilitate "a consideration of the knowledge base of the…students in the summer bridge program as the students were asked to rate their level of experience" [17] in respect to as many as 29 different topics. "A ten-point scale was used and informants were instructed to submit a rating of zero for 'no experience/ability' and a rating of ten for being 'well informed/very capable' in the area" [17]. "The responses facilitated a rank ordering of ratings by topic, with the highest mean as the primary sort and standard deviation (lowest) and then mode (highest) as tie breakers" [17]. The 2021, 2022, and 2023 cohorts reported higher levels of prior experience than the 2020 cohort. The means for the prompts were grouped closer together and higher up the scale than in 2020 (one mean above 6.0 in 2020 while eight were in 2021, six in 2022, and all in 2023). Interestingly, the sorts of SBP program topics by mean did not result in similar rankings for each year. Collectively, these factors point to cohorts having different backgrounds. Any positive outcomes that occurred consistently given this and the other variation in the cohorts, would, as a result, point to the instructional and practical experiences during the SBP as the influencing factor.

Table A1 in the Appendix reports pre- and post-participation means and standard deviations for 29 questions that asked about student understanding of or ability regarding a specific topic or task. One was only asked in 2020 and did not reoccur due to changes in the curriculum of the summer program. Seven were asked in three of four years, the final three years following the initial offering and subsequent revisions of the curriculum. Two others were asked in 2022 and 2023 as they addressed an emphasis added for the summer of 2022 and following. Of the 102 pre- to post-participation comparisons for the queries as asked in each year, all but one was statistically significant for increased understanding or perceived skill. The one non-significant change was for 2023 and the statement "I can write a formula in Excel." This is understandable as students who would be interested in engineering are likely to have experience with Excel. And yet there was a one-point increase in the mean and a decrease in the size of the standard deviation though that level of change was slightly less than needed for the outcome to be significant. Ubiquitous significant findings that were repeated across four years with cohorts that varied from each other in gender distribution (Figure 1), ethnic and racial makeup (Figures 2 and 3), percentage of parties who were first-generation college students (62.2% in 2020, 57.4% in 2021, 48.8% in 2022, and 41.0% in 2023), perceived competence in mathematics (Figure 4), and prior engagement with dual enrollment and Advance Placement courses (dummy values for advanced levels of study) (Figure 5), point to instructional efficacy of the programming. "The clear indication is 'that the educational programming was effective in altering students' understanding, even in areas in which they felt they had a good understanding prior to participating'" [18]. Figures 6, 7, and 8 have been included to provide a visual representation of the degree to which these changes occurred.

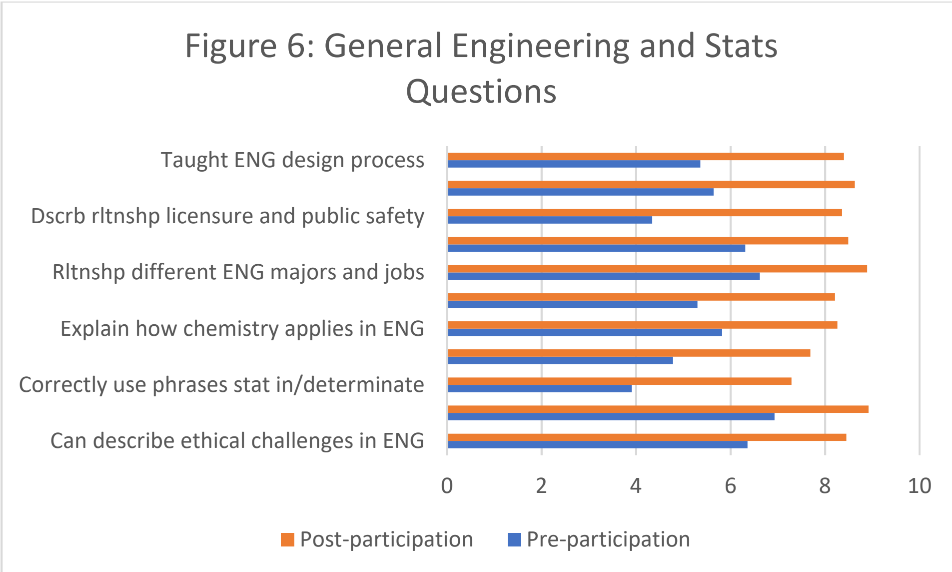


Figure 6: General Engineering and Stats Questions
Taught ENG design process
Dscrb rltnshp licensure and public safety
Rltnshp different ENG majors and jobs
Explain how chemistry applies in ENG
Correctly use phrases stat in/determinate
Can describe ethical challenges in ENG
0
2
4
6
8
10
Post-participation
Pre-participation

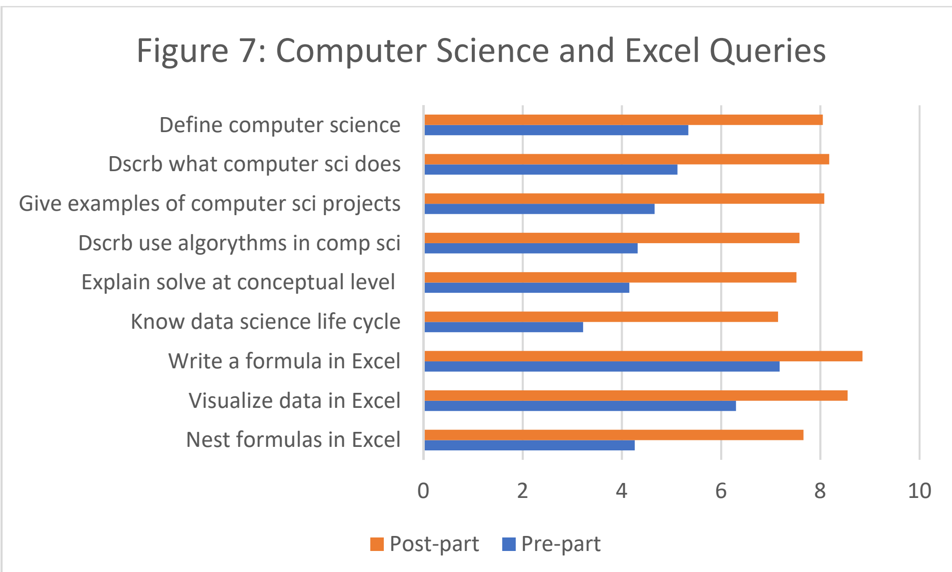
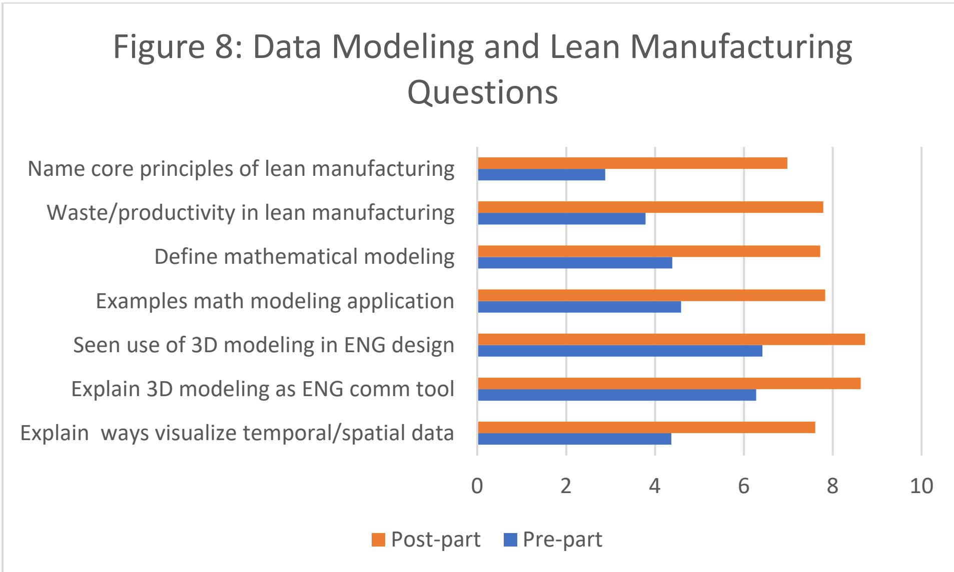


Figure 7: Computer Science and Excel Queries
Define computer science
Dscrb what computer sci does
Give examples of computer sci projects
Dscrb use algorythms in comp sci
Explain solve at conceptual level
Know data science life cycle
Write a formula in Excel
Visualize data in Excel
Nest formulas in Excel
0
2
4
6
8
10
Post-part
Pre-part



It should also be noted that when the data for all four years is considered as a combined set, comparison of pre- to post-participation submissions returns statistically significant findings for all 29 queries. The combination of the sets is appropriate since there were very limited differences found by modality (online versus in person participation) as discussed below.

It was possible to disaggregate and analyze the data set by gender, ethnicity, first-generation student status, modality, perceived mathematical aptitude, and prior advanced study. Disaggregation by race could be completed but resulted in several cells that were too small to support analysis and for the larger subsets race and ethnicity were found to be collinear. As a result, the impact of ethnicity was assessed.

The color-coded table in the Appendix Table A2 illustrates there was little difference in learning reported by the online and in person participants. Statistically significant differences between the reported learning of the two groups were found in only three of the 29 comparisons with p values of 0.04, 0.02, and 0.006. In all cases, both groups reported significant increases in understanding from pre- to post-participation, yet the increase was greater in the three areas for the in-person attendees. The areas in which significant differences were found for in-person participants were greater understanding of the relationship of licensure to public safety ($p = 0.02$), of waste and productivity in lean manufacturing ($p = 0.006$), and their having experience working with a group of peers ($p = 0.04$). Neither the first or the second difference has a simple explanation, but the weakest and third is likely a result of the challenges faced in working as groups via the internet which could explain the lower ratings from online participants.

Comparison of submissions by ethnicity resulted in significant differences for all but one query (Table A2) with the Hispanic/Latinx students providing higher ratings for the learning or skill advancement achieved for each of the questions. Twenty of the 29 calculations resulted in differences at the $< .001$ level, four were at the ≤ 0.01 level, with four others between 0.035 and 0.015. The gender, first-generation college student to not first-generation, and perceived mathematical aptitude for the Hispanic/Latinx and non-Hispanic student ratios were similar for the two groups and therefore unlikely to contribute to the difference at the ethnic level. However, there was a marked difference in the percentages of students who reported having completed dual enrollment and Advance Placement courses, 80.0% of Hispanic/Latinx parties had while 48.3% of non-Hispanics had. Completing courses of this type may be an indication of academic interest, motivation to excel, attending a high school with better resources and opportunities, or some other factor. It cannot be known from the data gathered which of the factors just noted or which other possible influences may have contributed to the strong differences by ethnicity, but it is possible that there is an intervening variable that would account for a portion of the difference found by ethnicity.

Comparison of responses by gender did not result in as simple a set of differences. Rather than all the means for one group being higher than those for the other, three of 29 were higher for males and the remaining 26 were higher for females. Fourteen of the 29 comparisons produced significant results, but to a much weaker extent than for ethnicity, eleven of the 14 significant findings had p values just below 0.05 to above 0.01 while the other p values were 0.002, 0.003, and 0.007. All the significant findings occurred as females reporting greater learning than males and existed for most of the more general prompts, the two mathematical modeling questions, and the computer science related questions. Female informants also were 14 percentage points more likely to report advanced math skills and 16.5 points more likely to have taken dual enrollment and/or Advance Placement courses than their male peers. Thus, the set of characteristics encapsulated in mathematical aptitude and access to and pursuit of advanced course work may have contributed to the significant differences found.

First-generation student standing produced results similar to gender. All the means for learning and skill advancement were higher for the first-generation student group than for the non-first-generation group with 11 of 29 comparisons yielding significant findings. Only one of the significant findings had a p value of $< .001$ with three at the $< .01$ level and seven above the 0.01 level (as high as 0.037). Nine of the 11 significant findings were for items found to be significant for gender suggesting there is a cumulative effect of several characteristics or some other factor impacting these findings. This is supported by the first-generation group having a higher percentage of females than the non-first-generation students (24.7 percentage points more) and higher levels of perceived math skill (15.6 percentage points more) and prior participation in advanced courses (26.1 percentage points).

Perceived skill in mathematics had, unsurprisingly, higher means for learning and skill developed during the SBP for students who felt they entered the programming with above average or higher math skills. For twelve of the comparisons of above average or higher to average or below average there were significant findings. Two-thirds of these, eight, were statements directly related to mathematics like “I can explain how simultaneous equations apply in engineering” and “I can explain how calculus is important in creating technological solutions to human problems or needs.” Other differences in the two groups may have contributed to these findings as there were more females in the upper-level math skill group (21.8 percentage points more), fewer first-generation college students (18.2% percentage points less), and more persons who took dual enrollment or Advanced Placement courses (23.7% percentage points more). So, the parallel and potentially interrelated influence of being a female and the females having taken more advanced courses were, likely, contributing factors, but the simplest and most direct explanation is that parties with higher level math skills were able to absorb and apply math concepts covered to a greater extent than their peers.

The final means of disaggregating the survey responses was by prior experience in dual enrollment and/or Advanced Placement courses. The comparisons were between students who reported past experience with one or both and those who had not taken courses of this type. All the mean ratings for students who had taken advanced courses were higher than those for students who had not, and the comparisons produced the second highest level of significant findings, 26 of 29 possible (Table A2). Thirteen of them were at the highest level reported, $p < 0.001$ with nine others at the $p < 0.01$ level. The apparent interrelated factors of being female and having more advanced math skills were present with 20.3 percentage points more females among the students who had taken advanced courses and 18.6 percentage points more who felt they possessed above average skills in mathematics.

To determine the extent to which each of the above factors impacted outcomes Mann Whitney U analysis was completed. Results by instructional modality (Table A3), ethnicity (Table A4), gender (Table A5), first-generation college student status (Table A6), perceived skill in math (Table A7), and prior experience with dual enrollment and/or Advanced Placement courses (Table A8) appear in the supplemental tables. The tables list Z scores and values for *r* as well as containing markers of statistical significance. Z scores measure the difference between two independent samples [30] and report "exactly how many standard deviations above or below the mean a data point is" [31]. The p value of a comparison can then be calculated from the Z score [32, 33]. The *r* value "is a measure of the closeness of association of the points in a scatter plot to a linear regression line based on those points" [27]. The value of r can occur as a positive or negative number but the interpretation of it is the same in both directions as the distance from the value zero (0.0) is the critical factor. In either direction, values of 0.0 to 0.2 indicate no association to a very weak association, 0.2 to 0.4 a weak association, 0.4 to 0.6 a moderate association, 0.6 to 0.8 a strong association, and 0.8 to 1.0 a very strong association, while a value of one (1.0) is a perfect association [27, 28].

The p values found in the Mann Whitney U analysis of differences in post-participation responses resulted in patterns of significance similar to those found using *t* test to compare pre- to post-instruction responses. But, the r values help to separate the impact of the apparently interrelated variables identified in the *t* test outcomes: (1) ethnicity and prior experience with advanced courses, (2) being female, perceived skill in mathematics, and having experience with advanced courses, and (3) first generation college student status, being female, perceived skill in mathematics, and having experience with advanced courses.

- Modality had two significant differences in the Mann Whitney U analysis both of which had *r* values in the lower half of the weak association range.
- Gender had 18 significant differences. Three in lower half of the weak association range and 15 in the very weak category.

- Ethnicity had 24 significant differences three of which were in the moderate association category, 12 in the upper half of the weak association range, with the remainder in the lower half of the weak association range.
- First-generation student standing had 14 significant differences nine of which were in the lower half of the weak association range with the remainder in the very weak category.
- Perceived skill in mathematics posted 17 significant differences, one at the moderate level, 11 in the lower half of the weak association range, with all others in the very weak category.
- Having completed dual enrollment and/or Advanced Placement courses had 24 significant differences three of which were in the upper half of the weak association range, 19 in the lower half of the weak association range, and two in the upper half of the very weak association range.

Based on these findings, ethnicity can be said to have the greatest level of impact on outcomes with Hispanic/Latinx students posting greater gains than their non-Hispanic peers. Next in rank would be experience with advance courses, dual enrollment and/or Advance Placement courses followed by perceived skill in mathematics and first-generation student standing.

Retention of Participants

One of the goals for the summer bridge program was to increase retention of students in engineering study. Two different lines of evidence were gathered. The surveys included three questions about increased awareness of engineering opportunities, interest in an engineering degree, or refined career plans. Greater awareness of or interest in engineering opportunities or more precise career plans among students already interested in engineering could serve as a motivator to persist in studies. Mean post-participation responses were all near or above 8.5 on a ten-point scale, 8.81 for increased awareness, 8.64 for increased interest, and 8.44 for refined career plans, indicating the programming impacted students in these areas. Table 2 presents results for the data set when disaggregated by ethnicity, gender, first-generation college student status, above average skill in mathematics, prior experience with dual enrollment and/or Advanced Placement courses, and instructional modality (online or in person). While the overall response for each query was positive, students who identified as Hispanic/Latinx still submitted significantly higher ratings than their non-Hispanic peers. The same was true for females in comparison to males, for the career goals question for first generation college students, for all three queries for students who had taken dual enrollment or Advanced Placement courses in the

Table 2

Significant Differences by Disaggregated Groups for Awareness, Interest, and Career Goals

Prompt	***Ethnicity***	***Gender***	***1st Gen***	***Math***	***Advncd***	***Mdlty***
Increased awareness ENG opportunities	< 0.001	< 0.001	-	-	< 0.01	-
Increased interest in ENG study	< 0.001	< 0.01	-	-	< 0.01	-
Refined career goals	< 0.01	< 0.05	< 0.05	-	< 0.05	-

Note: 1st Gen = first-generation college student status; Advncd = prior experience with dual enrollment or Advanced Placement courses; Mdlty = instructional modality, either online or in person.

past. Thus, while increasing awareness of engineering opportunities, interest in study of engineering, and helping refine career goals was present for all populations, the impact in these areas was even more pronounced for Hispanic/Latinx students, females, and students with prior experience with advanced course options in high school. Mann Whitney U analysis was also completed for these queries (Q6_1, 2, 3 in Tables A3 to A8). The findings for significance mirrored those from the *t* test comparisons of pre- and post-instruction submissions. Ranking the three areas in which three significant differences occurred by *r* values from that with the strongest association (greatest impact) to least results in ethnicity, gender, and advanced course experience. The first two are strongly positive outcomes as persons identifying as Hispanic/Latinx and females are underrepresented in the engineering workforce. That students who had taken dual enrollment and/or Advanced Placement courses would also experience a stronger impact in these areas may be related to their ability to focus on and abstract from to apply the other content to their personal circumstances as they needed to invest less mental energy to comprehend and apply some of the principles covered and employed in the SBP due to prior learning achieved in advanced courses.

To directly assess program efficacy in respect to retention, institutional records were consulted to determine which of the students native to the University or who transferred to the University following SBP participation persisted in majors classified as an engineering discipline at the institution or completed an engineering degree (Table 3). Engineering degrees at the institution include Computer Science and Industrial Management and Applied Engineering Technology degree tracks.

Since the target audience was freshmen and sophomores, only the 2020 cohort members reached the point at which they all have been in a tertiary education setting for four years. Even with this caveat, the outcomes are strong. As percentages, 91.7% of the 2020 cohort has graduated with an engineering degree or is still enrolled, with the 2021 cohort at 90.0%, 2022 at 95.2%, and 2023 at 100%. The overall retention rate for engineering majors at the University was 77.2% in the four years prior to the grant and has been 67.8% during the four years in which the grant programming has been functioning. Thus, the SBP is associated with higher retention rates for

Table 3

Student Retention following the Summer Bridge Program

Year	**Counts**			**ENG Study**		**Graduated**	
	Native	***Transfer***	***Total***	***Count***	***%***	***Count***	***%***
2020	18	6	24	3	12.5%	19	79.2%
2021	16	4	20	11	55.0%	7	35.0%
2022	17	4	21	20	95.2%	-	-
2023	7	2	9	9	100%	-	-

former participants than is the case for their peers in engineering fields of study. Whether this is a result of participating in the program, is related to a strong commitment to engineering and thus interest in the program, or some other factor, cannot be known from the data available but the goal of increased retention was achieved and has remained consistent across four years of programming and for four different cohorts of students that varied in respect to ethnic, racial, and gender distribution, percentage of parties who are first-generation college students and with above average math skills and prior experience with dual enrollment or Advanced Placement courses. Even operating in two different instructional modalities, an adaptation caused by the COVID-19 pandemic, did not depress the retention numbers.

Limitations

The study was limited to one university, four moderate sized cohorts (none exceeded 50 persons), and to engineering disciplines. Some change, in many ways related to the COVID-19 pandemic, occurred in the programming that included shifting instruction online in the first two years and adding in person participation in the last two years. The initial adaptation to a fully online endeavor was completed in a short period of time as pandemic related restrictions on travel and in person meetings were instituted at the University near the mid-point of the Spring 2020 semester, and that may have impacted the initial offering. It prevented reliability testing the surveys as the urgent and labor-intensive immediate transition to online instruction for all courses and revision of all plans for the summer dominated faculty time. There were adjustments made to some programming with several topics dropped and several more added across the four years. There were also some faculty whose involvement did not span the entire four years of implementation but the core group of faculty remained the same the entire time. Despite these limitations, adequate-sized cohorts and samples were gathered to support statistical analysis each year, the patterns found were consistent year-to-year (Table A1) limiting the possibility that they occurred at random, and the combined data set was large enough to mitigated concerns related to programming variance year-to-year.

Conclusions

Evidence was gathered supporting the conclusion that the SBP as implemented works as a learning and skill advancement platform for prospective and early career engineering students. The presence of significant differences in student responses regarding their understanding and capability for all 29 queries in the combined four-year data set and for all but one comparison in the year-by-year data presents a strong case for efficacy. The presence of even greater advancement for subsets of the participants is an advantage rather than a shortcoming. This is especially the case in respect to Hispanic/Latinx students who reported impacts at a statistically significant and higher level than their non-Hispanic peers, fourteen of which were in the weak association range for impact and three of which were in the moderate association range. That a short-term summer program could have such an impact is an important finding for HSIs like the university at which the SBP was conducted but also for other institutions who seek to increase the potential for students from underrepresented groups to become engineers [21]. The outcomes for females, especially their significantly higher level of response that they had achieved greater awareness of engineering opportunities and increase their interest in engineering (r values placing both in the weak association range), should not go unnoted as females are underrepresented in engineering fields [21].

There was also evidence that the SBP improved retention of engineering students. This is an important outcome as there is a forecasted shortfall of engineers in the near future [34]. It is possible that the higher retention is an artifact of recruiting persons already committed to pursuing an engineering degree or some other factor. But even in that case, the SBP appealed to persons who had this characteristic which then resulted in higher retention as well as increased awareness of engineering opportunities, interest in study of engineering, and refined career plans.

Ability to generalize findings

The University at which the SBP was completed is a state university and Hispanic-Serving Institution with over 70% of its enrolled students identifying as Hispanic/Latinx. The institution in located in the southern quadrant of Texas and in a region with a high concentration of Hispanic residents. As such, the results should be generalizable to engineering education at all HSIs in the southwestern United States, over 300 institutions, and especially to those in a state bordering Mexico, which will have similar regional demographics. There is also the potential to generalize to other colleges and universities who would employ similar SBP activity in engineering, although impacts and outcomes might vary more than for HSIs due to differences in the participants recruited. Ability to generalize findings to disciplines other than engineering is more limited and diminishes the further the customary practices of the discipline depart from those common to engineering activity.

Recommendations

The authors recommend investigation of practical and financial viability of completing similar summer bridge programming for engineering students. It is the authors' opinion that the benefits of such programming outweigh any challenges or detriments, especially given the strong impacts found for females and parties identifying as Hispanic/Latinx, groups underrepresented in engineering study and professions.

Faculty time, institutional facilities and infrastructure, and support staff involvement are the primary costs of offerings of this type. Initial development of the programming and the first several years of implementation could be supported with grant funds, as was the case in the project described herein. The costs of a short-term summer program can be covered by a small award sought from any of a number of federal agencies, included as a subproject in a larger endeavor, or funded with a supplemental award on an existing grant. Other possible sources of funding are working in collaboration with the office of university advancement to seek sponsorship from industry and alumni and requesting financial support from university and college administrators. Institutions would, though, need to be prepared to absorb at least some costs in hopes of producing similar outcomes over an extended period, especially the very high retention rates of engineering students. With sufficient sized cohorts, these costs can be balanced, but achieving that balance depends on institution specific patterns. Combining several of the strategies for funding would result in the lowest direct cost to the institution over time.

At TAMUK, the future of this summer bridge program after NSF grant expiration can be discussed in the near future. The options that will be part of that discussion are: (1) seeking support from industry and alumni, (2) seeking additional grant funding as small awards, supplements to, or partial support from other related projects (with associated re-budgeting), (3) continuing the current summer bridge program by funding the program partially or wholly with student registration fees and perhaps limiting scholarship availability to financially-challenged participants, (4) enhancing our existing Introduction to Engineering freshman courses with some of the activities included in this summer bridge program, although this approach would exclude the community college portion of our bridge program cohorts, and (5) some combination of the above. .

Acknowledgement and Disclaimer

This work was funded by the National Science Foundation Award #1928611. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

[1] Texas A&M University-Kingsville. "Interactive campus data." https://www.tamuk.edu/oira/institutional-data/Interactive-Campus-Data.html (accessed.________

[2] U. S. Census Bureau. "QuickFacts: Texas." https://www.census.gov/quickfacts/TX (accessed.

[3] A. Enriquez, Langhoff, N., Dunmire, E., Rebold, T., Pong, W., "Strategies for Developing, Expanding, and Strengthening Community College Engineering Transfer Programs," presented at the ASEE Annual Conference and Exposition, 2018.

[4] M. Khasawneh, Bachnak, R., Goonatilake, R., Lin, R., Biswas, P., Maldonado, S.C., "Promoting STEM Education and Careers among Hispanics and Other Minorities through Programs, Enrichment, and other Activities," presented at the ASEE Annual Conference and Exposition, 2014.

[5] D. Martinez, Jacks, J., Jones, D., Faulkner, B., "Work In Progress – Recruiting Initiatives for Hispanic, First-Generation Students," presented at the 40th ASEE/IEEE Frontiers in Education Conference, 2010.

[6] N. Acevedo-Gil, Santos, R. E., & Solorzano, D. G. , "Examining a rupture in the Latina/o college pipeline: Developmental Education in California community colleges," Issues in Higher Education Policy and Practice, vol. 3, pp. 1-19, 2014.

[7] M. C. Vasquez Urais, "Predictors of sense of belonging among Latino men in community college," Doctorate, San Diego State University, 2014.

[8] G. A. Garcia, Patron, O. E., Ramirez, J. J. & Hudson, L. T., "Identity salience for Latino male collegians at Hispanic Serving Institutions (HSIs), emerging HSIs, and non-HSIs," Journal of Hispanic Higher Education, vol. 17, no. 3, pp. 171-186, 2016.

[9] C. E. Sibila, "Factors effecting intent to persist among Hispanic/Latino students attending a private non-profit nonresidential university," University of Miami, 2015. [Online]. Available: https://scholarship.miami.edu/discovery/fulldisplay/alma991031447934602976/01UOML_INST:ResearchRepository

[10] R. G. Mireles-Rios, N. M. , "What would your ideal graduate mentoring program look like?: Latina/o student success in higher education," Journal of Latinos and Education, vol. 18, no. 4, pp. 376-386, 2018.

[11] M. D. Preuss, Merriweather, S. P., Walton, S.D. & Butler-Purry, K. L., "Minority student preparation for STEM PhD study: Impact of NSF Bridge to the Doctorate programming," International Journal of Technology in Education and Science, vol. 4, no. 3, pp. 168-187, 2020.

[12] L. I. Rendón, Nora A., Ray, J. M., and Cabrales, J., "Realizing the PROMISE for Latinx STEM students," Laredo Community College, 2018.

[13] A. Carpi, Ronan, D.M., Falconer, H.M., and Lents, N.H., "Cultivating minority scientists: undergraduate research increases self-efficacy and career ambitions for underrepresented students in STEM," J. Research in Science Teaching, vol. 54, no. 2, pp. 169-194, 2017.

[14] M. R. Kendall, Choe, N.H., Denton, M., Borrego, M., "Engineering Identity Development of Hispanic Students," presented at the ASEE Annual Conference and Exposition, 2018.

[15] T. L. Strayhorn, "Work in progress: Diversifying STEM: Underrepresented students' experience in undergraduate research programs," presented at the 40th ASEE/IEEE Frontiers in Education Conference, 2010.

[16] M. L. Alexander, Hosur, M., Bailey, B., Hicks, D., Mogiligidda, R., Preuss, M., "Work-in-Progress: Hands-on Learning in a Summer Bridge Program Targeting Underclassmen and Transfer Students at an HSI," presented at the ASEE Annual Conference and Exposition, 2021.

[17] M. L. Alexander, Preuss, M., Bailey, B., Hicks, D., Mogiligidda, R., Hiremath, N., Liu, J., Zuo, L., Hosur, M. (2022, August). "Work-in-Progress: Project-based Learning in a Summer Engineering Program Implemented Virtually," paper presented at 2022 ASEE Annual Conference and Exposition, 2022.

[18] M. L. Alexander, Preuss, M., Bailey, B., Hicks, D., Mogiligidda, R., Soydas, V. B., Zuo, L., Hosur, M. (2023, August). "Work-in-Progress: Design Activities in a Summer Engineering Program Implemented in Both Virtual and Hybrid Modality," paper presented at 2023 ASEE Annual Conference and Exposition, 2023.

[19] Pew Research Center. "7 Facts about the STEM Workforce." https://www.pewresearch.org/fact-tank/2018/01/09/7-facts-about-the-stem-workforce/ (accessed.

[20] National Center for Education Statistics. "Fast facts: Degrees conferred by race and sex." https://nces.ed.gov/fastfacts/display.asp?id=72 (accessed.

[21] National Center for Science and Engineering Statistics. (2023). Diversity and STEM: Women, Minorities, and Persons with Disabilities. https://ncses.nsf.gov/pubs/nsf23315/report/introduction

[22] V. H. Hardebolle, Tormey, R., & Deparis, S. (2022). Gender, prior knowledge, and the impact of a flipped linear algebra course for engineers over multiple years. Journal of Engineering Education (Washington, D.C.), 111(3), 554–574. https://doi.org/10.1002/jee.20467

[23] K. L. Hardtke, Lang, C., & Nasiri, N. (2023). Gender Complexity and Experience of Women Undergraduate Students within the Engineering Domain. Sustainability (Basel, Switzerland), 15(1), 467. https://doi.org/10.3390/su15010467

[24] A. Mohammadi, Grosskopf, K., & Killingsworth, J. (2020). An Experiential Online Training Approach for Underrepresented Engineering and Technology Students. Education Sciences, 10(3), 46. https://doi.org/10.3390/educsci10030046

[25] S. M. Kolb, "Grounded theory and the constant comparative method: valid research strategies for educators," Journal of Emerging Trends in Educational Research and Policy Studies, vol. 3, no. 1, pp. 83-86, 2012.

[26] Lee, S. & Lee, D. K. What is the proper way to apply the multiple comparison test? Korean J Anesthesiol. 2018 Oct;71(5):353-360. doi: 10.4097/kja.d.18.00242.

[27] Boston University. (2021). PH717 Module 9 – Correlation and Regression: Evaluating Association between Two Continuous Variables. https://sphweb.bumc.bu.edu/otlt/MPH-Modules/PH717-QuantCore/PH717-Module9-Correlation-Regression/PH717-Module9-Correlation-Regression4.html

[28] Newcastle University. Strength of Correlation. https://www.ncl.ac.uk/webtemplate/ask-assets/external/maths-resources/statistics/regression-and-correlation/strength-of-correlation.html

[29] Texas A&M University - Kingsville. (2021). 2021-2022 Factbook: Enrollment data - student demographics by college. https://www.tamuk.edu/oira/institutional-data/factbook/factbook_enrollment.html

[30] Datatab. (2024). Mann Whitney U Test. https://datatab.net/tutorial/mann-whitney-u-test

[31] Khan Academy. Z Scores Review. https://www.khanacademy.org/math/statistics-probability/modeling-distributions-of-data/z-scores/a/z-scores-review

[32] Statology. (2021). How to Calculate a P-Value from a Z-Score by Hand. https://www.statology.org/p-value-from-z-score-by-hand/

[33] Khan Academy. (2018). Calculating a P-Value Given a Z Statistic. https://www.khanacademy.org/math/ap-statistics/xfb5d8e68:inference-categorical-proportions/xfb5d8e68:carrying-out-test-proportion/v/calculating-p-value-from-z-table

[34] Boston Consulting Group. "The US Needs More Engineers. What's the Solution?". https://www.bcg.com/publications/2023/addressing-the-engineering-talent-shortage

Appendix: Table A1

Comparison of Pre- and Post-Participation Survey Responses Regarding Engineering Concepts

Query	Period	Mean	SD	Mode	Sign.
I have been taught a design process specific to engineering.	Pre-2020	4.77	2.96	3	< .001
	Post-2020	8.19	1.74	8	
	Pre-2021	5.0	2.85	5	< .001
	Post-2021	8.45	2.16	10	
	Pre-2022	4.95	2.65	5	< .001
	Post-2022	8.46	1.62	10	
	Pre-2023	5.89	2.92	7	< .001
	Post-2023	8.46	1.46	10	
I have used an engineering design process to complete a project.	Pre-2020	4.65	3.41	4	< .001
	Post-2020	8.61	1.69	10	
	Pre-2021	5.84	3.09	10	< .001
	Post-2021	8.77	2.02	10	
	Pre-2022	5.47	3.06	7	< .001
	Post-2022	8.83	1.89	10	
	Pre-2023	6.35	3.13	10	= .003
	Post-2023	8.29	2.29	10	
I can describe the relationship of licensure for engineers and public safety in the use of products designed by engineers.	Pre-2020	2.36	2.44	1	< .001
	Post-2020	8.08	1.66	8	
	Pre-2021	5.21	2.73	5	< .001
	Post-2021	8.63	2.03	10	
	Pre-2022	4.50	2.82	7	< .001
	Post-2022	8.83	1.71	10	
	Pre-2023	4.70	2.82	3	< .001
	Post-2023	7.80	1.98	8	
I can explain how calculus is important in creating technological solutions to human problems or needs.	Pre-2020	4.56	2.86	6	< .001
	Post-2020	8.08	1.70	10	
I can explain how engineering is different than science and mathematics.	Pre-2020	5.48	2.80	7	< .001
	Post-2020	8.53	1.84	10	
	Pre-2021	7.21	3.09	10	= .004
	Post-2021	8.49	1.86	10	
	Pre-2022	5.80	1.96	5	< .001
	Post-2022	8.76	1.39	10	
	Pre-2023	6.29	2.78	8	= .001
	Post-2023	8.17	2.20	10	
I know several types of jobs or projects in which engineers in each of the major disciplines might be involved.	Pre-2020	6.13	2.84	7	< .001
	Post-2020	9.08	1.40	10	
	Pre-2021	6.89	2.45	8	< .001
	Post-2021	8.79	1.79	10	
	Pre-2022	6.41	2.64	7	< .001
	Post-2022	9.24	1.23	10	
	Pre-2023	6.61	2.87	10	= .001
	Post-2023	8.46	1.95	10	
I can explain how simultaneous equations apply in engineering.	Pre-2020	4.0	3.0	0	< .001
	Post-2020	7.47	2.80	10	
	Pre-2021	5.30	2.55	5	< .001

Appendix: Table A1

Comparison of Pre- and Post-Participation Survey Responses Regarding Engineering Concepts

Query	Period	Mean	SD	Mode	Sign.
	Post-2021	8.26	2.19	10	
	Pre-2022	4.68	2.38	4	< .001
	Post-2022	7.93	1.94	10	
	Pre-2023	4.82	2.70	3	= .001
	Post-2023	6.98	2.88	8	
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.	Pre-2020	4.90	2.93	7	< .001
	Post-2020	8.31	1.79	10	
	Pre-2021	5.69	2.84	5	< .001
	Post-2021	8.30	2.07	10	
	Pre-2022	4.88	2.66	7	< .001
	Post-2022	8.61	1.69	10	
	Pre-2023	5.55	2.72	5	< .001
	Post-2023	7.61	2.33	8	
I can correctly use the phrases statically determinate and statically indeterminate when describing engineering analysis.	Pre-2020	3.57	2.95	0	< .001
	Post-2020	7.14	3.03	10	
	Pre-2021	4.61	2.76	6	< .001
	Post-2021	8.0	2.14	10	
	Pre-2022	3.18	2.67	1	< .001
	Post-2022	7.55	2.01	10	
	Pre-2023	4.12	2.89	3	= .002
	Post-2023	6.34	3.11	7	
I can define computer science.	Pre-2020	4.74	3.02	5	< .001
	Post-2020	8.28	1.77	10	
	Pre-2021	6.11	3.01	10	< .001
	Post-2021	8.49	1.64	10	
	Pre-2022	4.82	2.74	3	< .001
	Post-2022	8.22	2.21	10	
	Pre-2023	5.56	2.75	7	= .009
	Post-2023	7.17	2.38	8	
I can describe what people who work in computer science do.	Pre-2020	4.31	2.93	4	< .001
	Post-2020	8.44	1.59	10	
	Pre-2021	5.57	3.10	8	< .001
	Post-2021	8.53	1.61	10	
	Pre-2022	4.82	2.75	3	< .001
	Post-2022	8.32	1.98	10	
	Pre-2023	5.70	2.99	7	= .007
	Post-2023	7.41	2.37	8	
I can give accurate examples of the types of projects and problems on which computer scientists work.	Pre-2020	3.87	2.45	5	< .001
	Post-2020	8.08	1.83	10	
	Pre-2021	4.89	2.85	8	< .001
	Post-2021	8.49	1.64	10	
	Pre-2022	4.24	2.54	3	< .001
	Post-2022	8.37	1.78	10	
	Pre-2023	5.70	2.82	4	= .01
	Post-2023	7.34	2.67	10	
I can describe the use of algorithms in computer science.	Pre-2020	3.38	2.78	0	< .001
	Post-2020	7.47	2.12	10	
	Pre-2021	4.59	3.00	3	< .001
	Post-2021	7.98	2.18	10	
	Pre-2022	4.10	2.99	3	< .001
	Post-2022	7.90	2.32	10	

Appendix: Table A1

Comparison of Pre- and Post-Participation Survey Responses Regarding Engineering Concepts

Query	Period	Mean	SD	Mode	Sign.
	Pre-2023	5.16	3.26	10	= .02
	Post-2023	6.85	2.92	10	
I could explain to a friend what it means to solve a computer science problem at the conceptual level.	Pre-2020	3.21	2.83	0	< .001
	Post-2020	7.36	2.07	7	
	Pre-2021	4.78	2.97	5	< .001
	Post-2021	8.04	2.17	10	
	Pre-2022	3.98	2.98	1	< .001
	Post-2022	7.88	2.22	10	
	Pre-2023	4.42	3.12	3	= .002
	Post-2023	6.69	3.04	10	
I can write a formula in Excel.	Pre-2020	6.94	2.86	10	< .001
	Post-2020	9.14	1.33	10	
	Pre-2021	7.59	2.57	10	= .003
	Post-2021	8.96	1.70	10	
	Pre-2022	6.86	2.90	10	< .001
	Post-2022	8.93	1.70	10	
	Pre-2023	7.39	2.96	10	= 0.12
	Post-2023	8.39	2.37	10	
I know several options for visualizing data in Excel.	Pre-2020	5.58	3.26	8	< .001
	Post-2020	8.63	1.68	10	
	Pre-2021	6.65	2.65	10	< .001
	Post-2021	8.61	1.92	10	
	Pre-2022	6.33	2.88	10	< .001
	Post-2022	8.71	2.20	10	
	Pre-2023	6.53	2.88	10	= .008
	Post-2023	8.27	2.56	10	
I know how to nest formulas in Excel.	Pre-2020	4.13	3.36	0	< .001
	Post-2020	7.86	2.33	10	
	Pre-2021	4.41	3.19	1	< .001
	Post-2021	8.0	2.36	10	
	Pre-2022	3.50	2.84	1	< .001
	Post-2022	7.95	2.66	10	
	Pre-2023	5.13	3.31	0	= 0.03
	Post-2023	6.78	3.15	10	
I have seen how 3D modeling software can be used in engineering design and analysis.	Pre-2020	5.73	3.51	8	< .001
	Post-2020	8.64	2.04	10	
	Pre-2021	6.55	3.30	10	= .002
	Post-2021	8.74	1.92	10	
	Pre-2022	6.30	2.95	8	< .001
	Post-2022	8.73	2.07	10	
	Pre-2023	7.0	3.13	10	< .001
	Post-2023	8.83	1.62	10	
I can explain how 3D modeling software serves as a communication tool for designers, manufacturers, and end users.	Pre-2020	6.10	3.22	10	= .001
	Post-2020	8.31	2.17	10	
	Pre-2021	5.98	3.08	5	< .001
	Post-2021	8.80	1.67	10	
	Pre-2022	6.43	2.99	9	< .001
	Post-2022	8.88	1.45	10	
	Pre-2023	6.66	2.96	10	= .001
	Post-2023	8.49	1.73	10	
I know the data science life cycle.	Pre-2020	2.19	3.10	0	< .001

Appendix: Table A1

Comparison of Pre- and Post-Participation Survey Responses Regarding Engineering Concepts

Query	Period	Mean	SD	Mode	Sign.
	Post-2020	7.06	2.47	10	
	Pre-2021	3.36	2.92	0	< .001
	Post-2021	8.04	2.24	10	
	Pre-2022	3.54	2.53	4	< .001
	Post-2022	7.40	2.36	8	
	Pre-2023	3.03	3.02	0	< .001
	Post-2023	6.0	3.21	7	
I can describe how geographic information systems relate to spatial data, attribute tables, and temporal data.	Pre-2020	3.63	3.45	0	< .001
	Post-2020	6.94	2.51	7	
I can define mathematical modeling.	Pre-2021	4.57	2.70	5	< .001
	Post-2021	8.22	1.70	10	
	Pre-2022	3.67	2.48	5	< .001
	Post-2022	7.40	2.06	10	
	Pre-2023	4.91	2.21	5	< .001
	Post-2023	7.10	2.51	10	
I can give examples of how mathematical modeling has been used to address engineering tasks/challenges.	Pre-2021	4.95	2.68	5	< .001
	Post-2021	8.27	1.90	10	
	Pre-2022	4.05	2.57	3	< .001
	Post-2022	8.00	1.93	10	
	Pre-2023	4.76	2.62	7	< .001
	Post-2023	7.17	2.40	7	
I can explain one or more ways of visualizing temporal and spatial data.	Pre-2021	4.38	2.85	5	< .001
	Post-2021	8.22	2.08	10	
	Pre-2022	4.03	2.69	4	< .001
	Post-2022	7.56	2.63	10	
	Pre-2023	4.81	3.07	3	< .001
	Post-2023	7.0	2.85	10	
I can explain how an understanding of chemistry is applicable in engineering.	Pre-2021	5.98	2.67	7	< .001
	Post-2021	8.47	1.87	10	
	Pre-2022	5.67	2.33	6	< .001
	Post-2022	8.37	1.75	10	
	Pre-2023	5.82	2.61	5	< .001
	Post-2023	7.91	1.99	8	
I can describe some ethical challenges that arise in engineering.	Pre-2021	6.65	2.52	5	< .001
	Post-2021	8.70	1.88	10	
	Pre-2022	5.85	2.39	8	< .001
	Post-2022	8.59	1.86	10	
	Pre-2023	6.62	2.71	8	= .01
	Post-2023	8.02	2.11	10	
I have experience working with a group of peers on an engineering project.	Pre-2021	7.39	2.45	10	= .006
	Post-2021	9.02	1.80	10	
	Pre-2022	6.17	3.44	10	< .001
	Post-2022	9.07	1.44	10	
	Pre-2023	7.30	2.72	10	= .01
	Post-2023	8.66	1.84	10	
I can explain the concepts waste and productivity as they apply in lean manufacturing.	Pre-2022	3.69	2.95	1	< .001
	Post-2022	8.46	1.84	10	
	Pre-2023	3.90	3.17	0	< .001
	Post-2023	7.12	2.64	9	
I can name at least three of the five core principles in lean manufacturing.	Pre-2022	2.97	3.17	1	< .001
	Post-2022	7.78	2.43	10	

Appendix: Table A1

Comparison of Pre- and Post-Participation Survey Responses Regarding Engineering Concepts

Query	Period	Mean	SD	Mode	Sign.
	Pre-2023	2.75	3.05	0	< .001
	Post-2023	6.15	3.27	8	

Note: Underlined values mark non-significant findings.

Appendix: Table A2

Comparison of Disaggregated Pre- and Post-Participation Survey Responses: Significant Differences

Query	Mdlty	Ethncty	Gender	1st Gen	Math	Advncd
I have been taught a design process specific to engineering.	-			-	-	
I have used an engineering design process to complete a project.	-		-	-	-	
I can describe the relationship of licensure for engineers and public safety in the use of products designed by engineers.			-	-	-	
I can explain how calculus is important in creating technological solutions to human problems or needs.	-		-	-		
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.	-				-	
I can explain how simultaneous equations apply in engineering.	-		-	-		
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.	-			-	-	
I can correctly use the phrases statically determinate and statically indeterminate when describing engineering analysis.	-		-			
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.	-					
I could explain to a friend what it means to solve a computer science problem at the conceptual level.	-					
I can write a formula in Excel.	-		-	-	-	
	-		-	-	-	

I know several options for visualizing data in Excel.						
I know how to nest formulas in Excel.	-		-	-		
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.	-		-			
I know the data science life cycle.	-			-		
I can describe how geographic information systems relate to spatial data, attribute tables, and temporal data.	-		-	-		
I can define mathematical modeling.	-			-	-	
I can give examples of how mathematical modeling has been used to address engineering tasks/challenges.	-					
I can explain one or more ways of visualizing temporal and spatial data.	-		-	-	-	
I can explain how an understanding of chemistry is applicable in engineering.	-					
I can describe some ethical challenges that arise in engineering.	-			-	-	
I have experience working with a group of peers on an engineering project.					-	
I can explain the concepts waste and productivity as they apply in lean manufacturing.		-	-	-	-	-
I can name at least three of the five core principles in lean manufacturing.	-		-		-	-

Note: Mdlty = Modality (online or in person); Ethncty = Ethnicity; 1^{st} Gen = First-generation college student standing; Math = Perceived ability in mathematics; Advncd = Prior completion of dual enrollment or Advanced Placement course(s); Light grey = p value of < 0.05 and > 0.01; Medium tone grey = p value of 0.01 to > 0.001, Black = p value of < 0.001

Table A3

Mann-Whitney U Results for Instructional Modality in the Bridge Summer Program

	At a distance via the internet		In person on campus			
	n	*Mean Rank*	*n*	*Mean Rank*	*Z*	*r*
Q3_1	132	79.66	32	94.22	- 1.63	-0.13
Q3_2	132	79.48	32	94.94	-1.80	-0.14
Q3_5	132	80.06	32	92.55	-1.39	-0.11
Q3_4	37		0			
Q3_3	131	77.18	32	101.75	-2.74**	-0.21
Q3_4A	93	64.20	32	59.50	0.65	0.06
Q3_22	93	62.91	32	63.27	-0.05	0.00
Q3_6	132	79.36	32	95.47	-1.89	-0.15
Q3_7	131	82.08	32	81.67	0.05	0.00
Q3_8	132	80.49	32	90.78	-1.14	-0.09

Q3_9	127	78.84	31	82.21	-0.37	-0.03
Q3_10	132	82.69	32	81.72	0.11	0.01
Q3_11	132	32.00	32	79.06	0.47	0.04
Q3_12	132	82.78	32	81.33	0.16	0.01
Q3_13	131	81.38	32	84.55	-0.35	-0.03
Q3_14	128	80.01	32	82.47	-0.27	-0.02
Q3_15	132	80.31	32	91.53	-1.36	-0.11
Q3_16	130	78.82	32	92.41	-1.61	-0.13
Q3_21A	93	62.97	32	63.09	-0.02	0.00
Q3_17	130	79.84	32	88.23	-0.94	-0.07
Q3_18	132	80.46	32	90.92	-1.24	-0.10
Q3_19	130	79.78	32	88.47	-1.01	-0.08
Q3_20	129	80.23	32	84.11	-0.43	-0.03
Q3_21	38		0			
Q3_23	95	65.26	32	69.17	-0.95	-0.08
Q3_26	50	35.94	32	50.19	-2.71**	-0.30
Q3_27	49	39.22	32	43.72	-0.85	-0.09
Q3_24	94	61.90	32	68.20	-0.89	-0.08
Q3_25	95	61.33	32	71.92	-1.60	-0.14
Q6_1	131	80.09	32	89.83	-1.12	-0.09
Q6_2	131	79.31	32	93.00	-1.60	-0.13
Q6_3	131	80.00	32	90.17	-1.19	-0.09

Note. *$p < .05$. **$p < .01$. ***$p < .001$

Table A4

Mann-Whitney U Results for Ethnicity

	Hispanic		Non-Hispanic			
	n	*Mean Rank*	*n*	*Mean Rank*	*Z*	*r*
Q3_1	105	95.95	59	58.56	5.06***	0.40
Q3_2	105	92.99	59	63.83	4.11***	0.32
Q3_5	105	87.22	59	74.10	1.78+	0.14
Q3_4	27	20.52	10	14.90	1.44	0.24
Q3_3	105	91.49	58	64.83	3.58***	0.28
Q3_4A	78	67.81	47	55.01	1.95+	0.17
Q3_22	78	71.60	47	48.73	3.49***	0.31
Q3_6	105	88.62	59	71.61	2.41*	0.19
Q3_7	105	92.22	58	63.50	3.82***	0.30
Q3_8	105	93.01	59	63.79	3.93***	0.31
Q3_9	104	90.79	54	57.75	4.38***	0.35
Q3_10	105	90.30	59	68.63	2.90**	0.23
Q3_11	105	91.32	59	66.81	3.29***	0.26
Q3_12	105	91.83	59	65.89	3.47***	0.27
Q3_13	105	90.74	58	66.18	3.27***	0.26
Q3_14	104	89.56	56	63.67	3.44***	0.27
Q3_15	105	91.37	59	66.71	3.61***	0.28
Q3_16	104	91.64	58	63.32	4.04***	0.32
Q3_21A	78	74.97	47	43.13	4.91***	0.44
Q3_17	105	91.21	57	63.61	3.71***	0.29
Q3_18	105	93.91	59	62.19	4.55***	0.36
Q3_19	105	91.88	57	62.39	4.10***	0.32
Q3_20	105	91.28	56	61.72	3.89***	0.31
Q3_21	28	22.46	10	11.20	2.78**	0.45
Q3_23	78	72.45	49	50.55	3.38***	0.30
Q3_26	49	42.07	33	40.65	0.27	0.03
Q3_27	48	44.12	33	36.45	1.46	0.16
Q3_24	78	72.74	48	48.48	3.82***	0.34
Q3_25	78	72.97	49	49.71	3.94***	0.35
Q6_1	105	93.67	58	60.88	4.56***	0.36
Q6_2	105	92.53	58	62.93	4.18***	0.33
Q6_3	105	89.38	58	68.65	2.91**	0.23

Note. +$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$

Table A5

Mann-Whitney U Results for Gender Identity

	Female		Male			
	n	*Mean Rank*	*n*	*Mean Rank*	*Z*	*r*
Q3_1	62	95.27	102	74.74	2.81**	0.22
Q3_2	62	91.24	102	77.19	2.00*	0.16
Q3_5	62	95.09	102	74.85	2.77**	0.22
Q3_4	18	19.97	19	18.08	0.55	0.09

Q3_3	62	93.04	101	75.22	2.43*	0.19
Q3_4A	44	72.78	81	57.69	2.27*	0.20
Q3_22	44	77.78	81	54.97	3.43***	0.31
Q3_6	62	97.07	102	73.64	3.36***	0.26
Q3_7	62	90.79	101	76.60	1.91+	0.15
Q3_8	62	94.17	102	75.41	2.55*	0.20
Q3_9	60	88.38	98	74.07	1.94+	0.15
Q3_10	62	100.27	102	71.70	3.86***	0.30
Q3_11	62	97.67	102	73.28	3.30***	0.26
Q3_12	62	95.57	102	74.55	2.84**	0.22
Q3_13	62	92.67	101	75.45	2.32*	0.18
Q3_14	61	92.42	99	73.16	2.61	0.21
Q3_15	62	86.94	102	79.80	1.06	0.08
Q3_16	61	87.67	101	77.77	1.43	0.11
Q3_21A	44	72.25	81	57.98	2.17*	0.19
Q3_17	62	91.46	100	75.32	2.21*	0.17
Q3_18	62	90.35	102	77.73	1.83+	0.14
Q3_19	62	88.95	100	76.88	1.71+	0.13
Q3_20	62	93.12	99	73.41	2.65**	0.21
Q3_21	19	19.50	19	19.50	0.00	0.00
Q3_23	44	78.60	83	56.26	3.37***	0.30
Q3_26	28	41.57	54	41.46	0.02	0.00
Q3_27	27	39.02	54	41.99	-0.54	-0.06
Q3_24	44	77.20	82	56.15	3.25***	0.29
Q3_25	44	74.99	83	58.17	2.78**	0.25
Q6_1	61	99.53	102	71.51	3.94***	0.31
Q6_2	61	95.48	102	73.94	3.07**	0.24
Q6_3	61	91.54	102	76.29	2.17*	0.17

Note. +p < .10. *p < .05. **p < .01. ***p < .001

Table A6

Mann-Whitney U Results for First Generation Student Status

	No		Yes			
	n	*Mean Rank*	*n*	*Mean Rank*	*Z*	*r*
Q3_1	72	88.61	86	71.87	-2.40*	-0.19
Q3_2	72	84.49	86	75.32	-1.36	-0.11
Q3_5	72	89.31	86	71.29	-2.57**	-0.20
Q3_4	14	19.18	23	18.89	-0.08	-0.01
Q3_3	72	83.55	85	75.15	-1.20	-0.10
Q3_4A	58	62.70	61	57.43	-0.85	-0.08
Q3_22	58	69.07	61	51.38	-2.86**	-0.26
Q3_6	72	84.29	86	75.49	-1.32	-0.10
Q3_7	72	84.62	85	74.24	-1.47	-0.12
Q3_8	72	87.51	86	72.80	-2.09*	-0.17
Q3_9	71	86.27	81	67.93	-2.61**	-0.21
Q3_10	72	88.65	86	71.84	-2.38**	-0.19
Q3_11	72	90.85	86	69.99	-2.95**	-0.23
Q3_12	72	89.87	86	70.82	-2.69**	-0.21
Q3_13	72	89.89	85	69.78	-2.84**	-0.23
Q3_14	72	89.76	82	66.73	-3.26***	-0.26
Q3_15	72	85.10	86	74.81	-1.59	-0.13
Q3_16	72	83.60	84	74.13	-1.43	-0.11
Q3_21A	58	65.08	61	55.17	-1.62	-0.15
Q3_17	72	84.29	84	73.54	-1.54	-0.12
Q3_18	72	82.83	86	76.71	-0.93	-0.07
Q3_19	72	86.64	84	71.52	-2.24*	-0.18
Q3_20	72	84.49	83	72.37	-1.70+	-0.14
Q3_21	15	20.77	23	18.67	-0.57	-0.09
Q3_23	58	69.29	63	53.37	-2.58**	-0.23
Q3_26	40	36.64	37	41.55	0.98	0.11
Q3_27	40	34.38	36	43.08	1.74+	0.20
Q3_24	58	66.47	62	54.91	-1.91+	-0.17
Q3_25	58	68.41	63	54.18	-2.56*	-0.23
Q6_1	72	82.60	85	75.95	-0.98	-0.08
Q6_2	72	84.17	85	74.62	-1.43	-0.11
Q6_3	72	86.65	85	72.52	-2.11*	-0.17

Note. +$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$

Table A7

Mann-Whitney U Results for Mathematical Skill

	Above average		Average or below			
	n	*Mean Rank*	*n*	*Mean Rank*	*Z*	*r*
Q3_1	121	86.21	43	72.06	1.76+	0.14
Q3_2	121	82.48	43	82.56	-0.01	0.00
Q3_5	121	88.36	43	66.02	2.77**	0.22
Q3_4	26	22.06	11	11.77	2.71**	0.44
Q3_3	120	86.27	43	70.09	2.00*	0.16
Q3_4A	93	64.48	32	58.69	0.80	0.07
Q3_22	93	67.98	32	48.53	2.67**	0.24
Q3_6	121	87.15	43	69.41	2.31*	0.18
Q3_7	120	88.02	43	65.20	2.80**	0.22
Q3_8	121	87.01	43	69.81	2.12*	0.17
Q3_9	116	85.99	42	61.58	3.01**	0.24
Q3_10	121	87.35	43	68.86	2.27*	0.18
Q3_11	121	87.11	43	69.53	2.16*	0.17
Q3_12	121	88.10	43	66.74	2.62**	0.20
Q3_13	120	88.19	43	64.72	2.87**	0.23
Q3_14	117	87.98	43	60.15	3.44***	0.27
Q3_15	121	86.08	43	72.42	1.83+	0.14
Q3_16	120	86.90	42	66.07	2.72**	0.21
Q3_21A	93	66.49	32	52.86	1.89+	0.17
Q3_17	119	89.53	43	59.27	3.76***	0.30
Q3_18	121	85.81	43	73.20	1.66+	0.13
Q3_19	119	87.74	43	64.22	3.02**	0.24
Q3_20	118	87.75	43	62.48	3.09**	0.24
Q3_21	27	21.11	11	15.55	1.42	0.23
Q3_23	95	66.82	32	55.64	1.54	0.14
Q3_26	64	41.27	18	42.33	-0.17	-0.02
Q3_27	63	41.18	18	40.36	0.13	0.01
Q3_24	94	65.21	32	58.47	0.95	0.08
Q3_25	95	65.94	32	58.23	1.16	0.10
Q6_1	120	85.07	43	73.43	1.49	0.12
Q6_2	120	83.65	43	77.40	0.81	0.06
Q6_3	120	82.15	43	81.59	0.07	0.01

Note. +$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$

Table A8

Mann-Whitney U Results for AP and/or Dual Enrollment Status

	I have not taken AP or dual enrollment class(es)		I have taken AP and/or dual enrollment class(es)			
	n	*Mean Rank*	*n*	*Mean Rank*	*Z*	*r*
Q3_1	52	66.15	112	90.09	3.14**	0.25
Q3_2	52	64.92	112	90.66	3.51***	0.27
Q3_5	52	61.02	112	92.47	4.13***	0.32
Q3_4	13	16.04	24	20.60	1.25	0.21
Q3_3	51	69.15	112	87.85	2.44*	0.19
Q3_4A	37	53.32	88	67.07	1.98*	0.18
Q3_22	37	47.62	88	69.47	3.14**	0.28
Q3_6	52	66.82	112	89.78	3.16**	0.25
Q3_7	51	63.47	112	90.44	3.48***	0.27
Q3_8	52	65.38	112	90.45	3.27***	0.26
Q3_9	48	65.10	110	85.78	2.66**	0.21
Q3_10	52	73.79	112	86.54	1.65+	0.13
Q3_11	52	67.38	112	89.52	2.88**	0.22
Q3_12	52	68.93	112	88.80	2.57**	0.20
Q3_13	51	71.36	112	86.84	1.99*	0.16
Q3_14	49	64.84	111	87.41	2.90**	0.23
Q3_15	52	67.10	112	89.65	3.20***	0.25
Q3_16	51	65.70	111	88.76	3.19***	0.25
Q3_21A	37	52.14	88	67.57	2.24*	0.20
Q3_17	50	69.71	112	86.76	2.22*	0.17
Q3_18	52	69.12	112	88.71	2.73**	0.21
Q3_19	50	64.00	112	89.31	3.40***	0.27
Q3_20	50	69.23	111	86.30	2.18*	0.17
Q3_21	13	16.96	25	20.82	1.03	0.17
Q3_23	39	46.17	88	71.90	3.76***	0.33
Q3_26	23	38.28	59	42.75	0.78	0.09
Q3_27	22	41.50	59	40.81	-0.12	-0.01
Q3_24	38	43.37	88	72.19	4.29***	0.38
Q3_25	39	50.50	88	69.98	3.13**	0.28
Q6_1	52	64.63	111	90.14	3.45***	0.27
Q6_2	52	68.73	111	88.22	2.68**	0.21
Q6_3	52	69.18	111	88.00	2.58**	0.20

Note. +$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$