ASEE 2022 ANNUAL CONFERENCE
Excellence Through Diversity
MINNEAPOLIS, MINNESOTA, JUNE 26TH-29TH, 2022 ASEE
Paper ID #37598

# Development of A Bootcamp for Freshman Student Success During COVID-19 Transition

## Noe Vargas Hernandez (Assistant Professor)

Dr. Vargas Hernandez is an Assistant Professor in Mechanical Engineering at UTexas Rio Grande Valley with expertise on product innovation and entrepreneurship, design thinking, sustainable design, biomedical design, and design education. He has ample experience teaching design and innovation to student teams currently at UTRGV, and previously at UT El Paso and Carnegie Mellon University. He is currently leading an effort to promote Innovation and Entrepreneurship at the departmental and College levels at UTRGV and collaborating with the College of Business. Dr. Vargas has various patents, and over 20 years of expertise and leadership in engineering design, creativity, and innovation.

## Eleazar Marquez (Dr.)

Dr. Marquez is a Lecturer in the Department of Mechanical Engineering at The University of Texas Rio Grande Valley. His research efforts focus on dynamics and vibrations of mechanical systems under various loads. The mathematical models developed include deterministic and stochastic differential equations that incorporate finite element methods. Additionally, Dr. Marquez research efforts focus on developing and implementing pedagogical methods in engineering education.

## Arturo A Fuentes (Professor) (The University of Texas Rio Grande Valley)

Dr. Arturo Fuentes is a Professor in the Department of Mechanical Engineering at UTRGV. He received his Ph.D. at Rice University. His research interest include engineering education, nanomaterials, and finite element analysis. He serves as the associate chair of his department and is involved in different student and faculty success initiatives in his college.

# Development of A Bootcamp for Freshman Student Success During COVID-19 Transition

Results from internal assessments show that passing rates in introductory courses as well as retention rates of first-year students in the College of Engineering and Computer Science at The University of Texas Rio Grande Valley, a predominantly Hispanic Serving Institution (HSI), significantly dropped with the advent of COVID-19. Such results and trends provide an overall perspective on the academic preparation of incoming students. There is a high concern that the necessary skill set (e.g., adaptability, persistence, and performance) of the new cohort, who are primarily underrepresented Hispanics from underserved and challenged communities from the Rio Grande Valley, is not optimal for the rigor of engineering education. To this end, an onboarding bootcamp for incoming and transfer students was created to bridge the transition from secondary education to higher education by priming students to overcome academic deficiencies, develop a critical skills portfolio, learn problem-solving techniques, build a sustainable community of mentoring support with faculty and students, and provide a template to sustain academic and professional success during their undergraduate education. This research-to-practice paper presents the bootcamps' design process steps: curricular analysis, identification of areas of opportunities, skills inventory, and blueprinting process, as well as its initial implementation in the mechanical engineering program. In this regard, the bootcamp was organized over a week span with hands-on engineering activities, faculty and student talks, and engineering lab tours; and was based on a design thinking approach. Daily activities were structured based on challenge-based instruction, innovation, design, and mentoring, and focused primarily on promoting critical thinking, being assertive in the face of adversity, making informed decisions, and prioritizing tasks. Results indicate that the bootcamp increased student confidence and established a valuable network system amongst other findings. Future work will focus on expanding the bootcamp to include students from other engineering and computer science departments and to offer the template to institutions with similar academic challenges.

## I. INTRODUCTION

This research-to-practice paper describes the development and implementation of the BOOST (Bolstering Opportunities to Orient Students in their Transition) onboarding bootcamp for incoming and transfer students in the College of Engineering and Computer Science (CECS) at The University of Texas Rio Grande Valley (UTRGV), a predominantly Hispanic Serving Institution (HSI) and one of the newest universities in the state of Texas and the United States.

### I.1 UTRGV Background

UTRGV consolidates the former University of Texas-Pan American (UTPA) with the University of Texas at Brownsville (UTB) and is now the second largest federally certified HSI of higher education in the United States, with a student population of more than 32,000, almost of 90% of whom are Hispanic, mainly Mexican American due to the region's proximity to Mexico. Statistical data defines UTRGV as follows: 1) ethnic enrollment, 88% Hispanics, 2) graduation rates: four years (Fall 2020: 24%), six years (Fall 2020: 46%), 3) commuter school, approximately 60% of student population, and 4) 84.6% of the student body receives financial assistance (e.g., 65% receive Pell Grants).

## I.2 Bootcamp Background

The bootcamp was conducted prior to the start of the 2021-2022 academic year and developed with the intention of adhering to the ongoing academic mission of UTRGV (Figure 1), which is to increase student persistence and self-efficacy in STEM fields, particularly serving the Hispanic RGV population. An area of opportunity for many Hispanic Serving Institutions (HSI) is retention rates. According to the retention rates from Texas Public Universities, UTRGV has an average freshman retention rate of 75% (Table 1), which is relatively low compared to institutions in Texas such as UT Austin (95%), Texas A&M University (92%), UT Dallas (88%), and the University of Houston (85%) but higher than many other institutions in the state.

**Table 1**. Texas Public Universities Freshman Retention Rates. Freshman entering in Fall 2015 through Fall 2018 [1].

| **Texas Public University** | **Average Freshman Retention Rate** |
|---|---|
| UT Austin | 95% |
| Texas A&M University | 92% |
| UT Dallas | 88% |
| University of Houston | 85% |
| Texas Tech University | 85% |
| University of North Texas | 79% |
| Texas State University | 77% |
| Texas Woman's University | 76% |
| Sam Houston State University | 76% |
| *UT Rio Grande Valley* | *75%* |
| UT El Paso | 74% |
| UT San Antonio | 73% |
| UT Arlington | 72% |
| Texas A&M Kingsville | 68% |
| Texas A&M Commerce | 66% |
| UT Tyler | 64% |
| Texas A&M Corpus Christy | 58% |
| Texas Southern University | 54% |

At UTRGV, statical measures indicate that retention rates of first year (full-time) students in the CECS have been at an average of 60% between the Fall of 2015 and Fall 2019 (Table 2). However, it is observed that in the wake of COVID-19, retention rates of incoming students fell to 53.3% in the Fall 2021, while retention rates within the institution similarly plummet to 60.9%. In this regard, passing rates in introductory courses in the UTRGV CECS have significantly dropped during the pandemic (Table 3). For instance, CIVE 1101 had passing rates in the Fall 2019 and Spring 2020 of 84.4% and 91.9%, respectively. However, this past academic year, which was surrounded by COVID-19, passing rates fell significantly to 69.9% in the Fall semester and 63.1% in the Spring semester. Similarly, passing rates in ELEE 1101 fell significantly from 75% in the Fall 2020 to 39.2% in the Spring 2021 semester. This data is concerning, and its trends give an overall perspective on the academic preparation incoming students previously attained, as well as the significant gap needed to be bridged between secondary education and higher education.

**Table 2**. UTRGV College of Engineering and Computer Science First Year Full Time Freshman 1st Year Retention Rate [1], [3]

| Cohort | Retention Within College | Retention Within University |
|---|---|---|
| Fall 2015 | 62.3% | 78.2% |
| Fall 2016 | 66.6% | 77.0% |
| Fall 2017 | 64.7% | 74.9% |
| Fall 2018 | 69.4% | 78.5% |
| Fall 2019 | 67.2% | 79.0% |
| Fall 2020 | 53.3% | 60.9% |

**Table 3**. UTRGV Passing Rates in Intro to Engineering and Computer Science Courses [3]

| Semester Course | Spring 2019 | Fall 2019 | Spring 2020 | Fall 2020 | Spring 2021 |
|---|---|---|---|---|---|
| CIVE 1101 - Introduction to Civil Engineering | 78.9% (n=83) | 84.4% (n=122) | 91.9% (n=74) | 69.9% (n=156) | 63.1% (n=84) |
| CMPE 1101 – Introduction to Computer Engineering | 68.8% (n=32) | 78.2% (n=110) | 48.2% (n=54) | 64.2% (n=95) | 75.0% (n=48) |
| CSCI 1101-Introduction to Computer Science | 62.8% (n=94) | 75.8% (n=244) | 70.2% (n=151) | 78.0% (n=282) | 67.6% (n=148) |
| ELEE 1101 – Introduction to Electrical Engineering | 72.2% (n=36) | 70.4% (n=81) | 63.3% (n=49) | 75.0% (n=88) | 39.2% (n=51) |
| MANE 1101 – Introduction to Manufacturing Engineering | 71.4% (n=21) | NA | 90% (n=20) | 68.0% (n=25) | 86.7% (n=15) |
| MECE 1101 – Introduction to Mechanical Engineering | 67.4% (n=95) | 75.2% (n=206) | 70.6% (n=85) | 69.3% (n=215) | 57.9% (n=76) |

To address this need, an onboarding pilot bootcamp was conducted prior to the start of the 2021-2022 academic year in the CECS with incoming and transfer students. Through this ongoing commitment, the long-term objective is to increase the number of professionals and graduate students in STEM related disciplines by promoting student centered programs such as Mentor/Coach and Undergraduate Professional Development Experience. In this regard, the CECS is synchronously implementing various initiatives with the intention of promoting student motivation and retention in engineering fields, particularly for incoming students. With the addition of the onboarding bootcamp, a targeted long-term goal is to increase six-year graduation rates and retain students throughout program completion.

In this context, 75% of the students who participated in the bootcamp passed the Introduction to Mechanical Engineering course (MECE 1101) in their first attempt in the Fall 2021. This is a moderate increase of 6% to the passing rate for the Fall 2020 semester. However, 100% of the students who participated in the bootcamp are still enrolled at UTRGV for their second semester and 85% continue with their ME major. If these trends persist, the retention number for the freshman year will be significantly higher than previous years (e.g., 53.3% freshman retention for the college and 60.9% across the institution for the Fall 2020).

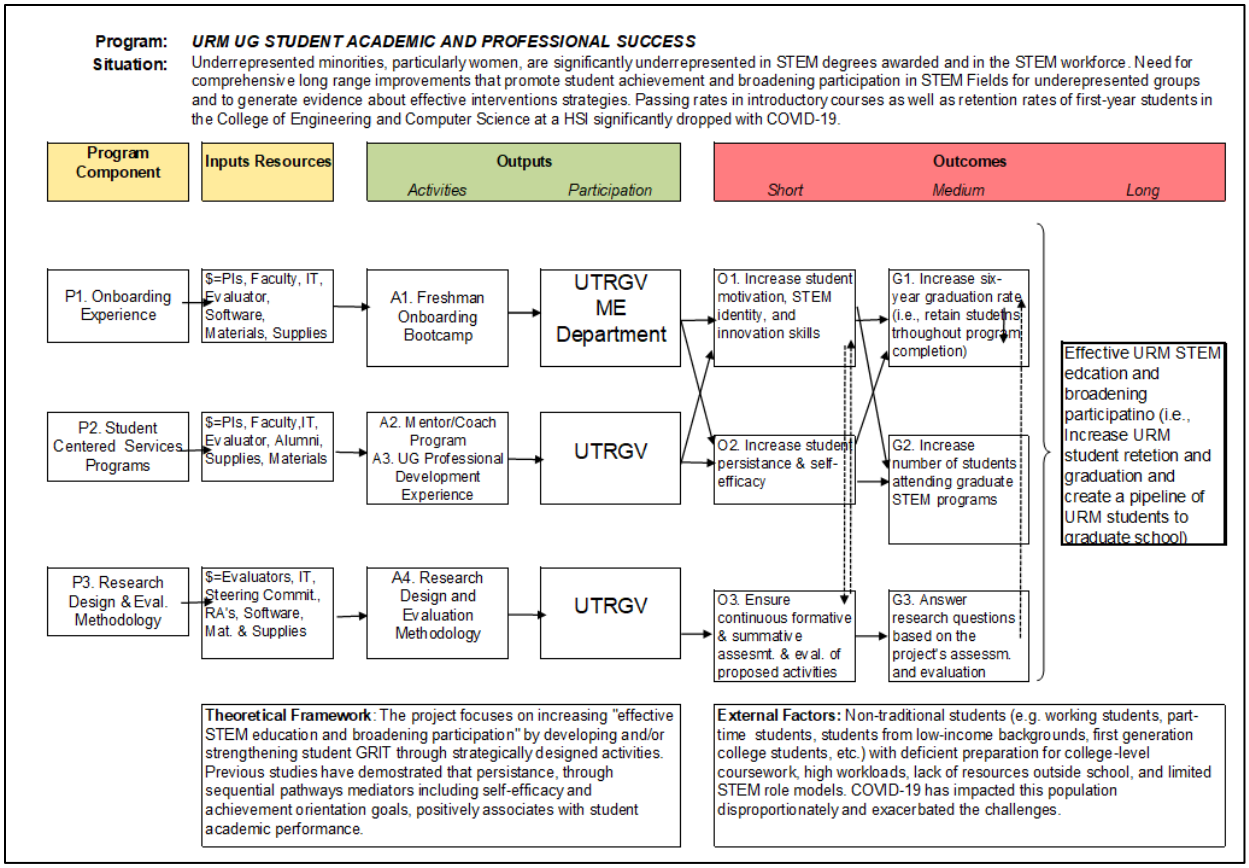


**Figure 1**. UTRGV and ME Department Long-term Mission for STEM Growth

## II. BOOTCAMP DESIGN

This section presents the development of the BOOST (Bolstering Opportunities to Orient Students in their Transition) bootcamp. For this purpose, a hybrid prescriptive-descriptive approach was followed using the Design Thinking steps as a prescriptive framework that was enriched with a previous pilot bootcamp experience (descriptive approach). The main reason for applying Design Thinking is its emphasis on people [2], while other reasons include its flexibility, solution-focus, and its evolution with context understanding. The Design Thinking steps include:

1. Frame a Question
2. Gather Inspiration
3. Generate Ideas
4. Make Ideas Tangible
5. Test to Learn
6. Share the Story

### II.1. Frame a Question.

In this first step, the main question that motivated this bootcamp was identified:

> How can a group of students be provided with a set of specific knowledge and skills for academic success?

Dissecting the question in more detail, the group of students refers to incoming freshman students to the CECS at UTRGV. This initial customer segment can later be expanded to include other STEM areas (e.g., College of Sciences), four-year institutions, community colleges, and high schools. The academic knowledge and skills necessary to succeed in higher education are missing from a vast majority of incoming students. This skill gap originates from the socioeconomic conditions of the RGV region, elevated percentage of first-generation college students (e.g., first person in the immediate family to attend college) lacking role models; and is exacerbated by the effects of the COVID-19 pandemic.

### II.2. Gather Inspiration.

Having framed the central question, inspiration for this study was attained by discovering what incoming students really need. The authors communicated with faculty members with the intention of understanding the needs and challenges of the incoming cohort, which included:

- Difficulty realizing when they are in trouble.
- Not asking for assistance.
- Weak study habits and learning networks.
- Lack of time management skills.
- Lack of involvement in engineering activities, organizations, or research.
- Lack of intentionality in planning for academic resume building and future career paths.

Similarly, the authors met with students to attain an alternative perspective. It was concluded that:

- Students realize curriculum vitae require skills outside the classroom.
- Students are cognizant of the ecosystem of student support at UTRGV, but are unaware how and when to access it.
- Students are familiarized with scholarship opportunities, research positions, internships, etc., but do not see themselves as sufficient candidates.
- Students seek employment in local service industry to become financially independent from their families instead of seeking loans or funding opportunities to focus on academics.

Based on this insight, the authors identified an initial set of skills and knowledge for the BOOST bootcamp [3] critical for academic success:

1. Be in control of building a resume by participating in extracurricular activities, plan academic career to effectively prepare for professional career or graduate studies. Simply taking courses is insufficient.
2. Build a network of support with students and/or faculty, create, or join a community of learning, group study, or club.
3. Be proactive, assess situations, identify and ask for help when problems arise. Take advantage of the help and support options. Asking for help does not imply students are weak.
4. Engage faculty during class and in research projects; they are committed to student success.
5. Be efficient with time.

### II.3. Generate Ideas.

After gathering additional information from the faculty and students to improve the understanding of the situation, a solution was proposed. It is clarified that the conditions described in this paper

represent a broader, complex problem that should be addressed from multiple perspectives. For example, several of the knowledge and skills can (and should) be addressed with outreach activities early (k-12) in the students. Similarly, student families play a critical role and should be considered as part of a general solution. However, the authors' perspective is focused on the entry point of incoming freshman and transfer students to the CECS.

How to effectively prepare students for academic success? The authors identified the following:

- There is an existing student support ecosystem at UTRGV, but students do not take full advantage of these valuable services.
- There are introductory courses (e.g., Intro to Mechanical Engineering); these can play an important role in addressing the skills gap but modifying courses can take some time and effort.
- Most of the desired skills are non-technical in nature (i.e., soft skills, professional skills, habits)

Based on these considerations, the authors envisioned two approaches:

- Curricular Spine: this means modifying existing courses such as Intro to Mechanical Engineering.
- Curricular Exoskeleton: this avoids modifying the existing curricular spine by offering educational experiences outside the coursework.

The proposed strategy is to create an educational experience following the curricular exoskeleton approach. This allows far more flexibility to quickly attempt multiple approaches and gain experience. In this case, the purpose of the "exoskeleton" is to assist the "spine" temporarily, allowing for the spine to be strengthened by absorbing these educational experiences into the courses to eventually "drop" the exoskeleton.

### II.4. Make Ideas Tangible.

The authors realized that a bootcamp was the best option to provide an intense, short-term, flexible, highly focused learning experience. Furthermore, this bootcamp should be engaging, dynamic, and hands-on. For this reason, the bootcamp was ideated as a series of challenges, more specifically, a different project challenges every day (see Figure 2). This follows the Challenge Based Instruction approach [4], [5], [6]; the authors have ample experience with CBI. The use of competitions has been documented as an efficient learning approach [7], [8]. As a starting point, the bootcamp would last one week where the students would work in teams on a different project every day, as well as be part of other activities such as faculty talks, student talks, lab visits, team building activities and opportunities for networking with other students and faculty. Each bootcamp activity (project, talk, etc.) would have specific learning objectives.

The authors followed the curricular Blueprinting approach to align the Student Learning Objectives, Learning Activities, and Assessment as shown in Table 4 below. Another important element of the bootcamp was student mentors, which were senior or graduate students that worked closely with student teams and provided mentorship, shared experiences, and assisted in initiating an effective academic network. Student mentors had groups between 4-6 students each day, and were responsible for introducing engineering activities, advising with technical problems, debriefing, and answering questions related to undergraduate curriculum, engineering organizations, and research opportunities.

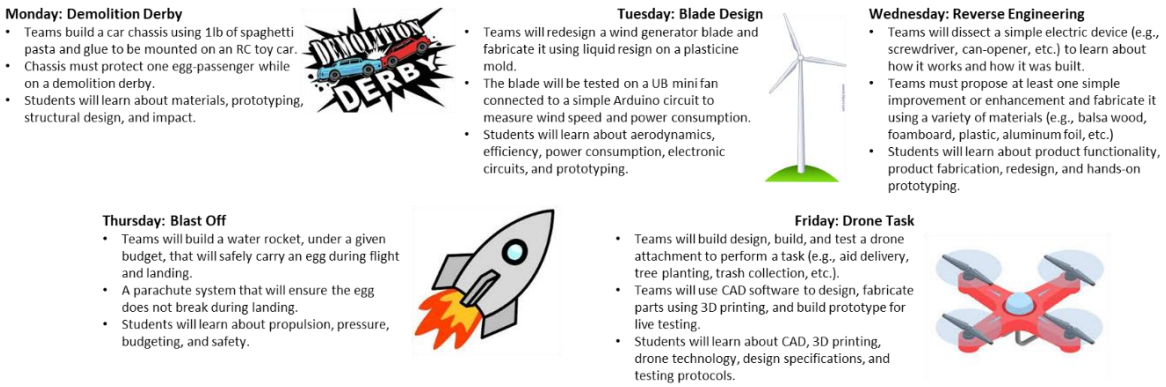


**Figure 2**. CBI Bootcamp Projects.

### II.5. Test to Learn.

A pilot of the BOOST bootcamp was offered to 30 students in the 2021 summer with great success and carefully following COVID-19 safety protocols. Details of this implementation can be found in the next section of the paper. This was a great opportunity to learn for the organizers (i.e., authors). The feedback of the student, both qualitative (anecdotal and focus groups), and qualitative (from surveys) was valuable to help improve the next bootcamp iteration.

### II.6. Share the Story.

The authors believe that the BOOST bootcamp can be useful for departments and institutions with similar needs. Currently the authors have received requests from other departments in the CECS and other Colleges at UTRGV to help develop similar bootcamp experiences. Based on this, the authors realized the need for a Facilitator Academy. If a department, college, or institutions wants to develop a similar bootcamp, we plan to invite their facilitators (faculty or graduate students) to be part of the bootcamp as student team mentors to closely experience the bootcamp and learn the logistics of the event. The bootcamp organizers would then meet with the facilitators in training every day after the bootcamp activities to debrief and help them blueprint their specific skills portfolio into their own bootcamp.

## III. RESULTS

### III.1 Pilot Bootcamp Testing and Validation

With the implementation of the week-long bootcamp, the objective was to further take early steps towards bridging the transition between secondary education and higher education, and thus familiarize participants with relevant leadership skills and problem-solving techniques needed to become an effective and innovative engineer. Further, the onboarding bootcamp was intended to alleviate academic and technical disorientation by providing a template to sustain success in higher education, which has been exacerbated by the COVID-19 pandemic. However, bridging transition from secondary education to higher education involves more than academic preparation, it requires the ability to adapt to unfamiliar cultural and social environments. Given that most of the current cohort attending UTRGV, as well as the incoming class, are first-generation college students,

navigating the academic path becomes a continuous challenge as various campus and departmental resources are simply unfamiliar to them.

**Table 4**. Activity-Learning Objectives-Assessment Alignment.

| Activity | Learning Objectives | Skills | Assessment |
|---|---|---|---|
| Monday: Demolition Derby | • Resourcefulness<br>• Time Management<br>• Finding Alternative Plans<br>• Open Mind, Listening to Others | **Creativity**: ability to generate ideas that are novel, varied, abundant, and functional. | **Ideation Metrics**: developed by Vargas Hernandez et al. the metrics are quantity, quality, novelty, and variety. |
| Tuesday: Blade Design | • Strategizing<br>• Considering Multiple Factors<br>• Taking Informed Decisions<br>• Explaining Decisions<br>• Communicating Alternatives | **Decision Making**: ability to organize info, define options, evaluate choices, tradeoffs, and communicate decision. | **Self-efficacy** student surveys: students will evaluate their own perceptions. |
| Wednesday: Reverse Engineering | • Problem Framing<br>• Effective Communication of technical ideas to non-engineers; Writing Skills<br>• Conflict Management | **Problem Framing**: ability to understand, define and prioritize complex problems. | **Peer Reviews**: students will evaluate their own work, individually and as a team. |
| Thursday: Blast Off | • Safety Considerations<br>• Prioritization of Information<br>• Project Management<br>• Delegating<br>• Deadlines and Responsibility | **Project Management**: ability to break a problem into tasks and schedule them to meet a required deadline. | **External Reviews**: faculty and senior students will be invited to provide real-time direct feedback to students on their project plans. |
| Friday: Drone Task | • Design Creativity<br>• Literature Review<br>• Time Management<br>• Conciseness<br>• Presentation Skills | **Oral Communication**: ability to deliver an effective and engaging presentation. | **Evaluation Rubrics**: Faculty and TAs will use these rubrics to evaluate student presentation skills. |
| Overall Bootcamp | | | **Surveys**: Pre and post bootcamp experience surveys.<br>**Exit interviews**: this will help collect anecdotal feedback.<br>**Focus groups**: selected students give their feedback. |

With the pilot bootcamp, participants had a unique opportunity of enlarging their academic and personal interests beyond their local communities by being exposed to a range of activities promoting: 1) engineering leadership, innovation, and technology, 2) teamwork, 3) summer internships, 4) undergraduate research, 5) engineering clubs and leadership, and 6) faculty interaction. The activities for the bootcamp were built on Challenge-based Instruction (CBI), which is a pedagogical approach to foster critical thinking skills. As described in Bransford *et al*. [6] seminal work "How people learn: Brain, mind, experience and school" the design of effective learning environments requires the "rethinking of what is taught, how it is taught, and how it is assessed." In this regard, the following skills were targeted on the bootcamp:

1. Critical thinking

2. Being assertive in the face of adversity
3. Finding motivation in adverse situations
4. Asking for help in a timely manner
5. Making informed decisions
6. Continuously adapt to unexpected changes
7. Prioritizing tasks and scheduling time

### III.2 Methods

The primary method of data collection in this study consisted of 1) a pre-bootcamp survey was distributed to a total of 30 students who attended the weekly program, and 2) focus group student interviews at the end of the bootcamp. The intent of the pre-bootcamp survey was to gage the academic background of the incoming cohort prior to the start of the program, while the post-bootcamp questions were developed to assess the degree to which participants found the bootcamp activities useful, as well as to find areas of improvement. In this regard, pre-bootcamp questions were administered electronically, while the post-bootcamp interviews were conducted by the bootcamp mentors, which collected student data, and ranged between 4-7 students per group. The nature of the interviews stimulated conversation amongst students centered on their unique experiences related to the bootcamp.

### III.3 Quantitative Results - Findings

#### Pre-Bootcamp Survey Results

For the pre-bootcamp survey, three questions were posed:

- Pre-Bootcamp Question 1: Question one sought to elicit free responses by asking whether participants were first-generation college student or not: *Are you a first-generation college student?*

According to the responses, 43.3% of the bootcamp students identified as being first-generation college students, while 20% responded by saying 'maybe/did not know.' These statistics reveal that more that 50% of students from the bootcamp may be unfamiliar with various academic aspects such as navigating the college environment, planning undergraduate education, or being acquainted with campus or departmental resources needed to experience success as an undergraduate student.

- Pre-Bootcamp Question 2: Question two sought to understand whether students knew about the engineering programs at UTRGV. *I have appropriate knowledge about engineering at UTRGV.*

According to the collected data, 10% of the population 'Strongly Agreed' about knowing about the engineering programs at UTRGV, while 13.3% 'Agreed' on the matter. However, 36.7% of the students 'Disagreed' on knowing about engineering, and 40% were 'Neutral.' These statistics inform that the majority of the incoming students pursuing engineering related fields are unaware on the expectations required to complete such demanding careers (Figure 3).

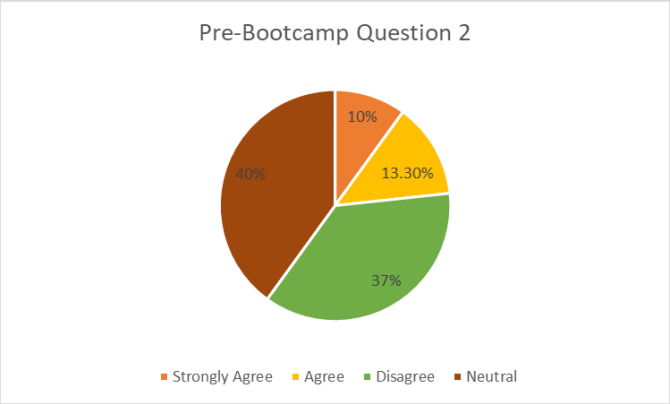


**Figure 3**. Pre-Bootcamp Question 2

However, when asked about '*being confident about majoring in engineering*,' 96.7% of the incoming students displayed confidence in engineering related fields, while 3.3% remained neutral. This data reveals that despite lacking appropriate knowledge about engineering at UTRGV, the majority of the students have a strong inclination towards pursing engineering.

- Pre-Bootcamp Question 3: Question three sought to inquire about the previous high school experience working with engineering relate projects: *I have experience on working on engineering related projects/activities*. According to the responses (Figure 4):
  Strongly Agree – 20%
  Agree – 46.7 %
  Disagree – 10%
  Neutral – 20%
  Strongly Disagree – 3.3%

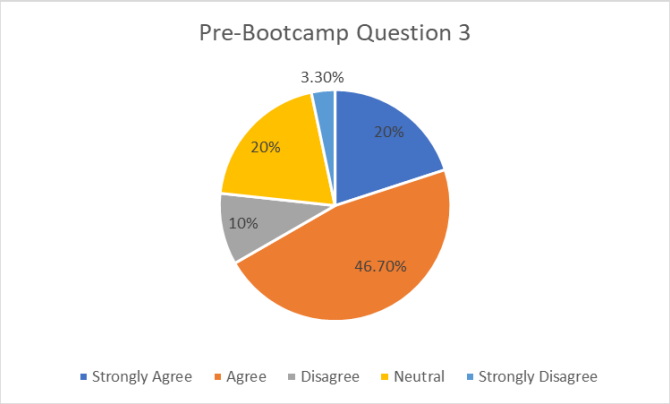


**Figure 4**. Pre-Bootcamp Question 3

Based on the data, 67.7% of the students had experience with some sort of engineering related projects or activities during their secondary education. In this regard, students also responded about their previous experience related to working with any sort of computer-aided design software. Only 26.7% of the students participating in the onboarding bootcamp 'Agreed' about having

experience with such engineering software, while the rest of the population did not have any knowledge in this matter.

In a similar context, students were surveyed prior start of the bootcamp regarding the various skills necessary to succeed in engineering disciplines. When asked '*I feel that I am resourceful (able to find quick and clever ways to overcome difficulties*,' 76% of the students 'Agreed,' while the rest were 'Neutral' about their ability to overcome difficulties in challenging situations. Result clearly indicate a strong inclination on the students' behalf to use various types of resources to overcome difficulties. Similarly, when asked '*I have the ability to find alternative plans when obstacles arise*,' 17% of the students 'Strongly Agreed', 56% 'Agreed,' 3% 'Disagreed,' and 24% remained neutral.

An additional question sought to elicit the free responses by asking '*I am efficient managing my time (ability to use one's time effectively or productively, especially at work*.' Student responses were as follows:

- Strongly Agree – 17%
- Agree – 52%
- Disagree – 7%
- Neutral – 24%

It is evident by the responses that more than half of the bootcamp participants perceive that they can manage time efficiently when given a particular task, which is a skill needed as a student and as practicing engineer. However, this frame of thinking may be sort of pronounced given their inexperience at the college level.

**Post-Bootcamp Survey Results**

Prior to the last engineering activity on the final day of the bootcamp, students were asked about their confidence with various skills needed in engineering. The survey questions and results were as follows:

**1.** *I feel I can be a creative designer (I can generate novel and varied ideas)*
According to the results of this question, 28% of the students 'Strongly Agreed' on their ability to be a creative designer, 64% 'Agreed,' and 8% remained neutral. The findings reveal that after a week span of working in time-constraint engineering activities, students could think of creative solutions to their challenges.

**2.** *I am able to perform sufficient literature review on technical topics (find relevant information online and in books, journals, etc.)*
Several engineering activities throughout the week included performing literature or online reviews of various products. The idea was to have a holistic understanding of the product and be able to find creative solutions to enhance the product. To this end, results of the survey include:

- Strongly Agree – 24%
- Agree – 28%
- Disagree – 4%
- Neutral – 44%

**3.** *I have sufficient time management skills (I can plan activities efficiently)*
Since every engineering activity in the bootcamp was time-limited, students were asked on the last day to provide feedback on their time management skills, particularly when working in groups. More than 85% of the students responded by agreeing to having time management skills, which is significantly higher than what students felt before the start of the bootcamp. These results reveal that time management skills may develop over time. There may be students who believe their management skills are not strong, however, they may respond differently under pressure.

**4.** *I can be concise when presenting and explaining my projects, ideas, and work (I can efficiently convey my message to others)*
Part of the bootcamp activities included having short presentations after each engineering competition. Groups were given seven minutes at most to present on the various aspects, as well challenges, surrounding their projects. However, after the survey, 36% of the students felt their presenting skills, as far as explaining project, ideas, and work, were not very concise.

### III.4 Qualitative Results – Open-ended Questions

Based on the data collected from the bootcamp, it was evident that [student] participants had an overall positive experience from the piloted program. It was repeatedly mentioned that incoming and transfer students were unsure on what to expect before the bootcamp, however, their perspective changed when the enthusiasm of their peers was displayed on the first day. The students commented as follows:

> "*The environment was nice since we could meet people before the first day of class, make new friends, the enthusiasm motivated us to compete more with others*"
> "*Students did not expect other students to be as enthusiastic as they were and the faculty to be as involved as they showed to be*"

These results indicate that the social environment of the onboarding bootcamp allowed students to feel comfortable since their arrival, which consequently encouraged engagement with their peers, mentors, and faculty members.

One student echoed these comments by stating the following:

> "*The faculty and mentors were very approachable and want us to succeed since day one*"

The bootcamp was designed with the intention of facilitating networking amongst students, mentors, and faculty members that would lead to identifying resources and opportunities within the ME Department and CECS. Students were asked to reflect on the aspects of the program which they enjoyed the most. One student stated that the piloted program served as a medium to establish new acquaintances, particularly the new cohort, before the start of the semester. The following statements illustrate students' overall appreciation of the onboarding program:

> "*Meeting with new people and teams*"

"*Student engagement and discussion*"

"*Working with different people and new projects every day*"

"*The rotation of activities was perfect since we could learn a little bit of everything and motivated us to learn more about the mechanical engineering field*"

As disclosed by the feedback, it was evident that the incoming class enjoyed networking with each other as well as with the activities provided in the bootcamp. This data further affirms the significance of establishing such an onboarding program before the start of the semester, in which students may establish affiliations that will be beneficial for the remainder of their undergraduate education.

Results further manifest students' appreciation for the involvement of the faculty members during the duration of the bootcamp, particularly, with those organizing the bootcamp as well as those participating in research talks or lab tours. The following statements reflect the students' satisfaction with the involvement of the faculty:

*"Faculty is approachable, they look forward for you to succeed."*

"*I was pleased to see the faculty so involved"*

*"I was inspired from the real-life experiences of the faculty members"*

*"Dr. X's presentation was inspiring with thinking outside the box"*

A UTRGV graduate student who served as a bootcamp mentor also echoed these comments by stating:

*"All the talks were great in my opinion. Everything I would tell myself as a freshman was discussed throughout the bootcamp"*

It was apparent that the faculty members had an impact on the bootcamp participants, not only from an academic perspective, but also from real-life experiences, which resonated favorably with the majority of the first-generation college students. In a similar context, student mentors participated during the duration of the bootcamp, particularly in providing brief presentations pertaining to internship opportunities, campus life and resources, undergraduate research, and engineering clubs and organizations. These scheduled presentations were well received by the incoming class:

*"It was really helpful, you get to know more about campus, student life, organizations, labs and the departments"*

*"Engineering organizations was very enjoyable"*

*"Enjoyed X's talk about internships and how not everything is about good grades but about experiences"*

*"Mentors were really helpful throughout the camp, answer all the question regarding the school, program, sports, organizations, exam etc."*

Lastly, students were asked to reminisce on their overall experiences throughout the onboarding bootcamp. Student feedback reflects positive experiences with their engagement with engineering activities, faculty and student talks, and lab tours. The following remarks indicate the advice attendees would give to future participants:

> *"Always give your fullest and don't hesitate to ask for help because everyone is here to help"*
>
> *"It's important to get involved with people & invest in yourself"*
>
> *"Get to know the engineering building and how to use a program before the first day of class"*
>
> *"It will help you know the campus"*
>
> *"Helped me contribute with own ideas & create something"*
>
> *"I learned to use different resources and facilities"*

Mentors also provided their opinion regarding their overall experience with the bootcamp:

> *"I overall really enjoyed participating in the mentor program as it was very fulfilling in getting to assist incoming students and motivating them fully apply themselves in the program"*
>
> *"Overall, for a first run at this program I think it was an amazing opportunity and should continue to be an option every year. I very much enjoyed my time with the program and with being able to see the students' progress through the days"*

**Bootcamp Areas of Improvement**

Based on the data collected from the bootcamp, students further recommended several areas in which the onboarding program could be improved. According to the assessment, students felt new groups could have been created more often throughout the week:

> *"Changing groups more often to meet more people"*
>
> *"Group diversity & swap more"*
>
> *"Switching group everyday so that they will know more people and feel comfortable when school starts"*
>
> *"Wanted more interaction among students"*

One mentor conjointly echoed these remarks and stated the following:

> *"Changing teams every day might work good, but we lose the opportunity to develop stronger mentor-mentee bonds"*

These comments are imperative as students were scheduled to work in teams during the engineering activities to promote team dynamics and networking, and thus have opportunities to maximize local resources to enhance and sustain their academic, technical, and social development. In this regard, students were arranged in groups (e.g., between 5-7) the first day of the bootcamp and remained with the corresponding group the first two days. On Wednesday,

nevertheless, participants were partnered with different students with the intention of expanding their social network. One mentor recommended having smaller groups so that everyone could participate in the hands-on activities.

An additional improvement for the bootcamp, according to the feedback, related to granting supplementary time to work on engineering activities. Students commented as follows:

> *"I wanted more time to work on the project. I would prefer to be notified of the project requirements that way we can work on it much sooner and get several ideas in discussion"*

> *"More time like an additional week for a challenge without the help of the mentors so we can develop networking skills and how to be resourceful. Additionally, more activities throughout the day so we can expect what is to be an engineer on the making and develop more aspects to become a successful engineer"*

Other students felt that it would be enjoyable having the opportunity of iterating on their projects to improve the overall performance, and thus understand the engineering process in more technical depth, while others stated that incorporating more outdoor activities would enhance their appreciation towards the bootcamp.

> *"Allow more of the engineering process, more iterations and testing"*

> *"More outdoor activities. Blast off was the most enjoyable activity to the students. More outdoor activities can make the boot-camp more enjoyable to them"*

Lastly, there was a minor modification implemented by the bootcamp organizers halfway through the program. It involved ending the bootcamp two hours in advanced due to COVID safety. This minor, time adjustment resonated extremely well with students and mentors. Thus, it was acknowledged that reducing the total time of the bootcamp allowed students to better focus throughout the day.

> *"End time was good, shorter time frame helps with concentration"*

One mentor echoed the posture of the students by stating the following:

> *"The reduction in length of each daily session was welcomed and students felt more focused on the daily activities and presentations with the reduced timeframe"*

## IV. REPLICATION TEMPLATE

As previously discussed, a very successful pilot bootcamp was conducted in August 2021, before the start of the Fall semester. This pilot was a 5-day bootcamp with incoming freshman majoring in Mechanical Engineering students. Based on the pilot implementation, the authors learned that the work, knowledge, resources, and experience required to have a successful bootcamp is very significant. This section provides a replication template along some of the important lessons learned to facilitate faculty and staff successfully implement a bootcamp to address different types

of skill gaps of incoming freshman students. Finally, we briefly describe the ongoing related work at UTRGV.

For faculty and staff interested in implementing a similar bootcamp, Table 5 provides a sample day schedule for facilitator to continue the bootcamp planning. While the week bootcamp is organized around different student challenges, the suggested bootcamp schedule has further important elements to facilitate the networking of students and faculty and the identification of resources and opportunities in the Department and College. These elements include events where the students interact with peers, graduate students, faculty, staff, and facilities.

To further assist the design and the implementation of the bootcamp, Table 4 provides a starting point of specific set of aligned skills, learning objectives, activities, and assessments which are accomplished through the introduction of specific major challenges.

**Table 5**. Tentative Day Schedule

| TIME | ACTIVITY |
|---|---|
| **MORNING - DRONE Challenge** | |
| 9:00 - 9:10 | Icebreaker |
| *Walk to Computer lab EENG 2.628* | |
| 9:15 - 9:25 | **Drone Challenge**: Background |
| 9:25 - 9:30 | Instructions |
| 9:35 - 9:45 | Design – Planning |
| 9:45 - 11:00 | Develop CAD model - 3D printing |
| 11:00 - 11:10 | **Break – snacks** |
| *Walk outside* | |
| 11:15 - 12:00 | Drone Testing |
| 12:05 - 12:50 | **Lunch Break** |
| **AFTERNOON** | |
| 1:00 - 1:45 | Students prepare Presentations |
| 1:50 - 2:50 | Student group presentations |
| 2:50 - 3:00 | **Break - snacks** |
| 3:00 - 3:30 | Faculty Talk - Research |
| 3:30 - 4:00 | Undergraduate Student Panel |
| 4:05 - 4:15 | MECH -LAB XXXX Tour |
| 4:20 - 4:45 | Debrief - Farewell |

Several relevant lessons included the importance of:

- Engaging hands-on projects that further promote understanding of what the engineering major involves, learn how to work in groups, and balancing student collaboration and competition
- Significant time invest and attention to detail to demonstrate genuine care for the students and their academic and professional success (e.g., flexible schedule to react to students interests and needs
- Selecting student role models for near-peer mentoring for students to engage, open, and ask questions.
- Mentoring activities to promote early academic planning and academic success.
- Students understanding of how to compete in the marketplace and the specific steps for professional development and to build the resume (e.g., undergraduate research, student design competitions, volunteering, student organizations, …)

The next bootcamp will be offered in Fall 2022 which will not only have an increased student participation but will begin training facilitators from other departments in the College of Engineering and Computer Science. As part of their training, the facilitators from other departments will review and criticize the ME department learning objectives, skills, assessment, and major specific challenges and provide feedback. They will then determine the necessary refinements needed for their appropriate majors. In the following summers, the authors would like to assist other faculty and staff to replicate the bootcamp success in other UTRGV Colleges (e.g., Sciences), Community Colleges and High Schools in the RGV area.

## V. CONCLUSION AND FUTURE WORK

The implementation of the onboarding bootcamp will serve as opportunity for incoming freshman and transfer students to build a sustainable community of support, guidance, and mentorship with 1) program TA's, which are current ME students at UTRGV, and 2) ME faculty. Through team collaboration and interpersonal interaction throughout the boot camp, it is believed that students will have opportunities to maximize local resources to further enhance and sustain their academic, technical, and social development. The idea is for the incoming cohort to build networks that will extend beyond the boot camp and serve as an immediate support when inquiring about the curriculum, applying for internship and/or research opportunities, getting involved with engineering clubs, or finding strategies to succeed in the classroom. Results show that 75% of the students who participated in the Bootcamp, passed the Introduction to Mechanical Engineering course (MECE 1101) in their first attempt in the Fall 2021. This is a moderate increase of ~6% to the passing rate for Fall 2020 semester. However, 100% of the students who participated in the camp are still enrolled at UTRGV for their second semester and 85% continue with their ME major. If these trends persist, the retention number for the freshman year will be significantly higher than previous years (e.g., 53.3% freshman retention for the college and 60.9% across the institution for Fall 2020).

A further impact of the bootcamp is to instill fundamental skills in its participants, which will enable them to thrive in an academic environment with challenges and limited resources. By focusing on developing skills such as critical thinking, asking for assistance, prioritizing tasks, time management, and making informed decision during the bootcamp, it is believed that incoming

students will be prepared to be innovative as they encounter similar challenges once they start studying engineering.

The short-term goal of the piloted bootcamp is to increase the number of ME student participants and invite instructors from other departments in the CECS to serve as facilitators and help them replicate the bootcamp. During its first implementation, the bootcamp initiated exclusively with students from the ME discipline, however, the vision is to expand the onboarding program to every department in the CECS once every aspect surrounding the initiative is well-established. Given the initial stage of the piloted program, the entire cohort of incoming and transfer students (approximately 200 total) were encouraged to apply, however, only 40 students were selected based on a first-come first-serve basis. Since the bootcamp was not mandatory, not every single student admitted to the CECS program participated. However, videos of bootcamp activities and student interviews were documented as a medium to promote the upcoming bootcamp and encourage more participation. In this regard, the objective is to invite students who have completed the bootcamp as mentors for the subsequent bootcamp. The idea is to build a sustainable community of support, guidance, and mentorship throughout four years of study.

## REFERENCES


[1] US News, 2022, "U.S. News Education Rankings Colleges," [Online]. Available: https://www.usnews.com/best-colleges/rankings [Accessed Feb. 13, 2022].

[2] IDEO, 2022, "What is Design Thinking?" [Online]. Available: https://www.ideou.com/blogs/inspiration/what-is-design-thinking [Accessed Feb. 13,2022].

[3] Vargas Hernandez, N., Fuentes, A., & Crown, S. (2018, October). Effectively Transforming Students through First Year Engineering Student Experiences. In 2018 IEEE Frontiers in Education Conference (FIE) (pp. 1-5). IEEE.

[4] A.A. Fuentes, R. Freeman, S. Crown, Desegregated Learning: An Innovative Framework for Programs of Study, New Directions for Teaching and Learning, Wiley, 2006, pp 17-31.

[5] A.A. Fuentes, S. Crown, R. Freeman, Human Bone Solid Mechanics Challenge Functionally Graded Material Structure with Complex Geometry Loading, AC 2001-2056, ASEE 2008 Conference Proceedings.

[6] Bransford, J. D., Brown, A. L., and Cocking, R. R. (eds.). How People Learn: Brain, Mind, Experience, and School. Washington, D.C.: National Academy Press, 1999.

[7] Exploravision (2021) http://www.exploravision.org

[8] Miller, K., Sonnert, G., & Sadler, P. (2018). The influence of students' participation in STEM competitions on their interest in STEM careers. International Journal of Science Education, Part B, 8(2), 95-114.