Work in Progress: Development of a Bootcamp for Freshman Student Success During COVID-19 Transition

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Edna Orozco, MSE, EdD is currently a Lecturer II, and undergraduate coordinator, for the Department of Manufacturing & Industrial Engineering. Edna has been key for the Department of Manufacturing & Industrial Engineering in many facets. The department opened in the year of 1993 and since then the department has hired only two faculty women, Dr. Karen Lozano, who currently works in the mechanical engineering department, and Edna Orozco, who is the female who has been working the longest at the department despite of being the only female. This is important to mention because she has been able to collaborate with all tenure, tenure track, and lecturers at the department. She has led the accreditation process and undergraduate curriculum of the department and has been greatly involved in outreach not only for the department but also for the College of Engineering & Computer Science. Her contribution to the engineering college was to bring the Girl Day in Engineering, a national celebration that focuses only on female students. She is also currently the chair-elect for the UTRGV Women Faculty Network. Edna Orozco is a former Specialist in the Texas Army National Guard and worked as an administrator in secondary education K-12 for 7 years.

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

Assessment results show that passing rates in introductory courses and retention rates of first-year students in the College of Engineering and Computer Science at The University of X, a predominantly Hispanic Serving Institution (HSI), significantly dropped with the onset of COVID-19. These results and trends highlight the academic preparation of incoming students, particularly the new cohort of underrepresented Hispanic students from underserved and challenged communities in the region, who may not have the necessary skills (e.g., adaptability, persistence, and performance) for the rigor of engineering education. To address this challenge, an onboarding "boostcamp" was created for incoming and transfer students to bridge the transition from secondary education to higher education. The boostcamp primes 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 gain a template to sustain academic and professional success during their undergraduate education. The paper presents the boostcamp's design process steps, including curricular analysis, identification of areas for improvement, skills inventory, and blueprinting, as well as its initial implementation in the mechanical engineering program. The boostcamp was organized over a week and featured hands-on engineering activities, faculty and student talks, and engineering lab tours. It was based on a design thinking approach and structured around Challenge-based Instruction, innovation, design, and mentoring. Daily activities focused on promoting critical thinking, assertiveness in the face of adversity, informed decision-making, and task prioritization. Results indicate that the boostcamp increased student confidence and established a valuable network system among participants. Future work will focus on expanding the boostcamp to include students from other engineering and computer science departments and developing a template for other institutions with similar challenges.

Introduction

In this paper the authors describe the motivation and process to design and implement a "boostcamp" for incoming freshman to the College of Engineering and Computer Science (CECS) at University X.

Motivation

University X is a Hispanic Serving Institution (HSI), currently the second largest federally certified HSI of higher education in the United States. The student population is more than 32,000. University X sits in a border region with Mexico, and the student population is 88% Hispanic or of Mexican American origin. More than half of the population in the X region fall below the poverty line and have low education attainment levels. 84.6% of University X students receive financial assistance. The goal of University X is to prepare regional students for the nation's workforce and enhance their prospect for economic mobility.

Typically, incoming CECS freshman students are first generation students with multiple academic challenges, lack of role models, and little economic privileges. The mission of the institution and faculty at University of X is to welcome these students and provide them with

high quality education and extraordinary growth opportunities. University of X has a variety of resources to support students academically and the CECS has a great student support ecosystem that includes student organizations, research opportunities, faculty mentoring, peer mentoring, among other resources. The authors noticed that not all students take advantage of these resources and suffer the consequences of missed opportunities. It takes a learning curve for incoming freshman to get acquainted and take full advantage of these resources. Furthermore, students that take advantage of these resources are the ones that are more aware and typically doing much better while students in need are the ones missing out on these resources. Based on these observations, the authors realized that is not enough to have resources available; something needs to be done to engage these incoming freshman students. How to shrink this learning curve? What students taking advantage of resources know that others don't?

Adding to these socio-economic conditions, the COVID-19 pandemic has impacted students across the spectrum. The COVID-19 pandemic effects are still under study to clearly define its impact. As with many other higher education institutions, the pandemic has clearly exacerbated the academic issues of incoming freshman students.

The Boostcamp Concept

In 2019 the authors proposed the creation of a "boostcamp" for CECS incoming freshman students. The realization was that the ecosystem of available resources is for students that are at the "starting line" or "zero" level, offering a variety of opportunities to grow academically, but some of the students are not at the "starting line"; they are below "zero" level. The boostcamp objective was to quickly bring all students to a high level of understanding of this ecosystem of resources and opportunities and other useful experiences in a short period of time (i.e., one week or less).

The authors made a list of freshmen lost opportunities that included:

- Students may have some friends, but not a peer support network, study circle, or community of learning.
- Students see faculty as distant entities, if a faculty talks to you is because you are in trouble.
- Students don't see themselves as part of research labs.
- Students don't understand the benefits of joining an organization.
- It takes various semesters to create a strong identity as an engineer.
- Students feel that accessing resources implies that they cannot solve problems on their own.
- Students think that it is enough to take the necessary courses and not engage in extracurricular activities.
- Family is a strong priority in the Hispanic culture, this can be lost opportunity if the family is not involved in the student's plan.
- The COVID-19 pandemic exacerbated some challenges such as course knowledge retention, socialization skills, focus and attention, among others.
- Existing "welcome day" activities in the university are helpful but limited to general information such as library services, recreation, dining options, and other resources, but there are no explicit CECS immersion events.

Boostcamp Building Blocks

Based on these observations, the authors designed a series of activities over one week to provide incoming CECS freshman students with a jumpstart and accelerate the learning curve, effectively priming the students to take advantage of the available academic resources.
The elemental blocks of the boostcamp included:

- Bring faculty to introduce their research, explain opportunities, and offer advice.
- Bring lecturers to provide their perspectives on course taking success.
- Hire senior and graduate students as peer mentors for the boostcamp to help and establish closer connections with freshmen.
- Somehow involve the families of the freshmen students.
- Have activities where students work in teams, have fun, and establish peer networks.
- Invite student organizations to pitch their activities.
- Include key university resource representatives to reinforce their message.
- Allow junior and senior students to share their experiences with freshmen.
- Faculty presentations on relevant topics such as: leadership, well-being, etc.

All these, organized in an agenda of engaging activities.

The Big Picture

The authors are also involved in the Mechanical Engineering Senior Design Project course (SD) as instructors or team mentors. Although the SD is currently a well-structured and robust learning experience, a continuous improvement analysis identified multiple areas of opportunity for the SD experience. Typically, SD is the last opportunity to develop a variety of technical (design process) and professional skills in undergraduate students such as oral and written technical communications, teamwork, time management, etc., The authors' conclusions is that the SD experience is too little and too late to cover all these skills which should be cultivated early on, starting as early as freshmen level. Parallel to these professional skills, students must take ownership of their academic path and professional planning as early as freshmen level. The authors have a vision of having a sequence of intervention such as boostcamps and key courses such as Intro to Engineering at each level, from freshmen to senior, to help students develop this portfolio of skills based on a plan that the students define and own, with all the support from the network of faculty and peers and the ecosystem of resources. This is the long-term goal of the authors and have decided to start with the freshmen stage and grow gradually into the next levels. So far, the authors have secured funding from NSF and 3M Company for projects, including the boostcamps described here.

2021 Boostcamp Pilot

In the Spring of 2021, the authors planned the first Boostcamp pilot for August of 2021. This pilot included only 40 incoming Mechanical Engineering freshmen, and the authors as facilitators. For one week, participant students experience a hectic program of activities that included:

- Hands-on student team project competitions. This activity was based on the Challenge Based Instruction (CBI) pedagogy (How Students Learn).
- Peer Mentoring. Each team of five students had one student mentor helping during the activities.

- Faculty talks. The faculty presented their research and made specific recommendations on how to build a resume and apply it to research experiences.
- Lecturers Panel. Faculty teaching lower-level courses were invited to share their suggestions on course taking strategies.
- Student Organizations Panel: A variety of organizations were invited to participate in this panel (e.g. ASME, SHPE, SWE, Rocket Launchers, etc.) and pitch their membership.
- Visits to Labs. Students had guided visits to research and teaching labs where faculty and staff answered their questions.
- Welcome. The college Dean and department Chair welcomed the students and encouraged them to have a sense of belonging to engineering (i.e. identity).
- Faculty Talk. The talks were on key selected topics such as navigating the curricula, mental health and well-being, and leadership.
- Lunch. This was taken as an opportunity for participating students to network with peers, mentors, and faculty.

Students were primarily selected based on the University's definition of "at-risk" students, then the invitation was opened to all incoming mechanical engineering freshmen. In this pilot, the authors included additional faculty facilitators from the mechanical engineering department with the intention to train them for future boostcamps. Faculty facilitators and student mentors received stipends from the CECS.

The outcomes of the pilot boostcamp can be divided into immediate (student surveys and interviews) and long term (student retention and graduation). The student surveys and interviews indicated that the pilot boostcamp was a success. Similarly, the feedback from the student mentors, faculty facilitators, and support staff was very positive. We are currently following up on the student retention and graduation of these students to report in future publications.

Beyond the clear success of the pilot boostcamps, the participants, mentors, and facilitators debriefings indicated various areas of opportunity:

- Freshmen recruitment. It was difficult to reach out to the incoming freshmen students by email.
- Evaluation Data. Although the surveys and interviews indicate a great success of the pilot boostcamp, the authors must clearly define the specific target metrics (i.e., skills) and instruments (i.e., data collection).
- Scalability. The organizing team realized that a successful boostcamp requires an enormous amount of work.
- Family involvement. In this pilot, there was no activity considered for family involvement.

These observations were considered in subsequent boostcamp iterations. This pilot boostcamp was partially funded by P&G company.

2022 Boostcamp

Based on the successful 2021 boostcamp pilot experience, the 2022 boostcamp was planned and implemented. In this iteration, with funding from 3M Company. These were the major improvements:

- Boostcamp structure: two boostcamps in two back-to-back weeks in August, B1 for mechanical engineering freshmen only and B2 combining all other departments in the college. 40 participants in each boostcamp.

- Faculty facilitators: B1 to be run by faculty trained in the boostcamp pilot and B2 facilitators selected from each department to be trained by the organizers. The objective was to a facilitator training academy every time to expand on future boostcamps.
- Student Mentors: these were recruited from every department in the college to have a matching representation in each boostcamp. These mentors were senior or graduate students selected because of their experience as TAs, ability to communicate, and service attitude, among other parameters.
- Freshmen recruitment: the recruitment process started earlier in the summer targeting at-risk students for B1 and B2, then open to all incoming freshmen. Recruitment was challenging, the authors realized that many students do not open their newly assigned university email before starting the fall semester. The organizers started reaching out by phone with some limited success.
- Activities program. For B1, activities were similar to the pilot boostcamp, focusing only on mechanical engineering interests. For B2, a challenge was to strike a balance in a mixed group that included electrical, civil, computer science, and manufacturing freshmen. Some activities were common to all B2 students, and some were split according to interests, for example visiting specific labs.

According to the freshmen exit surveys and interviews:

- Students were surprised to learn for the first time all the resources and opportunities that the college and university had to offer.
- Students had a much clearer understanding of what they needed to do to successfully start their academic path.
- Students were inspired by their peers, student organizations, and mentors on how to achieve their goals.
- Students were impressed by the faculty and their research, and the closeness to the faculty and the opportunities to get involved in research work.
- Students quickly created a network of peer support with other participants and student mentors.
- Students liked how the faculty teaching lower-level courses provided strategic advice.
- Students felt a sense of belonging and identity to the college and to their respective departments.
- Students valued how in one week got to know key faculty in their departments.
- Some students immediately joined student organizations.
- Some qualified students were invited by faculty into research activities.
- Some students immediately went into machine shop certification.

From the facilitators and mentors debriefing, it was noted:

- Recruitment strategy must be improved to circumvent challenges.
- Each department must invest in training their faculty to replicate department specific boostcamps.
- The initial focus on at-risk students is meritorious, but the boostcamp experience should be expanded to eventually include all incoming freshmen. This is a long-term goal since the boostcamps so far have around 80 students while the total incoming freshman are over 1,000.
- Everyone involved in the boostcamps enjoyed the experience, realized it is a lot of work, and valued the effect on the participating students.

2023 Boostcamp

In this iteration, the boostcamps were supported by NSF and 3M Company funding. Based on the 2021 boostcamp pilot and the 2022 boostcamp, the 2023 boostcamp was improved as follows:

- Boostcamp structure: three boostcamps, B1 for mechanical, manufacturing, and civil engineering freshmen only, B2 for computer science, electrical, and computer engineering, and B3 including all majors in campus B of University X. Approximately 40 participants in each boostcamp.
- Faculty facilitators: trained faculty in the pilot and 2022 boostcamps where in charge of B1, B2, and B3, with the help and supervision of the organizers (authors). Continuing with the facilitator training academy, additional faculty from each department in the college were invited to be part of the boostcamp.
- Student Mentors: preference was given to mentors from previous boostcamps observed to have good performance and connection with students. More student mentors were invited to join, allowing each faculty facilitator departmental group to select their own student mentors.
- Freshmen recruitment: based on the challenges identified in previous boostcamps (students not checking their new email), the organizers assigned each faculty mentor group by department the list of incoming freshmen to define their preferred recruitment strategy. Most followed a combination of emails and calls. Curiously, the computer science recruitment effort was much more successful since students have stronger media networks such as forums and groups early on (starting in high school).
- Activities program. In general, each boostcamp and department group defined their activities schedule, some with the whole boostcamp for activities of general interest and some specific to departmental interests.

The organizers, faculty facilitators, and mentors made the following observations:

- Recruitment efforts should also include the parents of the students.
- Maybe the boostcamps can be reduced to fewer days (2 or 3) to include more freshman students.
- Include family activities in future boostcamps.
- Have follow-up sessions with boostcampers to check on their progress.

Results

The research study aimed to find if there was an association between retention rate of at-risk college freshmen students who completed the boostcamp and students who did not complete it. Also, it was important to find out how does the boostcamp impacted on these students and what recommendations they had to improve the boostcamp.

This mixed-methods study was done to a population of students at the university X. These students were identified as at-risk college freshmen by the office of student affairs. Once the students are identified then the college sends out different ways of communication (email, phone calls, and text messages). In the year of 2021and 2022 a total of 484 at-risk students were asked if they wished to participate in the Boostcamp. A total of 122 students replied they would participate. However, not all students who accepted came, and not all students who came to the camp finished it. Hence, three different categories of students were identified.

1. Students who agreed to participate and COMPLETED boostcamp (COMP),
2. Students who agreed to PARTICIPATE and did NOT COMPLETE the boostcamp (PNCOMP),
3. Students who did NOT PARTICIPATE and did NOT COMPLETE the boostcamp (NCOMP).

Table 1 shows the findings on the boostcamp for these three different groups of students. Results show that the group of students who had the highest retention rate were those students who fully completed the boostcamp. Followed by those who did not participate. Those students who partially participated had a retention rate as shown in the following table.

Table 1: Count and Percent Retained by Group (Orozco, 2023)

		Not Retained	Retained	Total
COMP	Count	12	38	50
	Percent	24.0	76.0	100.0
NCOMP	Count	121	278	399
	Percent	30.3	69.7	100.0
PNCOMP	Count	13	22	35
	Percent	37.1	62.9	100.0
All	Count	146	338	484
	Percent	30.2	69.8	100.0

Although retention rate was studied, the Chi-square test of independence (X 2) results showed no statistical significance between any of the subgroups studied, although students who completed the boostcamp experienced a higher retention rate than the other two groups. No association between boostcamp completion and retention of at-risk college STEM freshmen students was supported by this study's data and results, and the study's null hypothesis was not rejected. However, it is important to note the Chi-square test includes limitations. One limitation is that it is very sensitive to sample size (McHugh, 2013). Since the population size of the NCOMP was almost eight times larger than COMP, this large difference in group sample size may have limited identifying association. Another Chi-square test limitation is that an individual cannot fit in more than one category (McHugh, 2013). This latter limitation was accommodated by separating the PNCOMP students into their own subgroup for analysis.

The qualitative part of the research study identified five main themes from focused groups and individual interviews with some of the students who completed the Boostcamp (Orozco, 2023).

1. Projects & freedom
2. Mentorship
3. Sense of Belonging
4. Family and Higher Education
5. Transitioning from High School to Higher Education

Also, students recommended some areas of the boostcamp to be improved, these areas were related to the following themes.

1. Mentors
2. Grouping of Students
3. Time management of the projects
4. Length of the boostcamp intervention

Discussion

There are multiple opportunities to continue studying this topic since there are few studies specifically focused on STEM interventions (Boostcamps) in higher education (Hite & Spott, 2022; Reena, 2018; Tomasko et al., 2016, Orozco, 2023). Research and publication on this topic are relevant and in need. Producing enough numbers of graduates who are prepared for STEM occupations has become a national priority in the United States (Chen, 2015; The White House, 2016; The White House, 2022). Hence, future research on how to retain these students in STEM programs has great potential to support this national priority.

While any university STEM program can improve its STEM intervention based on the findings in this study, future research could work toward finding a larger number of students completing the STEM intervention comparable to the number of students who did not complete the STEM intervention to minimize possible population statistical testing size effect. Future research can also focus on an association between longer than one-week STEM intervention completion and retention of at-risk students. Moreover, future research can further focus on other student populations, such as first-year students, first-generation students, low socioeconomic status students, females, other minority students, and other student groups that need greater support in college STEM program retention. Finally, future research studies could focus on why students decided to drop out and how to help them return to the STEM program. Student retention in STEM programs provides a great opportunity for future studies because of its potential impact on the future of students, communities, the US national economy, and the US international economic standing.

Conclusions

This mixed study investigated whether a statistically significant association between STEM intervention completion and the retention rate of at-risk college engineering freshmen students existed, the reasons at-risk STEM students decided to stay in the program after completing a STEM intervention, and ways to improve the STEM intervention to support engineering program retention of at-risk college freshmen engineering students. In the quantitative analysis, a test of independence X2 (chi-square) found no statistically significant association between STEM intervention completion and retention. Testing limitations may have affected the statistical results.

Future Work

The success of the boostcamp program has attracted the attention of every department in the CECS as well as other colleges at University X and local community colleges. Various versions of the boostcamps are being considered for the future, including a boostcamp recruitment version where selected high school students are invited to participate, a boostcamp for transfer students (a pilot was run in the fall 2023 semester), a boostcamp for other college of science, and a boostcamp for a local community college.

Acknowledgements

The authors express their gratitude to the participating faculty facilitators, student mentors, and freshmen students involved in the multiple boostcamp iterations. Funding for this project was provided by NSF award 2217780, the 3M Company, and P&G Company.

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