

Building a Sense of Community for Freshman Civil Engineering Students

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Abstract

Across the country, less than two-thirds of engineering students persist and earn a degree in engineering. A considerable amount of research on the topic has been conducted, leading to a few key ideas on why students leave engineering. In particular, disinterest in the curriculum, a limited sense of belonging, perception of inadequate academic ability, and disconnect between learning style and instruction mode are some reasons that students depart engineering. Consequently, many first-year programs aim to address one or more of these issues.

The TRANSCEnD program at the University of Nevada, Las Vegas seeks to improve undergraduate civil engineering and construction management education, as well as increase retention and graduation by specifically focusing on students and curriculum in the first two years of the civil & environmental engineering and construction management (CEEC/CM) programs. Retention and graduation rates are on the lower side of national averages; therefore, faculty at the institution are taking the lead and making changes within the department. One aspect of the program is community cohesion building (CCB), i.e., a learning community, where first-year students create connections, engage in community and engineering design projects, and gain exposure to CEEC/CM professions. Specific objectives are to increase the sense of belonging among students and between students and faculty, as well as increase retention in the first two years. Through biweekly meetings, participants in CCB build connections with freshman CEEC/CM peers, upper level CEEC/CM undergraduate students, CEEC graduate students, and CEEC/CM faculty. Participants also engage in the engineering design process and compete in a national engineering design challenge geared toward freshman and sophomore students.

This paper describes the first one-and-three-quarter years of CCB implementation of a five-year grant. We present the program structure, challenges, changes, and successes. This information should prove useful to other institutions who are in the process of implementing new first-year programs, especially for institutions who have similar characteristics (i.e., urban setting, commuter school, highly diverse, high proportion of first generation students). Program evaluation focuses on the following items related to CCB objectives: 1) increase in sense of belonging (tool: student survey), 2) increase in CEEC/CM retention between freshman/sophomore and sophomore/junior years (tool: institutional data), and 3) completion of program activities (tool: internal records).

Background and introduction

One of the biggest challenges faced by the universities in the US is the lower graduation rates in their engineering programs. It limits the qualified engineers entering the workforce and affects the budget planning of the universities [1]. So, universities have adopted various measures to increase the student retention rates in the undergraduate engineering programs. One of the most sustainable educational reforms to tackle this challenge is the implementation of learning communities. Functionally, learning communities are the structures where students with common learning agendas, goals and aspirations connect to share their ideas and learn from each other. Active learning, cooperation and social activities outside of a classroom setting are some of the significant features of learning communities.

Various studies demonstrate the importance of learning communities in improving student retention in engineering programs. For instance, learning communities for first-year students in the Department of Engineering at Colorado State University-Pueblo improved the retention rate from 84% (fall 2008) to 89% (fall 2009) and 94% (spring 2010) [1]. Similar results were also seen in the School of Engineering and Computer Science in West Texas A&M University, Indiana University Purdue University Indianapolis (IUPUI) and Virginia Tech University [2] - [4]. Introduction of learning communities in agriculture engineering and technology programs in Iowa State University improved the retention rate by 12.3% in a year [5]. Additionally, some studies have linked learning communities with enhanced academic performance and communication skills in the students [5]. A study conducted by Mickelson and Brumm (2005) found that learning communities enhance the sense of community in the students and alleviate the student-faculty relationship. The National Center of Teaching, Learning and Assessment conducted a study that found that learning communities' students engage more in academic and social activities and form study groups easily [5].

Learning communities are implemented in different forms. For instance, in Colorado State University-Pueblo, students formed a curricular learning community to jointly solve the homework and lab assignments in two courses [1]. In West Texas A&M University, the course 'Fundamentals of Engineering' was linked to two mathematics courses, precalculus and calculus. The students in the learning community dual enrolled in the linked courses during their first year of undergraduate studies [2]. A similar program structure was also found in IUPUI where students, connected through themed learning communities, enrolled together in some linked courses that covered a common topic [3]. In some programs, students in the learning communities resided together in a shared space; these programs are accordingly called living and learning communities. In some cases, learning communities are required for first year students, and this is an optional activity for other university programs. A unique aspect of the learning community in this study at the University of Nevada, Las Vegas is that it is voluntary and takes place outside of a formal course. Regardless of the setting and nature of interaction, a common theme for learning communities is improved student retention.

This paper describes the first one-and-three-quarter years (under a five-year grant) of community cohesion building (CCB) implementation, which started in fall 2019. CCB is analogous to a learning community. We present here the program structure and specific activities, including student recruitment. In addition, we disclose initial results from the program evaluation and challenges we faced during implementation, especially with respect to COVID-19.

Program structure

Freshmen and sophomore students in the Civil and Environmental Engineering and Construction Management (CEEC/CM) program are eligible to participate in the TRANSCEnD program. The program helps the participants to build connections with fellow CEEC/CM freshmen and sophomore students, upper-level CEEC/CM undergraduate students, CEEC graduate students, faculties, and civil engineering professionals. During the program, the students explore different disciplines of civil engineering while being engaged in different group projects under constant guidance from the mentors throughout their first two years of college. Another benefit of joining the program is the financial incentive of \$600 per year. Students receive \$200 and \$400 stipends in the fall and spring semesters respectively. Students must attend at least 80% of bi-weekly meetings and successfully complete the group projects in each semester to be qualified for the stipend. UNLV students tend to be economically disadvantaged and usually work to financially support themselves. The stipend helps to offset some of the income they are giving up from work by joining the program.

In this program, students meet outside of a formal class and participate in different technical and social activities beyond their coursework. The program comprises recruitment, biweekly cohort meetings, departmental social events, group projects, and field trips executed in an academic year. Interested freshmen and sophomores are recruited at the beginning of each semester. Students participate in different activities during the biweekly meetings. The social activities are similar in both semesters but group projects are different. Two group projects are conducted in a year, one in each semester. The community service project and 'Engineering for People Design Challenge' are conducted in the fall and spring semester respectively. Additionally, different social events such as barbeques and meet and greet are also held within the program to increase the participants' integration in the cohort.

The student cohort is assigned two faculty mentors, one to two graduate assistants (GAs), and two to four undergraduate mentors (UGMs). The GAs and UGMs are responsible for the execution of recruitment, biweekly cohort activities, group projects and social events. The faculty mentors act as facilitators and liaisons between the cohort and the department, including faculties and staff.

The COVID-19 pandemic has changed the structure of the program significantly. The recruitment and biweekly meetings are conducted online. The cohort meets with the mentors and faculties via Webex or Zoom meetings and participates in different social activities and group

projects. Similarly, the recruitment channels changed from in-person class visits to audio-visuals, emails and telephones. The social events such as departmental barbecues were cancelled and the mode of field visits were changed to virtual from in-person mode.

Description of activities

Mentor recruitment

The faculty mentors recruit the GAs and upperclassmen UGMs. The number of GAs and UGMs depends upon the number of participants and semesterly activities. Faculty mentors, GAs, and UGMs are collectively responsible for participant recruitment.

At the start of the program in fall 2019, only one GA and two UGMs were recruited with three volunteer graduate students. One additional GA and four UGMs were recruited in the next year (academic year 2020-21).

Participant recruitment and communication strategies

Various approaches are adopted to recruit participants in the program. For instance, student mentors and faculty meet the freshmen and invite them to the recruitment meetings during different class visits and campus-wide involvement fairs. Similarly, freshmen are introduced to the program via personalized emails and phone calls at the start of the semester. Peer recruitment is another approach for student recruitment. The cohort students are asked to invite their friends and classmates to join the program. Ten students joined the program in spring 2020 (Table 1).

Due to the remote nature of classes during the COVID-19 pandemic, short Question-Answer sessions are held through online meetings instead of in-person class visits. The freshmen are provided with a pre-recorded introductory video in advance. Recruitment meetings are held and interested freshmen are told about the program. During fall 2020, the third semester of CCB implementation, 15 freshmen showed interest in joining the program during the recruitment meetings and more students joined through peer recruitment. The number of students continuing in the program was six. Two former CCB participants became UGMs and one student was no longer eligible as he was now a junior. Of the twenty four that participated in one or more of the fall 2020 activities, only nine students met the program requirements to earn a stipend.

Through continued recruitment, the cohort maintained a similar size in spring 2021. A total of nineteen participants have committed, with fifteen students signing on for the group project (Engineering for People Design Challenge [6]). When a handful of cohort participants missed a meeting, UGMs reached out to understand why; subsequently, activity attendance is 100%.

Table 1. Number of participants on a semester basis.

	Number of participants	Number of returning Participants
Fall 2019	2	-
Spring 2020	10	2
Fall 2020	24	6
Spring 2021	19	10

Through experimentation with various communication methods, the program team has found that a mix of strategies is the best approach. Faculty mentors used personal phone calls to connect with students. During the phone calls, many students declared that they had not seen or read the email introducing the program, and they stated an intention to look for the email after talking with the faculty mentor. Email is often only effective after establishing connection with students. This was seen through an email tracking system that registers who opens and clicks links in a message. It was seen that the students preferred a mass communication platform for interactions with their peers and mentors rather than emails. So, based on their preference, a communication tool, namely Discord, was added in spring 2021, and it has become the most used communication platform since. Discord is a virtual communication platform where people can communicate via texts, video or voice media. While emails are still used on a weekly basis to inform the cohort about upcoming activities, Discord provides additional peer-to-peer communication, which is expected to strengthen connections among cohort participants.

Biweekly meetings

The cohort, faculty mentors, GAs, and UGMs meet biweekly for at least an hour to oversee the progress of the students in their major and group projects. These meetings provide the students a platform to bond with each other and share their academic experiences and problems. The first half of these meetings involves various social activities, such as personality tests and quizzes. In the latter half of the meetings, the cohort participates in various games, professional development activities and group projects. These meetings are also the avenues for continued guidance about university resources for success, time management, and faculty engagement.

In fall 2019, only two cohort activities were held during which the cohort met with the student mentors and faculty mentors to play games such as Jenga. During spring 2020, a 'Department Meet and Greet' was held over two days in which the participants met with the CEEC faculties and learned about 'Engineering for People Design Challenge'. Another activity was 'Geowall' in which students created a retaining wall using as little amount of paper as possible. Students and

mentors also discussed study tips and reflected on their experience working on the group project in the last meeting of the semester.

In fall 2020, four cohort activities were held virtually since the in-person interactions were limited because of the COVID-19 pandemic. During one activity, the cohort participated in the 'Fun with Professors' event and played a virtual game 'Skribbl' [7] with faculties, GAs and UGMs. Another activity was 'Virtual Bridge Design' [8] in which the students designed a truss bridge based on the load and budget criteria provided by the mentors. The students voted for the best design and the winner was awarded a prize. The students also attended seminars about 'Navigating the transition to college' by guest speakers from the university's Academic Success Center. During the lecture, the students were informed about university resources for success, health, time management, and engagement with faculty. One of the faculty mentors presented on civil engineering sub-disciplines and construction management as a way to introduce cohort participants to the various fields within the major.

Group Projects

During group projects, students are challenged to find real solutions to real problems in different sectors of a real community. This project-based learning approach involves problem identification as well as solution development, testing, and reflection. These projects enhance the professional and social development of the cohort participants. They enhance life skills such as time management, responsibility, collaboration, motivation, leadership and work ethics and develop a sense of belonging among the freshmen.

Engineering for People Design Challenge

This group project is conducted in collaboration with Engineers without Borders-USA every spring semester. It invokes the engineering design process, and students are able to utilize civil engineering and construction management principles. During the design challenge, the sub-cohorts compete with other underclassmen (i.e., freshmen and sophomores) to provide the best technical solutions to the problems of a real community.

In spring 2020, three groups, totaling ten students, participated in the Engineering for People design challenge and designed solutions targeting problems in water, transportation and built environment sectors of Maker's Valley, South Africa. The groups commenced the project by developing problem statements for their challenge area. Under constant guidance from the mentors, the students finalized their problem statement, criteria and constraints, followed by solution development and evaluation using a decision matrix in subsequent weeks. After the mentors reviewed the report drafts, each group presented their solution in the national competition Grand Final.

Community Service Project

This group project connects the cohort with the local community and expands the sense of belonging among students to beyond the college campus. In fall 2020, 12 students participated in a community service project and reconstructed an existing outdoor kitchen of Vegas Roots Community Garden. The students were divided into four groups for the design, cost analysis, scheduling, and construction. Each group was assigned one UGM as a facilitator and guide during the three phases of the project. During the first phase, students designed and constructed an L-shaped area to include a double-sided grill, preparation/serving area, herb drying racks, and food smoker. The pizza oven and preparation station were constructed in the second phase. Finally, a slightly raised ground cover was prepared in the third phase. The whole project was completed with a budget of around \$300.

Program evaluation and results

Program evaluation centers on specific outcomes and completion of activities, which are aligned with the grant proposal and department goals. These items, as well as the data collected, are shown in Table 2.

Table 2. Alignment of outcomes, activities, and goals for the TRANSCEnD program, along with data sources.

Category	Item	Purpose	Data
Outcome	Increase in first-year student retention rate by 5%	Grant proposal & department goal	Institutional data
Outcome	Increase in sense of belonging	Grant proposal & department goal	Survey
Activity	Attendance at biweekly meetings	Grant proposal	Internal records/logs
Activity	Completion of service project / engineering design project	Grant proposal & department goal	Internal records/logs

After just 1.75 years into the 5-year grant, it is difficult to assess the major outcomes. However, the program is making progress in the right direction.

- First-year student retention data are not yet available.
- A majority of survey respondents indicated that the cohort gave them a sense of belonging.
- Attendance at biweekly meetings for the spring 2020 and fall 2020 semesters were 78% and 70%, respectively.

- Completion rate of the engineering design project in spring 2020 was 100%, and current attendance for the engineering design project meetings in spring 2021 is 100%.

Sense of belonging was assessed through a mixed-mode survey at the end of the semester in spring 2020 and fall 2020. First, respondents (n=11) were prompted to identify what they felt the cohort provided (Table 3). One respondent did not select any of the prompts. Nearly all respondents agreed that the cohort connected them with a faculty member and provided them with academic support, and the majority rated these two items as exceptional or excellent (78% and 67%, respectively). Faculty connections are built into the community building model through direct participation by faculty mentors and invited involvement of department faculty for games. Academic support is featured through UGMs sharing about their experiences, creating a course chart for students to know what classes other students in the cohort are taking, and building in dialog opportunities for students to share study habits or concerns about their courses. Nearly all respondents also agreed that the cohort increased their passion for their major, and the majority rated this item as exceptional or excellent (78%). While this feeling cannot be attributed to one particular cohort activity, it is likely that the engineering design project contributed to their excitement for engineering based on excerpts from the group reports provided in a later section of this paper. Lastly, most respondents indicated that the cohort provided them with friendships and a sense of belonging. Again, the majority of respondents rated these items as exceptional or excellent (86% and 67%, respectively).

Table 3. Student responses for a survey targeting a sense of belonging.

Response: My cohort has...	Percent who agree that the cohort affected this aspect
Provided me with a close group of friends	73%
Aided me in becoming more passionate about my major	91%
Allowed me to connect with a faculty member	91%
Provided me with academic support	91%
Given me a sense of belonging	82%

Sense of belonging was further examined based on formation of study groups. Not all respondents formed study groups in their classes. Those who did form study groups all identified five close friends in their classes. On the other hand, two respondents who did not form any study groups identified three or fewer close friends. The value of study groups to students is apparent in the quote below:

“Some of my group members were in [the cohort] with me and it helped in classes since we knew each other and were close. We weren’t shy to ask or felt intimidated but rather felt joy and relief.”

At this early point in the program, there are too few responses to look at statistically significant differences between formation of study groups, friendships, and retention.

Activities were completed to the extent proposed in the grant proposal, but there is room for improvement. In the spring 2020 semester, ten students joined and earned the stipend for attending meetings and completing the engineering design challenge. In the fall semester of 2020, twenty-two students joined with nine students earning the stipend for attending meetings and completing the community service project. While recruitment strategies may have increased the initial number of participants, fewer than half of the participants fulfilled the requirements in the fall 2020 semester to receive the stipend (i.e., attendance of 80% of meetings and active involvement in community service projects). Participants in the spring 2020 semester had the opportunity to meet face-to-face a few times before working together in an online environment, whereas there were no face-to-face meetings until after 10 weeks in the fall 2020 semester when they met to work on the community service project. In addition, students in the spring 2020 semester met weekly with the same sub-cohort for the engineering design project. Students in the fall 2020 semester did not work exclusively with a sub-cohort. The program team will emphasize sub-cohort interactions in future semesters to increase the sense of community felt by students.

Individual student and team reflections from the engineering design challenge in the spring 2020 semester showed progress toward department goals for increased understanding of the engineering design process and increased motivation to study engineering.

Student 1: “As a future engineer this [project] illustrates the work that is put into cultivating a project and proposing it. It gave me a much needed experience and knowledge of what it takes to be an engineer. Furthermore, it gave me the motivation to further my studies as a STEM major due to the fact that it was quite fun and entertaining to actually work in this simulated environment with deadlines. All in all, it allows for students to be enlightened in the processes that lay ahead for engineering majors.”

Student 2: “This challenge was very eye-opening and inspirational. Even though this is all theoretical, I hope to make a difference in a community like this someday.”

Team A: “All in all, we as a group feel that this was a great enlightening experience that illustrated what lay ahead in our engineering careers.”

Team B: “Having not just someone, but a team available to bounce ideas and concerns off of, a team when assistance is necessary, a team to encourage,

motivate, and cheer on an individual's gains. Not one of us could have completed this project alone."

No instruments were specifically designed to assess these two department goals (i.e., knowledge of the engineering design process and increased motivation to study engineering) due to time constraints as the program started part-way into the school year. However, a survey to examine these subjects, especially in relation to engineering identity, is in the planning stages. When the survey is ready, the project team would like to get the student's perspective on how the following have changed since joining the community building program:

- How has your knowledge of civil engineering or construction management disciplines changed?
- How has your knowledge of the engineering design process changed?
- How has your interest in a career in civil engineering or construction management changed?
- How has your interest in an engineering or construction management career changed?
- How has your motivation to finish a college degree changed?

Program challenges

The first challenge we faced was that the program start date (tied to the grant start date) was six weeks after the beginning of the fall 2019 semester. This made recruitment challenging. By the time we had our first recruitment meeting and visited freshmen classes, it was almost 10 weeks into the semester. We had very low turnouts in our two recruitment meetings; only 1-2 students showed up for each of the meetings. We asked the students that showed up to help us with the recruitment by bringing friends and classmates to the biweekly cohort meetings. The peer recruitment scheme and additional meet and greet events were effective and we ended up with 10 students interested in the program in fall 2019. However, we were not able to have as many meetings and activities as originally planned, and there was not enough time for participation in a community service project. Therefore, participants were informed that the program would commence in spring 2020. Because of the late start date, it was challenging to recruit GA and upperclassmen UGMs because they had already committed to other jobs/positions. For the fall of 2020, we started our participant recruitment two weeks before the semester began by having faculty call incoming and continuing CEEC/CM students.

In various universities, students who are enrolled together in a particular course make up the learning community. However, in this program, students formed the learning community apart from their courses and met outside of the designated class. So, throughout the program, we faced difficulties in finding a common time for activities because of different class and work schedules among the participants. To overcome the difficulty, we have had to run our activities two or three times per week. This practice has resulted in more consumption of our GAs' and mentors' time.

Because of the schedule constraint, we were not able to secure our faculty and guest speakers for some of the activities. We are thinking about offering a course with a defined class time for the program to solve this scheduling issue.

We underestimated the level of demand of the design challenge project. As we progressed further in the project, the students felt overwhelmed and suggested that we should convert some or all biweekly cohort meetings to design challenge meetings so that they could focus on the design project. Based on their suggestion, we converted all the cohort meetings and they were able to complete the project on time.

Due to the COVID-19 pandemic, after spring break in 2020, we had to cancel some of the planned activities such as field trips and participation in the National Geowall competition. In addition, we had to convert all the activities, including the design challenge project, from face-to-face to virtual. This restriction made it more difficult to find enough suitable activities. This challenge was different from the challenges faced by the previous implementations of similar programs. Certain virtual activities, such as field trips, are less effective than the corresponding in-person versions. On a positive note, we now have an option to conduct the program totally in a virtual mode and are capable of offering it in parallel with a face-to-face mode to attract more participants to the program.

The program allows cohort participants to opt out of completing the community service and design challenge projects. For this option, they will participate in all other activities and will not receive the stipend. In the first year of the program, one out of ten students chose this option. However, in the second year, a higher proportion of the students, eleven out of twenty students, opted not to participate in the community service and design challenge projects citing time commitment as a major reason. If the program transitions to a course that students register for in advance, there may be a greater fraction of students who allocate time for the program in their schedule.

Recommendations and future work

We have the following recommendations for institutions looking to form learning communities.

1. Recruiting is the most challenging aspect of the program, if the college/program does not mandate participation. We recommend starting recruitment planning early, at least 1-2 months before program launching. We tried many different recruitment schemes, but personal phone calls by faculty and peer recruiting have been the most effective methods. Our data have shown that once participating in the program, students tend to complete the program (minimal dropout).
2. We were disappointed with the low turnout in the first year of the program but kept working on our recruitment strategies. For example, we added personal phone calls as our recruiting

method in the second year. Do not get discouraged by low turnouts, which will likely occur in the first year.

3. Flexibility is the key for attracting and retaining the participants. Expectations should be reasonable. For program completion, we allow the participants to miss 20% of the meetings/sessions. A virtual mode of participation has allowed us to achieve high retention after the COVID-19 pandemic. Having the same meetings/sessions offered more than once a week has been helpful for the participants with conflicting class and work schedules.
4. Active involvement of faculty is important to the program. The participants cite connecting with faculty in their major as one of the key benefits of the program along with the stipend and valuable experience. There are two faculty that are in charge of the program and at least one of them joins most of the meetings/activities. Other faculty in the department sometimes participate in social activities.
5. Some of our upperclassmen mentors in the second year are former participants from the first year. They are familiar with the program team and know the program well, including what and how to improve. They have been very efficient in recruiting and creating a sense of community. Their participation in the first year allowed us to informally evaluate their potential as mentors.

For potential changes for the next three years of the program, we will attempt to run a program through a course with a defined class time to overcome the difficulty with schedule conflicts. The attempt, if successful, will also reduce time commitments from faculty, GAs, and UGMs. When the pandemic is under control, we plan to offer the program in 2 parallel modes: face-to-face and virtual. We expect that the change will help increase the number of participants, especially given our commuter student population, and maintain high retention.

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