

## **WIP: Pilot Implementation of Mandatory Club-Led Workshops in a First-Year Engineering Course**

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## **Introduction**

Retention of undergraduate engineering students has been of significant concern at many universities as the percentage of students who begin in engineering programs and successfully complete their degree has remained stagnant at approximately 50% for the past several decades [1]. Retention of first- and second-year students is a particularly pressing issue; these students typically have the largest drop-out rates from STEM majors [2]. Several authors have attempted to understand why students leave engineering and other STEM programs and have found that a lack of belonging in engineering [3], academic reasons [3], and a lack of connection and quality relationships with peers and university staff [4,5] all influence students' persistence in STEM. Additionally, demographic factors such as race [6] and first-generation status [7] have been found to influence retention rates. Due to this, universities have dedicated significant resources to improving first-year engineering programs and curricula to bolster students' sense of belonging and academic success in an attempt to improve retention rates.

In addition to curricular-based improvements, increasing the percentage of first-year students engaged with engineering clubs may be another viable strategy to improve sense of belonging in engineering and connection between peers. Numerous benefits of student organizations have been identified in the literature, including the function of clubs as informal "learning communities" which connect students to peers with similar interests and academic pursuits [8], and as platforms to help students develop various professional skills [9] and apply theory from engineering classrooms to hands-on and relevant problems [10]. Additionally, providing students authentic opportunities to engage with engineering concepts, including through internships and other co-curricular activities such as clubs has been shown to improve students' engineering identity [11]. Considering the various benefits that engineering-based clubs have on students' connection with their peers, skill development, and identity formation, we postulate that increasing the participation rate of first-year students in these organizations may lead to an increased sense of belonging in engineering and thus, higher retention rates.

Although student organizations are highly beneficial, clubs on our campus and across the country have not fully recovered from the significant impact caused by the COVID-19 pandemic and subsequent limitations on in-person gatherings. One study in 2022 revealed 20% of student organizations disappeared completely [12]. In our own Voiland College of Engineering and Architecture (VCEA), we lost 9 clubs out of the 48 that were active in 2019. Another study from 2023 showed that, of the clubs that remained after the pandemic, 50% of them have struggled to retain membership that matched pre-pandemic levels [13]. Not only had membership dwindled, but leadership recruitment within the clubs also suffered because "...groups were not active at a certain time, so they weren't then able to recruit the younger students, the freshmen, to grow through the organization" [14]. The push to resurrect engagement is crucial to student success. Ernest T. Pascarella spent more than 30 years researching what works and noted, "...the one crucial thing that happens that leads to benefitting from college in all sorts of ways, is how much

you get engaged” [15]. We postulate that incentivizing engagement in first-year courses will provide opportunities for students to join clubs, which in turn will help to build community and promote a sense of belonging.

To address current challenges faced by clubs and encourage first-year students to become involved in extracurricular activities, we developed a club-led workshop program and piloted it in our large Introduction to Engineering course during the fall 2024 semester. Students in the course were required to attend one of six workshops led by student representatives from engineering clubs and submit a reflection assignment about their experience for course credit. The primary goal of this pilot program was to decrease barriers to first-year participation in clubs by providing students with an incentivized, accessible, and highly organized opportunity to engage with these organizations. To evaluate the success of the pilot program, we considered three primary research questions:

- 1) What was the students’ perception of the mandatory workshop activity?
- 2) Did the introduction of the workshop activity increase the percentage of students voluntarily participating in extracurricular club events compared to the previous year?
- 3) Did the introduction of the workshop activity increase students’ sense of connection to and belonging in the college of engineering compared to the previous year?

In this paper, we will summarize the workshops developed and preliminary results for each of the research questions above, collected via written student reflections and two end-of-course surveys. We will also summarize lessons learned, future directions, and limitations of the pilot.

## **Methods**

### *Development and Description of Workshops*

Nine student club organizations were asked to participate in the workshop program. Clubs worked independently or together with one other club to develop a 1-2 hour workshop activity for first-year students. Six workshops were offered to students and are detailed briefly below. To ensure an approximately equal number of students at each workshop, attendance was limited to 50. The workshops were developed and presented by the student leadership of the organizations after an introductory meeting with the study authors to explain the purpose and goals of the workshop series. Supplies and materials for the workshops requested by the clubs were provided by the study authors; clubs were given a supplies budget of \$400 for each workshop.

American Society of Civil Engineers (47 attendees):

In the ASCE workshop, students created a model building while following the Design-Build method of project delivery. Students were placed into small groups and role-played as a small consulting firm. They were given a Request for Proposal (RFP) document which contained guidelines and requirements for their building and created schematic drawings, a model building using toothpicks, marshmallows, and gumdrops, and a schedule of materials. According to club leaders, this activity was inspired by a similar activity done at the 2024 ASCE Multi-Region Leadership Conference for Regions 8 & 9 in Seattle, WA.

Biomedical Engineering Society (42 attendees):

BMES's workshop was focused on connecting biological systems to a common college game. The workshop was split into presentation and participation sections; in the presentation section leaders explained how a TENS (Transcutaneous Electrical Nerve Stimulation) unit works at a biological level, and in the participation section students attempted to play "beer" pong (cups filled with water) while connected to a TENS unit used to control arm muscles. The goal was to win the game, and winners were given a small prize.

Cougs in Space and American Society of Mechanical Engineers (46 attendees):

In this technical skills-focused workshop, each club gave a brief initial presentation on their organization and then a practicing mechanical engineer from a local design firm presented on engineering drawings. Students were given large format copies of an engineered part drawing that was explained throughout the presentation. The speaker discussed each aspect of the drawing, standard format and nomenclature of engineering drawings, and why drawings are important in component design and manufacture.

Crimson Robotics and Institute of Electrical and Electronic Engineers (42 attendees):

This workshop was broken into two sessions to give students a better understanding of each club individually, but also show how they have commonality. IEEE led a breadboard workshop which included constructing several simple circuits with various basic circuit components and information about how similar components are used within projects created by Crimson Robotics. Crimson Robotics concurrently hosted a workshop demonstrating and explaining their combat-robotics projects to students. Groups of students rotated between the two sessions.

Society of Hispanic Professional Engineers (14 attendees):

SHPE workshop attendees worked in small teams to build and test mini-scale roller coasters created from flexible tubing, foam pipe insulation, tape, cups, marbles, and a variety of supports. Students discussed technical issues faced by the marble sent through the track, and club leaders led discussion on the challenges faced by engineering majors, with an emphasis on minority student issues and the resources available for a variety of needs.

Society of Women Engineers and National Society of Black Engineers (38 attendees):

The collaborative SWE/NSBE workshop consisted of a hands-on design challenge. Attendees were broken into small groups (3-4 students) and tasked with designing and constructing three basic "vehicles" to compete in an "engineering triathlon." Students were provided basic materials and asked to build an airplane, boat, and rubber-band powered car within a limited time frame. Each vehicle was tested and prizes were awarded to the winning teams.

### *Course Implementation*

Representatives from each of the nine clubs involved in the workshop series visited a lecture period of the Introduction to Engineering course early in the semester to give a short presentation about what their workshop would entail and share brief introductory information about their club. After this lecture, students were asked to self-select into one of six workshops based on

their interests and schedule; sign-ups were completed through the Learning Management System. Workshops were limited to 50 attendees each; total course enrollment was 252 students. Students then attended their selected workshop and were required to submit a half to one page written summary, worth 5.2% of the final course grade, detailing what they did at the workshop, what elements they liked and disliked, what they learned, and how the workshop related to their major or career goals (if at all). To receive credit for their summary, students were also required to sign a physical sign-in sheet to verify attendance. Half of the student summaries, representing all submissions from three out of the six course laboratory sections, were read by the course instructor and a list of frequently occurring positive and negative feedback was compiled. To reduce workload, summaries from the remaining three laboratory sections were not included.

*Survey Instruments*

To evaluate the effectiveness of the workshops on increasing students’ participation in student clubs and their sense of belonging, two Qualtrics surveys were administered. The first survey (Survey A) was anonymous and was given during the final week of classes to students enrolled in the Introduction to Engineering course. Students were asked to complete the survey outside of class. The survey focused on several elements of the course including achievement of learning outcomes, lab activities, groupwork, and extracurricular involvement. Two survey questions were analyzed for this study. The first asked students about participation in clubs. In 2023, students were asked whether they participated in *any* club event; in 2024 students were asked whether they participated in any *additional* club events besides the required workshop. The second question (five-point Likert) asked if students agreed that the course, in general, helped them feel more connected to the engineering college. Results from the 2023 and 2024 cohorts were compared. The effect of the workshop activity on sense of belonging in the engineering college (VCEA) was evaluated using results collected in a college-wide, IRB approved survey administered in all first-year engineering, computer science, and design and construction courses at the end of the fall semester in 2023 and 2024 (Survey B). Responses from students not enrolled in the Introduction to Engineering course and non-first year students were excluded from analysis. To evaluate sense of belonging in the engineering college (VCEA), a five-item, five-point Likert scale adapted from a validated scale developed by Johnson [16] was used. Scores for the five items were averaged to evaluate students’ overall sense of belonging (Cronbach’s alpha = 0.897). Table 1 below summarizes the questions used for analysis.

Table 1. List of Survey Questions Evaluated for Study

Survey	Question Text	Question Format
A	I attended an engineering club meeting or event*	Yes/No
A	ENGR 120 has helped me feel connected to the Engineering College	Likert
B	I feel comfortable in VCEA	Likert
B	I would choose VCEA over again	Likert
B	VCEA is supportive of me	Likert
B	I feel that I am a member of the VCEA community	Likert
B	I feel a sense of belonging to the VCEA community	Likert

\*In fall 2024, question text was rephrased to exclude participation in mandatory workshop

The response rate for Survey A was 32.5% for the 2023 cohort, and 17.1% for the 2024 cohort. The response rate for Survey B was 66.7% for the 2023 cohort, and 68.3% for the 2024 cohort. Additionally, the ethnicity, gender, and program of study of Survey B respondents were compared for the two cohorts to identify any significant demographic differences that may have impacted sense of belonging. No significant differences were found in the percentage of female or ethnic minority students and the distribution of programs of study represented was similar for both years (0.2 - 6.6% change in percent of students enrolled in each area of study).

## **Results and Discussion**

### *Student Participation and Qualitative Student Feedback*

Overall, a high rate of participation in the club workshops was achieved and student feedback was generally positive. Over 90% of students enrolled in the course attended one of the club workshops offered. Written student feedback, collected via the required reflection assignment, showed that the majority of students enjoyed the workshop experience. Approximately half of the written responses (112 out of the 216 reflections submitted) were evaluated to identify the most common positive and negative feedback from students. Commonly discussed elements are listed below (in no particular order):

Commonly noted positive elements:

- Opportunity to meet people and/or collaborate with peers
- Learned skills relevant to future career/real engineering applications
- Creative freedom or hands-on nature of activities
- Fun or engaging activities
- Food provided

Commonly noted negative elements

- Length of workshop (too short or too long)
- Activities not engaging/ not hands-on
- Vague or inconsistent instructions/information
- Disorganized leaders/other logistical issues
- Too entry level/ no specific technical skills introduced
- Size of groups/ group dynamics (some students not engaged, large group size, etc.)

The most frequent positive elements identified by students were the opportunity to collaborate with their peers and the creative and hands-on nature of several of the workshop activities such as the “engineering triathlon” competition. The most frequent negative elements were the lack of engaging content in some workshops such as the engineering drawings presentation, vague or inconsistent instructions, and various logistical issues such as room size, difficulty hearing club leaders, and issues with construction materials for some of the workshop projects. Hands-on activities that allowed students to design or construct a physical product were particularly well-received. Several students also specifically noted that the workshops provided an opportunity to

meet peers in the same major or connect with club leaders, which was one of the goals of the workshop series. For example, a Hispanic female who attended the workshop hosted by the SHPE club left the following feedback in her summary: “I really connected with the people. They were really wonderful and really accepting. I actually met 2 people with the same major as me and they gave some really good advice and what to expect in future classes.” Overall, qualitative feedback was positive and student responses can be used to improve logistics, organization, and focus of workshop activities in the future.

#### *Qualitative Feedback from Club Leaders*

Additionally, five of the student clubs filled out an informal survey seeking feedback on the workshop. Feedback from club leaders was very positive overall; 60% somewhat agreed and 40% strongly agreed that the workshop was worthwhile, and all clubs that responded to the survey indicated that they would like to be involved in the workshop program in the future. Specific comments from club leaders about the workshop pilot included:

- “... we had a lot of fun doing this project and had a great turnout”
- “...workshop was an enjoyable opportunity to get to know the students”
- “...the officers from both [clubs] interacted well and were able to get closer as cabinet members”

When asked whether engagement from first-year students had been better, the same, or worse since the workshop, 20% of the respondents to the survey indicated it was much better and 80% said it was about the same. Specific feedback on what didn’t go well for the workshop included:

- A lack of participation from some attendees
- Some attendees leaving early
- Some students finishing the activity provided much faster than others

One responder also indicated they had logistical issues with not having a large enough space to accommodate the number of people attending and running out of food. Challenges noted by club leadership (i.e., lack of engagement and logistical issues) were similar to those noted by students.

#### *Quantitative Results: Club Participation Rate and Sense of Connection and Belonging*

We hypothesized that the addition of the mandatory club workshop assignment would significantly increase the percentage of students voluntarily involved in clubs by increasing students’ familiarity with these organizations and encouraging interest. Results from Survey A indicated that the addition of a mandatory club workshop did not impact the percentage of students who voluntarily participated in club meetings or events during the semester. The percentage of students who indicated participating in any club activity, excluding the required workshop, was 54.4% in 2023 and 52.3% in 2024, statistically similar rates based on a Chi-square test ( $p= 0.73$ ). Additionally, we believed participation in the club workshops would increase students’ sense of belonging and connection to the engineering college through promoting interaction with their classmates and peers involved in extracurricular activities. Results from Survey A indicated no significant difference in how connected students felt to the engineering college as a result of enrollment in the Introduction to Engineering course. In fall

2023, 75.9% of students agreed or strongly agreed that the course helped them feel connected to the college, compared to 72.1% in fall 2024. There was no statistical difference in the average Likert value for the two semesters, 3.87 in fall 2023 and 3.91 in fall 2024, based on an independent samples t-test ( $p=0.82$ ), indicating an approximately equal sense of connection. To evaluate students' sense of belonging to the engineering college, average responses to the five-item Likert scale from Survey B were compared. Results from an independent samples t-test indicate that students in the fall 2024 cohort felt a higher sense of belonging to the engineering college than their counterparts in the fall 2023 cohort ( $p = 0.008$ ) with average Likert scores of 3.73 and 3.53, respectively. In fall 2023, only 30.7% of respondents had an average belonging score of 4 or above (corresponding to an average response of "agree" on the five items), compared to 47.1% in fall 2024. Results from Survey B should be interpreted with heavy caution. This survey had a significantly higher response rate than Survey A, but did not focus on the Introduction to Engineering course or workshop activity specifically; therefore, differences in sense of belonging may be due to students' other activities in the engineering college occurring outside the course.

Taken together, quantitative results indicate that the addition of the mandatory club workshop assignment into the Introduction to Engineering course did not significantly impact the percentage of students involved in student clubs or their sense of connection to the engineering college. The workshops may have improved students' sense of belonging in the college, but due to the broad nature of the survey used to evaluate this metric, it is unclear what the impact of the club workshop was, specifically.

### *Limitations and Lessons Learned*

As discussed, limitations related to evaluating the actual effectiveness of the workshop pilot program exist. Surveys used to determine the impact on belonging, club participation and sense of connection had low response rates (Survey A) or were too broad to isolate the workshop activity as a cause of increased sense of belonging (Survey B). These surveys were used in 2024 to allow a direct comparison to responses from students in 2023 who did not participate in the workshop program; however, the nature of the surveys limit the usefulness of the data. If the program is continued, a more targeted set of survey questions should be developed to ascertain whether the workshops independently have an impact on belonging, connection, and club participation rates. A pre-workshop survey and post-workshop survey could be administered to evaluate changes in sense of belonging and connection occurring as a direct result of the workshop. To improve response rates, all surveys should be administered during class time.

The pilot version of this workshop also revealed several opportunities for improvement and suggestions for those considering implementing similar programs. First, an appropriate level of oversight must be given to clubs throughout the workshop development process. For the pilot version, we used an intentionally "hands-off" approach and were minimally involved with planning and executing the workshops activities so that they would function as a growth opportunity for the club leaders developing them. However, we believe further guidance and more frequent communication with clubs would have been beneficial; in several workshops,

student participants noted that club leadership was disorganized, instructions were unclear, or that there were other logistical issues that could have likely been avoided. Second, we believe that increasing the connection between workshops and typical club activities would also be beneficial. The workshops did not appear to lead to a greater percentage of students involved in clubs. One explanation for this could be that some workshop activities were not well-connected to actual club activities and that leadership did not promote their clubs heavily during their workshops. We suggest that a portion of future workshops be devoted to sharing basic information about clubs, that leaders attempt to design workshops that are related to typical club activities and explain these connections, and that course instructors continue to encourage club involvement after the workshops so that workshops are interpreted by students as an entry point for further club involvement rather than stand-alone activities.

### **Conclusions and Future Directions**

In conclusion, a mandatory club-led workshop series was successfully implemented in a large Introduction to Engineering course in fall 2024 to provide an incentivized opportunity for first-year students to directly engage with student engineering organizations. Student leaders from nine different engineering clubs developed six out-of-class workshops, ranging from hands-on design competitions to technical skills presentations, and students in the Introduction to Engineering course were required to attend at least one of these for course credit. Over 90% of students participated, and qualitative feedback received was generally positive, with students commonly noting that the workshops provided an excellent platform to connect and collaborate with peers and participate in engaging activities. Initial quantitative results from the pilot, evaluated by comparing responses collected in fall 2023 and fall 2024 on two end-of-course surveys, indicate that the workshop series did not have a significant impact on the participation rate in clubs or students' sense of connection to engineering. The workshops may have had a small positive influence on the sense of belonging of first-year engineering students; however, the specific impact of the workshops could not be evaluated independently of other factors due to the design of the survey instrument. Despite the limitations of this study and areas for future improvement, the workshop program allowed the majority of first-year engineering students to engage directly and positively with clubs at least once during the semester. In the future, we hope to continue the workshop series given the positive student feedback and more rigorously evaluate the impact of the program on connection, belonging, and retention in engineering.

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