



Work In Progress: Evolution of A Near-Peer Co-Instructional Model for A Large-Enrollment First-Year Engineering Course

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Introduction

First-Year Experience (FYE) engineering courses at large, research-focused universities present a unique challenge from curricular, pedagogical, and logistical perspectives. Course content should be interdisciplinary to appeal to students from all engineering fields but include technical and discipline-specific content to aid students in career path decisions. Class sizes and pedagogical choices such as project-based learning are frequently constrained by the number and disciplinary background of available faculty instructors.

Prior work by our group has presented a framework for balancing competing curricular and administrative needs [1]. Over the past six years, through stakeholder feedback and formative evaluation, we have developed and continually refined a large-enrollment (ca. 650 students) one-semester FYE course taught by one to two faculty members. This course features a mixture of interactive didactic content and two multi-week, open-ended design challenges [2]. Students work in small groups within and outside of class time that are facilitated by near-peer teaching assistants. Compared to course structures with multiple smaller, faculty-led sections, our model is more financially and logistically feasible in that it represents a partial-to-full workload for a more limited number of faculty members [1].

The success of the large-enrollment FYE course that our group has developed is predicated on instructional support from cadre of near-peer undergraduate teaching assistants, called peer leaders. As they are undergraduate students who have taken the course within the last four years, peer leaders are intimately familiar with the course content and have personal experience of working in an interdisciplinary team for this course. They provide a small class feel in a large-enrollment class (1:25 peer leader-to-student ratio).

This paper summarizes the evolving role of the usage of peer leaders in a large-enrollment introductory engineering course at a mid-sized research-intensive state university in the USA. It presents an ongoing effort to bolster the coaching the coaching provided to the peer leaders and provides a framework for other institutions looking to adopt a similar model.

Background/Motivation

It's well documented that incoming first-year students struggle with the transition to college, particularly in STEM fields [3]–[8]. The challenges range from lifestyle changes and identifying resources, to differences in terminology and language used to describe STEM concepts in higher education [9]. These stresses can often feel overwhelming and decrease a student's confidence and persistence in STEM. However, with scaffolding that provides the needed conceptual framework, students are better prepared to develop analytical and critical thinking skills [6]. Providing first-year students with the tools to understand their new learning environment, identify resources, and scaffold their learning experience can increase student's persistence in STEM [4]. Near-peer mentors can aid first-year students transitioning to college by having familiarity with both the transition process and the content students are studying.

Near-peer mentors are individuals who have previously gone through the required coursework for a particular degree, program, or course. They're usually senior to the incoming freshman by at least one level and have experience with the terminology and language of the course. Utilizing near-peer mentors in the classroom can also be described as "peer learning", and refers to "teaching and learning strategies where students learn with and from each other without the immediate intervention of a teacher" [10].

The benefits to utilizing near-peer mentoring in the classroom are plentiful, and well documented. Overall education researchers have noted increased retention, confidence, motivation, feelings of belonging, and increased networks of study partners and peer study strategies [5]–[13]. In that same tone, utilizing near-peer mentoring has been shown to decrease DFW rates (percentage of students who get a D or F grade, or withdraw (W) from the course) and decrease feelings of stress and loneliness [12], [13]. Studies in large-enrollment first-year engineering courses have shown that the use of near-peer mentoring has helped to increase the retention of students in the field of engineering [5]. Not only has it been shown that mentees benefit, but also the mentors. Near-peer mentors can gain confidence in content knowledge, consolidate their subject knowledge, improve communication and interpersonal skills, and obtain satisfaction from helping their in-coming peers [13].

The role of peer leaders in our FYE engineering course has evolved alongside course content, as well as the logistical infrastructure to recruit, retain, and evaluate the performance of these individuals. Although they have historically been used in more of an instructional support role in large lecture sessions [1], peer leaders have more recently been responsible for independently facilitating active-learning breakout sessions [2]. With the changing role of the peer leaders from instructional support in large lecture sessions towards leading discussion sessions, our group's goal is to bolster the pedagogical training that the peer leaders receive. This paper presents a retrospective evaluation of student experiences with their peer leaders based on mid- and end-of-semester feedback surveys. It also presents a survey of the most recent cohort of peer leaders (Fall 2021) to understand the perceived positive and negative aspects of their roles. These results will inform the direction of training for future cohorts of peer leaders.

Use of Peer Leaders at the University of Delaware

Peer leaders serve as the first line of contact for students in the course. They are responsible for grading of weekly formative assignments, holding office hours, and answering student questions. They also serve as general advisors for team issues, whether technical or related to project management or team dynamics. Prior to Fall 2020, they attended the lecture sessions to facilitate activities alongside the faculty instructors [1].

With the shift to online learning in Fall 2020 due to the COVID-19 pandemic, pairs of peer leaders led weekly synchronous online (Zoom) workshops for their mentees following instructor-provided lesson plans [2]. These synchronous workshops supplemented asynchronous didactic content by the faculty instructors that was released weekly to the students. All students were required to attend these workshops. Each synchronous workshop summarized key concepts from that week's lectures and featured two breakout sessions where students worked in their assigned project teams to plan and conduct a portion of the week's major assignments. Prior work by our group demonstrated how course experiences and learning outcomes were preserved for our large-

enrollment class in an online format [2], we thus retained the peer leader-led small group sessions when in-person learning resumed in Fall 2021. Peer leaders continued to lead these same workshops as in-person weekly discussion sessions instead of the online format. These discussion sessions are a part of the credit hour requirement for the course and replace one of the large lecture meetings for the course. This is achieved by delivering some didactic content asynchronously. In its most recent offering in Fall 2021, the course employed 28 peer leaders, with each peer leader assigned to approximately 25 students (5 teams of 5 students).

Peer leaders undergo a day-long training prior to the start of the semester where they are oriented to the core values in the course (e.g., teamwork, communication, growth mindset), principles for how to monitor and intervene on team projects, using the learning management system for instruction, and grading policies and procedures (Table 1). Rubrics are used to grade all course elements, and prior work by our group has demonstrated high inter-rater consistency using this approach [14]. During the semester, there are weekly group meetings where peer leaders have opportunities to troubleshoot and clarify any questions with the faculty instructor(s).

Table 1: Structure of one-day peer leader training.

Section No.	Training Focus	Components Covered
1	Course Overview	Course learning Objectives & elements Peer leader roles and responsibilities
2	Assignments and Grading	Overview of assignments Rubrics Grading on Canvas CATME peer evaluations [15]
3	Discussion Sessions	Logistics Checklist Grading
4	Course Communication	Contact students Set office hours Weekly meeting First week checklist

Student Perceptions of Peer Leaders

Student perceptions of their peer leaders were measured using a mid-semester and an end-of-semester feedback survey. These surveys were distributed to all students enrolled in the Fall 2021 semester class of the introductory engineering course—total enrollment of 651 students.

Figure 1 and Figure 2 show a subset of results from mid-semester survey pertaining to questions related to student experience with peer leaders. From Figure 1, 69% of the student respondents indicated that they were very satisfied or satisfied with the mandatory Friday discussion sessions that were independently facilitated by their peer leaders (597 respondents out of 651, 92% response rate). Supplemental help sessions like Q&A sessions facilitated by the instructor and instructor/peer leader office hours were rated neutral by 57% of the student respondents. This was in line with the observation that students primarily sought help during the discussion session and these supplemental sessions were not well-attended. From Figure 2, 88% of the student

respondents strongly agreed or agreed that their peer leader was a good guide/mentor and 93% of the students indicated that they could get help when they needed it. These results were an early indicator that the implementation of the in-person peer leader-led discussion sessions in smaller groups was a useful addition to the large-enrollment course.

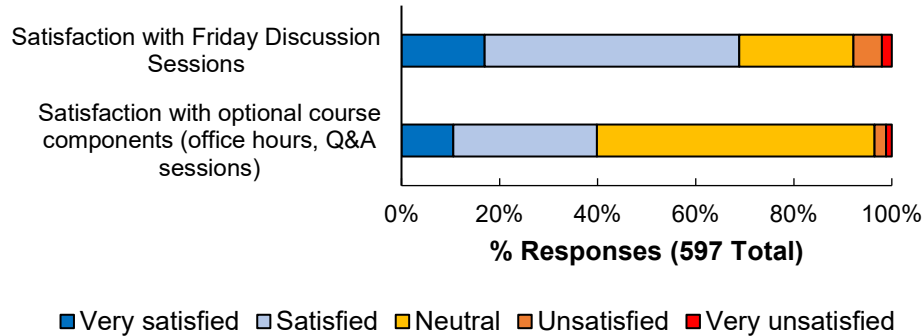


Figure 1: Responses from mid-semester feedback survey indicating student satisfaction with peer leader-led discussion sessions and other means of obtaining help (92% response rate).

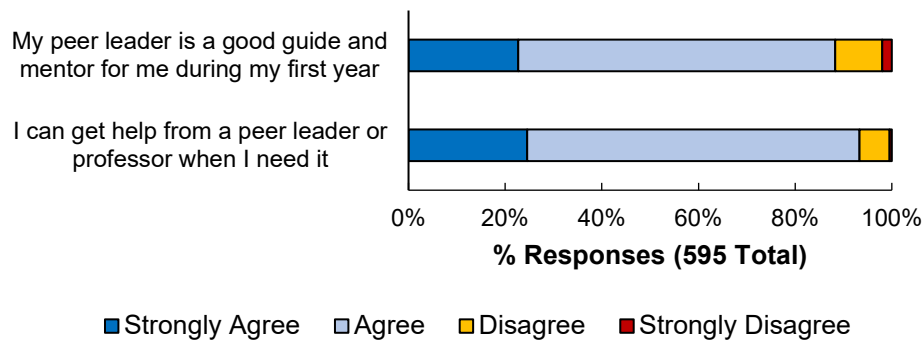


Figure 2: Responses from mid-semester feedback survey showing student agreement with statements related to obtaining guidance, mentoring, or help with the course (91% response rate).

End-of-semester student feedback also indicated overall positive experiences of students with discussion sessions facilitated by peer leaders and positive perception of peer leaders (Figure 3).

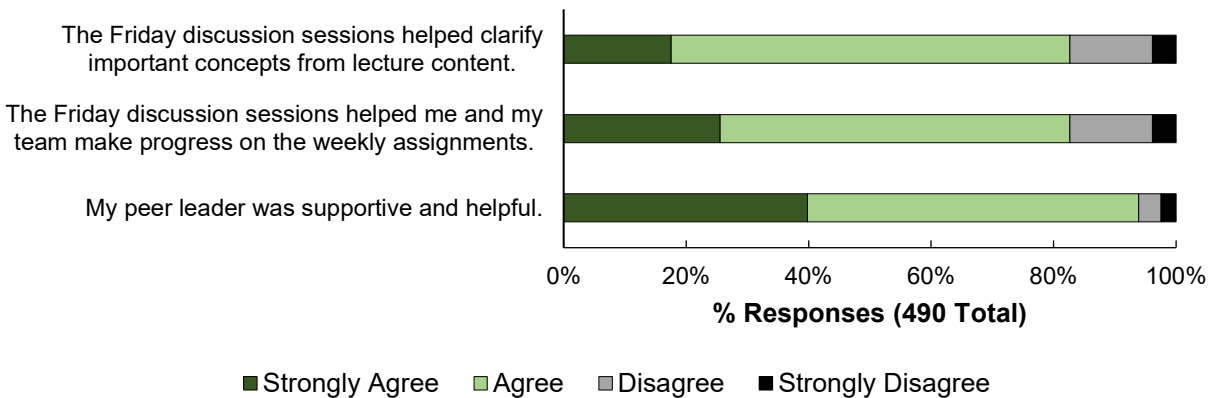


Figure 3: Responses from end-of-semester feedback survey showing student agreement to statements connected to their experiences with their peer leaders (75% response rate).

As seen in Figure 3, over 80% of the student respondents strongly agreed or agreed that the discussion sessions clarified important concepts, helped teams make progress, and that their peer leaders were supportive (490 respondents out of 651, 75% response rate).

Peer Leader Perceptions

At the end of the semester, the most recent cohort of peer leaders (Fall 2021, 28 peer leaders) were surveyed at the end of the semester; Table 2 shows the survey questionnaire. 27 peer leaders responded to the survey (96% response rate).

Table 2. Questionnaire for peer leader survey.

Question	Question Type
Select your level of agreement with the following statements. <ul style="list-style-type: none"> • I felt ready to be a PL after the training session. • I felt prepared to lead the discussion sessions with the material provided. • It is good to have a PL buddy in leading the discussion sessions. • The rubrics were clear on how to grade assignments. • My students did well in this class. • My PL experience matched my expectations going into the role. • I feel like I made a difference with my students. 	Five-level Likert scale: Strongly agree Somewhat agree Neither agree nor disagree Somewhat disagree Strongly disagree
How much time, per week, are you spending on your PL responsibilities? Include time spent watching lectures, preparing and leading discussion sessions, grading, and answering student questions.	Slider: 0-20
What is your biggest struggle in this position? What do you enjoy about being a peer leader?	Open-ended Text Entry

**PL stands for peer leader*

On average, peer leaders estimated that they spent an average of 7.8 hours per week on their responsibilities. Figure 4 shows the histogram of self-reported work time per week by peer leaders as reported on the peer leader survey. While the average value is in line with expectations for the role, the range of values indicates that peer leaders may need some additional coaching on time management and/or time tracking.



Figure 4: Histogram of self-estimates of weekly time spent by peer leaders on their job responsibilities.

Figure 5 shows peer leader responses to the Likert-scale questions in the survey. About half of the peer leaders strongly agreed that they felt ready to be a peer leader after their one-day training session at the beginning of the semester. Most of the remaining half responded “somewhat agree” to this question; one peer leader each chose “neither agree nor disagree” and “strongly disagree”, respectively.

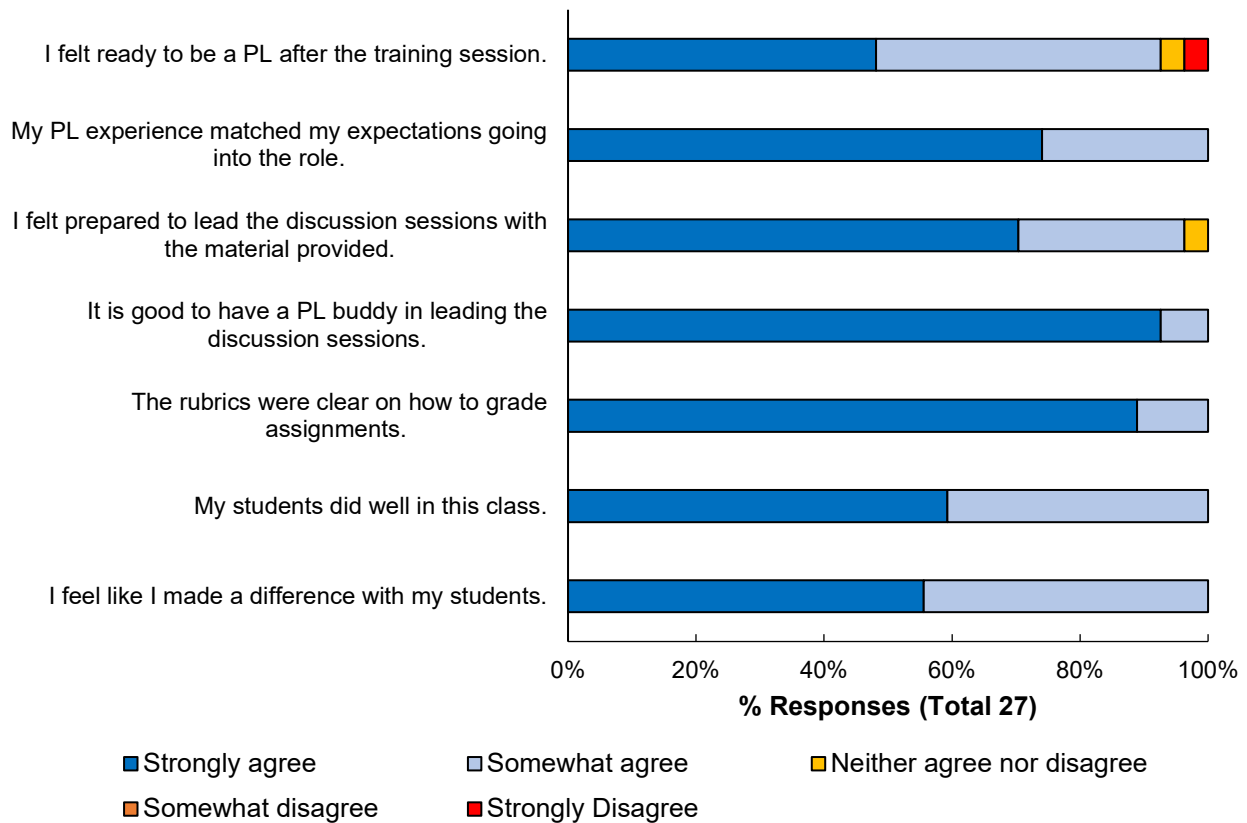


Figure 5: Peer leader survey responses to Likert-scale statements related to their training, preparation, and retrospective reflection on their experience in the role.

All peer leader respondents indicated agreement about their experience matching their expectations going into the role. 70% of the peer leaders strongly agreed that they felt equipped to lead the discussion session with the instructor-prepared material. Peer leaders responded positively towards leading their discussion session with a peer leader partner. They also responded positively towards the clarity of rubrics provided to them for grading assignments [14]. The peer leader responses also indicated general satisfaction and fulfillment with their role. This was further reflected in the text responses to the question about what they enjoyed about their role (as elaborated below and in Table 4).

The open-ended text responses to the questions, “What is your biggest struggle in this position?” and “What do you enjoy about being a peer leader?” were investigated for common themes. An inductive thematic analysis approach was used to code peer leader responses to both these questions. The themes that emerged for each of these questions and corresponding exemplar responses are shown in Tables 3 and 4.

In describing their struggle in the position, several peer leaders detailed instances of difficulty with interpersonal dynamics among the student teams that they were mentoring. A predominant theme within these comments is the prevalence of “social loafing”, which is defined as reduced motivation, effort, or performance from individual team member(s) [16], [17]. Table 3 shows examples of responses from peer leaders who dealt with social loafing among their mentees. Many peer leaders also expressed their struggle with helping students and guiding them towards answers.

Table 3: Themes and exemplars from open-ended text responses to the question, “What is your biggest struggle in this position?” from the peer leader survey.

Theme	Exemplar Responses
<p>Struggle: Social loafing</p>	<p>“The biggest struggle was working with students who did not fully care about the projects.”</p> <p>“Trying to motivate and encourage team members who repeatedly either miss discussion sessions or did not do their parts on time.”</p> <p>“My biggest struggle as a peer leader was I think trying to help the teams with members that would not do any work.”</p>
<p>Struggle: Conflict resolution</p>	<p>“Conflict resolution was the biggest struggle as I’m sure it was for many. I think having example scenarios and how to deal with them in peer leader training would be especially helpful in the future.”</p> <p>“Dealing with team conflicts.”</p>
<p>Struggle: Helping students</p>	<p>“My biggest struggle was trying to figure out the best way to help some students that were confused.”</p> <p>“I think sometimes the biggest struggle was figuring out how to point students in the right direction without doing their work for them.”</p>
<p>Struggle: Engaging students</p>	<p>“Engaging students enough to come to Office Hours”</p> <p>“One of my biggest problems was getting my students engaged. Obviously freshman year is a bit scary as everyone starts this new chapter in life, but I wish the students felt more comfortable speaking out in discussion/emailing me.”</p>

**Quotes from participants are unedited.*

Table 4 shows themes from peer leader responses to the question, “What do you enjoy about being a peer leader?”. A sense of fulfilment from helping students with course content and mentoring them were frequent themes in these responses. Several peer leaders also expressed benefits to their own professional development and peer network.

Table 4: Themes and exemplars from open-ended text responses to the question, “What do you enjoy about being a peer leader?” from the peer leader survey.

Theme	Exemplar Responses
Enjoyment: Helping students	<p>“I enjoyed helping the students and forming a bond with them. I believe that I helped my students understand the expectations of quality work and communicating information professionally.”</p> <p>“I liked being able to interact with the students, especially in person, and being able to help them since I had done the exact project so I could help them along the way”</p>
Enjoyment: Mentoring	<p>“I love helping the younger engineers and making connections with them outside of class. I was able to help spike their interest in engineering while also just saying a simple hi outside of class. Especially at the last discussion it was awesome to hear how many really loved the class and my peer leader and I. Not only seeing them become comfortable with us, but also asking more and more intriguing questions and mentoring them through the process was awesome. I felt way more than a peer leader more of a mentor for inside and outside of the class.”</p> <p>“I like that I am able to help the students out in many aspects and sharing the knowledge I have with them because we have been in their shoes before and know what its like.”</p>
Enjoyment: Self-improvement	<p>“Getting to see how much I’ve learned in the past year by helping to teach students who are in the position I was in a year ago. Having a built-in weekly refresher on core engineering concepts, which I’ve been able to use to my advantage in my own classes.”</p>
Enjoyment: Building community	<p>“I enjoyed getting to interact with other engineering majors (peer leaders).”</p> <p>“I made new friends with the upperclassman who were peer leaders.”</p>

**Quotes from participants are unedited.*

Conclusions and Future Work

Near-peer mentors (called peer leaders in this paper) are essential to the success of our large-enrollment introductory engineering course. With instructor-prepared lesson plans, peer leaders lead weekly discussion sessions that students are required to attend. These smaller group sessions are designed to reinforce key concepts of the week and provide student teams to plan and make progress on weekly assignments. Mid-semester and end-of-semester feedback in from students in Fall 2021 indicate that these discussion sessions were successful in achieving their objectives. Students indicated that their peer leader was supportive and helpful to them in the course. We plan to continue scheduling these discussion sessions in the future.

At present, peer leaders attend a one-day training session at the beginning of the semester. Survey responses from Fall 2021 peer leaders at the end of their term indicate a need to enhance the training and ongoing support for future cohorts of peer leaders during the semester. A prevalent theme emerging from peer leader responses is that they need tools to address conflicts in student teams, especially stemming from social loafing. Responses from peer leaders also indicate a need for pedagogical training to improve student engagement. We plan to develop evidence-based instructional coaching strategies to bolster peer leader training. Peer leaders also noted their own professional development benefits in this role. We also plan to provide guidance for peer leaders to be able to articulate and document their professional development in this role.

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