Work-In-Progress: An Updated Peer Mentorship Strategy for First Year Engineering

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Abstract
Undergraduate peer mentorship provides an effective strategy for allowing first-year students to adjust to a college setting by providing a connection with established students and increased access to institutional knowledge and resources. Previous work developed a peer mentorship strategy for a first-year engineering course at Anderson University and reported encouraging results for initial retention and student success outcomes. In particular, short-term retention was increased, and participants felt better engaged with the engineering program and university.

After the initial study, the peer mentorship strategy was refined to improve mentor accountability and structure. In this paper, the refined strategy is presented, along with updated retention data including medium-term retention information. In addition, retention and survey data from the second cohort of students are presented which attempt to measure outcomes for two research questions:

RQ1: Do students feel that peer mentorship was valuable in connecting to the engineering program and community?
RQ2: Does peer mentorship lead to better retention outcomes?

Results from this ongoing study are encouraging in demonstrating the efficacy of engineering-specific peer mentorship.

Introduction

Significant research has demonstrated that peer mentorship is an effective method for improving retention outcomes for engineering students [1,2,3,4]. The motivation to grow effective peer mentorship programs corresponds with the important efforts to improve retention, particularly at enrollment-driven institutions. Although peer mentorship has been studied widely, the challenges associated with these programs are still a relevant topic, particularly coming out of the COVID-19 pandemic [5,6]. The 2022 ASEE Annual Conference included 9 papers on the topic [7,8,9], including an entire session in the First-Year Programs Division called “Peer Mentoring/Learning, Teaching Assistants, and Career Mentorship,” which included three papers on peer mentorship [5,6,10].

Within this atmosphere of enrollment pressures and promotion of student success, previous work was carried out at Anderson University, a small enrollment-driven institution, to develop a peer mentorship program for first-year engineering students [2]. This work adapted lessons learned from other, much larger engineering programs into a cohesive peer mentorship program in this smaller context [11,12,13,14,15]. The results of this previous work indicated promising

results in short-term retention and an increased feeling of connection with the engineering program. In the current work, an updated peer mentorship model was developed to strengthen mentor accountability and expectations, and updated assessment was conducted including measuring medium term retention results for the original peer mentorship cohort.

Peer Mentorship Strategy

In previous work [2], peer mentoring volunteers were employed by the department and paid for about 5 hours of work over the course of the semester, split across three mentorship meeting times. Recognizing the benefit of peer mentorship to both the students being mentored and those serving as mentors, the mentorship strategy was adjusted this year to make peer mentorship a required curricular activity. This peer mentorship requirement was added to the upper-level Control Systems course, making up 3% of the grade for the course. This course was chosen because it is required for most engineering majors at Anderson University. Peer mentorship training and expectations were provided as part of the Control Systems course.

Individual peer mentors were assigned to first-year engineering project groups completing a project in their Intro to Engineering course. This course has no TA support, making it a good choice for leveraging student peer mentors. The groups each consisted of four students who were tasked with designing, constructing, and documenting mini-golf holes for a campus event [2,16]. In this project, students are given a strict material budget, constraints on storage space, and several requirements for 3D-printed and laser-cut objects with the objective of making a hole that is interesting to play with an expected par less than six strokes. At the campus event, participants vote on their favorite hole, awarding bonus points to the winning teams. The project is split into well-defined milestones spaced two to three weeks apart in the second half of the semester which require the application of the engineering design process. Each peer mentor completed a project with similar milestone and documentation expectations in their first-year engineering course, resulting in experiential knowledge of project requirements.

Peer mentors were required to meet with their groups a minimum of three times over the course of the semester and report the meeting attendance after each meeting by email. In order to specify timing, it was required that mentors meet with their students before each of the first three milestones for their mini-golf project. The following expectations were provided to these peer mentors:

- Provide a reliable primary and backup contact method to the group
- Provide review/feedback/project management support to groups on their design and project progress
- Ask group members about their adjustment to coursework
- Ask group members about integration to campus life, residence life, clubs, etc.
- Provide aid and support if there are student questions about scheduling courses
- Be positive about the engineering program
- Be professional in communication with groups and group members

Table 1 shows the rubric provided to the peer mentors demonstrating grading standards.

Table 1 Peer Mentor Rubric

Requirement	Value
Student group rating of peer mentor	10
Attendance at Meeting 1	5
Attendance at Meeting 2	5
Attendance at Meeting 3	5
Communication with Faculty	5
Total	**30**

In addition to requirements for the peer mentors, each student team had a requirement to report back to the responsible faculty member and communicate with their peer mentor. As part of their project grade, they were required to reach out by email to set up an initial meeting with their peer mentor; a minimum of three student-mentor meetings were required, including the student-initiated first meeting. Failing to attend all three required meetings resulted in a 2.5% deduction from the final grade for first-year students participating in the mini-golf project. This allowed the burden of responsibility for scheduling and holding meetings to be shared across both the peer mentors and the student teams which they mentored.

Assessment Methods

Indirect and direct assessment methods were applied to measure the efficacy of this updated peer mentorship model, specifically to answer the research questions:

RQ1: Do students feel that peer mentorship was valuable in connecting to the engineering program and community?

RQ2: Does peer mentorship lead to better retention outcomes?

As a mode of indirect assessment, a 5 point Likert scale survey was delivered to students using Google Forms, containing five prompts. In this survey, a rating of 1 corresponded to ‘Strongly Disagree’ and a rating of 5 corresponded to ‘Strongly Agree’. The particular prompts were:

1. I found my peer mentor to be a useful resource for completing my design project.
2. How would you rate your peer mentor (1-5).
3. I had an easier time adjusting to college life thanks to my peer mentor.
4. My peer mentor helped me connect better with the engineering program community.
5. I plan to continue studying engineering at Anderson University next semester.

Questions 1 and 2 were aimed at assessing the peer mentors and were used as part of the grading criteria as displayed in the rubric shown in Table 1. Questions 3 and 4 addressed the usefulness of peer mentors in connection to campus and adjustment to college life (RQ1), and Question 5 addressed retention (RQ2).

To directly assess retention outcomes for RQ2, retention to semester 2, 3, and 5 year graduation rate are used. Data are reported for three years prior to implementing peer

mentorship (2018-2020) and for both years that peer mentorship has been used (2021 and 2022).

Updated Results

Results of the Likert scale survey are shown in Table 2. Results from the same survey delivered to the previous cohort are included for comparison. Of the 39 students enrolled in the course, 34 responded for an 87.1% response rate. In the previous cohort, 30/32 responded (93.8% response rate).

Table 2: Average responses to the Likert scale survey with 1 being 'strongly disagree', and 5 being 'strongly agree'.

Survey Question	2021 (n_1 = 30)		2022 (n_1 = 34)		Mann-Whitney Test Results	
	Average	Std. Dev.	Average	Std. Dev.	*U*	*p*
1	4.33	0.80	3.88	1.03	386	0.095
2	Not Measured	Not Measured	4.06	0.95	N/A	N/A
3 (RQ1)	3.63	1.22	3.32	0.98	407.5	0.168
4 (RQ1)	3.77	1.04	3.29	0.91	363.5	0.049
5 (RQ2)	4.73	0.78	4.62	0.78	435	0.313

The averages reported all skew towards the 'agree' side of the scale, but every result is lower than the previous cohort. To compare the difference between results, the Mann-Whitney test was used. Only Prompt 4: "My peer mentor helped me connect better with the engineering program community" saw a statistically significant change between the cohorts (Mann-Whitney U = 363.5, n_1 = 30, n_2 = 34, p<0.05 two-tailed). It is unclear what caused this change, and this result should be studied further. The question which had the smallest change between cohorts was Prompt 5: "I plan to continue studying engineering at Anderson University next semester" (Mann-Whitney U = 435, n_1 = 30, n_2 = 34, p=0.313 two-tailed). To uncover the source of the differences in the data sets, Figure 1 shows the survey results in a stacked bar graph comparing the two cohorts. Table 3 contains the numerical data from this bar graph. From these, it can be seen that in 2022, Prompt 4 had a far lower percentage of positive responses and a greater percentage of neutral responses, meaning that many students did not feel that the peer mentors harmed their connection to the engineering program, but they did not help it either. It is also possible to see that Prompt 5 actually had a higher percentage of positive responses in 2022 than in 2021, so even though there was a lower average value, a greater percentage of students intended to retain. These results suggest that retention is positively impacted by engineering peer mentorship, but direct assessment results are needed to further evaluate that finding.

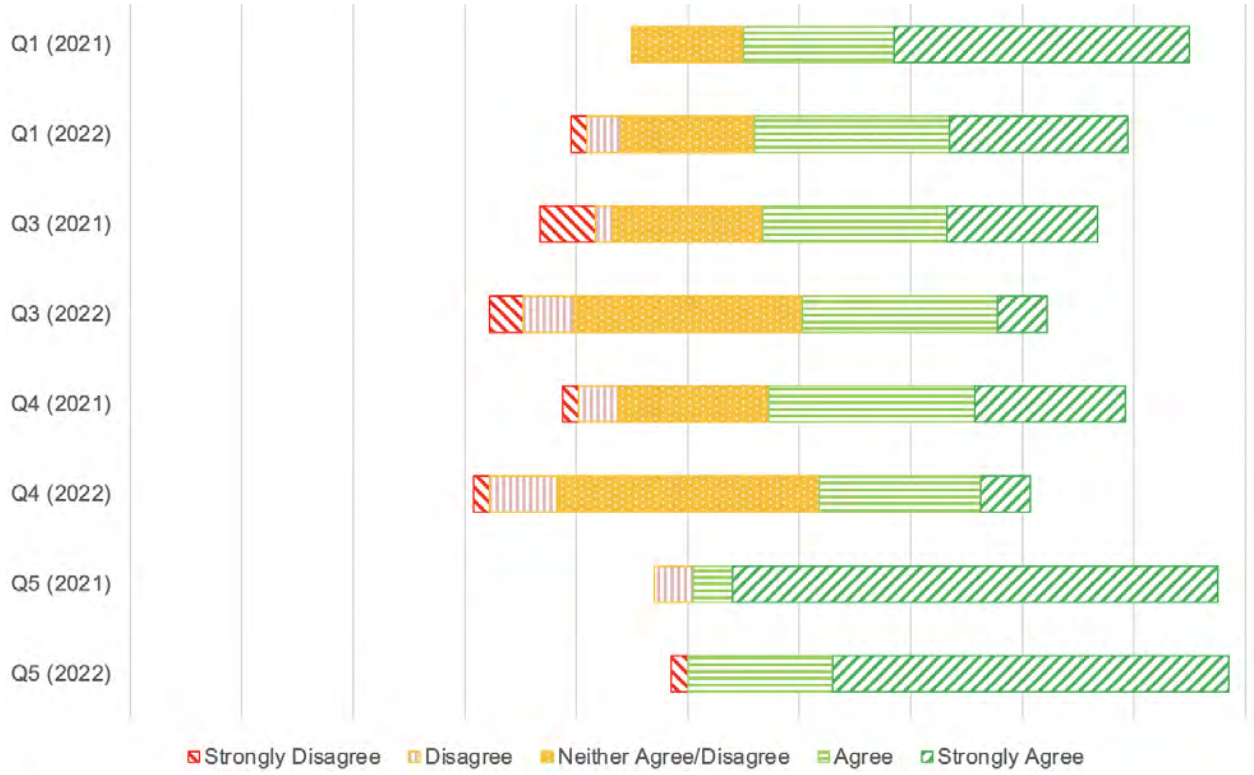

Figure 1: Stacked bar chart showing comparative Likert scale responses between the 2021 and 2022 cohorts, both of which had peer mentorship.

Table 3: Numerical results from the stacked bar chart in Figure 1 showing comparative Likert scale responses between the 2021 and 2022 cohorts, both of which had peer mentorship.

Prompt\Response	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Q1 (2021)	0.0%	0.0%	20.0%	26.7%	53.3%
Q1 (2022)	2.9%	5.9%	23.5%	35.3%	32.4%
Q3 (2021)	10.0%	3.3%	26.7%	33.3%	26.7%
Q3 (2022)	5.9%	8.8.%	41.2%	35.3%	8.8%
Q4 (2021)	3.3%	6.7%	26.7%	36.7%	26.7%
Q4 (2022)	2.9%	11.8%	47.1%	29.4%	8.8%
Q5 (2021)	0.0%	6.7%	0.0%	6.7%	86.7%
Q5 (2022)	2.9%	0.0%	0.0%	26.5%	70.6%

In addition to the indirect assessment of research questions, retention outcomes can be directly measured. Figure 2 shows the retention outcomes of cohorts pre- and post-peer mentorship, reported with respect to the original class enrollment size. Cohorts from 2018-2020 did not have engineering peer mentors, while cohorts from 2021 and 2022 did.

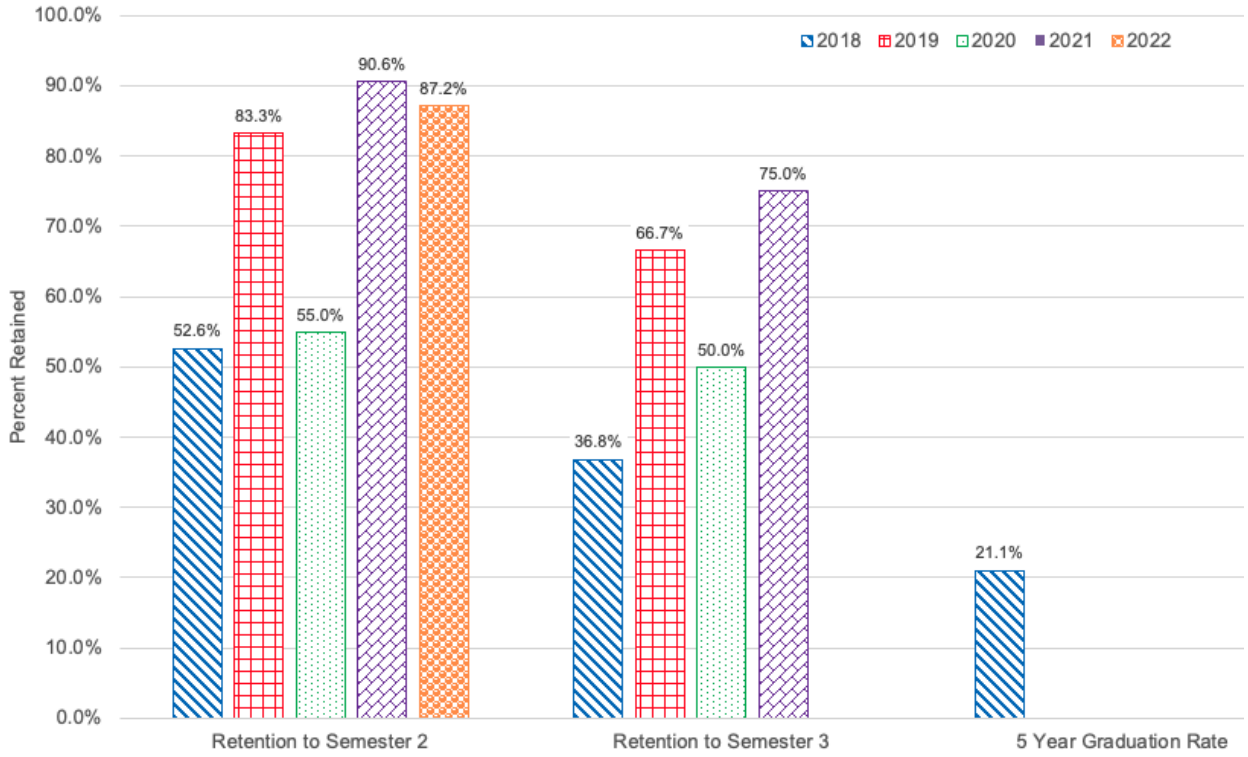

Figure 2: Retention results for continuation in engineering majors in semester 2 and 3, as well as 5 year graduation rate in engineering both with peer mentorship (2021-2022) and without it (2018-2020).

Evaluation of Mentor Performance

In addition to studying the effect of peer mentorship on first-year student retention and success, some discussion of the performance of the peer mentors themselves is useful. Of the 10 student peer mentors, 100% attended all three meetings. Each individual first-year student identified and rated their peer mentor through the survey tool, and mentors were rated an average of 7.97/10 by the teams they mentored, with a standard deviation of 1.56. Ratings for each peer mentor by members of their groups were fairly consistent, with an average variance of 1.45.

A few comments were provided by first-year students when evaluating their peer mentors. On one hand, a commenter stated "*[Our mentor] was helpful in navigating our project and laying out a solid work plan.*" In contrast, one particular mentor was not rated as effective and precipitated commentary from group members, shared here: "*I wish our peer mentor was more helpful. They really provided no mentorship in engineering and just talked to us about what was going on in general with each of us, and even in that they provided little to no mentorship regarding college life.*" A similar sentiment for that same mentor was echoed by another group member. These comments (good and bad) suggest that more training is needed for peer mentors on exactly

what role they should take in helping students plan and execute their projects in addition to providing community connection support.

Discussion of Results and Future Work

While results on both the survey and short-term retention are lower than in the first year of the program, the peer mentorship strategy appears to positively impact retention. It is notable that retention to semester 2 is highest for the two cohorts with peer mentorship. Another notable difference is that the variation in the semester 2 retention results is much smaller from year to year with peer mentorship than without. Although only one year of retention to semester 3 with peer mentorship is available, these results are also higher than cohorts without mentorship.

When considering survey results, it is also important to consider the differences between the two cohorts. The average incoming high school GPA for the 2022 cohort was 3.69 while the incoming high school GPA for the 2021 cohort was 3.58. However, the majority of the 2022 cohort's high school experience was directly impacted by the COVID-19 pandemic, so high school GPAs may not be comparable or may not hold as much weight as comparing previous cohorts. Standardized tests such as the SAT were also less common among the 2021 and 2022 cohorts than those prior to 2021, as many universities, including Anderson University, moved to test-optional admissions models. Another factor that is difficult to account for is the change in enrollment size between cohorts, as enrollment grew from 19 students in 2020 to 39 in 2022.

One area that can be easily measured is the comparative performance of the 2021 and 2022 cohorts to those of the cohorts from previous years. Table 4 shows the average semester 1 GPA and average Calculus 1 GPA for students participating in this study. It is difficult to compare the two peer mentorship cohorts with each other based on the difference in first semester performance. The 2022 cohort is much closer in performance to the 2020 cohort. The primary conclusion is that, despite similar performance in the first semester, the 2020 cohort had a short-term retention rate of 55.0%, while the 2022 cohort with peer mentorship had a short-term retention rate of 87.2%. This is both a significant improvement and an encouraging result for the peer mentorship program.

Table 4: Average semester 1 GPA and average Calculus 1 GPA for students participating in this study, shown by year of course offering.

Year	n	Semester 1 GPA	Std. Dev.	Calc. 1 Average	Std. Dev.
2018	19	2.70	1.0	1.91	1.28
2019	18	2.76	0.97	2.77	0.99
2020	20	2.52	1.29	1.93	1.65
2021	32	2.84	0.83	2.48	0.98
2022	39	2.69	0.83	1.93	1.26

Further engagement with the results leads to the following questions that require future research, thought, and discussion, listed here with commentary as appropriate:

- What are the primary benefits and drawbacks of a course-grade-enforced peer mentorship program?
    - When paid volunteers were sought in the first year of the peer mentorship program, only the high-achieving students who were more organized and motivated chose to serve as mentors. When mentorship is required of students in a course, a wider range of achievement levels is expected, which may impact the success of the peer mentorship program.
    - If serving as a peer mentor is retained as a curricular component for upper-level engineering students, this can be used to highlight and assess ABET Student Outcome 5: an ability to function effectively on a team and Student Outcome 3: an ability to communicate effectively with a range of audiences.
    - Careful selection of the best class for the training and recruiting peer mentors is required. Control Systems may not be the optimal course for this. Senior Design was considered as an alternative possibility, as peer mentors are intended to help guide the first-year students towards successful project management.
- If peer mentorship moves away from a curricular component, what is the best way to motivate and incentivize peer mentors and hold them accountable?
- Should more than one peer mentor be assigned to each student group to smooth variance in peer mentor performance?
- Is there a correlation between project grades and peer mentorship ratings?
- With the retention results provided, where do students who do not persist in engineering go? What is the retention rate to the institution, and what majors do they change to?
    - Many students in the past two years have changed their major to Engineering Management, which is housed in the School of Business. This major allows students to use some credits from completed engineering courses towards their degree program.
    - It is not clear what majors are declared by other students who stay at the institution, and this will be explored further.

In addition to these questions, some important changes will be implemented in future iterations of the peer mentorship program:

- In the future, student groups will be required to meet together with the course faculty member and their peer mentors early in the semester to reaffirm expectations for the peer mentorship program and the project. Currently, apart from initial training and end of project assessment, the course faculty takes no role in the mentoring program.
- An additional small, short time-frame project will be added to give students multiple experiences using the engineering design process and interacting with their mentors.
- Students will complete the MUSIC Model of Student Motivation inventory in order to measure the impact of course design and peer mentorship on student motivation and provide additional feedback on improvements to peer mentorship and teaching strategies [17, 18, 19].

Conclusions

The updated engineering peer mentorship program shown in this paper provides clearer guidelines and accountability for peer mentors and first-year students engaged in the program. After two years of peer mentorship in the Intro to Engineering course, retention outcomes have been improved in short- and medium-term, even though academic performance was vastly different between the cohorts. In addition, students in both cohorts indicated general agreement that peer mentors helped them better connect with the engineering program and campus community.

The next step for this project is to continue the engineering peer mentorship program for several more years to assess longer term retention data before reporting again, including key changes highlighted in the previous section. Future work will provide a more comprehensive view of the subsequent career of students who are not retained by the engineering program and will investigate the relationship between project performance and peer mentor rating.

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