Effectiveness of Peer Led Team Learning in Online Engineering Courses

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Abstract

Peer-led team learning (PLTL) is a peer support intervention where a peer leader facilitates active learning sessions with a small group of students to reinforce and provide additional clarity on various topics and concepts introduced in a course. PLTL has been successful in improving student performance and persistence in science, technology, engineering, and mathematical (STEM) disciplines in traditional face-to-face classroom environments. This Work-In-Progress research study investigates the effectiveness of PLTL in an online campus environment offered at Embry-Riddle Aeronautical University Worldwide campus. This work is sponsored by the National Science Foundation (NSF) Improving Undergraduate STEM Education (IUSE) program with the purpose of investigating peer-led team learning intervention in an asynchronous online environment. The student population of this online campus consists primarily of adult learners with a majority of them either military veterans or still serving in the military. The research was conducted in various undergraduate courses that historically have presented greater challenges to students, such as statics, dynamics, digital circuit design, and aerodynamics. The research supports engineering education and the support interventions investigated have potential to increase persistence in the associated engineering disciplines. The program also offers professional development to the peer leaders who are recruited from previous course offerings and participate in peer leader training to best support other students in their acclimation to engineering and commitment to engineering career pathways. Initial year one findings indicated that student participation in peer led learning activities resulted in achieving higher academic scores and a more positive learning experience when compared to non-peer led students.

Keywords: Peer-led team learning (PLTL), STEM, active learning, engineering education, Improving Undergraduate STEM Education (IUSE)

Introduction

This Work-In-Progress three-year research study sponsored by the National Science Foundation (NSF) Improving Undergraduate STEM Education (IUSE) program investigates peer-led team learning (PLTL) support interventions in an asynchronous online environment. Peer-led team learning falls under the umbrella of collaborative and active learning and leverages a peer leader to facilitate active learning sessions with a small group of students to reinforce and provide additional clarity on various topics and concepts introduced in a course [1] [2] [3]. Similar, active learning strategies have been used successfully in engineering education to strengthen STEM competencies to improve student success [4] [5]. Based off findings in the literature, student academic success is determined by mean course grade [6] and degree progression that are significant indicators of student acclimation to engineering pathways [7]. Primarily, PLTL has been implemented in in-person classrooms, though there is interest in investigating the effectiveness of PLTL implementation in online courses [8].

This research study examines a unique student population participating in engineering degree programs offered through online programs at Embry-Riddle Aeronautical University Worldwide

Campus. The student population of the online campus consists primarily of adult learners with a majority of them either military veterans or still serving in the military. The research was conducted in various undergraduate courses that historically have presented greater challenges to students, such as statics, dynamics, digital circuit design, and aerodynamics.

Research Plan

The research hypothesis is that PLTL learning support in foundational online engineering courses will lead to greater persistence in the associated engineering disciplines. The main goal aligned with the findings reviewed in this paper is to increase student's academic performance and commitment to engineering pathways. The anticipated outcomes are that the average final grades of students participating in the PLTL labs will be 10% higher than the baseline from AY 20-21.

Institutional and course data are used to assess academic performance and persistence in engineering. Focus groups, classroom observations, peer leader journals, and pre- and post-course surveys are used to assess student's commitment to engineering, acclimation, engineering identity and self-efficacy that are factors that influence persistence along with academic success [9].

Peer Leader Training and Recruitment

As part of this work, the authors developed a 10-hour, self-paced peer leader training course organized into three modules. In the first module, peer leaders learn about themselves as both individual learners and student leaders. The second module focuses on communication with diverse groups, especially adult learners and military students. Also, peer leaders learn about building effective peer relationships and community through empathy. The third module lets the peer leaders put into practice their leadership and communication skills by demonstrating how to engage students in an online environment and how to provide effective feedback on an assignment using an active learning technique [10].

Peer leaders were recruited from the undergraduate student population who have recently and successfully completed the specific engineering course with either an A or B average. In addition to looking at student grades, the authors engage with faculty of the engineering courses to assist in reaching students for a more personalized recruitment process along with the listserv outreach to students across the degree program. This recruitment process is repeated approximately six to eight weeks prior to the start of the academic term to allow sufficient time to hire, onboard, and complete the peer leader training course if they have not done so prior.

Year 1 Implementation and Lessons Learned

The Fall terms of AY22-23 were dedicated to developing the peer leader training course, recruiting peer leaders, and preparing to implement PLTL during the Spring terms (January 2023 and March 2023). PLTL activities (three per course) were also developed to be inserted into the courses as voluntary activities. The PLTL research was piloted in one section of Digital Circuits in the January 2023 term. The work was then scaled to three additional sections in two more

courses (Aerodynamics, Digital Circuits, and Statics) in the March 2023 term. There were 108 students enrolled in these courses.

The students were assigned to peer groups, but participation in the groups was voluntary. Peer leaders held hour-long virtual office hours each week during the nine-week term, and the PLTL activities occurred around the third, fifth, and seventh weeks. Participation in the PLTL activities was incentivized by the offer of earning extra credit. Students were also offered the opportunity to complete the pre- and post-surveys regarding self-efficacy.

There was a low participation rate in PLTL activities with 13 students (12.0%) participating in PLTL activities and 95 students (88.0%) choosing not to participate [11]. The small sample of PLTL students made it challenging to make any conclusion whether PLTL participation had improved the students' course average. Participation in the pre- and post-surveys was even lower with 10 pre-surveys completed, and only one post-survey completed.

The participation rate in the PLTL activities and the pre- and post-surveys was identified as issues to address during Year 2. A common challenge with adult students and military students enrolled in online courses is the time demand on those students due to job and family responsibilities. Many students choose not to participate in optional activities, even if they are beneficial, as they perceive they do not have the time to devote to those activities. In Year 2, the targeted courses for PLTL activities require all students in the courses to participate in PLTL activities. These courses could then be compared to control courses that do not have PLTL activities.

Year 2 and Working Results

For the Fall terms of AY 23-24 (August 2023 and October 2023 terms), the PLTL activities in PLTL courses became mandatory. However, the grading of these activities did not contribute to the overall course grade as that would require prior curriculum change and approval. Extra credit was offered to completion of pre- and post-surveys to incentivize completion of those surveys. During the Fall 2023 terms, there were five PLTL courses and four control courses.

Student participation in a single PLTL activity was assessed on a 10-point scale: 10 points – Actively Participates; 8 points – Moderately Participates; 6 points – Minimally Participates; and 0 points – No Participation. Student participation across the three PLTL activities was then averaged and categorized as the following PLTL Efforts: PLTL High Effort – 8.0-10.0; PLTL Medium Effort – 5.0-7.9; and PLTL Low Effort – 0.0-4.9.

Table 1 shows the student performance in Aerodynamics in both the PLTL and the Control Sections for August 2023 term. There was little significant difference between both section averages. The students with high and medium PLTL efforts outperformed the overall section average. This was a significant finding to support the anticipated outcomes of increased academic performance for those in the PLTL groups. The same type of data was captured for the other four PLTL and three Control courses during the Fall terms. Although the results are positive, more data collection and analysis are required to determine if any differences in student averages are statistically significant.

Table 1: Aerodynamics, August 2023, Student Performance (PLTL and Control)

	Student Count	Student Average	Std Dev		Student Count	Student Average	Std Dev
Aerodynamics (PLTL)	28	88.09	16.95	Aerodynamics (Control)	28	88.14	12.80
PLTL High Effort	19	90.67	10.60				
PLTL Medium Effort	2	96.00	1.90				
PLTL Low Effort	7	78.84	28.52				

Pre- and Post-Surveys

Incentivizing the pre- and post-surveys during Year 2 increased student participation. During the Fall 2023 terms, 94 students completed the pre-Survey and 68 students completed the post-survey. In both the pre- and post-surveys, students were asked demographic questions and career exploration questions. Students were also surveyed regarding self-efficacy in general engineering, engineering skills, tinkering, and design [12].

The following three responses to one of the open-ended questions were representative of many of the responses:

- "I feel the teacher was more helpful with the course material but I felt more comfortable reaching out to another student."
- "Interaction with peers has helped me by getting to see how others work through a problem to solve it."
- "I wish the group was more active in the peer led discussions."

The first response is indicative that the instructor is still essential to student education. However, the student felt more comfortable reaching out to a peer. The second response indicates that interacting with peers not only helps with problem solving, but also in practical terms such as navigating the learning management system and finding resources. The third quote indicates that there are areas of improvement with the peer leader and PLTL process. During this work, some peer leaders were more effective and more engaging with the students than other peer leaders.

Challenges and Future Work

A key challenge is the recruitment and hiring of peer leaders. Undergraduate students who have served as peer leaders will graduate, and new peer leaders must be recruited to fill those vacancies. The hiring process and onboarding also impacts the availability of peer-leaders. The challenge is to identify potential peer leaders during the term the student is taking a course and then to hire, onboard, and train that student to be a peer leader for the next term.

In the late Spring 2024 terms, PLTL activities will be incorporated into actual graded assessments. This requires approval by curriculum and department leadership as it affects graded

assessments. The intent is to reduce student workload by incorporating PLTL with existing assessments vice requiring additional assignments. The authors plan to scale this work beyond the three previously identified courses.

Conclusion

The results so far have been encouraging and show the peer support intervention has positive effects on student grades. The course averages indicate that students involved with PLTL activities have higher course averages an indicator of academic success that has potential to lead to persistence in engineering pathways compared to those students not involved with PLTL activities. This preliminary data appears to support the overall goal of improving academic performance. The persistence in engineering will need to be assessed as Year 3 begins as the initial cohort of students will start to enroll in upper-level coursework along the engineering pathway.

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