Board 283: Findings from the Spring 2022 to Spring 2023 Semesters of the PEERSIST Project - A Formation of Engineers Framework for Understanding Self-Efficacy and Persistence among Transfer Students

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Findings from the Spring 2022 to Spring 2023 Semesters of the PEERSIST Project - A Formation of Engineers Framework for Understanding Self-Efficacy and Persistence among Underrepresented Groups

Introduction

Recruiting women and historically marginalized populations into science, technology, engineering, and mathematics (STEM) fields became a national priority with the Science and Engineering Equal Opportunities Act. Transfer students, who disproportionately are first-generation and come from racial/ethnic minority groups, are a target population for boosting engineering representation. Transfer students at [the university] take thermodynamics, a required gateway course, in their first or second term. The course has a high failure rate, hypothesized to contribute to "transfer shock," resulting in low engineering self-efficacy and decreased persistence. Institutional data confirm that 39% of transfer students (TRN) who fail this course leave engineering within one year, compared to 18% of first-time, full-time students (FTFT). The PEERSIST team (PEER-led, Student Instructed STudy group) initiated a peer led study group (PLSG) model in thermodynamics to promote student achievement, self-efficacy, and identity formation—variables linked to engineering persistence. Initial results from the study are presented in this paper, and show that the PLSG model helps underprepared students who, without the intervention, would have otherwise failed the course.

The PLSG model promotes academic competence through peer dialogue, in which disciplinary knowledge is socially co-constructed and refined over successive study group sessions. The PLSG method is inspired by the Treisman model developed by Uri Treisman in the 1970s and 1980s. The Treisman model utilized cooperative learning to help historically marginalized populations of students in undergraduate calculus learn to think like mathematicians through socially, co-constructed inquiry[1–4]. Treisman designed the program to challenge students with difficult problems enough to promote student learning and discussion [1,3]. Peer-led team learning is a form of collaborative learning similar to the PLSG utilized in other academic programs [5–8]. Previous studies have shown collaborative learning benefits students in multiple ways, including improving students' sense of belonging, grades, and persistence [9,10].

A preliminary version of the PLSG model was piloted with volunteer students before the start of the study. The preliminary implementation differed from the study in that the treatment and comparison was given as an additional hour of instruction outside the normally scheduled course instruction, while a third no treatment group was made up of students in the course who did not participate. Students in the PLSG received little help in solving the thermodynamics problems posed to them during the session and were found to perform similarly to those in the comparison, who solved the problems as a group led by an expert teaching assistant (TA). Significant results were seen in the PLSG group regarding pass rate, final course grade, and persistence within their academic program compared to students in the general class who did not participate. These results inspired the researchers to continue the project into its current iteration.

Although prior studies have found PLSGs effective, this research is unique in that it situates the PLSGs in an engineering course and focuses on the effects of PLSGs on transfer students [11]. In this research, we are specifically investigating 1) to what extent peer and near-peer support in a gateway course promotes engineering students' self-efficacy, identity formation, course achievement, and engineering persistence and 2) whether these effects, if any, accrue differently between TRN and first-time full-time (FTFT) students. This paper outlines the research questions, project objectives, framework, and preliminary results from the Spring 2022, Fall 2022, and Spring 2023 semesters of the project.

Methods

During a given semester, there are 3-4 sections of thermodynamics at [the university], each composed of 100 students (300-400 students total) and taught by a different faculty member. Four recitation sections are held for each course section (16 recitation sections total), each with 25 students meeting once weekly for 50 minutes. In the current iteration of the study, each course section is split between the PLSG treatment and the TA-led control, where recitation sections are randomly chosen so that each class has 2 PLSG and 2 TA-led control. Students randomly sign up for both, and are unaware of the PLSG or TA-led control status until the start of the semester. Students in the PLSGs work together in groups of four to five, with a facilitator overseeing multiple groups and stepping in only if the group was stuck or pursuing a path that would not lead to a correct solution. Students in the TA-led session attend a typical recitation section at the university, where one TA lectures to the students for the entire session. Both the treatment and control utilize the same problems, homework assignments, and exams, with the only difference between the sessions being that the PLSGs involve student discussion and interaction rather than one TA instructing the students. More information can be read about the PLSG strategy in the quick reference guide, training materials, and videos available at [12].

Preliminary Results

A total of 1,016 students participated in the study across the three semesters, with 527 in the TA-led control and 489 in the PLSGs. Preliminary results from these semesters have come in two strands–the development of an observation protocol and the modeling of students' course pass rates and final grades–and have been very promising.

Observation Results

The research team developed an observation protocol and performed an implementation check to ensure that the benefits seen in the PLSGs are driven by peer interaction rather than by having more access to the TA [13]. Through this process, we found that peer interaction (vs. interactions with the TA) is the primary form of interaction within the PLSGs. Other benefits we observed were that students with lower incoming GPAs (predicted to perform worse in the course) performed similarly in their PLSG to those with higher GPAs, as no significant differences were found in students' ability to participate in the groups, nor in students' ability to ask and receive help [13].

Modeling Results

Utilizing a two-variable linear regression with treatment status and students' incoming GPA, students in the PLSG were *not* observed to earn significantly higher final grades in the course relative to their peers in the control (b=1.05, p=0.108). However, utilizing a two-variable logistic regression with the same variables, they *were* observed to pass the course at significantly higher rates (b=0.362, p=0.021). This result shows that the odds of students passing the course in the PLSGs are about 1.3 times higher than those in the regular TA-led recitation sessions, which underscores the intervention's main achievement, to help students pass the course who might otherwise fail. In addition, this illustrates that the PLSG method helps all students, including transfer students, pass the course at higher rates. The inclusion of other factors pertaining to students' starting course competency could potentially further elucidate these results. The research team plans to include demographic data and examine how transfer status is affected by study group participation in later studies.

Ongoing and Future Work

Ongoing work for the project includes investigating how the PLSGs affect students compared to the traditional TA-led recitation, through the use of surveys and interviews, and propagating the PLSG model as a promising practice in other courses at the university. In addition, future work will explore how the effects of the PLSG accrue differently between TRN and FTFT students in the course, such as on their persistence to graduation. These results are still pending until sufficient time has passed to examine their four- and five-year graduation rates. Initial results show that the PLSG model helps underprepared students pass thermodynamics, a course that may have otherwise impeded their progress and prevented their persistence in the academic program.

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