Work-in-Progress - Assessment of Peer-Led Team Learning in an Engineering Course for Freshmen

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Abstract - **ECE 110 is required for freshmen majoring in electrical engineering or computer engineering at Illinois. In ECE 110 in Fall 2007, we organized optional supervised study sessions to implement peer-led team learning workshops. Each session met for 90 minutes per week. In the sessions, students worked on difficult problems selected from examinations given in previous semesters. We obtained ACT-Math scores and implicit consent from 208 of the 297 students who started the course; 43 of these attended sessions regularly—six or more of the eleven sessions. The regular attendees scored significantly higher on the final examination than did the other students, even though their ACT-Math scores were slightly lower. Among electrical and computer engineering majors, regular attendance did not appear to affect decisions to remain in electrical or computer engineering. Regular attendees reported that in the study sessions, they improved their understanding of the material, and they made new friends.**

Index Terms – cooperative learning, peer-led team learning, workshop, first-year engineering course

INTRODUCTION

Peer-led team learning (PLTL) is a form of cooperative learning that uses learning teams [1]. Each team of six to eight students meets for 90 to 120 minutes once each week in a workshop, in which students work together on challenging problems. Each team has a leader who serves as a facilitator, not as a content expert. The team leader is typically an undergraduate who previously took the course.

Previous research indicates that workshop-style pedagogies such as PLTL promote the retention of women and underrepresented minorities in the sciences [2]. In an undergraduate course on organic chemistry, students who regularly attended PLTL workshops earned significantly higher scores on examinations and developed significantly better attitudes about the subject [3].

Although PLTL has been implemented in large undergraduate courses in biology, chemistry, and physics, PLTL has apparently not previously been implemented in engineering. We hypothesized that the findings about the effectiveness of PLTL in college science courses would extend to engineering courses.

IMPLEMENTATION

ECE 110, *Introduction to Computer Engineering*, is a large gateway course that is required for freshmen majoring in electrical and computer engineering, and for students majoring in general engineering at the University of Illinois at Urbana-Champaign. ECE 110 introduces selected topics in circuits, electronics, and digital systems, all directed toward the design of an autonomous line-following vehicle in the laboratory [4].

In Fall 2007, we implemented PLTL in ECE 110. Each 90-minute workshop was called a **supervised study session** (SSS). Participation in the sessions was optional. Students were randomly assigned to learning teams in their available time slots on Sundays. The team leaders were undergraduate and graduate teaching assistants, and undergraduate volunteers In each weekly session, each learning team worked on four to eight difficult problems from ECE 110 examinations given in previous semesters. These problems were more difficult than most homework problems: their solutions required understanding of the concepts, analysis of unusual situations, and integration of several ideas.

ASSESSMENT METHOD

We administered two paper surveys to students in ECE 110. Among the 286 students who finished the course, 208 completed the first survey, and 198 completed the second survey. The first survey gathered ACT-Math scores. In the second survey, which was anonymous, students reported their majors, whether they regularly attended the supervised study sessions, and whether they intended to continue taking courses in electrical and computer engineering. Regular attendees identified the benefits of the sessions. Other students explained why they discontinued attendance, did not attend, or studied in groups outside these sessions. All completed surveys were sequestered until after course grades had been filed.

RESULTS

I. Did SSS Attendance Improve Exam Performance?

We decided *a priori* to define a **regular attendee** to be a student who attended a strict majority, six or more, of the eleven supervised study sessions. Among the 208 students with complete data, 43 attended sessions regularly, and 165 did not. For these two populations of students, Table I presents their average Final Exam and ACT-Math scores.

TABLE I
FINAL EXAM AND ACT-MATH SCORES

Population	Final Exam Mean (SD)	ACT-Math Mean (SD)
Regular attendees (n = 43)	76.5 (14.1)	33.0 (2.35)
Other students (n = 165)	71.0 (15.2)	33.6 (2.27)

After examining the Q-Q plots, we concluded that the Final Exam scores for both populations followed the normal distribution sufficiently well. To determine whether the two populations shared the same mean, a one-tailed t-test was conducted using the Final Exam scores. The null hypothesis was rejected with a significance level of $p < 0.02$. Since the distributions of the ACT-Math scores for both populations were clearly skewed, a Mann-Whitney U-test was used to compare the ACT-Math scores. The null hypothesis was rejected with a significance level of $p < 0.1$.

The correlation between Final Exam score and ACT-Math score was 0.311 with $p < 0.001$. The correlation between Final Exam score and number of sessions attended (in the range from 0 to 11) was 0.138 with $p < 0.05$.

Two linear regression models were constructed in which the Final Exam score was the dependent variable. For the first model, the only independent variable was the ACT-Math score. For the second model, the independent variables were the ACT-Math score and the Attendance number. The R and R^2 values for the first and second models were R = 0.311, R^2 = 0.097 and R = 0.361, R^2 = 0.130, respectively. For the first model, 9.7% of the variance in Final Exam scores can be associated with the ACT-Math score (p < 0.001). Since the change in the models' R^2 is 0.033, about 3.3% of the variance can be explained by the study session attendance (p < 0.01): the Attendance variable effectively gives the second model 34% more predictability than the first model. That is, after controlling for ACT-Math scores, greater attendance produced higher Final Exam scores.

II. Did SSS Attendance Improve Retention?

Among the 198 students who completed the second survey, the 160 students who were majoring in electrical and computer engineering (ECE) were asked whether they planned to continue. Out of 50 students who claimed to attend the study sessions regularly, 46 students planned to continue in ECE, 4 decided to switch, and 1 was omitted. Of the remaining 110 students, 99 students planned to continue, 9 decided to switch majors, and 2 were omitted. The odds ratio of regular attendees remaining in ECE versus other ECE majors was 1.023. We infer that regular attendance did not affect retention in ECE.

III. What Benefits Did Regular Attendees Identify?

On the second survey, the students who regularly attended the supervised study sessions identified the benefits of the sessions. Mastery-oriented students [5] reported that they understood the course material better. Performance-oriented students reported that they felt better prepared for the exams, and that they might have scored better on the exams. Only three students reported both kinds of benefits, and more regular attendees appeared to be mastery-oriented than performance-oriented. In addition, regular attendees made new friends. No students reported as a benefit that they were able to help other students learn. Progressing on Perry's model of intellectual development [6], some regular attendees began to see peers as helpful sources, in addition to the team leaders. See Table II.

TABLE II
CATEGORIES OF BENEFITS FOR REGULAR ATTENDEES (n = 50)

Benefit	Frequency
Access to old exam problems	13
Extra practice (without saying why the practice helped)	13
Better understanding of the course material	21
Better preparation for exams	7
Improved performance on exams	4
Met new people and made new friends	16
Access to teaching assistants	8
Obtained help from other students in the course	13

CONCLUSION AND FUTURE DIRECTIONS

We implemented peer-led team learning workshops as optional supervised study sessions in a large engineering course that is required for freshmen in electrical and computer engineering. Students who regularly attended the sessions earned higher scores on the final examination than did other students. The difference was statistically significant, even after controlling for ACT-Math scores. Furthermore, regular attendees experienced social benefits by making new friends. Regular attendance did not seem to affect decisions to continue majoring in ECE, however.

The supervised study sessions may benefit not only the students in the course but also the team leaders. We plan to analyze the journal entries written weekly by the team leaders. Using the journals as evidence, we expect to document how team leaders learned about group dynamics and developed leadership skills.

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