Implementing Peer Led Team Learning in First-Year Programming Courses

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Abstract – In the Peer Led Team Learning model (PLTL) many of the skills developed by students correlate well with desired learning outcomes in CSET programs. The authors report the results of a project to implement PLTL in introductory programming courses. An overview of the implementation model is provided, lessons learned are reported, and the assessment process and results are described. The research questions explored are: (1) What is the impact of the PLTL model on student skills and confidence regarding teamwork, leadership and communication? (2) How effective is PLTL in terms of building problem-solving skills in introductory programming? This project involved a pilot implementation followed by full implementation in the following year. Student peer leader surveys, along with a peer leader focus group, were used to analyze project impact and to plan for improvement in achieving the learning outcomes described above. Results indicate that students are satisfied with the peer led team learning model and that significant skill enhancement is occurring. In particular, a significant fraction of peer leaders in the second year of implementation came from those participating in the pilot.

Index Terms – peer-led team learning, teams, problem-solving.

INTRODUCTION

I. Study description

In this paper the authors explore the results of a research project regarding the effectiveness of various aspects of the Peer Led Team Learning Workshop (PLTL) model in introductory computer science courses at the Georgia Institute of Technology via the use of multiple surveys, a focus group interview with peer leaders, and historical course data on student performance. The research questions at the heart of this study are:

- What is the impact of the PLTL Workshop model on student skills and confidence in the social domain of learning regarding teamwork, leadership and communication?
- How effective is PLTL in terms of building problem-solving skills in introductory programming?

The results of this research are contributing towards making efficient and effective refinements of the peer led team learning approach for future offerings of introductory computer science courses locally at Georgia Tech. The results of the research are also important nationally because they provide several key insights for programs that may be using peer led team learning in their introductory computer science courses or wish to do so.

II. Implementation

The model for implementation of the program is as follows. In Fall 2005, the course CS 1301: Introduction to Computing, designed specifically for computer science majors, included four pilot PLTL workshop sections for which students registered in addition to their regular recitation section. The four pilot sections held a maximum of 12 students each. This compares to 10 regular recitation sections serving 250 students. The four pilot workshop sections provided an additional hour of peer led team learning while students in those sections continued to attend their regular recitation section.

Based on positive feedback from the pilot sections, in the following year the PLTL model was implemented in CS 1301 as a replacement for all regular recitation sections and the additional hour removed. Additionally, in this second year a pilot expansion into the non-majors introductory programming course (CS 1315) was created.

Each workshop was directed by one student “peer leader” TA. These TAs were undergraduates who had been successful in their introductory programming courses in the past. As explained in the background section below, the role of the peer leaders differed from regular recitation TAs significantly. To date, the TA training, and even the format of the workshop sessions, has been quite varied. What seems to work best is to have a bit of training at the onset where some TAs act as students and others as peer-leaders. They go through a few exercises to get hands-on experience guiding a workshop. Those that play the students sometimes play "bad" students that are shy, controlling, or belligerent so that techniques to handle such students can be introduced in advance of leading real sessions. Ways to divide students into pairs or small groups to avoid cliques and broaden participation are also introduced.

BACKGROUND

I. Trends towards teaming in higher education

As stated by L. Dee Fink in his recent book:

“The last decade or so has seen a dramatic increase in the use of small groups, sometimes in the form of temporary groups (as with cooperative learning) and sometimes in the form of permanent groups...”

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that develop into high-performance team (team-based learning). Given the right kind of structure and assignments, small groups can create powerful kinds of learning…”[1]. For structured teams, Larson and LaFasto [2] have identified eight keys to team success which have been implemented across numerous disciplines.

Specifically in engineering, ABET 2000 [3] criteria for accreditation have prompted significant moves towards incorporation of teamwork into the engineering curriculum. A recent overview article by Smith et al includes cooperative learning and teamwork as one selected pedagogical practice in their overview of pedagogies of engagement [4].

In computing, an early report on implementing cooperative learning was presented in 1995 by Prey[5]. Another study in 1999 by Chase and Okie combined peer teaching and cooperative learning in a successful effort to reduce their DWF rate in two sections of an introductory computer science course [6]. Similarly, in 2000, a large European study outlined many facets of cooperative learning between psychologists and computer scientists specifically in the area of machine learning[7]. Later the application of cooperative learning in computer science became quite common and presentations in workshop type formats to help participants learn about different techniques and aspects of cooperative began to appear [8, 9].

1. Peer-led Team Learning (PLTL)

It is along the lines of thinking eventually utilized by Chase and Okie that PLTL developed in the early 1990s. Originally implemented in chemistry, the PLTL model has expanded to a number of other disciplines and is well documented in the literature. A simple definition is: “The PLTL Workshop model engages teams of six to eight students in learning sciences, mathematics and other undergraduate disciplines guided by a peer leader. The PLTL Workshop model: provides an active learning experience for students creates a leadership role for undergraduates engages faculty in a creative new dimension of instruction Students who have done well in the course previously become guides and mentors, Workshop Peer Leaders” [10].

Additionally, there are six critical components of the peer led team learning workshop model that help make it a successful learning model for students [11]:

• “Workshop session are integral to the course
• Faculty work closely with the peer leaders and the workshops
• Peer leaders are well trained student with previous course success
• Workshop physical are challenging, integrated, and encourage active learning
• Physical organization of the workshop environment promotes learning
• Institutional and departmental support must be at the highest levels”

A number of descriptions of specific implementations of the PLTL model are available such as [12, 13]. Extensive documentation of the PLTL model is available in the form of a guidebook for users[11]. Finally, a comprehensive discussion of issues relation to assessment of peer learning is presented by Boud et al [14].

METHODS

This is a case study involving multiple sources of data and triangulation of results to form a coherent set of conclusions.

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The case involves two courses with a total enrollment of approximately 350 students. Each course was divided into groups of 12 for recitation sections. An IRB protocol was developed and approved before the study was performed.

Data was collected using surveys and a focus group. Two separate groups formed the focus of the collected data: peer leaders and enrolled students. Peer leaders completed a survey about their learning experience with the PLTL model based on a modified version (to better apply to the peer leader situation described above) of the Student Assessment of Learning Gains (SALG) survey developed by Elaine Seymour [15, 16]. A one-hour focus group discussion was also conducted with volunteers from this group. The focus group questions were derived from questions of particular interest to the instructor and the concept of assessing the course using the Strengths, Areas for Improvement, and Insights (SII) format for performance-based assessment [17, 18]. Enrolled students also completed a survey about their learning experience with the PLTL model. This survey was, again, based on the SALG instrument (but this time two additional questions not appropriate to the peer leaders were included). The survey was required for all students and was counted as a quiz grade, but only an ID number was required to get full credit if they did not wish to contribute their results to the study. The survey and focus group instruments used are presented in Table I and Table II, respectively.

<table>
<thead>
<tr>
<th>TABLE I MODIFIED SALG SURVEY INSTRUMENT</th>
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<tr>
<td><strong>Q1: How much did each of the following aspects of your recitation help your learning?</strong> (NA, No help, A little help, Much help, Very much help)</td>
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<td>7</td>
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<tr>
<td>Comments</td>
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</tbody>
</table>

**Q2: How much has this recitation added to your skills in each of the following?** (NA, Nothing, A little, Somewhat, A lot, A great deal)

| 1 | Defining problems |
| 2 | Breaking down and analyzing problems |
| 3 | Solving problems |
| 4 | Tracing code |
| 5 | Debugging code |
| 6 | Working effectively with others in a team |

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Peel leader surveys: There were 6 comments from question 1 about the PLTL recitation format, 1 comment from question 2 about skills developed, and 2 comments from question 3 about learning gains. Some peer leaders appear to have rated student learning rather than their own learning. Of the comments, 3 indicated that students who buy into the format perform better and enjoy it more. Two comments indicated difficulty in creating quality activities but this may be offset by other comments indicating that interpersonal skills and leadership are significantly enhanced. It was not clear that there were any general differences between the two different classes based on these comments.

Peer leader focus group: Four peer leaders participated in the focus group. It should be noted that those who volunteered for the focus group represented a fairly involved group who generally bought into the PLTL model and worked hard to implement it as it was intended. Thus, they do not necessarily represent the “average” peer leader profile. Regarding strengths of the PLTL model, the peer leaders felt strongly that problem solving skills were enhanced and that the active/interactive learning environment aided students. They also enjoyed the informal atmosphere and socialized much more than in more traditional recitation formats. However, organization and planning ahead were noted as a significant need for the peer leaders. They also felt that perhaps a balance of time spent on fundamentals and non-traditional (but in-depth) activities might give a better overall outcome. Finally, the peer leaders in the focus group noted that students were not sure what to expect from the PLTL model and therefore struggled with acceptance, especially initially, before eventually settling in. In fact, the peer leaders themselves felt this same transition occur.

Triangulation between the data sources was carried out to assess the impact of the program and to plan for improvement in achieving the learning outcomes referred to in the research questions above. For the modified SALG surveys, a simple statistical analysis was completed for all questions. The response categories were converted to a five-point Likert scale with 5 being the most positive responses. The basis for this conversion is described in [16]. Average values for each question were calculated along with estimated error assuming a normally distributed population.

Survey comments and the peer leader focus group transcript were coded for themes using the open coding method with data reduction into major themes [19]. Results were analyzed separately for peer leaders and for the students in each class, and then also for the combination of both classes for the peer leaders and for the students.

RESULTS

I. Surveys: Likert-Scale Questions

A total of 22 peer leaders agreed to participate in the study and completed valid surveys. The total number of enrolled student respondents agreeing to participate in the study and completing valid surveys was 314. An additional 12 students agreed to participate and completed the survey but stated they never attended the PLTL recitation sessions and so were not included. Figure 1 shows the modified SALG survey results for the peer leaders, while Figure 2 shows the modified SALG survey results for students.

II. Focus Group and Survey Comment Coding

Peer leader surveys: There were 94 comments from question 1 about the PLTL recitation format, 34 comments from question 2 about skills developed, and 22 comments from question 3 about learning gains. The most prevalent comments were of a generally laudatory nature for the peer leaders, instructor, or the class as a whole (38). The next most common comment indicated that the course was very...
easy for those with previous programming experience, but difficult for those without (17). Eight students specifically mentioned how much fun they had in the course or PLTL sessions, while an equal number specifically pointed out the value they received from PLTL teamwork. However, there were a significant number of comments noting that the PLTL model was slow to develop or poorly planned by peer leaders (9). Similarly, a number of comments indicated a desire to more clearly link activities in the PLTL sessions to course content and level of difficulty (14). Finally, some felt that they would prefer a more traditional model (5) or that the quality of their peer leader was poor (6).

III. Triangulation of results

In general, students in the CS major tended to rate their gains more highly than the students in the non-majors course, although this is not true across the board. The results showing this discrepancy appear to be separated by a statistically significant margin because they fall outside of estimated errors bars in most cases. This trend also appears to be true for the peer leaders, but this will need to be investigated further as results are not statistically significant for the peer leaders.

Student comments tend to confirm the generally high marks for the overall format of the course (question 1). However, ratings for specific gains in skills and abilities do not rate as highly for the students (questions 2 and 3). The peer leader results are more consistent in this regard.

CONCLUSIONS AND NEXT STEPS

Since the data for this study was collected, the focus on the PLTL approach has shifted to CS1315 because of funding. Thus, the PLTL approach has lessened over time with CS1301. However, plans to revamp the use of PLTL during the summer are underway and may carry through to the fall.

During summer 2008 plans are developing to incorporate active learning and problem solving in the "lecture" portions of the courses CS1315 and CS1301. Lecture periods will be 1 hour 45 minutes in length. The peer leaders will attend lecture – or at least the active part of the period, and peer-led workshops (recitations) will also be very hands on even though the enrollment will be 25 students per peer leader.

Issues have occurred in the PLTL approach in that some TAs really are not comfortable with the facilitator role as compared with the more familiar lecturer role.

Experience from last summer’s teaching abroad in Oxford reaffirmed that students remain engaged and are able to master material when engaged actively on problems similar to what has just been lectured about during otherwise straight lecture periods. Those classes were small as well so the hands-on approach was easy. However, those students did not have recitations sections led by peers. The typical class session would be an instructor-led lecture followed by students working in class on problems or in a lab. In some ways this approach reaffirms the student comments about the need for clear recitation links to lecture. The summer approach worked very well without peer leaders involved, as the instructor was able to know exactly what a given student had experienced. In regular sessions, keeping a small army of 10-20 TAs onboard, in sync, and active is a significant challenge but does appear to produce positive results.

ACKNOWLEDGMENT

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REFERENCES

Question 1 - recitation format

- 1301 AVERAGE
- 1315 AVERAGE
- TOTAL AVG

average score

approach
activity coherence
pace
discussion
group work
hands-on
organization
assignments
review
mental stretch
grading
student contact
working with peers
overall

Question 2 - skills impact

- 1301 AVERAGE
- 1315 AVERAGE
- TOTAL AVG

average score

defining problems
analyzing problems
solving problems
facing code
debugging code
working with others
controlling to learn
communication in discipline
leadership
creativity

Question 3 - learning gains

- 1301 AVERAGE
- 1315 AVERAGE
- TOTAL AVG

average score

main concepts
concept relationships
real world relevance
appreciating field
thinking through problems
"doing" the field
complex idea comfort
subject enthusiasm

FIGURE 1
PEER LEADER SURVEY RESULTS.
Question 1 - recitation format

Question 2 - skills impact

Question 3 - learning gains

FIGURE 2
STUDENT SURVEY RESULTS.

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