

PEER-LED TEAM LEARNING IN INTRODUCTORY BIOLOGY AND CHEMISTRY COURSES: A PARALLEL APPROACH

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Abstract

Peer-Led Team Learning has been in use in *Introductory Biology* and *Introductory Chemistry* since Fall 1999 at the University of Portland. Its effect on improved conceptual understanding, retention of students, and improvement in study skills will be discussed. An ancillary, but no less important benefit in the development of interest in science teaching among the peer leaders, is also addressed.

Introduction

An ongoing concern among science educators has been the promotion of conceptual understanding in large lecture classes and the improved retention of beginning students in these courses [1-4]. In April, 2001, R. Pendarvis reported that the attrition rate in introductory science courses is on average 40%, with some open enrollment institutions reporting losses as high as 70%. Student-centered learning approaches are one way of increasing the retention of students and if needed, of improving student study skills to the college level. They have also been shown to improve students' conceptual understanding. Another concern, both nationally and locally, is the scarcity of well-prepared teachers of high school science and the shortage of students in the pipeline considering science teaching as a career. Peer-Led Team Learning is helpful in remedying these concerns [5,6]. For several years, the Departments of Biology and Chemistry at the University of Portland have been focusing their efforts on improving and increasing the success of their first-semester freshmen in *Introductory Biology* and *Introductory Chemistry*. The University of Portland is a private, primarily residential university in the city of Portland, Oregon with an enrollment of about 2,600 students. The number of students who declare science,

primarily biology, as a major has steadily increased with a corresponding increase in the SATs and high school grade point averages. For incoming first-time freshmen in Fall 2000, the average SAT score was 1132 and the average high school GPA was 3.54 out of a possible 4.00. Although more academically superior students are being admitted, the success of these students in passing first-semester *Introductory Biology* and *Chemistry* was not increasing. The study skills students needed to succeed were weak or non-existent. Freshmen who graduated from high school with high grade point averages reported that they never had to study to do well in science in high school. They were finding out that this was not the case in college, but too late to recover academically.

To remedy these concerns, the lead instructors in *Introductory Biology* and *Chemistry* adopted and adapted the Peer-Led Team Learning approach in their first-semester courses in Fall 1999. This model is an active and interactive learning experience for students. It creates a leadership role for undergraduate mentors in weekly workshops and engages faculty in new dimensions in teaching. This approach is based upon an NSF-supported initiative developed by David K. Gosser, et al. in 1991 at City College of New York [7]. Now in the dissemination phase, it is being extended to biology and physics, as well as chemistry. It is an especially flexible and versatile model, having already been implemented at a variety of educational settings as diverse as City College of New York, the University of Rochester, St. Xavier University, and the University of Portland.

In assessing the critical components for successful implementation of the Peer-Led Team Learning model since its inception, Gafney [8] has found the following criteria to be key:

- Peer-Led Team Learning must be integral to the course and coordinated with all of the elements of the course.
- The instructor must be centrally involved in the workshops.
- Undergraduate workshop leaders must be trained in facilitating group work—they do not function as lecturers or discussion leaders, but as mentors leading the group to find its solutions.
- Workshop materials must be challenging and interactive, meeting the needs of both the slower and the more advanced students by incorporating diverse methodologies to meet diverse learning styles.
- Institutional support must be present.

In adapting this model at the University of Portland, the following conclusions were reached concerning logistical arrangements:

- Group sizes of eight/room/leader were optimal.
- Weekly workshops of two-hour blocks functioned best.
- Scheduling workshops around the same class lecture was highly desirable.
- Group hopping was disruptive; the groups that functioned best were those whose members formed a cohesive unit, and this team cohesion deepened as the semester progressed.

In both the biology and chemistry courses, the group leaders met weekly with the instructors to discuss the upcoming workshop and to troubleshoot past workshops. The peer leaders also kept weekly journals reflecting their groups' progress. These journals became an encouraging record of each peer leader's growth and confidence as the semester progressed. From 1999-2002, there were on average 100 students enrolled in workshop chemistry each fall with ten peer leaders each responsible for one workshop. In the biology course, there were on average 145 students enrolled during this time with fourteen workshops and nine peer leaders. Some peer leaders in biology were responsible for two or more workshops. There were on average eighty students taking both workshop chemistry and workshop biology each semester. Both the biology and chemistry workshop leaders participated in a common training session prior to the start of the workshops in the fall. The training session focused on how to facilitate group work, how to respond to differing learning styles, how to handle sensitive issues that might arise in workshops, and how to provide an opportunity for new mentors to practice leading a group. This training session was reinforced during the year by hour-long sessions held weekly with the instructor assessing and troubleshooting problems that developed within a group. The peer leaders were selected by the instructor based upon their successful completion of the course and their demonstrated ability to work well in a group setting. Many of them were sophomores.

This peer-led model is, however, quite flexible. At the University of Portland, the biology and chemistry instructors differed in how Peer-Led Team Learning was implemented. The biggest difference was that in the chemistry course, attendance at workshops was required; whereas in biology, students were encouraged to attend workshop biology. Another difference was that the peer leaders for the chemistry course attended the "lecture," and their groups were encouraged to sit near one another in the lecture hall so that they could *facilitate group work* during class. This inclusion of peer leaders in the lecture had been introduced by the chemistry

instructor in 1998; however, those peer leaders, although upper division chemistry majors, were not skilled in facilitating discussions and sometimes gave incorrect information. In addition, their attendance in the lecture classes was sporadic and uneven. Formalizing the peer mentor program eliminated all of these problems.

In both chemistry and biology, the workshops used various approaches from model building to “jeopardy” games to involve the students in the workshop topics. Workshops began with a self-graded quiz since freshmen, in particular, are less skilled in formative self-assessment [9]. The quiz questions often were repeated in the midterm examinations reinforcing the importance of workshop participation. Workshop leaders were trained to emphasize active learning techniques that utilized different learning styles each week.

The most frequently used approach in chemistry, for example, involved workshops consisting of several problem sets. These sets were developed by the instructor from the workshop project, past examination questions, and/or textbook problems [10]. Students worked in pairs on a problem and each pair put its work on the board. After a suitable time, everyone would compare and contrast each pair’s solution. If the pair had difficulty solving the problem, another similar one would be assigned. If the pair had no difficulty, a problem involving new concepts would be introduced later. Students proceeded through the workshop at their own pace.

Chemistry Results

In order to assess the impact of the workshop approach on the students’ grasp of introductory chemistry, grade and exam results from a previous non-workshop class were compared to the results of those sections that had workshop chemistry. The Fall 1992 class was selected for this comparison because its composition of major, average GPA/SAT, and enrollment was most similar to the workshop classes and the instructor was the same. The text was different, but of similar rigor, and the class content was the same. In the first-semester *Chm 207: Introductory Chemistry I*, there was a significant increase in the percentage of students earning A’s and B’s compared to similar classes in the past without workshop chemistry. This is summarized in Table 1.

Table 1
Chm 207: General Chemistry I

Fall	92 ¹	99 ²	00 ²	00 ³	01 ²	01 ³
% A + B's	44	73	57	71	60	66
% D, F, W's	16	13	26	8	19	11

1. No Workshop
2. With Workshop
3. Data renormalized to include only those students who attended workshops.

Clearly, retention and final semester grades improved with the workshop approach. Higher final grades did not necessarily prove that students achieved greater conceptual understanding, but they are suggestive of this, especially since all the exams were concept-based and comparable in scope and emphasis.

Biology Results

There was a similar positive correlation between participation in workshop biology, which was optional, and the final grades in *Introductory Biology*. Figure 1 shows the grade distribution and the number of workshops attended for Fall 1999 and Fall 2000 in *Bio 205: General Biology*.

Workshops Attended 1999/2000

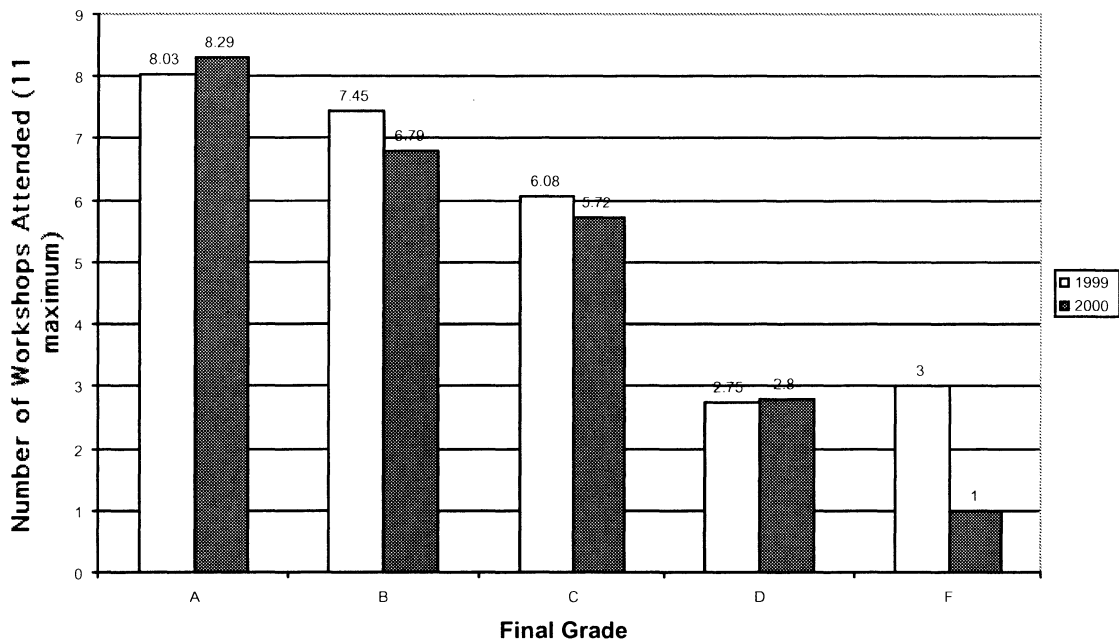


Figure 1. Mean number of workshops attended in each grade category for *Bio 205: General Biology*.

A regression analysis comparing the percentage grade in the course versus the number of workshops attended showed a correlation between workshop attendance and higher grades in the course ($p < 0.005$).

Students also showed a statistically significant increase in median scores on the comprehensive final exam in biology as shown in Table 2.

Table 2
Mean Percentage on Final Exam in *Introductory Biology*

Fall 98 ¹	Fall 99 ²	Fall 00 ²
76.8	79.5	80.3

1. No workshop
2. With workshop

Participation in workshop biology also seems to have had a positive correlation to female students' final grades in the course. Female students had a 0.521 positive correlation between the number of workshops attended and final class grades. Male students had a 0.238 correlation. This correlation is significant at the 0.01 level (2-tailed). This gender benefit to female students with peer learning was found in chemistry as well. While participation in workshop chemistry and biology was beneficial to both male and female students, it was even more beneficial to female students.

Results Common to Workshop Chemistry and Workshop Biology

Students in both chemistry and biology responded favorably when surveyed on their experiences with workshop chemistry and biology.

Table 3
Student Responses: Percentage of Students Agreeing or Strongly Agreeing to the Following Items

	F99	F01	F02
1. Interacting with the workshop leader increases my understanding of chemistry/biology.	85	100	92
2. Interacting with other group members increases my understanding of chemistry/biology.	87	89	86
3. I would recommend workshop courses to other students.	86	93	85

A strong majority of those students who were enrolled simultaneously in workshop biology and chemistry agreed with the statement that "having a workshop in both chemistry and biology helps me." The peer leaders were also asked to assess the value of the workshop approach in learning chemistry and biology. In every assessment, there was unanimous agreement that they would recommend a workshop course.

Benefits to Peer Leaders

Our original goals in introducing Peer-Led Team Learning into *Introductory Biology* and *Chemistry* had been to improve conceptual understanding of biology and chemistry, increase students' success in first-semester courses, and retain students in their desired field of study. Our preliminary data are very encouraging that these goals are being met, but there was a parallel and unexpected bonus in this student-centered learning approach: namely the involvement of undergraduate peer leaders as mentors who formed a bridge improving faculty and student communication. The peer leaders also reported enhanced skills in problem solving and understanding basic concepts in biology and chemistry. They developed confidence and facility in working with groups and became respected colleagues of the faculty. Another major bonus that has been noted in the three years that peer learning has been in place at the University of Portland, has been the change in our academic culture among majors favoring teaching as a career.

Table 4

Peer Leaders—Source of Future Teachers

Year	Mentors Planning on Teaching Career	
	Chemistry	Biology
1999-2000	3 out of 9	4 out of 9
2000-2001	5 out of 11	5 out of 8
2001-2002	5 out of 9	4 out of 6

This is from a science major pool which, in its first year at the University of Portland, had a student population in which only 2% indicated teaching as a career choice. Among the biology mentors in 1999-2000, all the graduating seniors pursued teaching fields or volunteered in a classroom setting immediately after graduation, even though none of these students had considered teaching as a career option before serving as peer mentors. This suggests that the workshop approach using peer leaders may be an effective remedy in addressing the critical shortage of future science teachers.

Institutionalizing Peer-Led Team Learning at the University Of Portland

Peer-Led Team Learning began in first-semester *Introductory Biology* and *Introductory Chemistry* in Fall 1999 at the University of Portland. By Fall 2002, it had been extended to the

full year sequence in *General and Organic Chemistry*, *General Physics*, as well as continuing in *General Biology*. The success of this approach at the University of Portland is due to: administrative support from the dean of the College of Arts and Sciences and the department heads of Biology and Chemistry; a critical mass of four faculty implementing the selection and training of peer leaders; our pioneering cohort of peer leaders (eleven in chemistry and nine in biology); and, in no small measure to the group of students who were the first to learn with this approach.

Acknowledgments

This work was supported in part by the Workshop Project Dissemination Grant of the National Science Foundation, Award 9972457; the Oregon Collaborative for Excellence in the Preparation of Teachers of the National Science Foundation, Award 9996453; and, WRITE ON! a writing retreat facilitated by the Oregon Collaborative for Excellence in the Preparation of Teachers, and funded by a National Science Foundation grant DUE-9653250 and 0222552.

Bios

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