
Peer-Led Team Learning: A Student-Faculty Partnership for Transforming the Learning Environment

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The challenge for faculty is how to engage students with content. Whether students are at a residential research university or commute to a community college, providing the many experiences essential for learning is often limited to the use of lecture. The lecture is efficient at transmitting content but does not provide the freedom to discuss and debate scientific concepts in a challenging but nonthreatening environment, the connection to mentors, and the power of working in a team. How can students be involved in serious debate and discussion in the context of a large lecture hall? How can they be engaged in critical thinking and problem-posing if their curriculum is driven by content coverage and the time constraints of three 50-minute meetings per week? How can students develop leadership and communication skills as part of learning science? A study by Astin (1993) outlined several factors that improve the quality of intellectual development during college years. The ones that are most influential are student-faculty interaction outside the classroom, involvement with student peer groups on campus through various forms of community-building activities, and the amount of time that students devote to studying, i.e., "time on task." The peer group was identified by Astin as the most potent source of influence on growth and development during the undergraduate years. It is important, therefore, that the design of the instructional environment includes opportunities for students to learn from each other, to communicate with each other in the language of the discipline, and to be able to explain scientific concepts to non-scientists. This chapter describes the development, implementation, evaluation, and dissemination of the Peer-Led Team Learning (PLTL) model of instruction, which introduces student leadership as a key unifying

element that catalyzes student engagement and achievement in the learning of science.

The PLTL Model

The PLTL workshop model was developed, in part, to address faculty concerns about student learning and high attrition rates (Woodward et al., 1993; Gosser et al., 1996; Gosser and Roth, 1998; Sarquis et al., 2001). A comprehensive report of the research and development work on the model is available (Gosser et al., 2001). The PLTL model addresses the needs of students by providing them with opportunities for intellectual and personal development as well as a restructuring of their content knowledge. This approach preserves the lecture and introduces a new structure—a weekly 2-hour workshop where six to eight students interact to solve problems under the guidance of a trained peer leader, a student who has done well in the course previously. Each weekly PLTL workshop centers on carefully constructed problems and activities. Typically, a course that includes a PLTL workshop consists of 2–3 hours of lecture per week, 1.5–2 hours of PLTL workshop per week, and a 3-hour lab facilitated by the course instructor and/or a TA. Homework assignments are selected for developing content mastery as well as to prepare for productive participation in the weekly workshops.

Peer leaders serve as role models. They are selected because they have recently completed the course, have done well, and demonstrate good communication and leadership skills. They are enthusiastic and motivated and have the desire to contribute to the learning of their peers. They are catalysts in forming a community of students that can serve as a support group for each other beyond the life of the

course. In addition, they serve as a bridge between students and instructors. Grading, preparing exams or quizzes, or “teaching” new content are not part of their responsibilities.

Effect on the Peer Leaders

A significant outcome of the PLTL model is the effect on the peer leaders. For peer leaders, the experience can be a transforming one. Not only do they gain a better understanding of the subject, they also become partners with faculty in implementing, documenting, and disseminating PLTL. With time, they become increasingly independent at performing these tasks and often become interested in taking on other leadership roles or become interested in pursuing careers that involve teaching and research. Student leaders have copresented with faculty at local, regional, and national meetings. Many peer leaders have used these opportunities to make connections to obtain jobs or gain admission to graduate schools. Recent research findings (Gafney and Varma-Nelson, 2002; Tenney and Houck, 2004) point to the following gains when students take on the role as peer leaders:

- Increased content knowledge and better success in higher-level science courses
- Increased confidence to pursue science-related careers
- An appreciation for different learning styles
- Improved people skills and collegial relationship with the course instructor

Appropriate Materials for PLTL Workshops

The workshop units used in the weekly discussions are carefully constructed by the instructor to address common misconceptions and to develop conceptual understanding. A straightforward question in a text that simply requests a numerical answer can be improved by structuring the problem into parts and asking the group to explain each part, reflect on the answers, explain to their neighbors, compare methods, and create flowcharts and visual representations of their thought processes. The workshop is a very good environment to explore various models and representations of concepts and problem-solving. The small-group setting is perfect for the introduction of model-building and intellectual processes characteristic of the discipline. This includes more traditional items such as molecular model-building (so

important for the development of tetrahedral carbon and DNA) as well as “games” of simulation based on assumptions and rules. The role of such intellectual model-building coupled with concrete representations can be very helpful for developing students' understanding of concepts that appear more abstract.

It is tempting when designing materials for a PLTL workshop to construct an answer key; however, the benefit of not providing an answer key is fourfold:

1. In the PLTL workshop, students embark on a venture of self-discovery, in collaboration with their peers. The existence of an answer in black and white will short-circuit the process. Students build self-confidence through authentic problem-solving, without reliance on answers.
2. A valuable part of the PLTL process is that several different and equally valid approaches to solving a problem will be explored. Answer keys cannot foresee this and typically emphasize a unique problem-solving path.
3. Similar to a research group meeting, conclusions are reached through debate, discussion, and consensus, and the learning will be deeper and longer lasting than that obtained by a quick check of the answer key.
4. The lack of answers models the process of science, where the purpose is to seek answers and use data to validate one's conclusions rather than to verify something that is already known.

Leader Training

The primary feature of the PLTL model that distinguishes it from other types of cooperative learning is the role of the leader; thus, a high-quality leader training program is an important factor in successful implementation of a PLTL course.

All leader training programs have a common temporal structure: students meet for a pre-term orientation, and then weekly meetings are conducted throughout the term for ongoing training. The length of the pre-term orientation varies depending on local needs. Some programs meet all day for two or three days, whereas others meet for a few hours on a single day. Ongoing training almost always involves a regularly scheduled one- or two-hour meeting once per week. The faculty member teaching the course must be involved in training. Often, a learning specialist—faculty or staff from a campus learning center, school of

education, academic success center, etc.—teams up with the faculty member in conducting leader training.

Goals for a leader training program generally fall into three categories: 1) development of content knowledge, 2) instruction about how students learn, and 3) the fostering of leadership skills. A review of the course material for the upcoming workshop usually constitutes at least half of weekly training meetings. The remainder of training time is devoted to topics on pedagogy and leadership. The primary pedagogical issue that must be conveyed to student leaders is the nature of their role in the course. Specifically, they must internalize that they are not lecturers. They are expert students who are guides to helping students learn how to learn. They must also learn how to lead small groups. Instruction about issues such as organizing and directing students in a workshop setting, ethics, and dealing with student problems need to be covered in the training sessions.

One of the most effective features of training programs is the reflective journal. Leaders are required to reflect on and write about their workshop experience each week. Generally, they are asked to write approximately one page describing any issues they wish within a day of completing each workshop. These journals reveal many of the concerns of the leaders, and they provide themes for discussion about pedagogy and leadership at weekly meetings. They also provide insight into the development of teams of students, and they provide feedback on the quality and appropriateness of materials.

Evaluation of the PLTL Model

Formative and summative evaluations of the PLTL model were conducted as the project developed and grew. Focus groups, phone interviews, written questionnaires, site visits, and analysis of grades and retention have been the primary methods by which evaluation has been conducted, involving students, peer leaders, faculty, and administrators. This evaluation process led to the following six “critical components” for the successful implementation of PLTL (Gafney, 2001).

1. The workshop is integral to the course.
2. Course faculty are closely involved with organizing the workshops and training the peer leaders.
3. Peer leaders are well trained and closely supervised.
4. Workshop materials are challenging at an appropriate level, integrated with other course components.

5. Organizational arrangements promote active learning, through factors including size of group (six to eight students), space, time, and low noise level.
6. The institution encourages and supports innovative teaching.

Several years of new adoptions and evaluations have demonstrated that these components are indispensable to the implementation of PLTL in ways that will lead to increased student academic performance, positive experiences for the peer leaders, and overall satisfaction for the faculty members involved. Extensive analysis has revealed the model's positive impact on student attitude and success in the study of science and mathematics. Surveys have indicated that when the method is introduced with fidelity to the model, students place a high value on the workshops.

Tien et al. (2002) conducted a study on groups of students who were in Jack Kampmeier's traditional Organic Chemistry course from 1992 to 1994 with those who were involved in PLTL workshops from 1996 to 1999. Although the control and treatment sections were not taught in the same year, they were similar in many ways. The same instructor taught the course, with the same textbook, lecture style, class size, and level of difficulty. It was found that the workshop participants outperformed the control group on exams in all cases. For overall means, the scores were significantly different with $p < 0.01$. When broken down by gender and ethnicity, the results show that all PLTL groups outperformed their counterparts in the more traditional course. While such rigorous statistical analyses have not been performed in all cases, at least 20 similar studies have been conducted involving PLTL workshops at other institutions involving several disciplines (see evaluation at www.pltl.org). As stated by Lyle and Robinson (2003), “Although there may be flaws in a study, if the study is repeated, taking into account the flaws that have arisen and the same general results occur, the results can be considered useful.”

Educational Design and Research Foundations of PLTL

PLTL has a positive impact on student learning because it draws from and combines the following four well-established areas of educational design and research. Varma-Nelson and Coppola (in press) have proposed a four-part theoretical model, which includes group learning, reciprocal

teaching, studio instruction, and social constructivism. Springer et al. (1999) conducted a meta-analysis of the effects of small-group learning on undergraduates in STEM courses, concluding that this type of instructional environment yields greater academic achievement, more favorable attitudes toward learning, and increased persistence through courses and programs of study. In PLTL, a small group generally consists of six to eight students. Too few students can yield too few ideas, and too many students prevent opportunity for all group members to participate. In their criticism of the Springer et al. (1999) study, Colliver et al. (2003) state that in medical education, the purpose of small-group instruction is to develop skills in teamwork, communication, and peer- and self-assessment. Certainly, these are also valuable outcomes of the PLTL approach.

Another feature of PLTL is its utilization of reciprocal teaching, which is where students take turns leading a dialogue among themselves in an effort to bring meaning to what they are studying (Palincsar and Brown, 1984). There are four components to this technique: 1) summarizing, which is gaining understanding by identifying the main concepts; 2) questioning, or asking questions about the topic; 3) clarifying, which is recognizing where understanding is unclear; and 4) predicting, or formulating hypotheses.

Small-group instruction and reciprocal teaching are ideally conducted in a studio instruction environment, where students can work in an integrated lecture-laboratory-discussion environment with less lecture than is commonly used and more student-student and student-instructor interaction. This model has been most frequently used in the sciences in college physics education (Cummings et al., 2004; McDermott, 1996; Wilson, 1996). PLTL uses a studio-like environment, especially when the workbook problems involve hands-on activities that involve concrete models or multimedia activities.

Group learning, reciprocal teaching, and studio instruction have their theoretical roots in the works of L. S. Vygotsky, a Russian psychologist who published his findings in the early 20th century. Vygotsky was a constructivist, believing that each student constructs his or her knowledge from an interaction between what is presently known and what is newly observed. He also believed that the mediating role of another person was critical in the learning process. Ideally, a learner is presented with hints while attempting to solve a problem just beyond the level at which he or she is currently profi-

cient (Vygotsky, 1986). PLTL provides a trained peer leader who can fulfill the role of hint provider, encouraging students to rise to a higher level of both content and process knowledge.

Dissemination of PLTL

Early on in the start-up of the "Workshop Chemistry" project, the precursor to PLTL, we decided that a good way to present the model was to involve our student leaders. The results revealed that students' passion for and eloquence about being a peer leader are key factors in disseminating the model. The poise and confidence that the leaders exhibited while presenting their views to sometimes skeptical faculty quickly and easily convinced us that students could indeed be partners beyond what we had initially imagined. Inclusion of students in most major presentations has been a hallmark of the PLTL project.

The PLTL project's national dissemination model includes four levels (Varma-Nelson and Gosser, 2004) of activities: 1) stimulate interest (presentations, websites, newsletter), 2) promote deeper understanding (1- to 3-day workshops/seminars), 3) assist implementation (the Workshop Project Associate [WPA] program to fund PLTL start-ups, with follow-up support), and 4) develop leadership (national leadership meeting; copresenting with new PLTL implementers, etc.) (Figure 1).

Supporting the dissemination of PLTL are a website (www.pltl.org); a quarterly newsletter, *Progressions*; the publication of five books by Prentice Hall (see Bibliography); materials in print form and CD for several disciplines; and regional centers and affiliates who serve as mentors for faculty interested in working with PLTL. Short workshops (3-hour or 1-day) are presented around the country by the initial dissemination team and new adopters, including through the Multi-Initiative Dissemination project, and a 3-day workshop on PLTL is offered through the Chautauqua Faculty Development program. Since 1999, there has been an annual 3-day leadership conference. This integrated dissemination plan has resulted in the dramatically expanded use of PLTL pedagogy beyond the initial core of enthusiastic faculty.

A conservative estimate of implementations suggests that over 180 faculty have adopted the PLTL model at 90 colleges in chemistry, mathematics, physics, and biology, affecting 16,000 students per year who are led by 1,700 peer leaders.

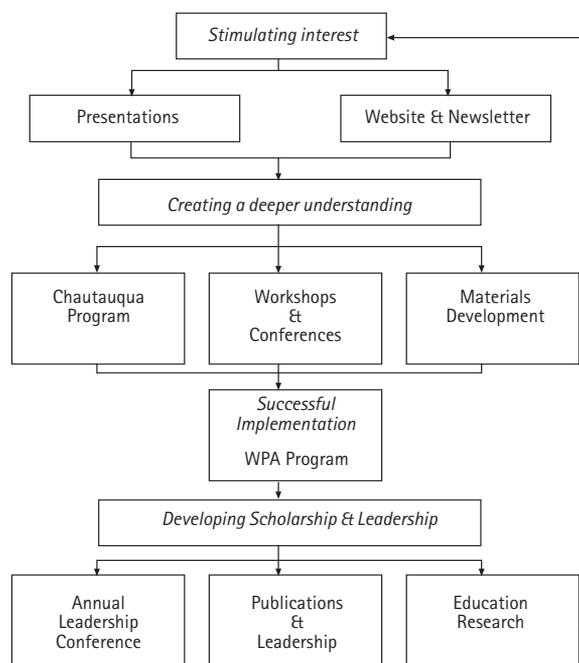


Figure 1. The PLTL project's national dissemination model.

Although the project has been successful in disseminating the PLTL model, the adoption of PLTL needs to reach many more institutions and faculty before it can be said to have attained a degree of permanency in the education of undergraduate students. The challenges that the project and those concerned about the development of PLTL must address include developing and sustaining further dissemination efforts, stimulating new adoptions, raising the level of the discussion of institutionalization, and constantly sustaining the network, developing new leadership, and integrating with other successful educational initiatives and new trends in science and technology. PLTL is adaptable to many different visions of content and learning goals and pedagogical methods. For these reasons, it has the potential to play a major role in the transformation of undergraduate science education in the United States.

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