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PROGRESSIONS: PEER-LED TEAM LEARNING

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MIAMI 2000: STUDENT LEADERS REPORT

The *Miami 2000* conference, *Active Learning in the Sciences*, was held April 28-30, 2000, at the University of Miami, and was hosted by Michael Gaines, Chair of the Biology Department, and Co-PI of the PLTL National Dissemination Grant. The conference was sponsored by the National Science Foundation PLTL Dissemination Project and the Howard Hughes Medical Institute, and co-sponsored by the Instructional Advancement Center and the Department of Biology. Supported by the excellent organization provided by Peggy Nickerson and Cindy Iglesias, the conference included presentations by nearly the entire team of the PLTL Project leadership.

Since its inception, the Workshop Project has included the participation of student leaders at presentations and conferences, where their insights have contributed greatly to the awareness of the PLTL model. This conference was no exception.

Student leaders from the University of Rochester, the City College of New York, and the University of Miami participated by facilitating small groups of faculty in a sample problem-solving workshop and by participating in general conference discussion. We asked the student leaders to reflect on their experiences, and their observations follow.

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The model workshop session, led by student leaders with groups of conference attendees as "students," was quite constructive. Despite some attendees' expressed doubts, the workshop session was an excellent simulation of an actual workshop. There were differing levels of both

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THE IMPACT OF THE PLTL EXPERIENCE ON WORKSHOP LEADERS: AN INVESTIGATION

A team at the University of Rochester, composed of Vicki Roth, Nancy Niemi, and Lydia Tien, has been investigating the PLTL experience on peer leaders. They gathered information by designing and conducting interviews with students leaders, in a semi-structured interview format, with the understanding that final grades alone do not capture all of the effects of student participation in this model. While initial reports of higher grades and retention rates are encouraging, they serve equally as catalysts for additional lines of inquiry. The evaluation reported here works on a paradigm that considers the Workshop participants 'words and interactions to be data that can be equally as informative as their test scores.

This report focuses on peer leaders 'descriptions of their experiences and hinges upon two broad questions:

1. Does being a PLTL leader influence what leaders think about and approach their own academic work? If so, how?
2. Does being a peer leader influence that leader's stated professional goals?

The first round of interviews, conducted by Nancy Niemi during the 1998-1999 academic year, began with five former student coordinators for the program. One of the coordinators interviewed was a graduate of City College of New York; the

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PROJECT NOTES: WHERE DO ANSWERS COME FROM?

If we define the development of the skills and attitudes of critical thinking as a key objective in our courses, then we can understand the desire to conduct workshops without readily available pre-prepared answers.

It is tempting when designing problem sets for peer-led team learning workshops to construct a set of worked-out answers, similar to the traditional answer key. However, many of us in the Project are convinced that the best practice of PLTL workshops is obtained without reliance on answer keys. Lack of an answer key creates some discomfort for both faculty and students. Faculty are concerned that without the availability of answer keys students are in danger of obtaining false information. Students and peer leaders may feel more comfortable with a handy set of answers to which they can refer. However, if we define the development of the skills and attitudes of *critical thinking* as a key objective in our courses, then we can understand the desire to conduct workshops without readily available pre-prepared answers.

John Dewey has been credited for coining the term "critical thinking" by defining it as "active, persistent, and careful consideration of any belief or supposed form of knowledge in light of grounds that support it and further conclusions to which it tends."*

A cursory survey on the internet finds multiple divergent definitions and examples about what constitutes the details of critical thinking, (i.e., the ability to solve open-ended problems with more than one solution, ability to arrive at the correct solution utilizing logical inference (*sic*), engaging in "reflective" practice, etc). Not surprisingly, there does not seem to be a full consensus on what constitutes "critical thinking." Sometimes, it is phrased in terms of what it is not, (e.g., rote learning and memorization of algorithms). However, the learning of algorithms is important for complex problem-solving as they automate certain processes and reduce the load on the working memory, which Herron (101-102) suggests is limited to "seven bits, plus or minus two." Many advocates of critical thinking propose that it is "context free" in contradiction to substantial research that indicates that thinking is situated in or tied to certain contexts (Herron). Without pursuing all of these possible elements and controversies of critical thinking, perhaps one thing that can be agreed on is that critical thinking is the ability to reach conclusions through a process such as described by John Dewey**,** *independent of appeal to an external authority*.

How can we relate this elementary statement of critical thinking to the preparation of materials, and, in particular, the ques-

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PEER LEADERSHIP SPURS INTEREST IN SCIENCE AT UNIVERSITY OF PORTLAND

In the past year (1999-2000), four faculty in two disciplines, chemistry and biology, adapted the PLTL Workshop model with supplemental funding to the University of Portland. How did we come to adopt this approach? How did it work out? Where are we going from here?

For several years, the chemistry and biology departments at the University of Portland have been focusing their efforts on improving and increasing the success of their first semester freshmen in general chemistry and biology. The University of Portland is a private, primarily residential university in the city of Portland, Oregon, with an enrolment of about 2600 students. The number of students who declare science, primarily biology, as their major has steadily increased with a corresponding increase in their SAT's and high school GPA's. However, we were not seeing increasing success in general chemistry and general biology. Students 'study skills were weak. Freshmen reported that they seldom had to study to do well in science in high school, but were finding out too late to recover academically that this was not the case in college.

In chemistry, attempts were made to include more interactivity in the lecture with team projects. The lecture typically had between 100-120 students, a very large section for the University of Portland. Toward that end, during 1998, three upper division chemistry majors were hired by the Department to attend the lecture course and facilitate group work in an auditorium setting. Although this improved students 'participation, three major problems arose. Firstly, these upper division students had no formal training in working with groups. Secondly, although these were junior and senior chemistry majors, their knowledge of the content was at times inadequate. Lastly, three mentors for 120 students was not enough.

Biology had tried to increase their students 'success in general biology lecture (160 students) by offering several sections of a course called *Readings in Biology*. This course typically had 25 students in each section and was offered by a faculty member in biology. This approach was very time-intensive for the faculty in biology and still resulted in 40% of their declared majors changing their major from biology after the first semester.

Both the lead instructors in general chemistry and biology had been participants in an NSF sponsored initiative, OCEPT, the Oregon Collaborative for Excellence in the Preparation of Teachers. It was through this connection that they became familiar with the PLTL Workshop model. This approach addressed many of the deficiencies that were present in their earlier attempts. Thus, peer led team learning was instituted in the Fall of 1999 in the first semester general chemistry course for science majors and in the first semester general biology course. Nineteen peer leaders were hired and trained in a two-day workshop on group facilitation skills prior to the start of the Fall semester. Ten of these leaders were in chemistry and were primarily sophomores. The chemistry lecture class had an enrolment of 99 students. Nine leaders led fifteen workshops in biology and were primarily seniors in biology. There were 160 students enrolled in biology. Around 80 students were enrolled in both workshop chemistry and workshop biology.

In chemistry, students were required to attend their two-hour workshop and questions from the workshops were integrated in exams. The peer leaders were also expected to attend the lecture so that they could facilitate group work. In contrast, in biology, the students were encouraged to attend the biology workshops with extra credit but the workshops were not required. Also, the peer leaders did not attend or participate in the biology lecture. Only the first semester of general chemistry had PLTL whereas both semesters of general biology used this workshop approach.

At the start of the semester, some of the students in chemistry objected to the required workshops but by the end of the term these same students were lamenting not having workshops available to them for second semester chemistry. Ninety-five percent of the students participating in both workshop chem-

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Freshmen reported that they seldom had to study to do well in science in high school, but were finding out too late to recover academically that this was not the case in college.

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PLTL AT THE UNIVERSITY OF PORTLAND

At the start of the semester, some of the students in chemistry objected to the required workshops but by the end of the term these same students were lamenting not having workshops available to them for second semester chemistry.

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istry and workshop biology reported that the workshops were helpful. In chemistry, 10% of the students dropped or failed the class. All of these students, save one, did not attend the chemistry workshop.

In both biology and chemistry we observed increases in A's and B's compared to previous semesters. Observed retention of biology majors significantly increased. The data have been forwarded to the Project Evaluator to add to the meta-study of the PLTL Project. We are hopeful that the PLTL approach helps students improve their study skills. Random interviews by the Dean of the College of Arts and Sciences also reported high student satisfaction with the workshop approach.

A somewhat unexpected but ancillary benefit of this approach has been the blossoming of the peer leaders. At the start of the Fall semester, they were a very tentative group and lacked confidence. They have matured into insightful advocates and representatives for their students. As a result of their peer leadership, some are now considering careers in teaching science.

We have been very encouraged by our preliminary results. Next year, our leaders have been invited to work in developing workshop chemistry and workshop math with the high school faculty of a neighborhood high school with a large Hispanic population and a high drop-out rate. Also, at the University of Portland, we will be extending workshop chemistry for the full-year course in general chemistry and incorporating the workshop model in half of the general chemistry laboratories. Organic chemistry and the chemistry sequence for the allied health majors will also be using the Workshop approach. Both semesters of general biology will again be using the Workshop approach. Physics is considering implementing PLTL in 2001.

The PLTL model is robust and flexible and thriving on the left coast!

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CHEMISTRY TEACHER INITIATES PLTL FOR H.S. CLASS

Sue Soto, chemistry teacher at Health Opportunities High School in the South Bronx, read a description of PLTL in an interview with Project Co-PI Victor Strozak. She contacted him and arrangements were made to have her class come to City College of New York on April 14th. Project Director David Gosser and Victor Strozak introduced each exercise, and CCNY peer leaders, including Olukemi Ayodeji, Balvinder Blah, Devanand Deonarine, Priya Shiwsankar, and Andrei Lalla led groups of students in the kinetics workshop, and in a lively game of *Mendeleev!*, a Jeopardy-type game.

Students were very enthusiastic about working as a group. "When a group works as a team," one student noted, "the answer to a question comes faster, and two brains are better than one. As a team we can give one another hints and help one another in order for everyone to be on the same level."

"It works because it motivates the students more and makes it more interesting to learn with a peer. It shows us that teachers are not the only ones that can teach," remarked another. A third supported this method of learning: "Make workshops of small groups so that no one will be shy and everyone will learn." And a fourth student noted that "It would be cool because it can make me understand my school work better."

"I've been looking all over for ways for my students to pass chemistry, and then I discovered that the experts are right here in New York, so you have to help me," Ms. Soto appealed to Dr. Strozak. It worked: "Getting a teacher who is enthusiastic and wants to work with us is a big step in actually implementing PLTL at the high school level," Dr. Strozak noted. "The experience on April 14th convinced me this is workable at the high school level. The students' responses were phenomenal."

STUDENT REPORTS ON MIAMI 2000

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interest and ability, just as in a real workshop session. There were digressions (about education and not about sports or campus life, but digressions nonetheless) just as in a real workshop. There were issues of people rushing ahead, losing interest, or disrupting the session, all just like in a real workshop. The issues every leader has to face were there, and they were addressed just as they would be with students.

As a student leader of organic chemistry workshops I was impressed by the amount of sincere interest in the workshop model from faculty, administrators and learning specialists, across disciplines and institutions present. A lot of great information was conveyed, in exciting conversations about workshops, their successes, their implementation, and the issues of leader selection and training.

For me personally, the conference provided many opportunities. I was able to share my passion for the workshop model with others. I, in turn, was able to learn more about the project as a cohesive whole. I got to meet many more members of the project leadership. I had the opportunity to spend time with student leaders from other disciplines and institutions.

I shared many interesting conversations with faculty members, learned more about my chosen career field, and differences and similarities among chemistry departments from various institutions. And I was able to enjoy the hospitality of the beautiful University of Miami campus, and even score a few precious hours by the hotel pool.

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Heard in the Hallway During the Conference

"We already have a recitation, what is so different about this method?"

"Lecture and recitation worked fine for me, so it should work fine for my students."

"The more advanced students will be bored by workshop while those who are struggling with the material will be lost."

"Workshop takes too long. I don't see how this exercise will help the students. Plus, I will never be able to complete the material I plan to cover in my lectures."

"I lead weekly discussions with my students during lecture. Isn't that the same thing as workshop?"

"I have workshop at my university, but I (the professor) serve as the leader."

"I don't have the time or resources to implement such a radical curriculum change."

"The cost in both time and resources can't possibly be justified by the gains."

These opinions heard from faculty during the *Miami 2000* conference made me realize the many obstacles the peer-led team learning model faces: professors doubt the efficacy of this model, and believe that workshop is something they can orchestrate themselves to avoid the perceived problem of "cost-inefficient" peer leaders. To those whose sentiments mirror those voiced above, I would ask you to simply listen to the other side of the story, the views of peer leaders and workshop students who have benefited greatly from involvement in peer-led team learning. Their words speak volumes to the *successes of* and the *desire for* peer-led team learning...

Over the past ten years, I have participated in many different initiatives to facilitate the instruction of undergraduate chemistry. As an undergraduate, I participated in and then taught traditional weekly recitations in organic chemistry, general chemistry and biology. As I was also involved as a chemistry and biology peer-tutor, I was able to see the difference that small group, peer-led learning made as compared to traditional recitation sections. Smaller sessions were not only easier for me to operate and handle, I *knew* the students learned more and were more interested in returning for additional sessions. However, it was not until my second year of graduate studies at the University of Rochester that I was able to see the incorporation of such a teaching philosophy into an undergraduate curriculum. During this time, my great interest in teaching led me to work with Dr. Jack Kampmeier who introduced me to the Workshop Model. For the past three years, I have been an active participant in the

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Workshops gave students an opportunity to ask questions that they may have been afraid to ask the professor while he was speeding through the material; it gave them a better grasp for the concepts that they may not have caught while in class...

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workshops, first as a peer-leader, and now as an "ambassador" of the Workshop model.

As a post-doctoral fellow, I am seeking to bring workshop chemistry not only to my current position, but build towards the future integration of this teaching philosophy in my own curriculum. The *Miami 2000* conference provided me with a unique opportunity to contribute my knowledge as a peer leader, and also to learn methods for the incorporation of this valuable model to different types of learning institutions.

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The Miami conference was extremely successful in providing a general idea of what the Workshop model is. Professors seemed very interested and asked thoughtful questions about how to begin similar programs in their own university or college. I enjoyed relating my past experiences as a workshop coordinator. Everyone seemed to have left the conference with new insights on learning techniques.

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The conference gave me an opportunity to see teaching from a professor's point of view. I also had a chance to learn new techniques in teaching my own biology workshop. The weekend was a great opportunity for professors from different places to interact and share their experiences. I think the most significant impact will be on the students at each of the schools that the professors are returning to.

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Fellow peer leaders from the City College of New York, the University of Rochester, and the University of Miami had the role of leading an actual workshop with teachers in the role of students, so that the professors could get a feel as to what actually takes place in a workshop. We conducted a chemistry workshop simulation showing the theory of kinetics, using pennies. With a mixture of backgrounds from high schools and colleges, the "students" proceeded to discuss the type of technique that was being used, and the discussion became heated, as some suggested that the technique would not reach some kids, particularly those in high school. Yet, as the workshop went on, the "students" began wondering aloud how they might fit the workshop into their normal class routine, and how they could trim class teaching time to fit the workshop into the schedule.

The session became an opportunity for questions to be posed to me as a workshop leader:

What do you get out of being a workshop leader?

What are some of the benefits that students gain through the workshop?

How are the biology workshops that I led structured as opposed to the chemistry workshop being used as an example?

I acknowledged that I gained leadership experience, and was able to retain the information that I had learned as a student in the class. Freshmen students are given an opportunity to get to meet other students and develop friendships that they might not otherwise have had. Workshops give students an opportunity to ask questions that they may have been afraid to ask the professor while he was speeding through the material; it gives them a better grasp for the concepts that they may not have caught while in class; and they develop a bond with a viable resource (the workshop leader) that the student can call upon at anytime, with any question without the fear that they are being a bother to the workshop leader.

After the workshop simulation, all the professors met in a plenary session with the workshop leaders. In this open forum, leaders were asked all sorts of questions, and helped dispel professors 'doubts about peer-led team learning.

For me, the *Miami 2000* conference was a wonderful opportunity to meet great minds from around the country, and actually to teach them was an honor. I received a lot of insight into the world of teaching and pursuing it as a career. I also learned more about different types of learning styles of students, something that I had not considered before in leading workshops. The experience will also help make me a better workshop leader when I "lead" another group of students again in

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STUDENTS POWER PLTL IN PUERTO RICO

Students from two campuses of the University of Puerto Rico met with PLTL Co-PI's Pratibha Varma-Nelson and Jack Kampmeier on May 2, and were trained to lead the "pennies" Workshop on chemical kinetics and equilibrium (see *Progressions*, Fall 1999). Fatin Abdallah, Zamara Aldarondo, Xiomara Aldarondo, Jennifer Rodríguez, María del Carmen Sánchez, Maricelly Colón, and Glorimar Vicente (Cayey campus); and Katherine Vega, Salimar Malavé, and Omar Mercado (Arecibo campus) then guided teams of faculty, learning specialists and graduate students to hands-on understanding of the problem and the educational and personal dynamics of the workshop. The faculty, learning specialists and graduate students in the disciplines of chemistry, physics, and biology came from the Cayey, Arecibo, and Rio Piedras campuses of the University of Puerto Rico, as well as from the Universidad Metropolitain in San Juan. They attended one of two all-day presentations of the Workshop Model by Varma-Nelson and Kampmeier, held at Cayey and Arecibo.

Several of the students are leaders in the CHEM-2-CHEM program, designed and implemented by Professor Rosita Baez at Cayey, but others were new to the model. As usual, the students won the day through their facilitation of the "pennies" workshop, communicating the power of the peer-led Workshop in ways that could not have been accomplished by Varma-Nelson and Kampmeier.

Professor Baez was the perfect host who arranged the two Workshop presentations, as well as visits to the radio telescope at Arecibo, and a performance of *Madama Butterfly* in San Juan. The visit even coincided with a student demonstration regarding Vieques! It was a stimulating trip: we hope that it will be productive as well and facilitate the development of PLTL Workshop opportunities in Puerto Rico.

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The peer-led team learning Workshop is a technique that facilitates the study of chemistry. I had the opportunity to take part in the workshop presentation. First we were the students and then we switched to be the leaders of a faculty members 'group. It was a great experience.

The workshop helped us understand abstract chemistry concepts in an easier way. The group participated very actively, letting everybody share their knowledge and experience. Definitely, the workshop is an excellent way to help make more difficult concepts easier to understand. I feel that professors, tutors and mentoring groups should use this method to bring a great learning opportunity to every student.

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Since 1997 we have developed a peer-led team learning model at the University of Puerto Rico at Cayey. Our project, called *Chem-2-Chem*, consists of learning communities composed of general chemistry students led by their upperclass peers. Goals include helping students in their academic performance and in their personal and social development. Excellent results have been obtained by providing this model for the active participation of our students in small groups. We have been in contact with members of the Workshop Chemistry Project leadership since 1999 and look forward to working together with them in the future. We appreciate their visit to our University, where they made an outstanding presentation.

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the Fall. The dinner social with the professors was also a highlight — good food, great conversations, and a chance to see stingrays off the coast of Biscayne Bay.

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PAIR PROBLEM-SOLVING:

The various relationships between concepts and ideas, which comprise a conceptual web of understanding, are best discerned through problem-solving discussed in a social context.

Pair problem-solving seeks to maximize on-task behavior by students, and affords the greatest opportunity for learning by *all* members of the cooperative learning group. The model for the pair problem-solving method comes from Whimbey and Lochhead (1986, 1981) which is itself modeled after the clinical interviews used by Piaget. These texts also provide an excellent source of problems to train students in the pair problem-solving technique.

Research indicates that the problems that students solve to develop conceptual understanding of content are not always, in themselves, sufficient for learning. The various relationships between concepts and ideas, which comprise a conceptual web of understanding, are best discerned through problem-solving *discussed* in a social context (Von Glasersfeld, 1988). Though knowledge is constructed individually, it is corroborated largely through consensus, and consensus-achieving is a social activity.

By encouraging students to verbalize their thoughts, they are forced to examine their ideas as they communicate. They must evaluate those ideas in the light of another person's interpretation of what they are saying. Requests for clarification and repetition often help students to catch and correct their errors as well as helping to reinforce ideas that they may have held only tentatively.

Pair problem-solving incorporates two key notions: constructivism; the idea that students must construct knowledge for themselves (not to be confused with making scientific discoveries *a la* Newton, Einstein, Maxwell, etc.) and metacognition; the supposition that the vehicle for the construction of knowledge is self-reflection, or in Piagetian terms, reflective abstraction.

Pair problem-solving promotes metacognitive activity through the use of questioning strategies, which require students to reflect on their thought processes. Four such strategies are (Confrey, 1985): 1) ask students to discuss their interpretation of the problem, 2) ask students to describe precisely their methods of solution, 3) ask students to defend their answer and their solution, 4) ask students to retrace the steps in their solution so as to review the process they engaged in to solve the problem.

Directions to Start

Students in the workshop session are divided into pairs: one is the *problem solver*, and the other is the *listener*. Each pair is given a problem.

Instructions to the Problem Solver

The student designated as the *problem solver* begins by reading the problem aloud to the other student (the *listener*) and verbalizes all thoughts on how to solve the problem. The problem solver does all the talking and all of the writing about the problem. The problem solver is responsible for articulating all ideas as they occur, whereas the listener has an opposite task.

Instructions to the Listener

The role of listener is quite difficult. The listener must:

1. *Listen carefully*. Ask the speaker to repeat statements if needed, or to slow down.
2. *Encourage vocalization*. Ask, "What are you thinking?" and "Can you explain what you are writing?"
3. *Ask for clarification*, for example, "What do you mean?" and "Can you say more about that?"
4. *Check for accuracy* by asking, "Are you sure about that?"

Yet there are also "do not's" for the listener:

1. Do not give hints,
2. Do not solve the problem,
3. Do not tell the solver how to correct an error.

As the problem solver is talking, the listener must suspend solving the problem him/herself so that complete concentration and attention is devoted toward understanding the problem solver's solution.

The pair's interaction is characterized by the focus on language used by the problem solver and by the listener's acceptance of the solver's vision of a solution path.

AN EFFECTIVE MODEL FOR LEARNING

Instructions for Peer Leaders

Every two or three minutes the peer leader moves from working with one pair of students to assist another pair, serving as a coach.

After first identifying who is the problem solver and who the listener, the peer leader should direct all questions to the listener and *not* to the problem solver. If the listener cannot explain the *problem solver's* solution, then the listener must be directed to ask the problem solver to repeat the solution. The peer leader should agree to return after the listener feels confident that they both understand the solution and that the listener can communicate it effectively. Upon listening to the solution, the peer leader should probe for any uncertainties or confusions, and state agreement when and where it occurs. A student's answer is not acknowledged as either right or wrong.

The peer leader continuously manages the workshop through constant and proximal observation, feedback, and when necessary, direction.

What Pair Problem-solving Looks Like

Upon entering the room an observer would notice students seated haphazardly in pairs, conversing and sometimes arguing with one another. The students may seem oblivious to the peer leader, who may be difficult to locate since she/he is not at the front of the workshop group. There may be more than one group of students working at the board simultaneously. The noise level in the room is such that the door to the hallway may need to be closed. Occasionally a hand goes up in the air, waving for the peer leader's attention. There are loud exclamations of "I got it!" intermixed with groans of frustration. The scene is active. It appears anarchic because no one person seems to be directing the activity.

Instructional Extensions

1. By *exchanging roles of problem solver and listener*, students have the opportunity to learn the related skills of problem-solving aloud and listening for meaning.
2. If time permits listeners should *present their partner's solution to the group*. In this manner the pair problem-solving roles of problem solver and listener will be reinforced.
3. In addition to listening to students, *leaders should model expert problem-solving* for the group. Students rarely see experts solve problems, much less hear them solve problems aloud. By describing one's thought processes aloud, peer leaders demonstrate the process of thinking with all of the dead ends, mistakes, and corrections that characterize real problem-solving.

The pair problem-solving process forces students to articulate their ideas to one another in a manner that causes them to explore their own understandings. In their attempt to explain their solutions, and to defend against argument, students develop representations, analogies, extreme instances, contradictory evidence, etc.. In pair problem-solving, the conceptual web of understanding grows as students engage in an interactive, reflective process.

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Editor's Note: For a student leader's experience with this method, see the Fall 1999 issue of Progressions.

Pair problem-solving promotes metacognitive activity through the use of questioning strategies, which require students to reflect on their thought processes.

WORKSHOP CHEMISTRY PROJECT DEEMED A HUGE SUCCESS

The Program has exceeded expectations in dissemination and acceptance by other institutions.

The National Visiting Committee for the 1995-2000 Workshop Chemistry Project was composed of Michael Gaines (Univ. of Miami), Chair; Patricia Cunniff (Prince George's Community College), Joseph Casanova (Cal State-LA), Dennis Evans (Univ. of Delaware), Eli Fromm (Drexel Univ.), John Johnston (Exxon Corp.), Bonnie Kaiser (Rockefeller Univ.), Clark Landis (Univ. of Wisconsin), Kathleen Parsons (Macalester College), Arlene Russell (UCLA), Jeffrey Steinfeld (MIT), Ronald Thornton (Tufts Univ.), and Hal Richtol, NSF Program Officer.

Its final meeting was held March 18-19, 2000 at the Graduate Center of the City University of New York, and its final report stated that "The Program has exceeded expectations in dissemination and acceptance by other institutions. The success can be attributed to several factors: 1) adopt and adapt grants; 2) enthusiasm in giving workshops; 3) preparing instructional materials; 4) finding a publisher; and 5) providing quantitative data on student performance and a mechanism for continuous feedback (from all participants, through website) from stakeholders (students, faculty, peer-leaders, and institutions). It is impressive that dissemination has proceeded already to other disciplines...

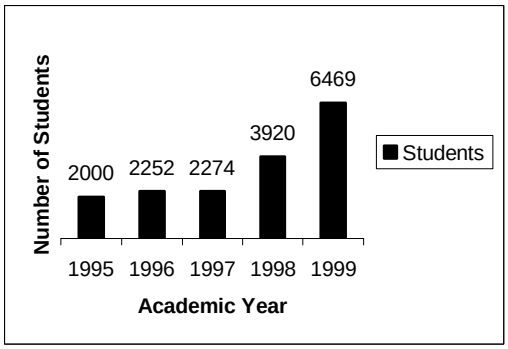
Peer leaders provide a powerful new force in undergraduate education...

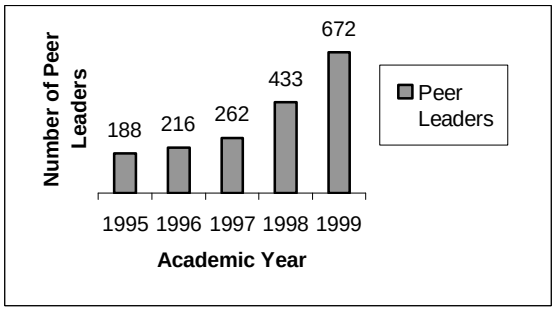
"The NVC also recommends that peer leaders assemble a "best practices" manual based on their experiences to assist future participants across disciplines... "

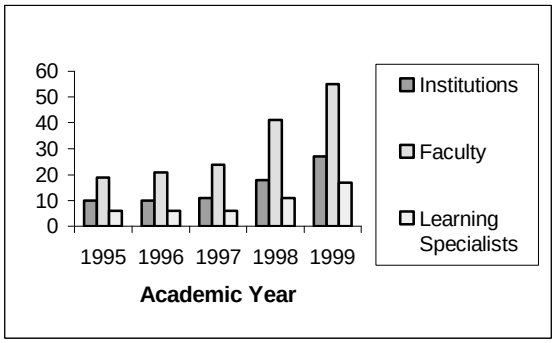
From its experience overseeing the Project for five years, the NVC arrived at the following conclusions on the question "What have we learned?"

"The following discoveries were made over the last five years:
1) Peer leadership requires a training program;
2) Materials need to be structured to coincide with workshop goals;
3) Peer leaders provide a powerful new force in undergraduate education;
4) Teaching the leaders provides new opportunities for faculty and staff;
5) Leaders and students have a tremendous capacity for support of each other;
6) Success depends upon paying full attention to the six critical components."

ADAPTATION & IMPLEMENTATION — 1995-2000







The three graphs reveal the growth of the use of the PLTL model from a number of perspectives. These include the number of students participating in PLTL courses each academic year, the number of peer-leaders, and the number of faculty, learning specialists, and the number of institutions where PLTL courses were offered.

Source: Final Report of the Workshop Chemistry Project, 1995-2000, David K. Gosser, Principal Investigator

INVESTIGATING THE PLTL EXPERIENCE

(Continued from page 1)

remainder were students or graduates of the University of Rochester (UR). Coordinators were included as initial interviewees because they shared a common, extensive set of experiences with the PLTL Workshop model. Moreover, each of them either had graduated from school and gone on to graduate school or were seniors, making definite plans about their future. These people could demonstrate, through their school and career choices, whether their feelings regarding the Workshop leadership translated into concrete actions.

Each coordinator interview lasted between one and two hours. Information collected from the transcripts of these interviews became the basis for the second round of interviews with 19 UR Workshop leaders. Each of the peer leader interviews included the following questions, although other topics were also discussed if the peer leaders chose to do so.

1. Please describe your experiences as a Workshop Leader in the [PLTL] Workshop Chemistry program.
2. Have your views of leadership changed as a result of your being a leader in the program?
3. Have your views of science or chemistry changed as a result of being a leader in the program?
4. Have your career plans changed as a result of your participation as a leader?
5. What do you know and/or understand about learning and learning styles that you did not know prior to being a leader?

Results

It is important to note two limitations of the study immediately: nearly all of the peer leaders in this study were Workshop *students* first. This fact makes it difficult to separate the effects of being a student from the effects of being a leader. Many times, former peer leaders would refer to their leadership experiences in one breath and their student experiences in the next. The other point to be highlighted is that although the former peer leaders sometimes indicated that they were certain one aspect of peer leadership had caused them to do something different, we cannot say for certain that the Workshop experience was the causal agent of these reported changes.

That said, the reports of the leaders about the impact on their own learning can be summarized as follows:

1. Leaders learned through this experience that people had different learning styles and that their personal learning style was not the only or best way to study.
2. Leaders 'understanding of the subject matter deepened.
3. Some leaders learned to be quiet while others thought about how to solve problems; others learned to be more outspoken.
4. Some leaders became more organized learners.
5. Some leaders began to think of science in general as more of a group process than as a singular pursuit.

A few comments from leaders illustrate these points:

"Up until Workshop, I never thought about how people learned before," said one leader. "For some people using a molecular model worked very well and for some people it wasn't very helpful. For some, writing on paper helped." Another leader said: "As a freshman it's a lot of 'I've got to do better than everyone else, memorize more,' but the more I got into Orgo [Organic Chemistry], the more I learned it's not about competition. You want everyone to learn. In a sense the class is only as strong as its weakest link. Me and my friends understood that if we could tell someone else about the concepts, we understood [them] ourselves." "I found myself understanding things a lot better as a leader," reported a third leader. "I could get questions right on the exam [as a student], but I really made sense of stuff as a leader. After having to present the material, I really understood it. I had to know it before I could teach it."

One of the coordinators clearly stated that her experiences as a leader and coordinator made her a more organized person, both in chemistry and in other areas of her life. "Prior to Workshop I did things very haphazardly. When I started concept mapping, I started organizing stuff better. I started as an abstract

(Continued on page 12)

As a freshman it's a lot of 'I've got to do better than everyone else, memorize more,' but the more I got into Orgo [Organic Chemistry], the more I learned it's not about competition. You want everyone to learn. In a sense the class is only as strong as its weakest link.

...But as you get older, you still have to work in groups. Workshop made me realize I'm still going to have to do that as a doctor.

(Continued from page 11)
thinker and became much more sequential, much more organized." Several other leaders also mentioned that they felt the leadership experience helped them rearrange how they did things, scientifically as well as in their other academic pursuits. "The learning paradigm introduced in Workshop would be effective with anything," stated yet another leader. "You find yourself as a student wanting to be the leader and encouraging other people, which is the goal of the model."

In terms of the influence of this experience on professional goals, it should be observed that all 25 leaders interviewed were asked about this matter, and *each* stated that being a Workshop leader had had an influence on intended professional aspirations to varying degrees.

Their responses can be divided into three categories:

1. those leaders whose career decisions were not changed but reinforced or enhanced by this experience;
2. those leaders whose career decisions were somewhat changed as a result of Workshop leadership, either by confirming previously tenuous plans or by invoking new thinking about previously established plans;
3. those leaders whose career plans were significantly influenced or completely changed as a result of their participation as a Workshop leader.

Examples of these three categories can be observed:

1. One leader said, "Being a doctor [meant taking] a leadership role in the old sense. But as you get older, you still have to work in groups. Workshop made me realize I'm still going to have to do that as a doctor."
2. "For me personally it [being a Workshop leader] was interesting because, mentally on my career track I wasn't sure whether or not I wanted medicine as a clinical practice or medicine as a research-oriented type thing. And at the time I was doing research in bio-physics, and I saw the big difference between sitting in the lab doing work and actually dealing with people and helping them...Personally for me that was what made me think, well, maybe clinical, you know, changing my opinion of what I think I should be doing with medicine, because I [had come to] thinking I wanted to be a research doctor, and just do my stuff in a lab." "I haven't applied to grad school yet," said another leader, "because I'm planning to take a year off. I'm a neuroscience major. I like neuroscience and I think I want to go into it, but now I'm not sure. I like doing research, I like teaching, just based on the teaching experiences that I've had, I think I would like to teach so I think I would like to combine the two in some way ...."
3. "Of everything I did in college, it's one of the things I most enjoyed and I finally came across something where I can see myself in a profession related to this."

The results of this initial leader evaluation study are varied; the leaders' experiences point to a successful program in the sense that the leaders enjoyed themselves, understood the subject better, gained knowledge about their and others' learning styles, learned about teaching, and for some, gained a new sense of their career possibilities.

A third round of interviews was initiated in the 1999-2000 academic year. Lydia Tien interviewed 15 undergraduate peer leaders (8 women, 7 men) during a three-week period at the end of the Fall 1999 semester. The semi-structured interviews ranged from 40-60 minutes. With the student's permission, the interviews were audiotaped and notes were transcribed during the interview. The data, discussed below, report some common themes and results that emerged from the interviews.

The interviews collected some information about leaders' attitudes toward the workshop, the role of the leader in the Workshop model, the team problem-solving activity, and student interaction during the workshop. For this study, a critical focus of the interview was its third section: the impact of this experience on leaders' professional plans.

In these interviews, leaders reported a unanimous espousal of the advantages of the team problem-solving activity central to the Workshop model. They recognized the value of all students contributing their ideas since many times "knowledge is distributed," i.e., no one person has all the pieces toward understanding a problem. Leaders also perceived additional benefits, such as increasing a student's confidence and easing individual fears as one sees classmates struggle and grapple with learning the material.

All of the leaders believed that their experiences leading workshops not only strengthened their subject knowledge and allowed them to learn other educational models, but also developed their communication and group facilitation skills. The Workshop experiences instilled an increased sense of self-confidence as leaders felt more at ease in front of a group and dealing with various group situations.

All of the leaders interviewed plan to pursue a graduate degree. Two intend to earn a Master's degree, and the remaining leaders intend to pursue a doctorate or medical degree. Two-thirds of those interviewed are planning or considering a career in academia, one on the secondary level and the remaining on the college or post-college level. One of the leaders interviewed shared that the experience of leading workshop was the determining factor in her decision to become a professor upon completion of her doctorate.

When asked how leading workshops affected their views on teaching and learning, the leaders mentioned ideas that had been discussed in their training class such as

accommodating for different learning styles, the influence of motivation on performance, and the role of gender and ethnicity.

The 1998-1999 interview results suggested that the Workshop experience influenced how leaders pursued their careers, such as creating study groups in medical school courses similar to the Workshop model and appreciating the value of cooperative problem-solving. The 1999-2000 interviews support the earlier findings as leaders have created peer study groups in other courses in which they are currently enrolled, or created opportunities to discuss ideas with their classmates.

Another potential impact on a leader's professional development that emerged was the issue of mentoring. The students who are selected as workshop leaders are among the brightest students on campus in their respective fields, so it would seem that these first-tier students would be likely to have developed mentoring relationships with classroom faculty members and their research advisors. However, a number of leaders also felt that their experiences as workshop leaders had also had the added benefit of being able to have the faculty of the Workshop [training] course as a role model and mentor.

Next directions

The results of the leader interviews serve to endorse the PLTL model. Not only do leaders report the value of this experience to them in an immediate sense, but we can see how this opportunity is shaping careers. In fact, these reports have encouraged a particular line of thinking about peer leadership, i.e., that it can be considered a component of pre-professional training for future faculty, serving some of the functions of a pre-medical or pre-law undergraduate program. Given that there is very little direct instruction in teaching in most faculty members 'education, this seems like an intriguing direction for continued discussion and investigation.

Some public discussion along these lines has already begun; e.g., at the October 1999 conference of the Professional and Organizational Development Network (the national faculty development forum), Vicki Roth presented a session entitled *Starting at the Beginning: Including Undergraduates in Faculty Development.* Vicki Roth and Ellen Goldstein will present a workshop on a similar theme at the *International Conference on Improving University Teaching* in Frankfurt, Germany in July 2000.

The interview team is also aware that there are limitations within this previous work. Our most serious concern is our lack of clarity about how different, if at all, being a PLTL leader is from being a teaching assistant, or how much these leaders would have gained the knowledge they did simply through the process of maturation. Our final year's interviews will include a four-way study to compare the attitudes and experiences of those who were Workshop leaders, undergraduate teaching assistants in more traditional formats, and other strong students who were neither leaders nor Workshop participants.

As we prepare for our next round of study, we are encouraged by the words of one of our first leaders at the University of Rochester, who said:

> *When you do [this] you are like a teacher ... You look from a different perspective, from a totally new point of view... [like being able to see] the back of the moon.*

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Acknowledgement

We would like to acknowledge the deeply appreciated contributions of Katherine McGill, Nirmala Fernandes, Gina Tonogbanuo, and Lynn Ashby to these investigations.

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Johnson, D., Johnson, R., & Smith, K. (1989). Active learning: Cooperation in the college classroom. Edina, MN: Interaction.

All of the leaders believed that their experiences leading workshops not only strengthened their subject knowledge and allowed them to learn other educational models, but also developed their communication and group facilitation skills.

...Leaders have created peer study groups in other courses in which they are currently enrolled, or created opportunities to discuss ideas with their classmates.

WPA GRANT APPLICATIONS DUE SEPTEMBER 1, 2000

The Workshop Project Associate (WPA) program provides funds to assist faculty and learning specialists to develop and implement a peer-led team learning course at their institution.

Eligibility

Proposals may be submitted for support of peer-led team learning course development in any field of science and in mathematics.

Proposals are invited from organizations in the United States and its territories: two-year colleges, four-year colleges, and universities. Applicants must show evidence of familiarity with the peer-led team learning model of instruction. This can be demonstrated through attendance at a PLTL short course or workshop. Evidence of a mentoring relationship with an experienced peer-led team learning instructor is desirable.

Submission

Proposals must be postmarked by September 1, 2000. Applicants will be notified about funding decisions no later than November 1, 2000.

Future deadlines will occur two times per year through academic year 2001-2002. These dates will be posted on the Workshop Project home page at
http://www.sci.ccny.cuny.edu/~chemwksp

Five copies of the written proposal must be submitted to the appropriate WPA officer. Proposals for disciplines that do not fit one of the categories below should be submitted to Pratibha Varma-Nelson.

Biological Disciplines
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Coral Gables, FL 33124-0421
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Chemistry (and other disciplines not listed)
Pratibha Varma-Nelson
Saint Xavier University
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Physics and Mathematics
Ronald Narode
Portland State University
Department of Curriculum and Instruction
P.O. Box 751
Portland, OR 97207-0751
ron@ed.pdx.edu
(503)725-4798

Proposal Preparation

The written proposal should contain the following information, assembled in the order indicated:

1. Cover Sheet

A one-page cover sheet indicating the following:
A. Name and postal address of the principal investigator (PI)
B. Telephone number, fax number, and e-mail address of PI
C. Name and postal address of the organization to which the award should be made
D. Discipline under which the proposal will be evaluated
E. Title of project
F. Requested amount

2. Project Description

Text in this section of the proposal should be double-spaced. Use standard margins, 12-point font, and print only on one side of the page. Limit the project description to *no more than five pages.* The description of the project should contain an explicit statement of plans for meeting the critical components of peer-led team learning, including:
A. Description of how the peer-led team learning component of the course will be integrated with other course components;
B. Description of how the course instructor will be involved with the peer-led team learning component of the course;
C. Plans for recruitment and training of leaders;
D. Plans for choice of materials to be used in the course;
E. Plans for obtaining appropriate organizational arrangements (time, space, group size, etc.);
F. Evidence of institutional support (such as matching funds for leaders, release time for faculty, recognition for teaching, etc.);
G. (Optional) describe plans to develop and test Workshop Modules (see "F" under Budget and Budget Justification).

Additionally, the project description should contain:
H. The philosophy of teaching guiding the proposed implementation;
I. Description of experience with collaborative/cooperative learning or other curricular revision projects;
J. Description of the course in which the peer-led team learning model will be adapted;
K. Plans for on-going evaluation (evaluation should utilize standard Project materials (see website), although more extensive plans are welcomed);
L. Description of contribution from the institution's learning center (if any);
M. Plans for dissemination of the PLTL implementation.

3. Biographical Sketch

Provide a biographical sketch of no more than two pages for the PI. Include items relevant to experience with curricula similar to peer-led team learning and/or curriculum reform.

4. Budget and Budget Justification

Provide a one-page budget and a one-page budget justification on separate pages. Funding up to $5000 per person (proposal) and $10,000 maximum for a discipline (department) at an institution will be considered. Requests for Workshop leader salaries must be matched on a one-to-one basis from the institution. Show matching institutional funds explicitly on your budget page. *No indirect costs should be included.*

The PLTL Project will provide evaluation assistance by the Project Evaluator.

Acceptable budget categories include (a) Workshop leader salaries, (b) support for preparation of materials, (c) travel for dissemination, including the presentation of posters, papers, workshops, or short courses, (d) evaluation, and (e) support for participation of a learning specialist, (f) an additional $1000 stipend for faculty to develop at least one original workshop module and $200 stipend for students to test the new module (Biology courses only).

5. Statement of tasks to be performed with time lines

Provide a statement of tasks to be performed, i.e., training of peer leaders, materials development, evaluation, dissemination, etc. All activities must have specific time lines.

Proposal Review Criteria

The general review criteria are: how well the proposal meets the critical components of peer-led team learning, evidence of understanding the peer-led team learning model, quality of plans, probability of successful implementation, and the other items requested in the project description section. The panel will also consider the qualifications of the personnel submitting the proposal.

Reviews are conducted by a panel appointed by the WPA

(Continued on page 15)

PROJECT NOTES: WHERE DO ANSWERS COME FROM?

(Continued from page 2)
tion of answer keys?

Let me recount the dynamics of my own experience with answer keys in school. In confronting a textbook problem, the tendency was to consider the problem briefly, but if the path to solving it was not rather obvious, I'd quickly consult the back of the book for the answer. It is embarrassing to admit this, but perhaps others may have had the same experience? And once we have the answer, the process of problem-solving is turned upside down, becoming a process of reverse engineering, working backward from the solution to the problem.

We can examine the PLTL process and discern, without the existence of an answer key, how the development of critical thinking attitudes is encouraged.

1. In the PLTL process, students are imbued with the feeling of embarking on a venture of self-discovery, in collaboration with their peers. The existence of an answer in black & white has the effect of undermining the spontaneity of the workshop. Answer keys short-circuit the PLTL workshop.

2. In a PLTL workshop it is likely that several different and equally valid approaches to solving a problem will be explored. Answer keys typically present one view of solving the problem, which then becomes the "standard." Yet the problem-solving path and even the answer are not always unique.

3. In PLTL workshop students build self confidence by the authentic experience of problem-solving. This is quite different from a process of verifying an answer prepared by an external authority.

4. Similar to a research group meeting, the focus of a PLTL workshop is to engage in a spirited discussion and debate of scientific principles and their application, arriving at conclusions by the process described by John Dewey. Clearly, in research there are no "prepared" answers.

5. The verification process in problem-solving is authentic, and will produce much deeper and longer lasting learning than by consultation with an answer key. Answer keys are often promoted as an "error" checking mechanism. The deeper understanding we desire will occur in the debate and consensus of the workshop, not by consultation of an answer key.

Finally, we can examine the alternative forms of building constructive supports for students as they engage in solving the more difficult problems. This can be achieved in a multitude of ways, which is at the heart of preparing workshop problems and the training of workshop leaders.

Problems can be graduated in complexity, carefully building the "scaffolding" which students require to move up in problem-solving difficulty.

By working through the problems in workshop style, with faculty as guides, both faculty and student leaders appreciate the actual complexity of the problem-solving process, and can work with more natural and "home grown" answers that exist in their understanding and confidence in leading a PLTL workshop.

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References

* Capossela, Toni-Lee, Ed. (1993) The Critical Writing Workshop: Designing writing assignments to foster critical thinking. Portsmouth, NH: Boynton/Cook, cited from University of Saskatchewan Library website (http://library.usask.ca/ustudy/home/index.html)

Herron, J.D., (1996). The Chemistry Classroom: Formulas for Successful Teaching. Washington, D.C.: American Chemical Society.

Our limited working memory suggests why learning is facilitated by using familiar examples and why logical arguments that are transparent to an expert are hopelessly opaque to a novice. The expert (by definition) is dealing with knowledge that is largely automatized; the novice is not. The expert has used the logical operations inherent in the development many times before; the novice has not. The expert has much of the knowledge in the field chunked; the novice does not. The expert has a large repertoire of familiar strategies for recording information in external memory; the novice does not.

J. Dudley Herron, (1996). The Chemistry Classroom: Formulas for Successful Teaching. Washington, D.C.: American Chemical Society. p. 103

WPA GRANT APPLICATION PROCEDURES

(Continued from page 14)
officer for each discipline. Each panelist writes an individual review for all proposals assigned to the panel. The reviews are used by the WPA officers to make final funding decisions.

Acknowledgement

The WPA program is made possible by a grant from the National Science Foundation.

Progressions: Peer-Led Team Learning is a quarterly publication of the Workshop Project.

Progressions is intended to build the Workshop community by telling the stories of adoption of the PLTL Workshop model at institutions of learning. It also will provide useful materials, and is intended to be a forum for what works in developing the PLTL model.

The editors are looking for contributions: announcements of presentations or workshops, examples of tested materials, and articles on aspects of peer-led team learning.

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PLTL INSTITUTE IN PORTLAND, OR — AUGUST 14-16

In conjunction with OCEPT-Sponsored Excel Model Workshop- August 16-18
Portland State University

The purpose of the PLTL Institute is to introduce the theoretical and practical elements of the PLTL model and prepare participants to implement programs in Biology, Chemistry, Physics and Mathematics.

For college teachers of physical and biological sciences and mathematics at two and four year colleges and universities.

Relationship to Excel: The PLTL model was influenced by the work of Uri Treisman, founder of MathExcel. Both models include cooperative learning, centered around challenging curriculum that goes beyond lecture and mainstream textbook problems. Participants in PLTL may wish also to attend the Excel workshop to round out the week. The Excel workshop will focus on the development of curriculum materials that could be incorporated into the PLTL weekly workshops. Contact Elaine Jane Cole for more info: colee@mth.pdx.edu

Registration by August 1, 2000
Contact: Ron Narode, Portland State University
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