The Workshop Project Newsletter

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Winter 2002

PROGRESSIONS: PEER-LED TEAM LEARNING

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WHAT HAPPENS NEXT? A FOLLOW-UP STUDY OF WORKSHOP LEADERS AT ST. XAVIER UNIVERSITY

The evaluation of the Peer-Led Team Learning (PLTL) workshop model has naturally focused primarily on student performance. But from the beginning of the PLTL Project, its leadership noted that the experience of leading workshops seemed to be of enormous value to the undergraduate peer leaders. St. Xavier University in Chicago is one of the few locations that has had workshops long enough (seven years) to have previous workshop leaders in the work force. How have graduates viewed the experience of leading workshops as they looked back from the vantage point of several years beyond college?

A survey for former peer leaders was prepared to include graduate study and career information, Likert-scaled items about the impact on learning, open-ended items asking about the effect of the program on career decisions, and on views of PLTL in their education. Twenty-six surveys were initially mailed in the fall of 2001. Follow-up with additional mailings and phone calls yielded a return of 16 completed surveys. The survey responses were quite detailed, with an average of more than 250 words written to answer the open-ended items.

Respondents are now occupied in a variety of careers or educational endeavors: three are employed as nurses; two are teaching in secondary school, one in a community college; four are employed in science related industries; one is with a financial institution; two are medical students; one is working on a master's in

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THE SKY'S THE LIMIT: LEARNING THROUGH PLTL TEAMS AT BIG SKY HIGH SCHOOL

Brett Taylor, a teacher at Big Sky High School in Missoula, Montana, was enthusiastic about his initial experience with a peer-led team learning workshop: "I was apprehensive at first, and as I walked around students kept coming to me for the answers," he said. "I finally had to leave the room to get them to interact with their groups. When I returned, every student was 'on task' and engaged in the subject. In fact, every student stayed engaged for 50 to 60 minutes." He could not believe how effective this method was at encouraging active learning and keeping students interested.

High school peer leaders at Big Sky High School also believe that PLTL is an effective learning tool. When asked whether participating in PLTL affected how students solve problems, one leader answered, "PLTL forces them to learn on their own and not have the teacher hold their hand every step of the way. The students must come up with their own answers and work together to figure problems out. The groups helped build student confidence because I didn't have all the answers and so they had to rely on each other for help."

Throughout all levels of education, there has been a shift in teaching strategies

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PROJECT NOTES: NAVIGATING CHEMISTRY (AND BIOLOGY, PHYSICS, AND MATHEMATICS!)

I have been intrigued by Donald Norman's "Things that make us smart: Defending human attributes in the age of the machine." The book is a refreshing exploration of the relationship of human intelligence, learning, planning and understanding to the devices (*cognitive artifacts*, in his terminology) that are intended to assist us in that process. The book is wide-ranging, and although the author is primarily interested in the role of computers or computer-related technology, he does include a broad view of "cognitive artifacts" and uses many low-tech examples to make some important points. Norman's general thesis is that qualities that emerge from technology are in conflict with human traits, and too often the technology wins. The 1933 World's Fair motto of "Science finds, technology applies, and man conforms" has too often dominated the development of technologies intended to assist people. Norman suggests instead a new motto: "People propose, science studies, technology conforms." Three chapters that make good reading for peer-leader and faculty discussions are "Chapter 2: Experiencing the World," "Chapter 3: The Power of Representation," and "Chapter 6: Distributed Cognition."

Experiencing the World (Experiential and Reflective Cognition) This is a simplified organization of types of cognition, a dichotomy between more passive experience (watching TV) which is definitely experiential, or chess, which is highly reflective. Norman argues that technological tools are often rigid and do not allow for exploration of ideas, and restrict the representations of knowledge to small displays. They favor experiential cognition.

Some activities are hard to classify: Would you classify your lecture as an experiential or reflective cognitive artifact for students? What about a peer-led workshop? What is the proper balance that might be achieved in either?

Power of Representation The overall concept of "cognitive artifacts" is very useful and can be applied to peer-led team leaning. The example given in the book is someone explaining a car accident involving two cars, a dog, and a green light, using two pencils, a paper clip (the dog), and a tabletop (the road). The author discusses the nature of representation: certainly the pencil doesn't fairly represent a car, but it perfectly suffices for the purpose. In the same sense, we might use pennies to fairly represent the stoichiometric features of atoms, without fearing that the student may imagine atoms look like pennies. What cognitive artifacts are useful? What about blackboards, models, and other devices that can support the group discussion in an appropriate manner in PLTL?

Distributed Cognition This is a concept formed from a marriage between organizational learning and cognitive science, with a lineage including Vygotsky's work. The example given in the book is of a study of navigation procedures on large ships in the US Navy (Hutchins) where members of a navigation team communicate via telephone headsets, in a shared conversation. The team members included the chief officer and plotters, persons taking bearings on port and starboard. Equipment could break down, leading to reliance on manual corrections, and, under this stress, more errors were made. Participants' conversation is filled with errors, random comments, etc. However, the conclusion was that the system was robust precisely because of the efficient sharing of errors among novices and experts: the system served as an informal training program, in which less experienced members made or heard others making errors, learned from the mistakes, the experienced crew members learned how to train, and what kind of feedback was most effective.

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PLTL & PRE-CALCULUS AT PGCC

Peer-Led Team Learning is being used in several departments at Prince George's Community College in Maryland: Mathematics, Chemistry, Biology, and Speech Communication and Theater (in English as a Second Language courses). Chemistry came first, with Dennis Bartow using what was then called Workshop Chemistry. Then James Bridger developed Anatomy and Physiology workshops for the Biology Department at the same time as Scott Sinex (Chemistry) and I were developing College Algebra workshops for the Mathematics Department, and Nadene Houser-Archield added PLTL to her Chemistry course.

We were all so excited about PLTL in our courses, that Martha Mathews was intrigued enough to try it in her English as a Second Language courses. I added workshops for Intermediate Algebra and was joined by Mathematics Department faculty Eldon Baldwin, Leslie Redwine, and Jack Bailey.

Each of us use PLTL somewhat differently. The workshops used in mathematics are mostly used to explore concepts before the lecture, which is more of a discovery method, while others use the workshops after a lecture to reinforce concepts learned and practice problem-solving using lecture ideas. English as a Second Language uses peer leaders to help students learn and master pronunciation software.

This is the fourth semester using PLTL in mathematics, in Intermediate Algebra and College Algebra. The results are somewhat inconclusive, since our sample size is small, but they are encouraging.

In College Algebra, I compared two of my PLTL sections to my two non-PLTL sections from previous semesters. The PLTL sections show a higher rate of success (A, B, C) than the non-PLTL sections.

	A, B, C	D	F, W, Q
PLTL	62%	8%	31%
Non-PLTL	54%	6%	40%

I believe the reason for this difference is the cooperative aspect of the groups. Students must learn to express mathematics verbally, rather than memorize steps to be followed. Explaining to others requires a deeper understanding than memorization. Faculty using PLTL in their mathematics classes cite the "attention to more advanced/multi-step problems" and "mathematical communication between students."

The peer leaders are essential to the model. Our peer leaders are chosen and trained by each individual department after an initial session before the semester begins. Our leaders are energetic, and learn nearly as much as the students. Some are training to become teachers, and their experience with PLTL will help them when they have their own classrooms.

In addition, the peer leaders are a valuable asset to help me evaluate student progress. They help me to identify what areas need additional lecture time and clarification. Students talk to the peer leaders, and admit difficulties to them that they may not admit to me. PLTL "reduces negative self-esteem and pressure on oneself" and "promotes...good practice of math problems with models, not just paper work," according to Diana Pedrigal, peer leader in Mathematics.

One mathematics faculty member also cited some disadvantages. "Students who need quiet, independent reflection cannot use 'their' approach in groups," and "the PLTL process... leaves the instructor somewhat in the dark as to the progress of the students and their respective groups." No one model meets the needs of all students, so we must be careful to consider those who learn differently than the model.

Overall, users of PLTL in the Mathematics Department at Prince George's Community College are enthusiastic about its benefits. We continue to recruit new faculty users, and expand into different courses.

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Students must learn to express mathematics verbally, rather than memorize steps to be followed. Explaining to others requires a deeper understanding than memorization.

PLTL "reduces negative self-esteem and pressure on oneself" and "promotes... good practice of math problems with models, not just paper work..."

A STACK OF COOKIES: A MATHEMATICS PROBLEM

Here is an example of a PLTL mathematics problem. This workshop is a particular favorite of students, because after collecting the data, they *eat* the data! *Note: This module uses a graphing calculator.*

We want to introduce the processes used to develop a mathematical model from data and how a model is used and verified. Is there a relationship between the height of a stack of cookies and the number of cookies? Let's investigate this hypothesis to find out. Carefully measure and record the height of the stacks of cookies given in the table below. After collecting the data, enter it into the lists in your graphing calculator:

Number of cookies in stack	Height of stack (cm)	Change in Height
1		*(blank)*
2		
3		
4		
5		
6		
7		
8		
9		
10		

L_1 - number, L_2 - height.

Use **[STAT PLOT]** to set up the graph as a scatter plot. Independent is L_1 and dependent is L_2.

Use **[WINDOW]** to set the minimum and maximum of the x and y variables.

What is the height of *zero* cookies?

Add this point to your graph.
Adjust the domain and range.

How are the two variables related?

Sketch and label the graph.

How does the rate of change vary from datum point to datum point?

What is the average value $\bar{x}$ of the height of a cookie? (How does one compute an average value?)

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CHEMISTRY WRITERS' WINTER RETREAT

The Winter Writers' Retreat for General Chemistry was held at Coastal Carolina University (CCU) in Myrtle Beach, South Carolina January 13-15, 2002. In attendance were John Goodwin (host), David Gosser (City College of New York), Vic Strozak (City University of New York), Mark Cracolice (University of Montana), Lucy Garmon (State University of West Georgia), Jerry Sarquis (Miami University, Ohio), Bob Blake (Texas Tech University) and John Reddic (CCU). CCU workshop leaders Vance Albaugh, Rebecca Abel, Melissa Yencho, and Valerie Echevarria provided the student leaders' perspective for part of the meeting.

The overall objective of revising the published Peer -Led Team Learning General Chemistry workbook (Gosser, Strozak, Cracolice, 2001, Prentice-Hall) for a second edition requires reworking of existing units, creation of new units, and preparation of a new workshop leaders' companion to the book. A template for creating the unit-by-unit assistance for workshop leaders included pedagogical support, logistical advice, and sections contributed by workshop leaders focusing on connections beyond chemistry that could be used to put the material in context for a variety of science majors. Writing assignments were determined with teams of two sharing responsibilities for their favorite topics.

In addition to discussing the Workshop General Chemistry materials, the group also spent time considering future directions for the PLTL Consortium. Most importantly, however, these esteemed educators identified a bowling alley at a neighboring hotel that had rates of $1.10/game including shoes.

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PLTL WORKSHOPS IN COLLEGE ALGEBRA AT THE UNIVERSITY OF HOUSTON-DOWNTOWN

The Peer-Led Team Learning workshops became another way of learning College Algebra here at the University of Houston-Downtown. I met Dr. David Gosser a year ago while I was visiting New York. He was kind enough to offer assistance to develop the PLTL for College Algebra classes. Dr. Kenneth Oberhoff, chair of the Department of Computer and Mathematical Sciences, and I attended the PLTL National Conference at Goucher College this past summer, and the planning and implementation of the PLTL workshops for College Algebra classes began.

I interviewed and hired 12 workshop leaders for the Fall 2001 semester. There were three pilot sections of College Algebra with PLTL, each section was limited to 25 students, and each leader started with six students. Having a semester of experience with the program, I interviewed and hired ten workshop leaders for the Spring semester. I assigned Mai Nguyen, a sophomore computer science major, to be the coordinator, and she is overseeing three sections of workshops. We limited each section to 28 students this semester, and so each leader started with eight or nine students.

Dr. Linda Becerra and I created 14 workshop modules last semester, and we are revising and creating more materials for this semester. These materials are available at http://cms.dt.uh.edu/Faculty/NakamuraM/PLTL/PLTLHomePage.html.

Some workshop materials were technology-oriented using graphing calculators and on-line tools created by Dr. Ongard Sirisaengtaksin. His on-line tools are available at: http://cms.dt.uh.edu/Faculty/OngardS/CollegeAlgebra.htm.

I meet with my leaders every Wednesday for one and a half hours to discuss the materials and go over the Handbook For Team Leaders (Prentice Hall, 2001). All of our workshops are held on Fridays. After the workshop is over each leader is asked to reflect and write a journal entry about the week's workshop, and e-mail it to me by the following Monday. I then post the journals for other instructors involved to read. I feel that the leaders became more expert in the subject, more confident about themselves and became more effective leaders. Here are some of their comments:

"The PLTL workshop is great because it allows everyone in the group to work together as a productive unit." *Angel Martinez*

"As someone said, 'What you think might not be what you speak.' Through the PLTL workshop, I have become better in expressing my thoughts and knowledge." *Khoa Do*

"The PLTL workshop really is a place where peers can talk about a subject and not feel intimidated." *Cyril Harris*

"The best experience that I've had in the PLTL workshop is seeing the look on students' faces when they understand a problem that I guided them through." *Isaura Montes*

Attendance was a little problem last semester. To overcome this problem, we decided to give a short quiz at the end of each workshop this semester, which was suggested by my workshop leaders. According to the leaders, we are having better workshop attendance this semester.

We do not have enough data to state that the students in the PLTL sections of College Algebra classes performed better than the students who were in the other sections. But we can say that PLTL gave the students a sense that learning Mathematics can be a meaningful and positive experience. Dr. Linda Becerra noted that "the students are having a positive learning experience through the PLTL workshops."

Here are some observations from last semester (Fall 2001):

- The students who attended the workshop regularly performed better than the students who did not.
- The PLTL sections averaged slightly better on the departmental final exam than the other sections.

We expect to report more positive outcomes with statistics this semester .

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"As someone said, 'What you think might not be what you speak.' Through the PLTL workshop, I have become better in expressing my thoughts and knowledge."

"The best experience that I've had in the PLTL workshop is seeing the look on students' faces when they understand a problem that I guided them through."

PLTL MATHEMATICS MODULES UNDER CONSTRUCTION

...the workshop materials they have developed [were separated] into two general categories: Pre-Calculus Mathematics and Developmental/ Teacher Preparation Mathematics. The materials in each category will be further classified as pre-lecture or post-lecture workshops.

The first Peer-Led Team Learning (PLTL) Mathematics Module Development Conference was hosted by New York City Technical College, Brooklyn, New York January 10 – 12, 2002. The participants, Peggy Beck (Prince George's Community College), June L. Gaston (Borough of Manhattan Community College, CUNY), Janet Liou-Mark (New York City Technical College, CUNY), and Mitsue Nakamura (University of Houston-Downtown) met to discuss the organization of their existing workshop materials in mathematics, and were joined by AE Dreyfuss and David Gosser (City College of New York, CUNY).

The conference began with the sharing by Peggy Beck and Mitsue Nakamura of their experiences running Mathematics Workshops at their institutions. June Gaston gave an overview on how the PLTL model is presently used in conjunction with CCNY's Teacher Preparation Program. *Science and Mathematics Teachers for the New Millennium,* a video documentary of that project, was shown.

The conference then focused on the organization and creation of workshop materials. AE Dreyfuss led a discussion on how pedagogical theories and techniques can be integrated in workshop materials for mathematics. Subsequently, materials written by the participants and by Roxanne King (Prince George's Community College) were reviewed. Based on the topics provided, it was agreed among the participants to separate the workshop materials they have developed into two general categories: Pre-Calculus Mathematics and Developmental/Teacher Preparation Mathematics. The materials in each category will be further classified as pre-lecture or post-lecture workshops. To facilitate publication efforts, Peggy Beck and Mitsue Nakamura will head the Pre-Calculus team; June Gaston and Janet Liou-Mark will head the Developmental/Teacher Preparation Mathematics team.

We hope to collaborate with colleges that have written workshop materials in mathematics. If you have materials to contribute at the Pre-Calculus level please contact Peggy Beck (beckpx@pg.cc.md.us). For materials at the Developmental/Teacher Preparation level, please contact June L. Gaston (jlg1196@aol.com). For workshop materials in mathematics at other levels, please contact Janet Liou-Mark (jlioumark@yahoo.com).

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BIOLOGY PIONEERS PLTL AT MIAMI

WITHOUT PEER! is the feature article of the Arts & Sciences Magazine, Fall 2001, published by the University of Miami College of Arts & Sciences. As explained by Michael Gaines, chair of the Department of Biology, and Co-PI of the PLTL Workshop Project National Dissemination grant, "Our *Workshop Leaders in Biology* program has been a resounding success. So far, we've had a wonderful team of undergraduates who not only help their younger peers learn biology in a small, intimate setting, but also learn more about biology by teaching it."

Thanks to PLTL Affiliates who sent in the data on their PLTL courses.
Results will be included in the Spring issue of Progressions

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www.pltl.org
and click on Progressions

SATISFACTION IN HIGH SCHOOL CHEMISTRY

I pressed my palms against my ears. Was I hearing correctly? My students were laughing, enthusiastically asking questions. To my disbelief they actually seemed happy to be spending an entire day learning about "Kinetics and Equilibrium."

After half a year of trying to show students how relevant and exciting Regents* High School chemistry can be, I was having very little success. They viewed it as a laxative being shoved down their throats. No fun, only necessary torture in order to graduate. At my wit's end and tired of listening to groans, I planned a trip to CCNY after reading about a program there called Peer Led Team Learning (PLTL). (See *Progressions, Vol. 1, No. 3, Spring 2000* for further background.)

The daylong demonstration on how the model works was able to involve and excite my students. They were typical students, all lived within the community of the Bronx, and 85% of them are female. My students are energetic and hopeful, filled with dreams, but dreams that definitely do not involve chemistry. Yet even a month after the trip, they still were talking about the activities and remembered the key chemistry concepts discussed during the trip. The way PLTL works is that it draws on all of the students' strengths, by allowing them all to be active learners.

I decided to implement PLTL in my classroom, but only for one key Regents chemistry topic, Electrochemistry. The first thing I did was to select five students who were currently taking the class (and of course were excelling in it) to become "peer leaders." I met with them to discuss basic teaching strategies, chemistry concepts, and to practice the lesson that they would have to lead with their groups. They were involved in major decisions such as how the rest of the class should be "grouped," what materials should be used or which ones should be discarded. The peer leaders even aided in selecting information I should present to the class prior to running a PLTL activity. Some of these students were natural leaders while others needed a little practice and confidence in order to shine.

When the students worked in groups, they all participated. They looked at their notes in search of answers, they asked relevant questions and at the end of the session they placed smug grins on their faces demonstrating a deep satisfaction at having grappled with chemistry and finally having gained comprehension.

The exam scores on the average were 10% higher than any other concept covered: it was a true success!

It is important to realize that my two-week experiment with PLTL required months of planning. A teacher has to believe in the program and slowly relinquish control of the classroom. There has to be a firm belief that students, given the opportunity to be active learners, will welcome the chance – and like anything else a teacher must know the students' skills and abilities.

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** Regents' examinations are special tests given to all students in New York State to demonstrate mastery of certain subjects. The entering class of 2000 will be the first required to pass all regents exams, with at least a 65 in order to receive the Regents Diploma beginning in 2004.*

...a month after the trip, [the students] still were talking about the activities and remembered the key chemistry concepts discussed during the trip.

...my two-week experiment with PLTL required months of planning. A teacher has to believe in the program and slowly relinquish control of the classroom.

The Six Critical Components of the Peer-Led Team Learning Workshop Model

- The Workshop is integral to the course.
- Course professors are involved in the selection of materials, training and supervision of peer leaders, and they review the progress of Workshops.
- Peer leaders are selected, trained and supervised to be skilled in group work as facilitators.
- Workshop materials are appropriately challenging, directly related to tests, designed for small group work.
- The Workshops are held once a week for two hours, contain six to eight students per group, in space suitable for small-group activities.
- PLTL is supported by the department and the institution with funds, course status and other support so that the method has the opportunity to be adopted across courses and disciplines.

WHAT HAPPENS NEXT? A FOLLOW-UP STUDY OF WORKSHOP LEADERS AT ST. XAVIER UNIVERSITY

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teaching; two are still undergraduates.

Survey Outcomes: Learning Gains

The first 11 items of the survey used the format of the Student Assessment of Learning Gains adapted from Elaine Seymour (http://www.wcer.wisc.edu/salgains/instructor/). Students are asked to rate different experiences insofar as they contributed to their learning. Perceptions of instructors, courses, and educational experiences often change as the college years recede from immediate experience. It happens that grades seem less important, while particular activities are seen in a new light. With this in mind, and in particular to compare the workshop with other experiences, typical learning activities were presented to be rated. The results are shown on the following chart.

For each of the following, please indicate the degree of impact on your learning when you were in college: 5 = very strong impact; 4 = strong impact; 3 = limited impact; 2 = very little impact; 1 = no impact

	Mean	Rank	SD
1. Acting as a peer leader for workshops	4.69	1	.6
2. Independent study of assigned work	4.31	2	1.08
3. Participating as a student in peer-led workshops	4.27	3	.7
4. Attending lectures	4.06	4	1.12
5. Working with a friend, study partner, or small group	3.81	5	.91
6. Individual consultation with professors	3.53	6	.83
7. Tutoring	3.31	7/8	1.2
8. Laboratory work	3.31	7/8	1.25
9. Independent projects, research, poster presentations	3.19	9	1.22
10. Off-campus meetings and conferences	2.94	10	1.29
11. Recitations led by graduate students	2.20	11	1.32

It should be noted that students were not asked to rank the different activities. The rankings shown are based on the mean scores. Students could have given high scores to many or to few of the activities listed. In general mean scores greater than 4 are quite high for this type of survey.

In this particular survey there are four mean scores greater than 4 and they provide an interesting profile of the former peer leaders. First these students rate "acting as a peer leader" considerably higher than any other activity. This item also has the lowest standard deviation, indicating a concentration of high ratings, with little variance. Independent study and participation in workshops are in a virtual tie for second place, with attendance at lectures in third place.

Based on these responses it appears that these students, who were successful in college and have continued to be successful during their first years after college, placed a high value on traditional forms of learning such as individual study and lectures, but they placed an even higher value on workshops. In other words, in their thinking the workshops did not substitute for lectures or private study; these were also considered very important. But leading workshops was considered the most valuable learning experience.

The first open-ended item asked about the effect of acting as a peer leader on one's learning of chemistry. All of the respondents commented that their knowledge of chemistry was enhanced or reinforced, and that concepts were solidified. Several also said that they gained an appreciation of the different ways in which students learn. Several said that acting as a peer leader contributed to success in exams for higher-level chemistry and biology courses. One student reflected on learning styles: "I learn almost everything through reading, but this taught me that sometimes students need to see things explained in a different manner from the textbook or lecture notes and handouts. A key point may have eluded them, but once another student asks a question and the topic is examined from a new perspective, things become clear and fall into place. That's always exciting to see - the transition from this stuff is just too hard and there's no way I can understand it "and a self-defeatist attitude to those same people explaining the concept to someone else because now that they understand it and own it, they can teach it because they've gone through the process."

Impact on Future Courses and Careers

It is interesting to note that all 16 respondents are energetically pursuing advanced education or careers related to science. All said that workshop leader activities had strengthened their interest and determination to pursue science-related careers. Two had changed career directions, both in the direction of teaching science.

Several students wrote about how the experience in workshops and as workshop leaders had greatly increased

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the confidence they needed to continue in science. The following comments are from three students:

Having Dr. Varma-Nelson ask me to be a workshop leader for biochemistry instilled confidence in me and I was honored. I was no longer afraid to enroll in chemistry/ science related courses and it has led me to enroll in a Master's prepared CRNA Roll, which is heavily chemistry-focused.

My involvement in the Project remains one of the most impressive entries on my resume and has come up in every job interview I've had since leaving St. Xavier U.

I entered St. Xavier as a nursing major. I knew I wanted to be a part of the medical field, but from past experiences in some scientific courses, especially chemistry, I was afraid I would not succeed. The only chemistry course required for nursing majors at the time was The Principles of Organic and Biochemistry. I entered the course with fear and uncertainty. I had an excellent teacher, Dr. Varma-Nelson, who gave me confidence and I began to excel in the class. She encouraged me to be a workshop leader and my fear of chemistry was gone. I enjoyed the subject so much that I changed my major to biology. As a leader, I gained the knowledge and confidence I needed to pursue a career in pharmacy. During many Medicinal Chemistry courses in pharmacy school, I became known as the group leader.

Interacting With People

It has been said that "everything comes down to people." In other words, whether in business, industry, academia, public life, social service, or medical work, we must work and deal effectively with people. Success depends on it. And yet there is little or nothing within the college curriculum that addresses this need.

Students attend lectures, study, take tests, write reports, make friends, and participate in a variety of activities. And all the while the basic need to develop skills and confidence in working with others, participating as a group member and group leader may be left unmet. Many students instinctively know that something is missing in their development and indicate a lack of confidence, even though they are achieving good grades in the courses they have chosen.

Fortunately things are happening in this area. Cooperative learning, paired problem-solving, increased opportunities for oral and poster presentations, as well as group work in labs and field situations are increasing, providing students with useful experiences. Acting as a peer leader for workshops is virtually unparalleled in offering the opportunity for growth in "people skills." Students testify to this in glowing terms.

In response to item 15, "How did your experience as a workshop leader influence the way you interact with people?" students offered a variety of enthusiastic examples of how they had improved or gained confidence in speaking and interacting with people. This confidence and comfort is an important beginning, but there is much more in students' reflections. The following comments by students speak to the interpersonal benefits of workshops:

- It gave me more confidence in myself. It also helped me to realize that you don't have to have all the answers as long as you have a basic understanding, and know how to ask questions.
- It helped me be more at ease speaking in front of a group, and able to express myself when everyone is looking at me.
- As a teacher at times I find myself dictating information to students. However, I remember from being a leader how discussions and leading students towards conclusions is a great benefit to them.
- I just love showing people how to do things, and I probably realized this during those two years as a peer leader. To show someone something new is to empower them just a little bit more.
- If a certain strategy wasn't working, I needed to find another way of demonstrating things to the students to maintain their focus and attention.
- Many of the students I had also worked part or full-time and/or had family responsibilities, so their time to spend on the subject matter was very limited. Every session had to count, to positively impact the learning process. If they felt that the time spent in the workshop wasn't valuable then there was no incentive to attend. All of these things are skills that relate to the business community where the client or end user wants value as part of the transaction, otherwise they can take their business elsewhere. "What can you provide that's unique?" - that's what matters.

Conclusions

This was a limited survey but the respondents were unanimous in placing very high value on their experiences as peer leaders. They viewed participating in workshops and acting as workshop leaders among their most productive learning experiences, increasing their confidence particularly in entering science-related careers, and making them more effective as they interact with people in a wide range of circumstances.

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PLTL AND SECONDARY SCHOOL TEACHING

The following is an excerpt from a telephone interview conducted by Leo Gafney as part of the study of former peer leaders at St. Xavier University in Chicago. It provides a dramatic illustration of how the peer leader experience inspired Yvonne O'Connell in her work as a secondary school teacher at a private school for boys.

When they come up with the answers I don't think they realize I am leading. They just think, 'Hey, it's in there and I know this. I'm smarter than I thought.'

Leo: *I am following up on the survey that you completed. I noticed that you are teaching in high school and you felt that the workshops were a factor in your decision to go into teaching. You also said that you use workshop skills as you teach.*

Yvonne: Yes. The workshops allowed me to see how much influence you can have on people. I had workshops in Organic Chemistry and the students came to them a little scared. And it amazed me how your attitudes as a workshop leader can give them confidence and make the experience positive. I'll be teaching chemistry next year. I will definitely use the workshop approach. I don't give them answers, I ask them questions and it gives them a lot of confidence. I work with some kids in the general track who were not taught what they need for high school, and they are constantly playing catch up; and they lack confidence. Workshops gave me the experience to tell them, "You are capable of learning anything. It's in your hands, and I will guide you." I've had parents come to me and say, "my child hated math, he never passed it. Now he studies every day. He is willing to open the book, and spend the time on it." And now these kids are getting B's. During the football season I had the coach come into my afterschool class and pull the kids out because they didn't want to leave. They are developing confidence that they never had, and I really think workshops had a lot to do with that; showing me how to build them up by asking questions, not by handing them answers. When they come up with the answers I don't think they realize I am leading. They just think, 'Hey, it's in there and I know this. I'm smarter than I thought.' It's phenomenal. They come on a voluntary basis to see me after school. They come during a free period and basically what I do is run a mini-workshop.

Workshops gave me the experience to tell them, "You are capable of learning anything. It's in your hands, and I will guide you."

Leo: *Answers have been an issue within the workshop group. The chemists are firm believers in not giving answers. But some of those in other disciplines want to give answers to the leaders.*

Yvonne: But then they are selecting poor leaders. I think workshops work because you are using them at a time when students are feeling vulnerable and that they are not capable, and the whole point of building confidence and having them learning more and feel good about it is that they can do it on their own, that it is in there and this person is just helping them bring it out. Students don't see it as leading questions. They feel that it is in them. I see it in my students.

One student's father is a teacher and he walked into my classroom and said, "I realize my son will fail, he will go to summer school. I don't have high expectations for him, therefore I'm not expecting much from you." And I'm thinking, "You're a teacher." I can't believe he said that.

Students rise to the expectations that you have, and I expect a lot. I sat down with this student and said, "This is my expectation and you will meet it; there is no option. I will help you meet it because that's my job." And just by giving him questions and guidance--he beams now. He walks into my classroom like he's a big man on campus. I mean he knows his stuff. And that's because of confidence; he came up with those answers on his own. In my class of students with special-needs I sometimes find that some students don't have that inner place that tells them what's the next thing they need to know: "Okay, I know this; now what do I need to know?" And workshops help them to think this way.

Once a week I have one of my students hold the class. They are 'teacher for the day.' And it's amazing, not only how much confidence it builds in that student, but the others really listen; they are glued to him. They respect him, they don't disturb the class. Kids who are a problem for me are perfectly quiet.

Leo: *So you are using the workshop techniques.*

Yvonne: Definitely. I would say workshops have an impact on about half of what I do in the class, and all of my reviews at the school have said, 'It's obvious you will never settle

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SYSTEMIC REFORM & PLTL AT BCCE

"What's New with the NSF Systemic Reform Initiatives?" will present two full days of mixed sessions at the 17th Biennial Conference on Chemical Education (BCCE), to be held in Bellingham, Washington, July 28-31, 2002. The sessions will range from mini-workshops and hands-on presentations to more traditional presentations of the process or results of implementing reform curriculum. To register, please go to http://chem.wwu.edu/acs/bcce/index.html and download a registration form.

BCCE Symposium #98 Schedule - What's New with the NSF Systemic Reform Initiatives?

Tuesday, July 30th

9:30 - 10:15: Eileen L. Lewis, Brock Spencer, *MID Project Active Learning Experience*

10:15 - 11:30: Eileen L. Lewis, *What Do We Know about Teaching and Learning in Chemistry?*

11:30 - 11:55: John Gelder, K. A. Burke, and Tom Greenbowe, *Can You Change the Way You Teach and the Way Your Students Learn Chemistry?*

11:55 - 12:20: Jennifer Lewis, *Workshops to Promote Curricular Reform: Participant Goals and Strategies for Assessments*

2:00 - 2:45: Angelica Stacy, *Educating Teaching Assistants in New Models for Teaching and Learning*

2:45 - 3:30: Sandra Lauren, Heather Mernitz, & Brock Spencer, *What's All the Fuss about Fat? General Chemistry in the Context of Dietary Fats and Human Health*

3:30 - 4:15: Linda Zarzana & Howard Drossman, *How Can We Reduce Air Pollution from Automobiles?*

4:14 - 5:00: Jack Bell, *Vitamin C: How Much Should I Take? - A Demonstration*

Wednesday, July 31st

9:30 - 9:55: Leo Gafney & Pratibha Varma-Nelson, *Impact of being a Peer-Leader on Students at St. Xavier University, Chicago*

9:55 - 10:20: Pratibha Varma-Nelson & Leo Gafney, *Role of the WPA Program in Curricular Reform.*

10:20 - 10:45: Lauren E. H. McMills, Karen E. Eichstadt, Kenneth L. Brown & Jared A. Butcher, Jr., *Assessing Student Performance and Involvement in the PLTL Model*

10:45 - 11:10: Morton Z. Hoffman & Alan D. Crosby, *Peer-Led Workshops in an Honors-Level General Chemistry Course*

11:10 - 11:35: Sami A. Ibrahim & Madeline Adamzceski, *Peer-Led Team Learning (PLTL) in Introductory Courses at San Jose/Evergreen Community Colleges*

11:35 - 12:00: Kenneth Pohlmann, *My First Year Experience of PLTL in Organic Chemistry Course*

2:00 - 2:25: Alan J. Pribula & Lawrence Boucher, *Improving Student Learning in Introductory Chemistry*

2:25 - 2:50: Arlene Russell, *The Molecular Science Project: One Year Later*

2:50 - 3:15: Marty Perry, *Utilization and Evaluation of Calibrated Peer Review*

3:15 - 3:40: James Rudd & Kelly J. Thomas, *Integrating Writing Assignments into Undergraduate Science Courses Using Calibrated Peer Review*

3:40 - 4:05: Marie Villarba, Carolyn Collins, Janice Chadwick, & Joann Chickering, *The FLASH Project: Getting Charged up for Chemistry at the Community College*

4:05 - 4:25: Martin Jones, *Resuscitating the Writing - CPR in the Chemistry Classroom*

In addition, the Multi-Initiative Dissemination (MID) Project will have a booth at BCCE to provide information and to promote the materials from each of the systemic reform projects. For further information, go to http://www.cchem.berkeley.edu/~midp.

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for mediocrity, and your students will rise to that.' And they have. The school has gotten calls from parents saying, "I can't believe how you have inspired my kid," and it's not that I inspire them; it's their confidence; they inspire each other. When they are teacher for the day 'they feel empowered by it. I love to see them starting to ask the leading questions. And they don't even know they are doing it.

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THE SKY'S THE LIMIT: LEARNING THROUGH PLTL TEAMS AT BIG SKY HIGH SCHOOL

(Continued from page 1)

away from lecture, rote memorization, and telling students what to think, and toward student interaction, active learning, and allowing students to develop their own conceptions. The nature of this shift was eloquently summarized by the well-respected science educator J.D. Herron who wrote, "The major influence that research in psychology and education has had on my teaching is the portion of time I spend telling students what I think versus the portion I spend asking them what they think" (Herron, 1984, 851). In secondary science education, a common approach to making learning active has been to implement cooperative learning. Although this is a step in the right direction, we believe that there is an even better choice: Peer-Led Team Learning (PLTL).

PLTL in Practice

When taking education courses, virtually every teacher is instructed to use cooperative learning. However, these courses often fall short of giving teachers a method of implementation that will work in a variety of classroom settings. Once these teachers are on their own, they may not understand how to apply cooperative learning strategies effectively. Although traditional cooperative learning is a solution to switch to less telling and more asking, when used alone it is lacking because students do not function as a team. In effect, teams need leaders. In the PLTL model, the teams have leaders. This method challenges students to take responsibility for their own learning, while at the same time it gives them the necessary guidance so often lacking in traditional cooperative learning.

The PLTL model organizes students from various grade levels into workshop groups or teams that meet regularly to solve problems and reinforce science content without teacher intervention. Each team has a student leader who recently completed the course, showed evidence of learning the material (usually earning a grade of A or B), and demonstrated leadership potential and strong interpersonal skills. PLTL has been defined by a model containing six critical components (Gafney, 2001) and all conditions must be met for successful implementation.

Each PLTL team holds workshops during lab or class time. The workshops require 45 to 60 minutes each and are held once for every unit of study, typically once every two weeks, as shown in Figure 1. A workshop group is comprised of four to six students plus a peer leader, and the groups remain intact throughout the year. The teacher provides materials designed for group work, and the peer leader facilitates a discussion among the students, encouraging them to voice their ideas, interact with one another, and think beyond simply getting the "right answer." The teacher does not interact with the students during the PLTL workshop session.

A typical session begins with students taking out their materials and breaking up into their workshop groups. The groups are spread far apart in the room to minimize cross-talking distractions. Whenever practical, desks are arranged in semi-circles next to a board so that the group members can face one another and write answers that all can see. Large sheets of paper taped to the walls or small hand-held dry-erase boards are also used.

The peer leader starts the session by asking a student to read aloud the first question from the written materials. The students then work toward a solution to the problem, with the leader typically acting as secretary, recording steps in the solution of mathematical problems, writing phrases summarizing student ideas, or constructing diagrams suggested by students. The leader also prompts students toward problem solutions by giving advice about the resources available (typically textbooks), suggesting the application of thinking patterns used in previous problems, and helping students examine their thinking processes.

This approach benefits students in many ways at both the intellectual and emotional levels. When students in the PLTL group learn about alternate approaches and beliefs, it causes them to consider the merits and flaws of their own thinking patterns. They can then advance counter-arguments to attempt to resolve any contradictions, which eventually leads to better content and procedural knowledge for each individual in the group. Students are more likely to express their ideas honestly--both scientifically valid conceptions and misconceptions--in a peer group where they have no fear of looking stupid in front of a teacher who will be issuing grades. This free-flowing exchange of ideas, assisted by a more experienced peer, is an ideal format for encouraging intellectual development.

Finding Peer Leaders

There are three major challenges to starting a PLTL-based curriculum: finding peer leaders, training the leaders, and selecting appropriate materials. Using peer leaders is a key element of PLTL, but recruiting them, especially at the high school level, can be challenging. High school students usually have rigid schedules that make it difficult for them to be available to lead the workshops. One option

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is to work cooperatively with other instructors within the science department so that students in advanced courses can be released weekly or biweekly to serve as peer leaders. For example, the sophomore-level biology instructor can work with the junior-level chemistry instructor so that the chemistry students can serve as biology leaders on workshop days.

In turn, the senior-level physics instructor can release a few physics students to lead chemistry workshops as needed. This option works nicely if serving as a workshop leader is included in the requirements of the advanced course. This scheme leads to a problem with senior-level courses, but college students can be used as peer leaders if there is a nearby post-secondary institution. Students in college science courses and those in science teacher preparation programs make good leaders.

Another approach used to recruit peer leaders is to give students credit as science teaching assistants. In class periods when they are not leading groups, the leaders can prepare laboratory materials, set up demonstrations, and do advanced studies. Study hall can also be scheduled to coincide with a science course so that the leaders can be available. No matter what the details, as long as they have the support and cooperation of the administration, teachers who want to implement PLTL can work with the local situation to ensure the availability of peer leaders.

Figure 1. Sample schedules for PLTL classes.

	Monday	Tuesday	Wednesday	Thursday	Friday
Traditional scheduling (45 min periods)	Lab	Lab and discussion	PLTL workshop	Discussion/ lecture	Discussion/ lecture
	Lab	Lab and discussion	Review for exam	Exam	Discussion/lecture
Block scheduling (90 min periods)	Lab	No class	Lab & Discussion/ lecture	No class	PLTL workshop & discussion
	No class	Discussion and Review for Exam	No class	Exam/ discussion/ lecture	No class

Training Techniques

Once arrangements have been made for peer leaders, the next challenge is training them. At a minimum, general training should occur once before the start of the first workshop, and content-specific training should occur before each workshop during the year. We use the President of the Carnegie Foundation for the Advancement of Teaching L.S. Shulman's categories of teacher knowledge--content knowledge, pedagogical content knowledge, and curricular knowledge--as guideposts for training leaders (1986). All three are touched upon in each training session, although the degree of each varies from week to week.

Content knowledge is understanding the subject matter of the course. The majority of training time is spent on content. We find that when peer leaders feel comfortable with their own understanding of the material, they are more likely to effectively engage their groups. Each major concept is reviewed immediately before the corresponding workshop.

Pedagogical content knowledge is the arsenal of content-specific teaching strategies that all good teachers learn throughout their careers. It includes knowing the best examples, analogies, illustrations, demonstrations, and so forth for teaching a particular concept. During peer leader training, we discuss what is important about each question from the written materials provided for the workshop. We then give the leaders focus questions to ask that will help probe more deeply into the heart of the target concept. We also tell the leaders what types of questions to expect and how to respond to them. We sometimes do this by role-playing the workshop itself, with the instructor acting as leader and the leaders acting as students.

The third category of teacher knowledge covered in leader training is general curricular knowledge. Because this is the first time that most students have been placed in formal instructional roles, we help them learn generally how to be effective leaders, keeping in mind that they are leaders and technically not instructors. This includes instructions on group dynamics and questioning techniques. We also survey the tools used in group work, such as the round robin (a group activity in which each student contributes one step to the solution of a multi-step mathematical problem and all students verify the correctness of each step as it is presented), paired problem-solving, and concept mapping.

Selecting the Right Materials

The final major challenge to implementing the PLTL model is the selection of the appropriate materials.

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The simplest approach is to use college textbooks for general chemistry (Gosser, et al., 2001) or organic and biochemistry (Varma-Nelson and Cracolice, 2001) and choose questions included in these materials with modifications as necessary. Other sources of questions for cooperative learning groups, such as the teacher's guide to the textbook and the accompanying worksheets that are often provided by commercial publishers, can also work well. However, in all instances the materials must be structured for group work at an appropriately challenging level.

Our preference at the secondary level is to write PLTL materials in a learning cycle format (Lawson et al., 1989). Workshops based on this format generally begin by the team leader introducing real data obtained by students in a laboratory experiment or by introducing hypothetical data that can be impractical to collect in a high school laboratory setting. The students are then asked to find a pattern in the data. The leader provides the scientific terminology commonly used to describe the pattern when appropriate. Once the initial pattern has been understood by the group, we like to provide further examples and counter-examples to increase the richness of students' understanding. Finally, we supplement the activity by providing questions of a more standard type for practice, as time permits.

A Model that Works

The PLTL model emphasizes student achievement through active learning. Peer leaders play an indispensable role in keeping students on task, providing guidance, and using language that can easily be understood by other students. They have a unique feel for gauging the appropriate level at which to provide help to their fellow students. The model also provides an opportunity for students to discuss their understanding, or time for leaders to ask them what they think.

A team learning approach in the classroom can greatly enhance any science curriculum. Working in teams not only improves students' understanding of the coursework but also prepares them for the modern workplace where corporations embrace the teamwork strategy for optimizing the management of their employees. According to Kelvin Cooper, senior executive director for candidate synthesis enhancement and evaluation at Pfizer Central Research, in Groton, Connecticut, "In short, we do believe that teams are the only way to succeed in today's environment" (Ainsworth, 1999, 54).

It is time to unlock the untapped potential in secondary school students who have the ability to become peer leaders. The gains in content knowledge, leadership abilities, and attitudes among the peer leaders are easily seen, and the growth that occurs as students work in their teams can be surprising. Peer-led team learning is cooperative learning that really works.

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Acknowledgments

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WPA Grants Awarded

(Continued from page 15)

University of Maine (Orono)
David J. Batuski
Courses: PHY 111 (General Physics 1) &
PHY 112 (General Physics 2)
Awarded: $5,000
Matched: $4,000 Peer Leaders: 8

University of Miami
James Nearing
Course: Calculus-based Introductory Physics
Awarded: $5,000 Peer Leaders: 10

FIFTH AND SIXTH ROUNDS OF WPA GRANTS AWARDED

BIOLOGY

Mount Wachusett Community College
Charles Weitz
Course: BIO 109
Awarded: $6,000 Peer Leaders: 15 (Spring 03)
Matched: $23,840

CHEMISTRY

Indian River Community College
Dr. Paul A. Horton
Courses: CHM1046 - Sp,02 & CHM1045/CHM1046 - F,02
Awarded: $5,000 Peer Leaders: 5 (Spring 02)
Matched: $3,386 10 (Fall 02)
(4 sessions w/groups of 8-10) Students: 90

Drew University
Dr. Melanie Wills
Course: Organic Chemistry
Awarded: $4,090 Peer Leaders: 6 (Fall 02)
Matched: $3,000 6 (Spring 03) (groups of 6 - 8)
Students: 20-25/semester

Eastern Kentucky University
Dr. Martin L. Brock
Course: CHE 101
Awarded: $2,500 Peer Leaders: 3 (Spring 02)
Matched: $2,528 3 (Fall 02)
Students: 21-25/semester

University of Miami
Dr. Curtis R. Hare
Courses: Chem 151 & Chem 111
Awarded: $5,000 Peer Leaders: 4 (Spring 02)
Matched: $8,100 4 (Summer 02) 6 (Fall 02)

San Jose City College
Dr. Iyun Lazik
Courses: Chem 1A & 1B, Chem 30A & 30B
Awarded: $5,000 Peer Leaders: 6 (Spring 02)
Matched: $3,350 6 (Fall 02) (groups of 6)

MATHEMATICS AND CHEMISTRY

Queensborough Community College, CUNY
Dr. M. Fabricant / Dr. P. Svoronos
Courses: MA 013 & 120/Ch 151, 152, 251 & 252
Awarded: Math–$5,000 Chemistry–$5,000
Matched: Math–$5,880 Chemistry–$6,005
Peer Leaders: 10 Math Chemistry 6
Students: 100 Math (groups of 6 – 8)
50 Chemistry (groups of 6 – 8)

MATHEMATICS

Borough of Manhattan Community College, CUNY
Dr. June Gaston
Course: MAT 100 (Fundamentals of Math 1)
Awarded: $6,000 Peer Leaders: 8
Matched: $2,000 (8 students per leader)

New York City Technical College, CUNY
Dr. Janet Liou-Mark
Course: MA175 (Intermediate Algebra)
Awarded: $3,750 Peer Leaders: 5
Matched: $3,750 (40 students per class)

Oregon State University
Dr. Thomas P. Dick
Course: Math for Prospective Elementary Teachers
Award: $5,000 Peer Leaders: 3
Matched: $5,500

Oregon State University
Dr. Barbara S. Edwards
Course: MTH 390 (Geometry)
Awarded: $5,000 Peer Leaders: 3
Matched: $5,500

University of Houston/Downtown
Mitsue Nakamura
Course: College Algebra – 3 sections (Computer Science)
Awarded: $10,000 Peer Leaders: 15
Matched: $1,000 (25 students/semester)

PHYSICS

San Jose City College
Rufino H. Ibarra
Course: Physics 4A, Mechanics
Awarded: $5,000 Peer Leaders: 3
Matched: $2,400

Sierra College
Dominic Calabrese
Courses: Physics 2A, Physics 4A
Awarded: $5,118.50 Peer Leaders: 4 (Fall 01)
Matched: $5,023.12 5 (Spring 02)

University of California, Santa Barbara
Robert Geller
Course: Physics 1
Awarded: $4,863 Peer Leaders: 3
Matched: $900

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The Workshop Project Newsletter

Progressions: Peer-Led Team Learning is a quarterly publication of the PLTL Workshop National Dissemination Project. *Progressions* is intended to build the Workshop community through discussion of the implementation of the PLTL Workshop Model at institutions of learning.

The editors are looking for contributions. Please submit announcements of upcoming events, articles, or pertinent concerns you would like addressed.

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Bring a Team!
A common element among most successful PLTL adoptions is the formation of a campus team, which ideally consists of content instructors using PLTL, a "learning specialist," a student leader, and an administrator.
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