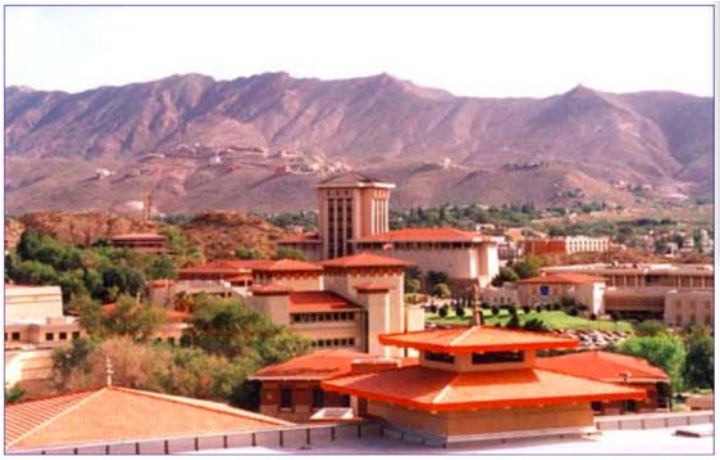
PEER-LED TEAM LEARNING IMPLEMENTATION

TWO PLUS TWO EQUALS MORE: MODIFYING THE CHEMISTRY CURRICULUM AT UTEP

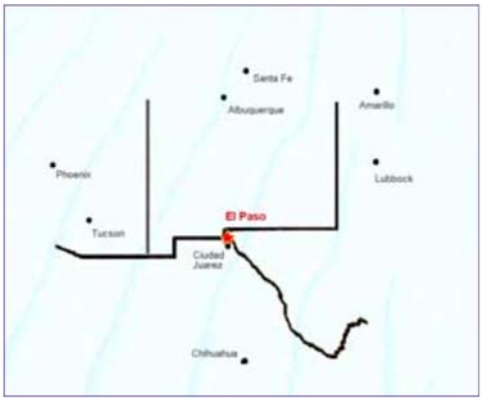
JAMES E. BECVAR

How familiar is this pattern for a three credit-hour course: three lectures per week, three lectures per week, three lectures per week . . . ? As of Fall 2000, however, we have a new weekly format for general chemistry at our institution: two one-hour lectures plus one two-hour required, well-integrated Peer-Led Team Learning (PLTL) Workshop. The PLTL Workshop in General Chemistry was adopted in answer to those Big Questions: Why are three lectures a week a necessary standard? Who mandated that rule? What has been the result of the change?



El Paso, Texas, has a population of 650,000, of which 80% are Hispanic. Juarez, Mexico, 1000 feet from our campus, has a population of 1.5 million. El Paso is located within the Chihuahuan Desert and is the home of UTEP, the University of Texas at El Paso.

The student population profile at UTEP is fairly non-traditional: the average undergraduate age is 24 years; 70% of the student body is Hispanic (Mexican American), 54% is female, 82% is from El Paso County, 98% commute, 81% is employed, 54% is first generation university students, and 10% is Mexican nationals. The UTEP enrollment represents 15% of all Mexican nationals in US higher education institutions. In the fall of 2003, total enrollment at UTEP was 18,542 students, of whom 72% were Hispanic. Of the undergraduate enrollment, 2,078 were in Engineering and 1,092 were in Science, for a total of 3,170 STEM students or 17.1% of the UTEP undergrad enrollment.



Numerology: First Year Chemistry Courses at UTEP

About 650 students per year attempt CHEM 1305, first semester general chemistry (required of every Science, Technology, Engineering and Mathematics (STEM) major). Historically the course had three clock hours of lecture for three semester hours of credit and had an historical passing rate of 55%. CHEM 1105 was the accompanying three clock-hour, one credit-hour laboratory course and CHEM 1306/1106 was the second semester Lecture/ Lab

combination. The low success rate in the first semester course meant that about 160 students each year were blocked in their progress on to a STEM major. Three failed attempts at passing this course prevent a STEM future for any student.

Non-STEM majors needing a course in chemistry take CHEM 1407, first semester Introductory Chemistry, which is primarily for nursing students; this course also has three clock hours lecture and three clock hours lab per week, followed by CHEM 1408, second semester Introductory Chemistry.

UTEP Context: Mathematics Preparedness of Entering Freshmen

The only course prerequisite for CHEM 1305 is concurrent enrollment in Precalculus. However, this also presents a problem for a "traditional" four-year course of study for STEM majors on our campus. Here are the facts for math placement for entering freshmen for Fall 2003; placement into:

Pre-Calculus:	27%
Calculus I or II:	4%
Math for Social Scientists:	6%
Remedial Math I or II:	63%

(Basic Algebra, Intermediate Algebra, no university credit)

Conclusion: Only about 30% of each entering class is math ready and meets the requirement to enroll in general chemistry their first semester on campus.

Why is a "Required" Workshop Component Important? Teaching Me a Lesson

In the early 1990's, over the strong but unsuccessful objections of the Chemistry Department, several Engineering disciplines made the parallel first semester chemistry laboratory course (CHEM 1105) optional for their majors. Immediately, 95% of those students no longer enrolled in CHEM 1105.

I concluded that, 1) with an optional, albeit valuable, course or learning opportunity, students would not voluntarily enroll; and 2) for many engineering students (35% of the total 1305 enrollment), no hands-on activities would be a part of their "chemistry" experience.

Nitty-Gritty: Time on Task

It was time to make some kind of revision in the general chemistry curriculum to improve the success rate. One option (everybody's first choice) was to add more lectures per week, say four (or five or . . . how many hours per week?). But would that significantly lead to better student mastery, i.e., understanding, and long-term retention of concepts? My supposition was, probably not. What I think we all know: The key to student mastery of this material is personal, active study: quality time by each student in frequent, short periods struggling with the application and integration of the concepts. This became the argument of including Workshop to improve the historical 55% passing rate in CHEM 1305: more PLTL active help in learning how to study and less time lecturing at the students (passive).

In the Summer of 2000, the Director of UTEP's Model Institutions of Excellence (MIE) grant from the National Science Foundation (NSF) approached me to request a proposal to fund incorporating peer-led, team- based learning into the 1305 curriculum. I was not that familiar with PLTL and my

initial response was, "OK, let's add one hour of PLTL activities per week as a required component."

The Administration reaction was "No Way!!" A required added hour of course activity per week would necessitate a change to a four credit hour course; this would precipitate negotiating through the regular University approval process and all the other departments affected by the additional credit hour, etc. To meet the University hurdles head-on (remember: Change is GOOD!), I then made the proposal to keep the course at three credit hours, but add a completely new dimension: PLTL Workshop. To "make room" something had to go! I took a big gulp and the proposal was to delete one lecture per week. Some of my colleagues were very skeptical that this would achieve the desired results.

Changing the format of CHEM 1305

Previously, as mentioned, the course consisted of three lectures per week in large sections (100+ students). Beginning in the Fall 2000, a new format was adopted: two one-hour lectures (large section) per week plus one two-hour Peer-Led Workshop (small section) per week. Student Peer Leaders (undergraduate STEM majors) were hired to lead the two-hour Workshops.

To accommodate the student enrollment in fall and spring semesters, the small section format requires that there be about twenty-four sections of Workshop. These are scheduled throughout the week with two workshop groups meeting in different rooms, but simultaneously per two-hour time period (this allows for "Peer Leader substitution" in an emergency). Each Workshop section has about 12 students commingled from the lecture sections; each Workshop is taught by a paid Peer Leader.

Peer leaders guide student teams through problem-solving and concept-building exercises

Registration: How it looks in the "Schedule of Classes"

- Physical Science Room 200: for collaborative, team-based learning
- Physical Science Room 310 for "wet chemistry": a central island table with lab benches along outside walls.

Note: Students enrolling in Chem 1305 must enroll in ONE lecture Section plus ONE Workshop Section below					
CHEM	**1305**	**General**	**Chemistry**		
25933	LECTURE	MW	1030-1120 am	UGLC 116	Gardner
26145	LECTURE	TR	0800-0850 am	PSCI 208	Noveron
CHEM	**1305**	**General**	**Chemistry**		
27037	WORKSHP	M	1130-0120 pm	PSCI 310	Noveron
27044	WORKSHP	M	1130-0120 pm	CRBL 203	Gardner
27045	WORKSHP	T	1200-0150 pm	PSCI 310	Gardner
27050	WORKSHP	T	1200-0150 pm	PSCI 200	Noveron
-	WORKSHP	W	-	-	-
-	WORKSHP	W	-	-	-
-	-	R	-	-	-
-	-		-	-	-

Explorations: What are they?

Chemistry is an experimental science where process and concept mastery are paramount! The 1305 Workshop includes Guided Inquiry "laboratory" exercises called *Explorations*. Laboratory is usually an integral part of the chemistry curriculum. *Explorations* are simple, somewhat descriptive, and much more qualitative in nature than the usual laboratory exercises. They are geared to relating observation to chemical processes and provide real-world examples of chemistry in action. Problem-solving strategies depend on conceptual understanding; hands-on observation of simple reactions builds an understanding of chemical processes and concepts. *Explorations* are not a substitute for laboratory; they complement rather than "compete" or duplicate the regular 1105 laboratory exercises accompanying the 1305 lecture.

Explorations: Why?

Some disciplines no longer require CHEM 1105, the laboratory parallel to CHEM 1305. Without the opportunity provided by Workshop, about one-third of the students enrolled in 1305 would not have any hands-on experience in chemistry; they would never see, feel, hear, and smell actual chemical reactions that they have initiated, that they can tweak to influence what happens, and that they can repeat to ascertain that what happened didn't just happen by chance. They would not otherwise have the chance to apply chemical concepts to "real-life" experiences.

Examples of *Explorations*

1. Growing Silver Crystals as an example of a chemical reaction.
2. The Sahara Desert and the concept of the Mole.
3. Slinkies and Standing Waves.
4. Spectroscopes: Explore the particle/wave duality of light.
5. Acid/Base reactions using purple cabbage extract and "bad breath" indicator.
6. Simple Titrations: ammonia soap and vinegar.
7. Peladow and Hammer: A four-act ChemPlay starring calcium chloride and baking soda.

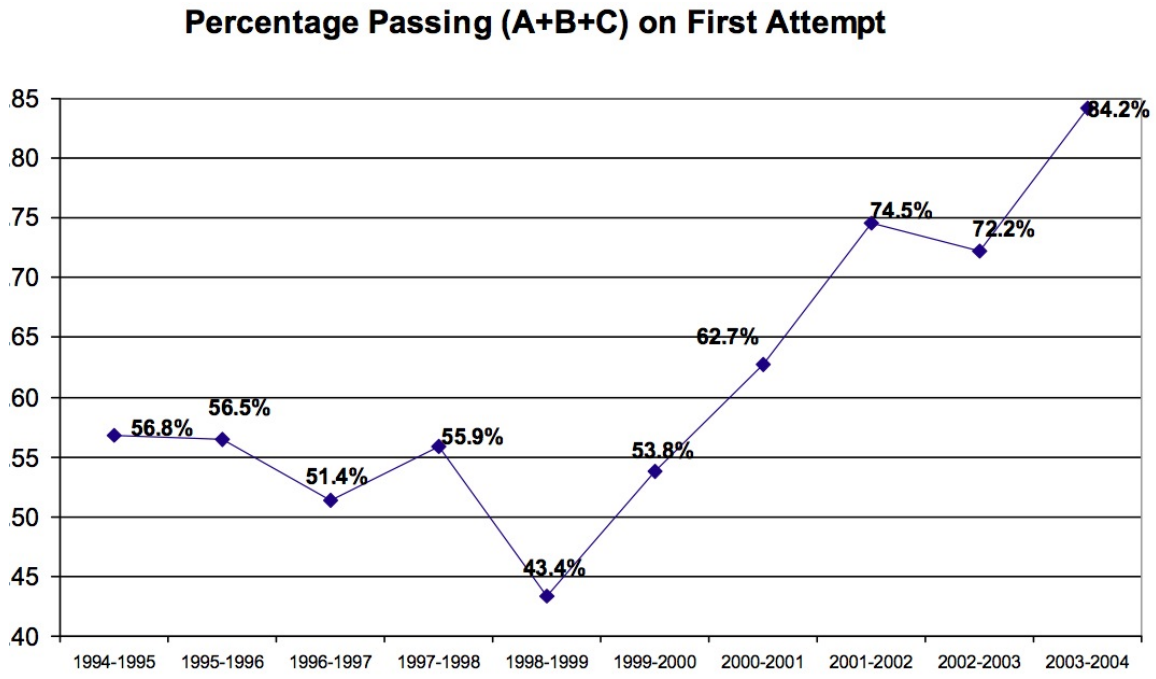
8. Gas Law Explorations: Crushing Soda Cans.

9. Dry Ice/Floating Bubbles: Use soap bubbles to demonstrate the difference in densities of carbon dioxide and air.

10. Ironic Chemistry: Prepare Iron (II) and Iron (III) from reaction of steel wool with nitric acid; then explore redox chemistry, acid/base chemistry, and solubilities.

Outcomes

- Marked improvement in Student Success (Percent [A + B + C] Grade) in course.



- Increased number of STEM majors progressing through this pathway course to enter their degree programs.
- Exposure of **all** General Chemistry students to actual chemical events.
- Better conceptual understanding of the process of chemistry for improved problem-solving abilities.
- Definite strengthening of Peer Leader understanding of chemical principles.
- Exposure of Peer Leaders to the practice of teaching, and:
- Unexpected Outcome: Many Peer Leaders consider teaching at the secondary level as a career.

Institutionalization: Challenges and Opportunities

In the Spring of 2003, the State of Texas substantially reduced the UTEP biennium budget for the 2004-06 period. In the Fall of 2003, to cover the impending deficit, UTEP proposed a tuition increase for Spring 2004 and further increases for Fall 2004 and Spring 2005. The UT System responded by requiring 25% of any tuition increase to be coupled with new opportunities for Student Financial Aid. In the Spring of 2004, I proposed to the UTEP Committee for Institutional Funding

for CHEM 1305 PLTL Workshop for the 2004-2005 year and (amazement!) the proposal was successful(!): $27,420 was awarded (for this one year).

Show me the money!

Having three hundred students in the course per long semester requires about 24 sections; 24 sections mean 12 Peer Leaders. Twelve peer leaders, for 15 weeks, each working eight hours per week, at $7.50 per hour, is an annual (Fall, Spring, Summer) cost of under $30,000.00

Cost Analysis

However, a 25% increase in student success (55% to 80%) in CHEM 1305 translates into about 160 more students at UTEP successfully progressing through this Gateway course into STEM majors each year. The annual loss in tuition for just **12** full-time students, or less than 10% of those 160 who previously failed 1305 and may have quit school (very conservative estimate), represents about $36,000 annually lost to UTEP. So the Cost Benefit Analysis is about $27,000 versus $36,000: a very worth-while comparison.

James E. Becvar
Chemistry Department
University of Texas at El Paso

Originally presented at the 18th Biennial Conference on Chemical Education, University of Iowa, Ames, IA, July 2004.

Acknowledgments

Thanks to all those excellent Peer Leaders! And thanks to Ben Flores, Director, Model Institutions of Excellence (MIE) Program and Grant to UTEP from the National Science Foundation. Thanks also to Ann Darnell, MIE Statistician. The MIE Grant funded the development of CHEM 1305 Workshop and its Peer Leaders from Fall 2000 to Spring 2004.
Since Fall of 2004, support for Peer Leaders has come from UTEP Institutional Funding.

Good Source of Peer Leaders: ACS Affiliates
About 50% of the Peer Leaders since 2000 have been ACS Affiliates. Many of the 1305 *Explorations* have come from vignettes developed for the UTEP Chemistry Circus (an outreach activity put on by Affiliates for students of all ages in the El Paso community).

Cite This Article as: Becvar, J.E. (2012). Two Plus Equals More: Modifying the Chemistry Curriculum at UTEP. Peer-Led Team Learning: Implementation. Online at http://www.pltlis.org. Originally published in *Progressions: The Peer-Led Team Learning Project Newsletter*, Volume 5, Number 4, Summer 2004.