PLTL: A Student-Faculty Partnership for Transforming the Learning Environment

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IUPUI
CENTER FOR TEACHING AND LEARNING
INDIANA UNIVERSITY–PURDUE UNIVERSITY
Indianapolis

IUPUI-Urban Research University

30,000 Students, in 22 Schools

Setting

- Urban Midwestern research university
- ~30,000 students
  - 15% underrepresented minorities
  - 36% $\geq$ 25 years old
  - 68% work off campus (mean 28 hrs)
- PLTL was implemented in General Chemistry at this university in mid-1990s
- DFW rates have dropped from 45% to 20% since implementing PLTL in General Chemistry

IUPUI University Library

Acknowledgments

- Peer Leaders
- PLTL Project Partners
- NSF-DUE 9455920
- NSF-DUE-9972457
- NSF-DUE-0231349
- NSF-DUE-0941978 (cPLTL)
- NGLC Wave I (cPLTL)
- NGLC Wave I (Follow-On)

EDUCAUSE

BILL & MELINDA GATES foundation

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History

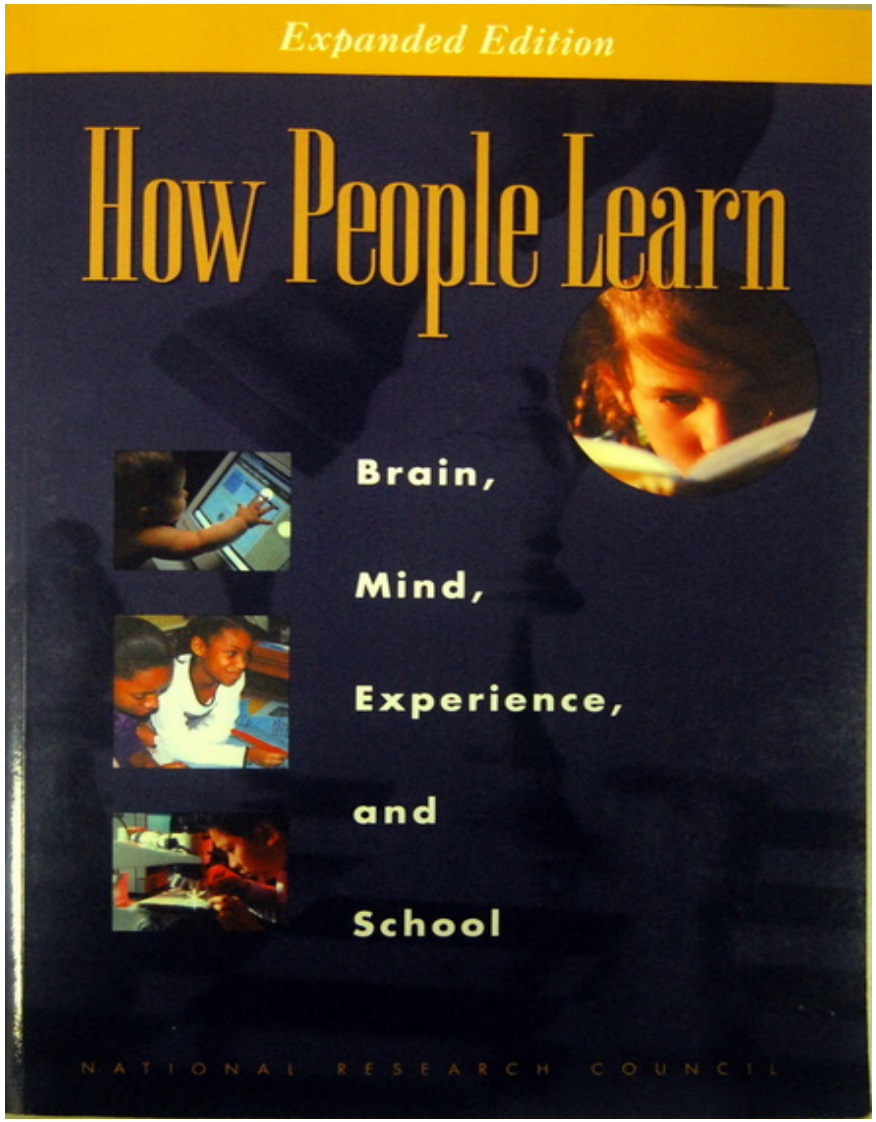
Outline

- Overview of PLTL method
- PLTL implementation
- Role of the peer leaders and
- Appropriate Materials
- Evaluation
- Dissemination
- Training of peer leaders
- cPLTL: development and preliminary results
- Lessons learned

Intellectual Development in College

- Student faculty interaction outside the classroom
- Involvement on campus through various forms of community-building activities
- Involvement with student peer groups
- “peer group---the most potent source of influence on growth and development during the undergraduate years”

Astin, A.W. (1993) What Matters in College? Jossey-Bass Publishers, San Francisco. pg. 394.



National Research Council, 2000

“How People Learn”

- Students come to the classrooms with preconceptions about how the world works.
- A metacognitive approach to instruction can help students learn.
- Teaching students about their own learning, reasoning, problem solving.
- Knowledge must be organized in ways that facilitates retrieval and application.

Student Preconceptions Must be Engaged in Learning Process

- Make prior knowledge visible
- Learning is optimized when students can see where new concepts build on prior knowledge

Learning is Optimized When Students Develop "Metacognitive" Strategies

- "Thinking about ones own thinking"
- Metacognitive students approach problems by automatically trying to predict outcomes, explain ideas to themselves, learn from failures and activate prior knowledge
- All students can learn metacognitive strategies

Strategies to Develop Metacognition

- State it, explain it, expand upon it, illustrate it
- Make their thinking visible, put in words their thinking process
- Have them talk about their thought process by asking questions
- Implicit to explicit
- Make them teach each other

The most important single factor influencing learning is what the learner knows. Ascertain this and teach accordingly.

Ausubel D. P., Novak J. D. and Hanesian H., (1978), *Educational psychology: a cognitive view*. New York: Holt Rinehart and Winston.

Deep Learning

- “Deep and meaningful learning will occur if at least two of three forms of interaction are present: student-teacher; student-student; student-content.”

Anderson (2003, p. 2)

“Active Learning Increases Student Performance in STEM”

Freeman, S., Eddy, S., McDonough, M. Smith, M.K., Okoroafor, N., Jordt, H., & Wenderoth, M.P. (2014) *Proceedings of the National Academy of Sciences of the United States of America, 111*(23), 8410-8415. Retrieved from http://www.pnas.org/cgi/content/long/111/23/8410

Key Takeaways (Freeman et.al.)

- Increases in achievement hold across all STEM disciplines
- Occur in all class sizes, course types, and course levels
- Active learning is particularly beneficial in small classes
- Beneficial at increasing performance on concept inventories

Peer-Led Team Learning (PLTL)

Peer: A more experienced undergraduate student who has recently completed the course.

Led: Refers to leadership. A leader is an undergraduate student who acts as a guide to others. Goes through extensive training to assume this role.

Team: A group of 6-8 students who work together to achieve a common goal.

Learning: The goal of the team is to learn chemistry.

Gosser, D.K., M.S. Cracolice, J.A. Kampmeier, V. Roth, V. Strozak, and P. Varma-Nelson 2001
The Workshop Model: Peer Leadership and Learning. A Guidebook. Prentice Hall, Upper Saddle River, NJ.

The PLTL Workshop

- Compliment to the lecture
- Problems slightly above the level of standard end-of-chapter questions, specifically designed for group work, organized around a big idea.
- Facilitated by a well trained leader

Gosser, D.K., M.S. Cracolice, J.A. Kampmeier, V. Roth, V. Strozak, and P. Varma-Nelson 2001 *The Workshop Model: Peer Leadership and Learning. A Guidebook*. Prentice Hall, Upper Saddle River, NJ.

Course

- 2 - 3 hours of lecture per week (interactive)
- 1.5 - 2 hours of PLTL workshop per week (replaces recitation, part of lecture or added)
- Flipped classroom
- 3 hour lab facilitated by faculty and/or a TA

Three Types of Implementations

PLTL workshop

- replaces part of a lecture
- replaces a TA led recitation
- is an added component to the course

The Role of Peer Leaders

- Not “answer givers.” They facilitate active learning and participation group members.
- Help students build trust and understanding to communicate openly with each other.
- Act as intellectual and social role models.
- Help new students make a smoother transition from high school to college or from community colleges to university.

Critical Components for a Successful PLTL Workshop Program

- Integral part of the course
- Challenging materials (no answer keys)
- Trained and closely supervised leaders
- Train the students*
- Supportive faculty
- Appropriate physical arrangement
- Supportive administration

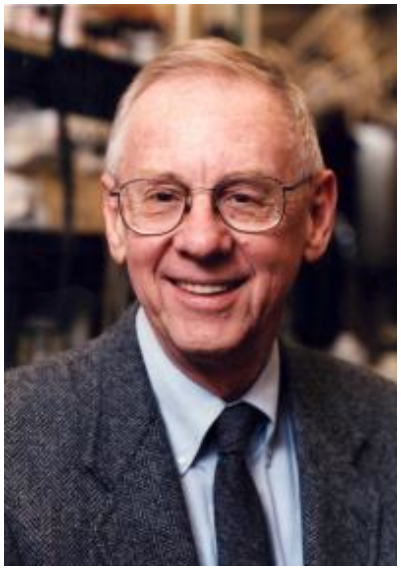
Gafney "Evaluation of PLTL, *Peer-Led Team Learning: A Guidebook*. Eds Gosser, D., Cracolice, M., Kampmeier, J., Roth, V., Strozak, V., Varma-Nelson, P. (2001). Upper Saddle River, NJ: Prentice Hall.

Assessing Quality of Implementation at Other Schools

Critical Components			
1. Integral part of the Course	Students view workshop as important to learning	Leaders are aware of the lecture approach	Lecturer refer to workshops
2. Professor's direct involvement	Reviews problems with peer leaders	Prepares and reviews materials	Available to students and peer leaders
3. Leaders are trained and supervised	Skilled with groups; Acts as a facilitator	Training and supervision is provided	Discipline knowledge and problem solving
4. Materials	Fit with course; related to tests	Engaging; appropriately challenging	Suitable for group activity
5. Org'l. Arrangements	Group size 6-8 Attendance required	Time 1.5 to 2 hours	Space: Good for small group work
6. Institutional Support	Increasing number of disciplines and courses	Support from department and dean	Local financial support

Creating PLTL Workshop Materials

- Workshop problems must make it impossible for the student to be a passive observer.
- Workshop problems must engage active participation of students with each other
- Engage the mind (puzzles)
- Engage the body (do something)
- Engage the spirit (“relevant”)
- Engage the group
- No answer keys



Check List for Good Workshops

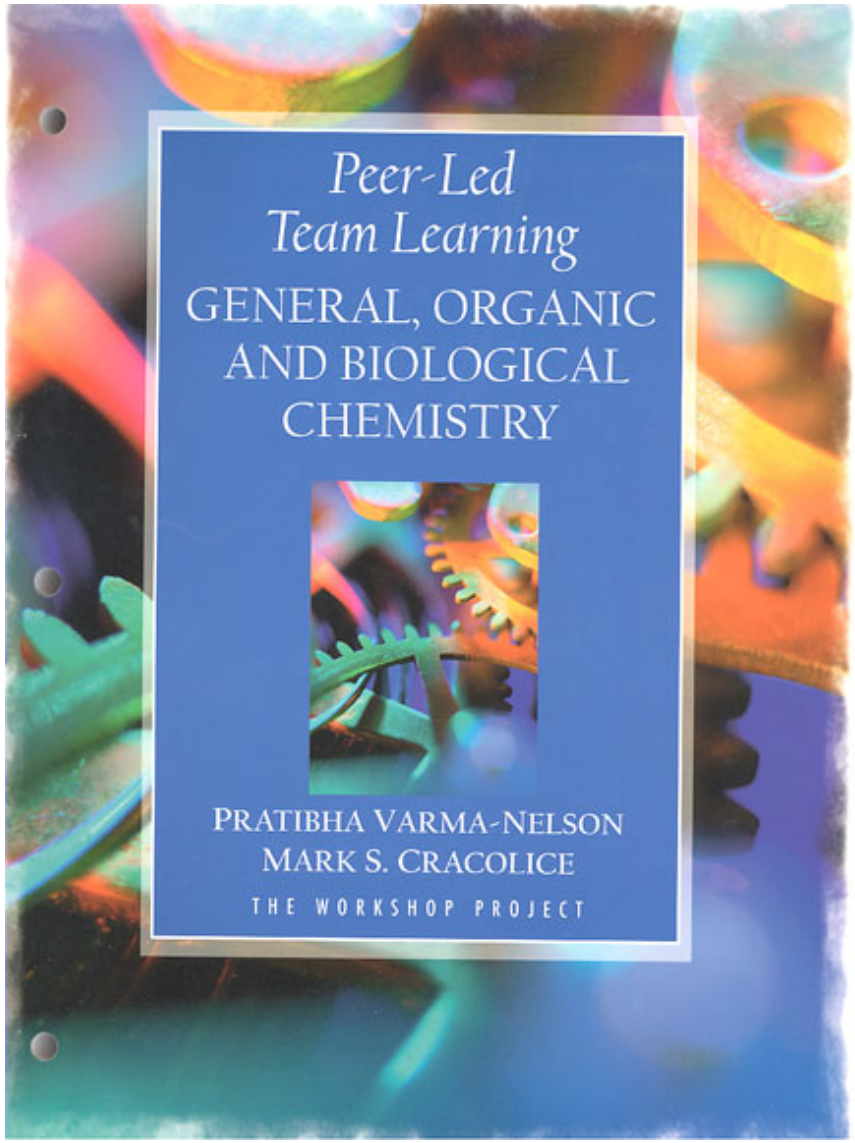
- Build on readings, lectures, homework
- Focus on conceptual understanding
- Are challenging
- Explore one or two BIG IDEAS
- Build new connections and perspectives
- Provide checks on understanding
- Use models, simulations, visual aids
- FUN

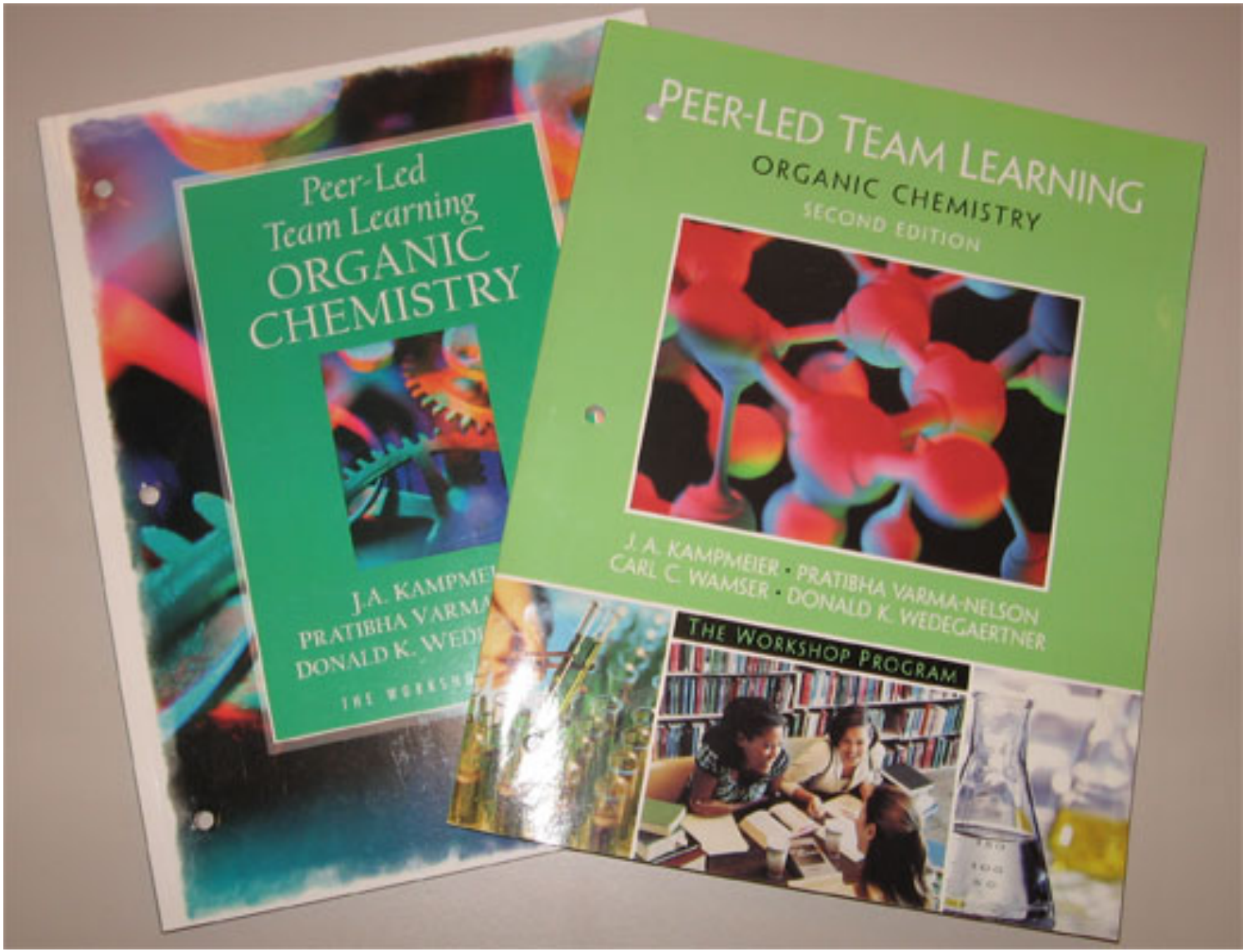
Facilitate Retrieval and Application of Knowledge

- Be organized around a conceptual framework
- Connect factual information to the framework
- Provide relevant examples to illustrate key ideas

An (1) optically active compound, (2) C_6H_{10}, was (3) hydrogenated over a platinum catalyst to give an (4) optically inactive hydrocarbon, (5) C_6H_{12}, which was (6) identical to methylcyclopentane. Give the structure of the optically active C_6H_{10} compound and explain why this structure is uniquely consistent with the above date. Carefully outline your logic.

Observation	Deduction
(1)	(1)
(2)	(2)
(3)	(3)
(4)	(4)
(5)	(5)
(6)	(6)


Peer-Led
Team Learning
GENERAL, ORGANIC
AND BIOLOGICAL
CHEMISTRY
PRATIBHA VARMA-NELSON
MARK S. CRACOLICE
THE WORKSHOP PROJECT


Peer-Led
Team Learning
ORGANIC
CHEMISTRY
PEER-LED TEAM LEARNING
ORGANIC CHEMISTRY
SECOND EDITION
J. A. KAMPMEIER • PRATIBHA VARMA-NELSON
CARL C. WAMSER • DONALD K. WEDEGAERTNER
THE WORKSHOP PROGRAM

PEER-LED TEAM LEARNING

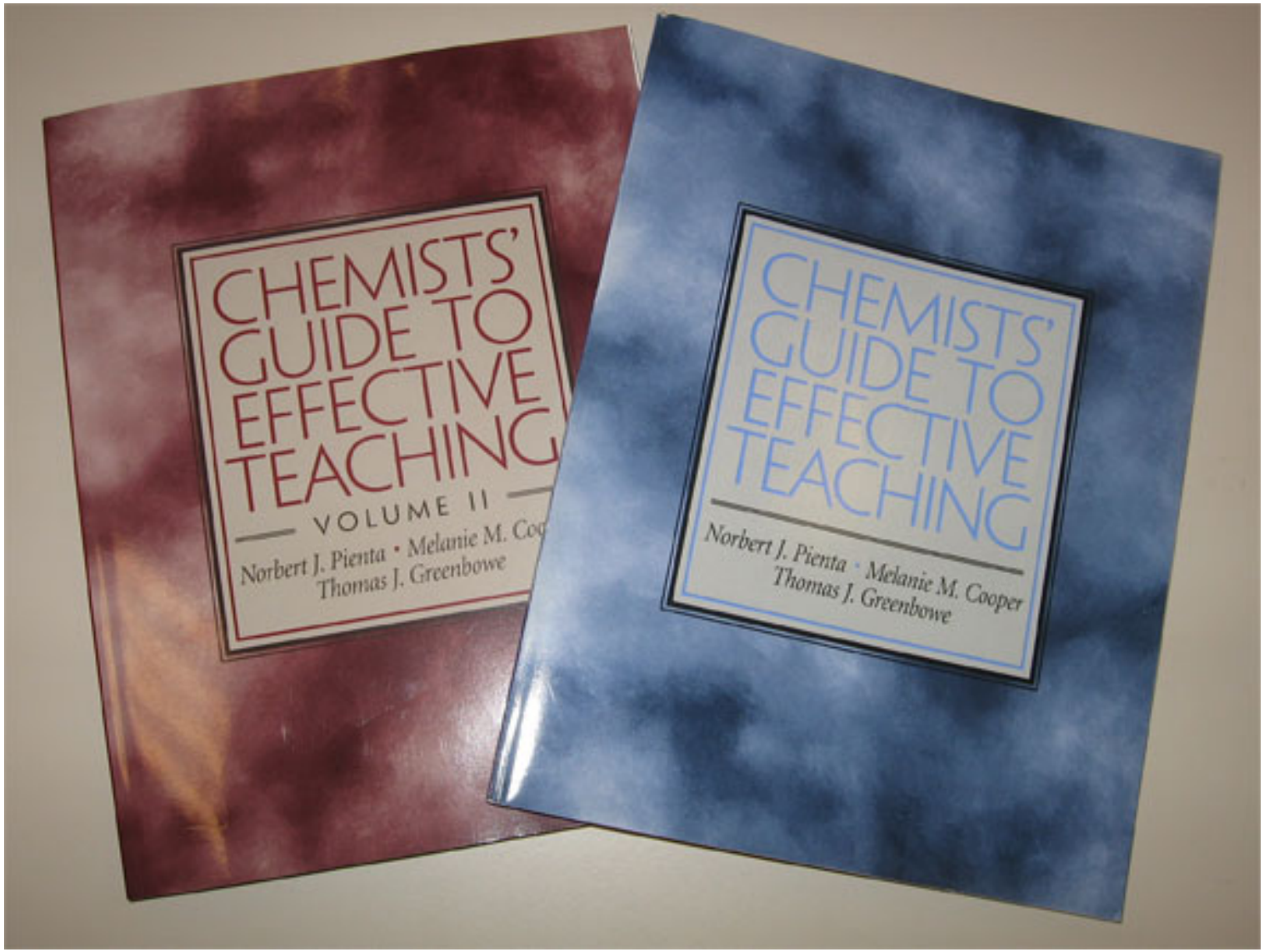
GENERAL CHEMISTRY

SECOND EDITION

DAVID K. GOSSER • VICTOR S. STROZAK • MARK S. CRACOLICE

Why No Answer Keys?
(The manuals have no answer keys)


Peer-Led
Team Learning
A HANDBOOK FOR
TEAM LEADERS
Peer-Led
Team Learning
A GUIDEBOOK
DAVID K. GOSSER
MARK S. CRACOLICE
J.A. KAMPMEIER • VICKI ROTH
VICTOR S. STROZAK
PRATIBHA VARMA-NELSON
THE WORKSHOP PROJECT


CHEMISTS' GUIDE TO EFFECTIVE TEACHING
VOLUME II
Norbert J. Pienta • Melanie M. Coo
Thomas J. Greenbowe
CHEMISTS' GUIDE TO EFFECTIVE TEACHING
Norbert J. Pienta • Melanie M. Cooper
Thomas J. Greenbowe

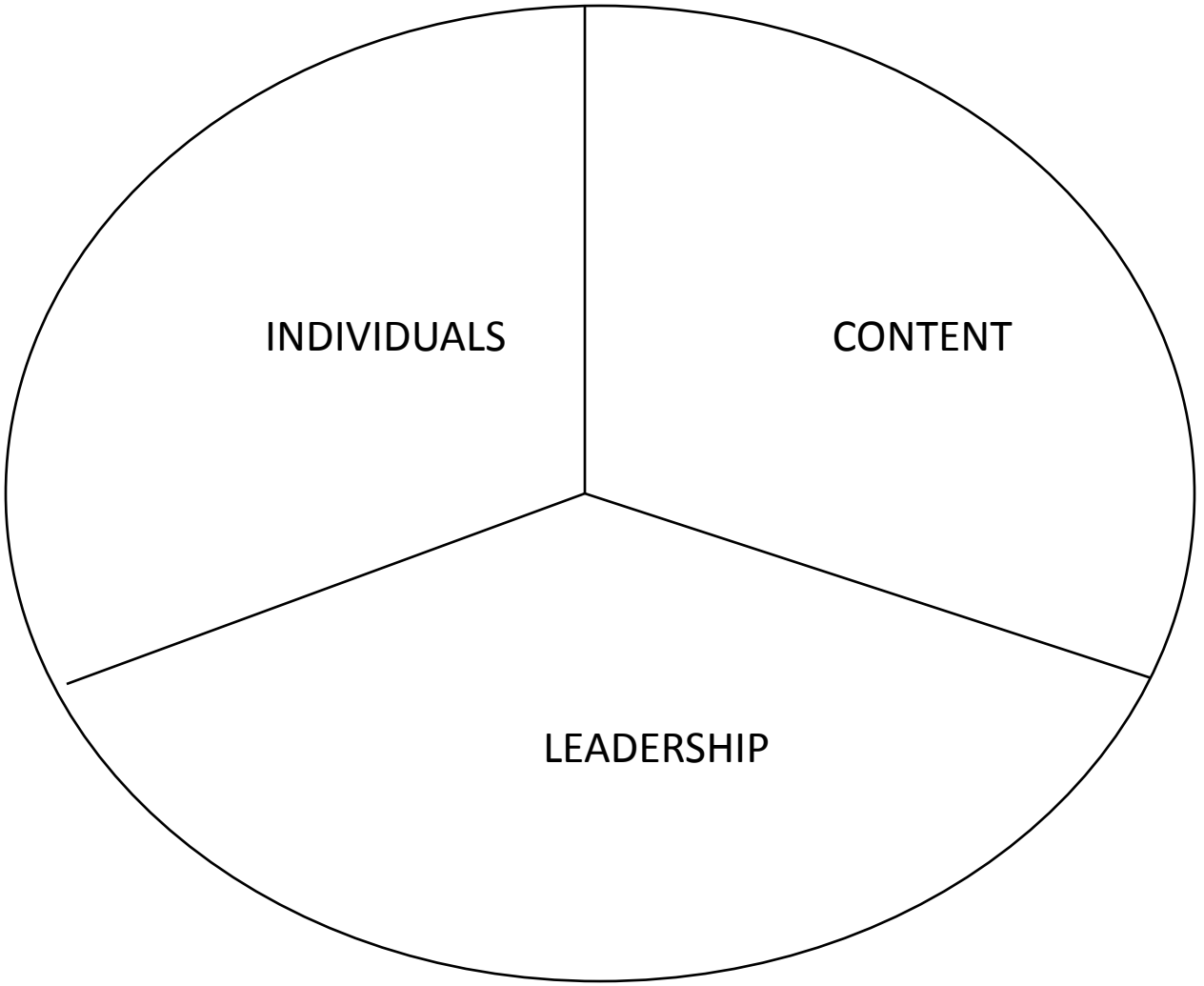
Peer Leader Challenges

- Engage students who are not interested.
- Doing the problem sets did not leave time for other questions.
- Time commitment.
- Student motivation.
- Dominating students.
- Engaging excellent students.

Leader Selection Criteria

- Recent completion of course with an “A” or “B”
- Recommendation by workshop leader, coordinator and professor in regard to being responsible and leadership ability
- Student must enjoy service
- Care about peer’s learning
- Recommendation by all three interviewers (at least one faculty member, coordinator and workshop leader)

LEADER – KEY ROLE



Leader Journals

- Weekly reflection on workshops
- What worked?
- What didn't work?
- Quality of problems?
- Special challenges?

Benefit to Peer Leaders

- Enjoy more deeply learning the material
- Professional relationship with Professor
- They get to test out their interest in teaching
- Development of personal communication and leadership skills
- Looks good on applications to professional/ graduate schools
- It's much better that working at McDonalds or Walmart

Former Peer Leader Quotes

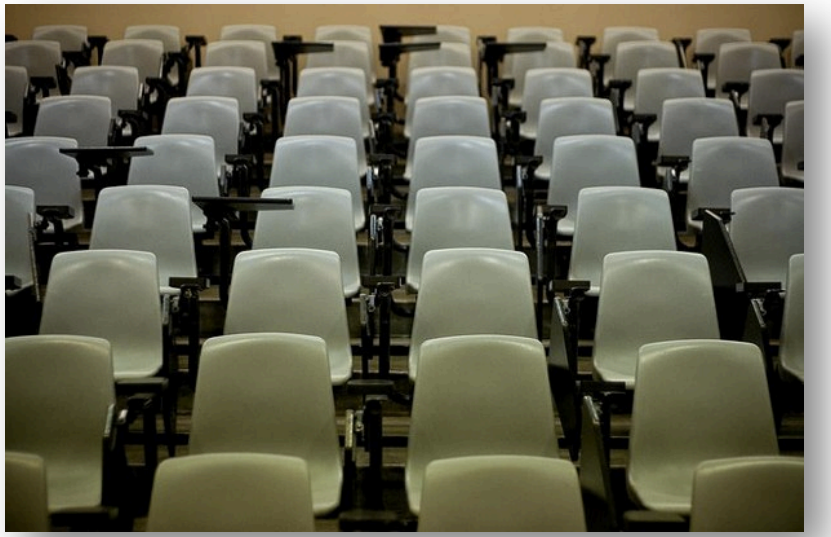
"… I gained the knowledge and confidence I needed to pursue a career in pharmacy. During many medicinal chemistry courses in pharmacy school I became known as the group leader."

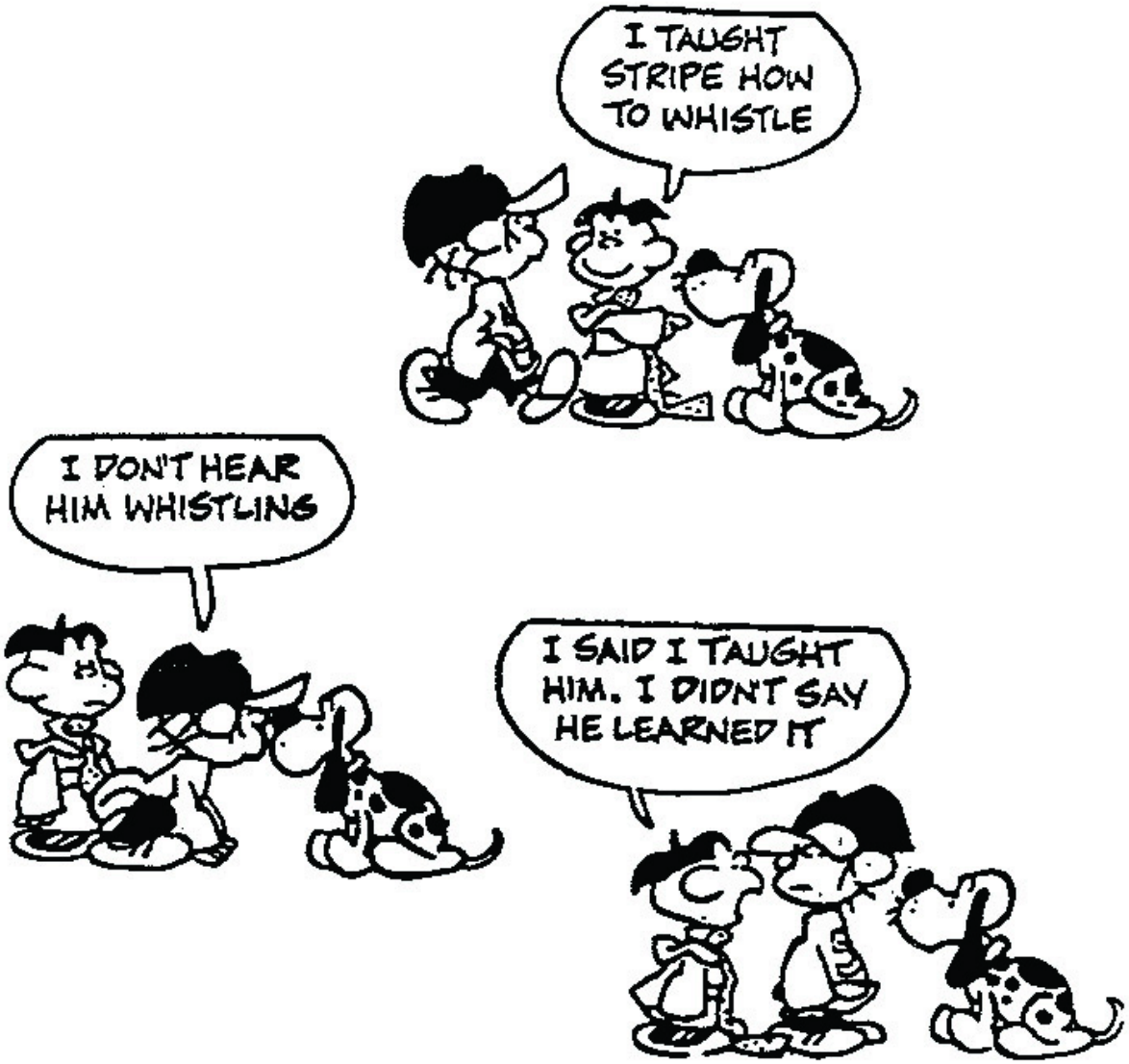
"… useful in my work, in acknowledging that sometimes when people don't understand a concept, it's simply because of the way it is being presented to them."

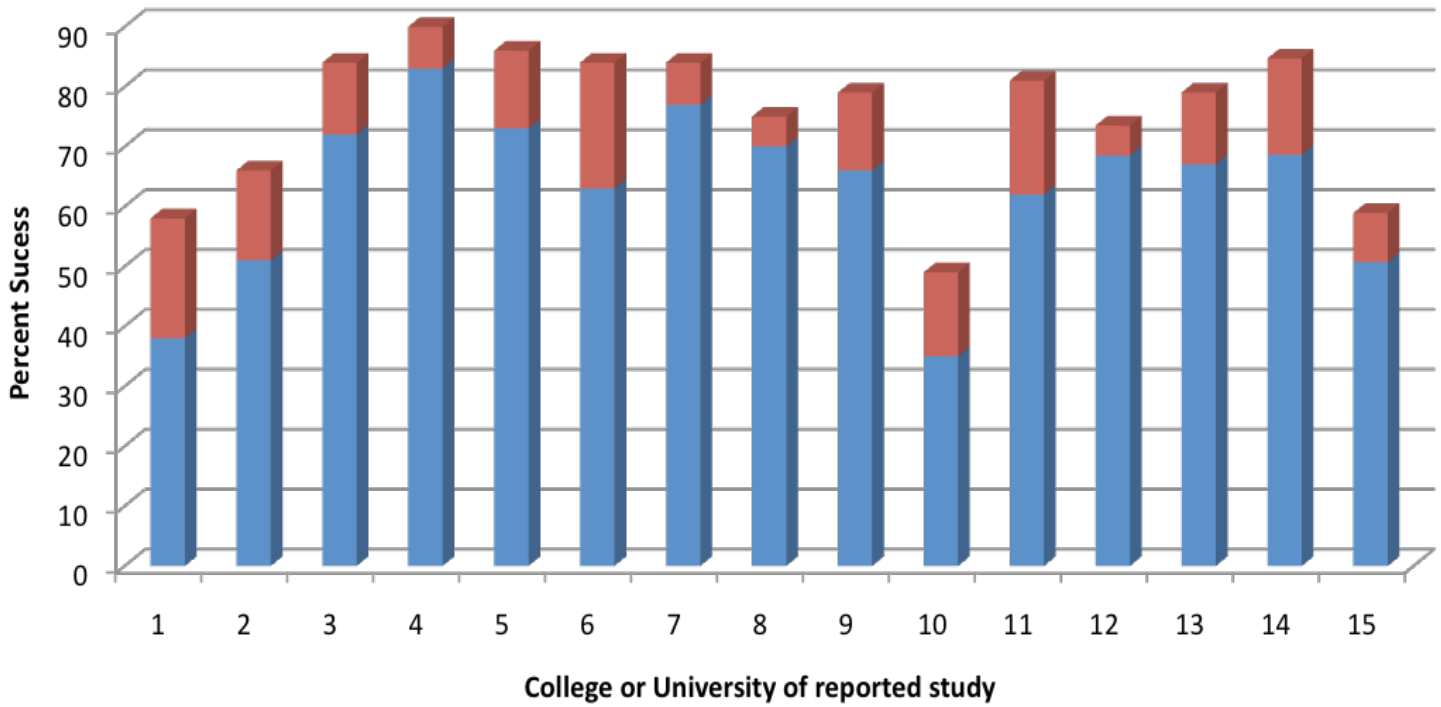
"It was the first time I realized how many gaps there are in my own understanding of chemistry."

Gafney, L. and Varma-Nelson, P. (2008) *Peer-Led Team Learning: Evaluation, Dissemination and Institutionalization of a College level Initiative*, Dordrecht, The Netherlands: Springer

Lecture Vs an Active Learning Classroom



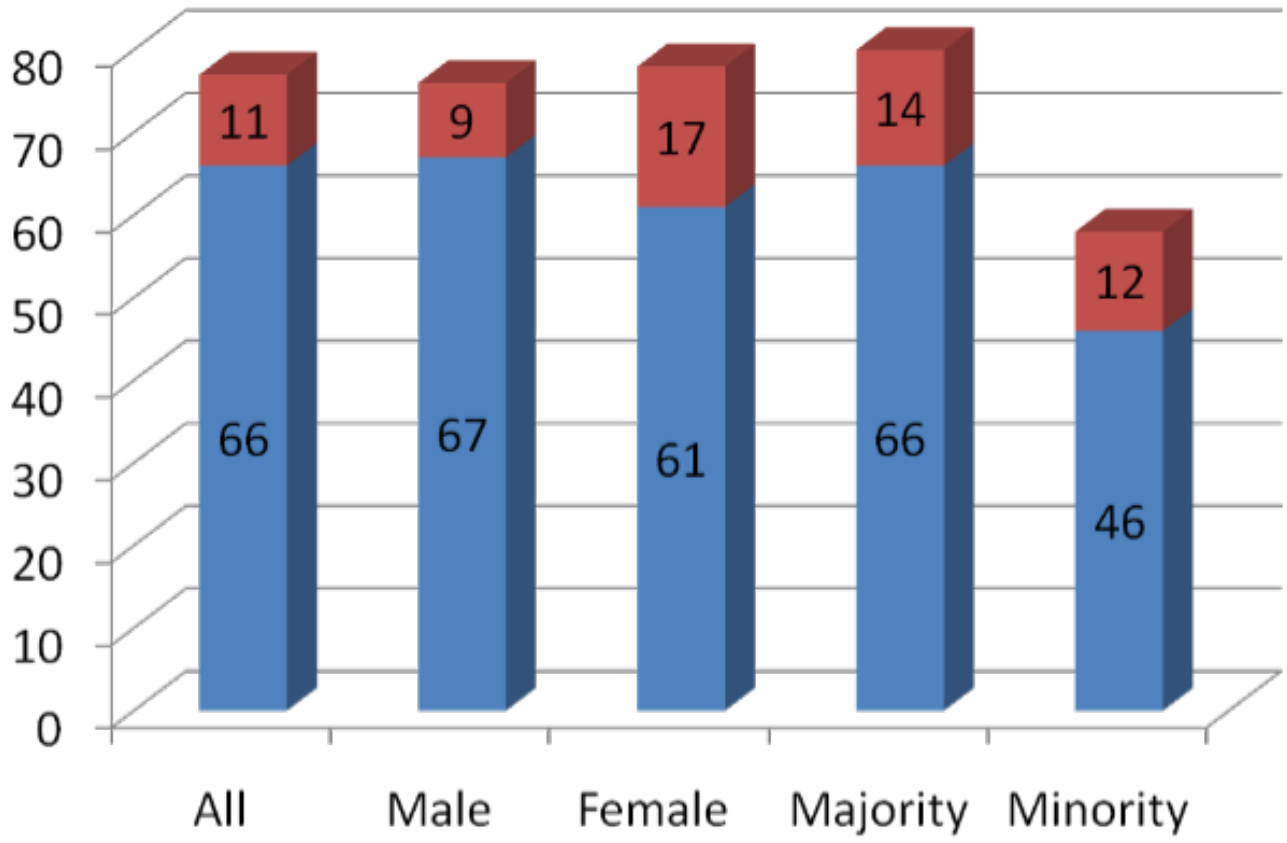

I TAUGHT STRIPE HOW TO WHISTLE
I DON'T HEAR HIM WHISTLING
I SAID I TAUGHT HIM. I DIDN'T SAY HE LEARNED IT



City College of New York, (1-2), St. Xavier Chicago, (3), U. of Pittsburgh (4), Penn State Schuykill, (5), U. of Kentucky (6), U. of Ohio Athens (7), U. of Miami Ohio (8), U. of Rochester, Org (9), U. of West Georgia (10), and NYC Technical (11).

12-15 (Independent studies)

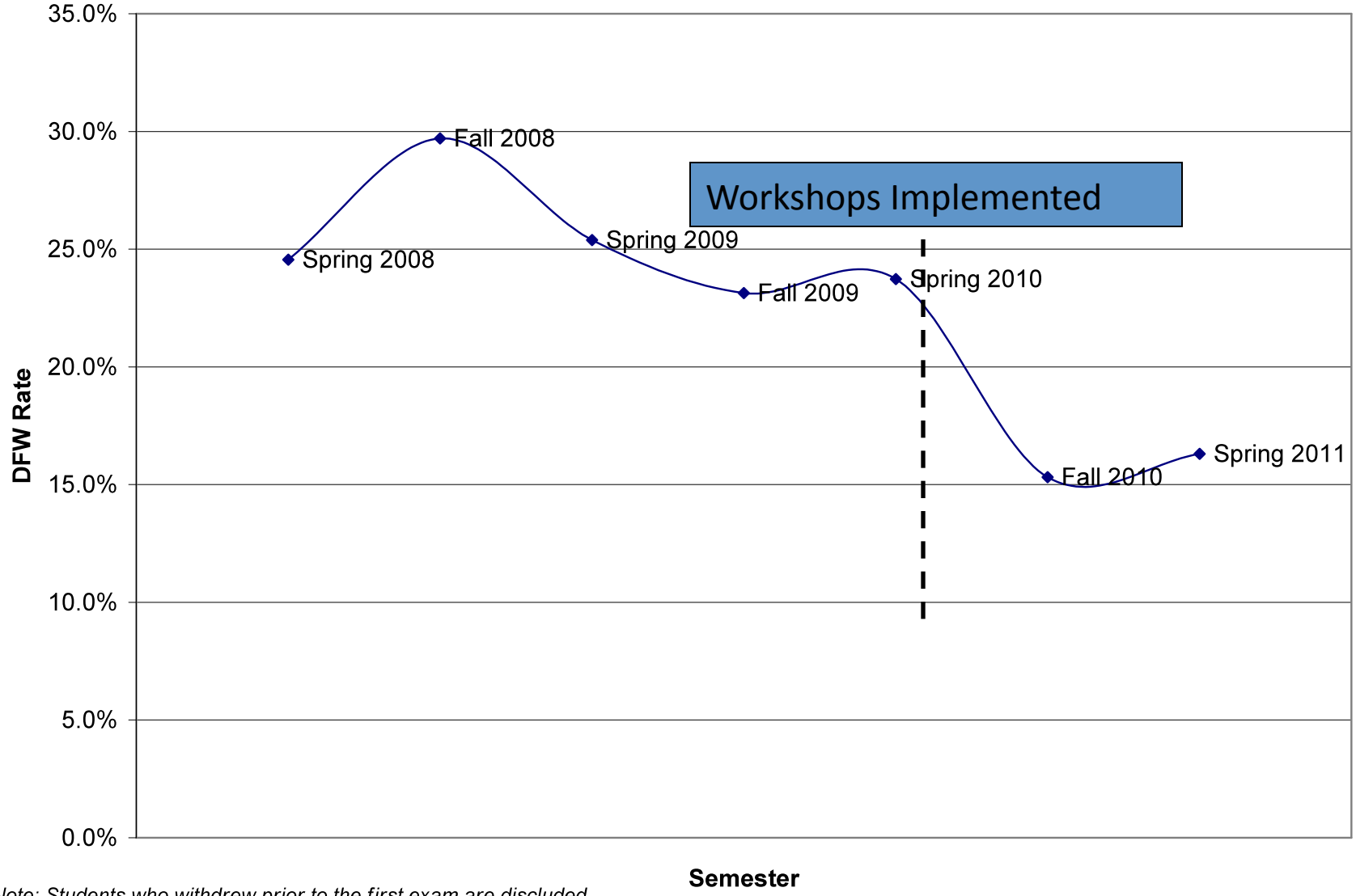
Blue = Non PLTL Red = PLTL



Tien, Roth, Kampmeier J. Res. Sci. Teaching (2002) U. Rochester Organic Chemistry

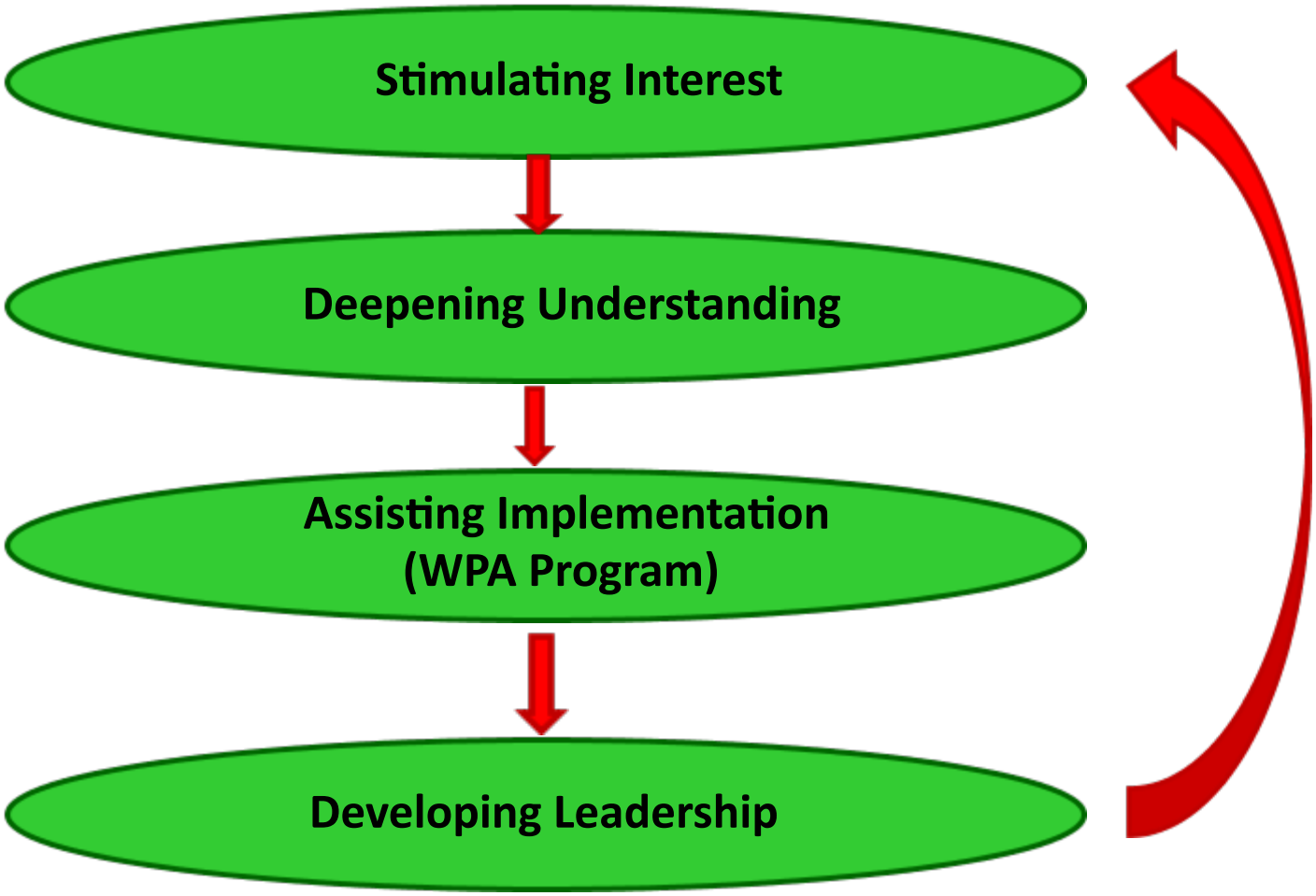
Blue = Non PLTL Red = PLTL

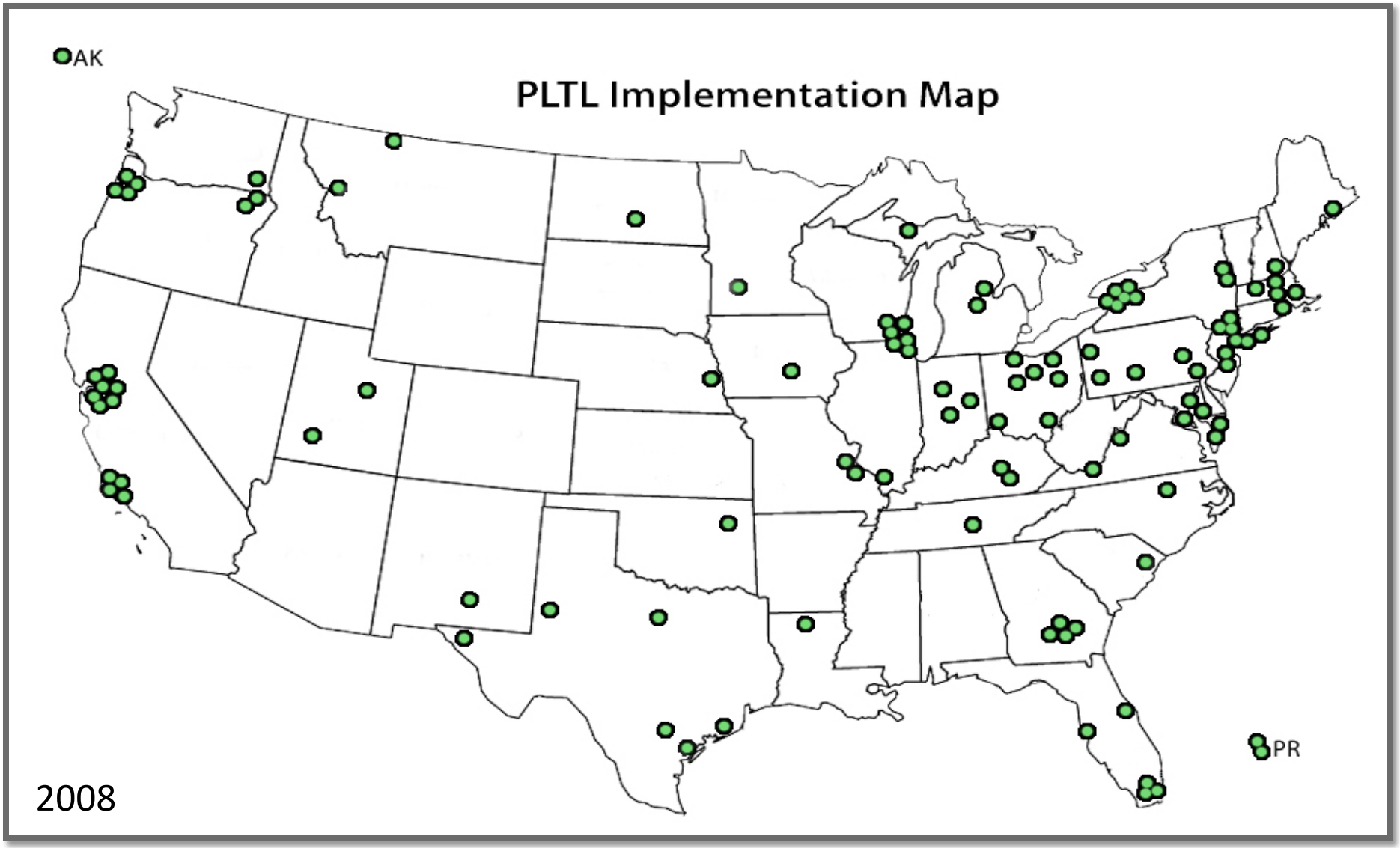
1st Semester Organic Chemistry DFW Rate



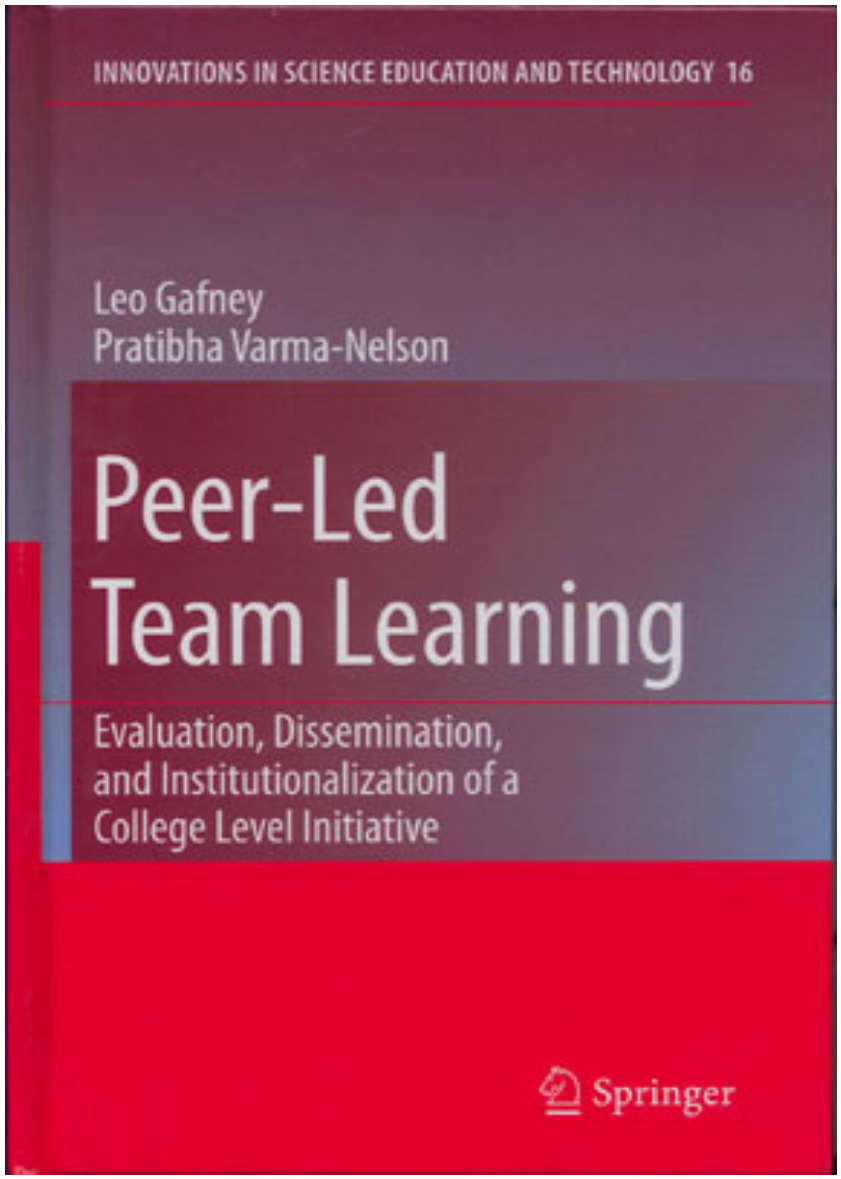
Note: Students who withdrew prior to the first exam are discluded.

Dissemination Model (Varma-Nelson & Gosser)





Gosser, D.K.,Kampmeier,J.A., & Varma-Nelson, P., (2010), Peer- Led Team Learning: 2008 James Flack Norris Award Address, Journal of Chemical Education, 87(4), 374-380.


INNOVATIONS IN SCIENCE EDUCATION AND TECHNOLOGY 16
Leo Gafney
Pratibha Varma-Nelson
Peer-Led
Team Learning
Evaluation, Dissemination,
and Institutionalization of a
College Level Initiative
Springer

Disciplines

- General Chemistry
- Organic Chemistry
- Biochemistry
- Biology
- Psychology
- Mathematics
- Computer Science
- Nursing

Publications from other PLTL Implementations

- Akinyele, A. F. (2010). *Peer-led team learning and improved performance in an allied health chemistry course*. Chemical Educator*, 15* , 353-360.
- Amaral, K., & Martin V. (2009). *What teaching teaches*, Journal of Chemical Education, 86, 630-633 *.*
- Báez-Galib, R., Colón-Cruz, H., Resto, W., & Rubin, M. (2005*). Chem-2-chem: A one-to-one supportive learning environment for chemistry,* Journal of Chemical Education, 82, 1859-1863.
- Bradley, A. Z., Ulrich, S. M., & Jones, M. Jr. (2002). *Teaching the sophomore organic course without a lecture: are you crazy?* Journal of Chemical Education , 79 (4).

  Bradt, S. (2002). *Organic chemistry made (relatively) easy—by students' own peers,* Journal of Chemical Education, 79(4).

  Hockings, S. C., DeAngelis, K. A., & Frey R. F. (2008). *Peer-led team learning in general chemistry: Implementation and evaluation*, Journal of ChemicalEducation85 (7), 990-996.

Publications from other PLTL Implementations Continued

Lewis, S. E., & Lewis, J. E. (2005). *Departing from lectures: An evaluation of a peer-led guided inquiry alternative,* Journal of Chemical Education , 82 , 135.

Murray, J. D. (2011). Peer learning and its applications to undergraduate psychology instruction . In R. L. Miller, E. Amsel, B. M. Kowalewski, B. C. Beins, K. D. Keith, & B. F. Peden (Eds.), Promoting student engagement <http://teachpsych.org/ebooks/pse2011/vol1/> (Vol. 1, pp. 166-169). Retrieved from http://teachpsych.org/ebooks/pse2011/index.php

Prezler, R. W. (2009). *Replacing lecture with peer-led workshops improves student learning*. CBE-Life Sciences Education8, 182-192.

Wamser, C. C. (2006). *Peer-led team learning (PLTL) in organic chemistry: Effects on Student performance, success*, and persistence in the course. Journal of Chemical Education, 83 (10).

“Pedagogies of Engagement in Science”

Characteristics of PBL, POGIL and PLTL are compared and contrasted

Pedagogies of Engagement in Science, Biochemistry and Molecular Biology Education, Vol. 36, No. 4, pp. 262–273, 2008

Foundations of Student Engagement

- Time on task (Tyler, 1930's)
- Quality of effort (Pace, 1960-70's)
- Student involvement (Astin, 1984)
- Social, academic integration (Tinto, 1987, 1993)
- Good practices in undergraduate education (Chickering & Gamson, 1987)
- College impact (Pascarella, 1985)
- Student engagement (Kuh, 1991, 2005)

Effective Undergraduate Education

- Student-faculty interaction
- Active learning
- Prompt feedback
- Time on task
- High expectations
- Respect for diverse learning styles
- Cooperation among students

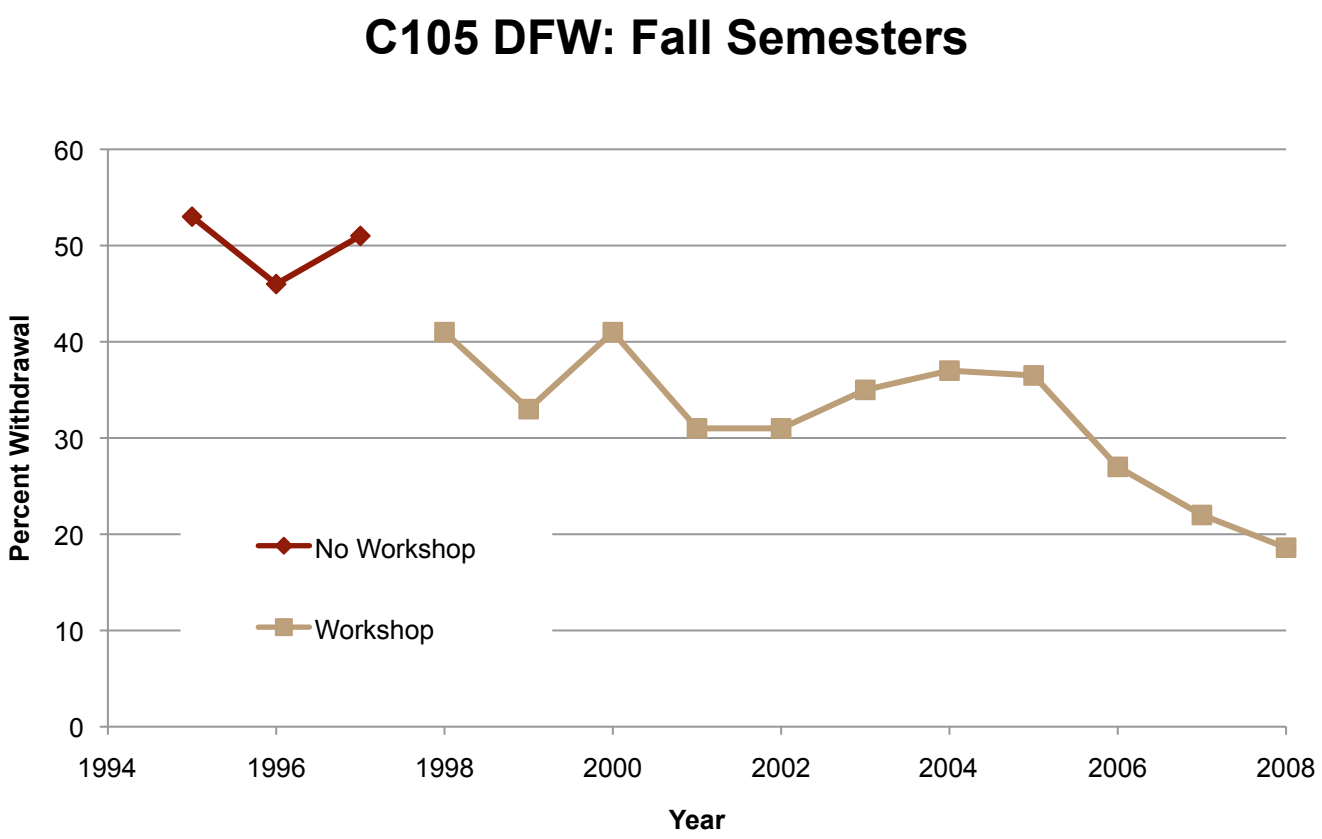
Chickering & Gamson, 1987 Pascarella & Terenzini, 2005

Chihuli in the Medical Sciences Bldg.

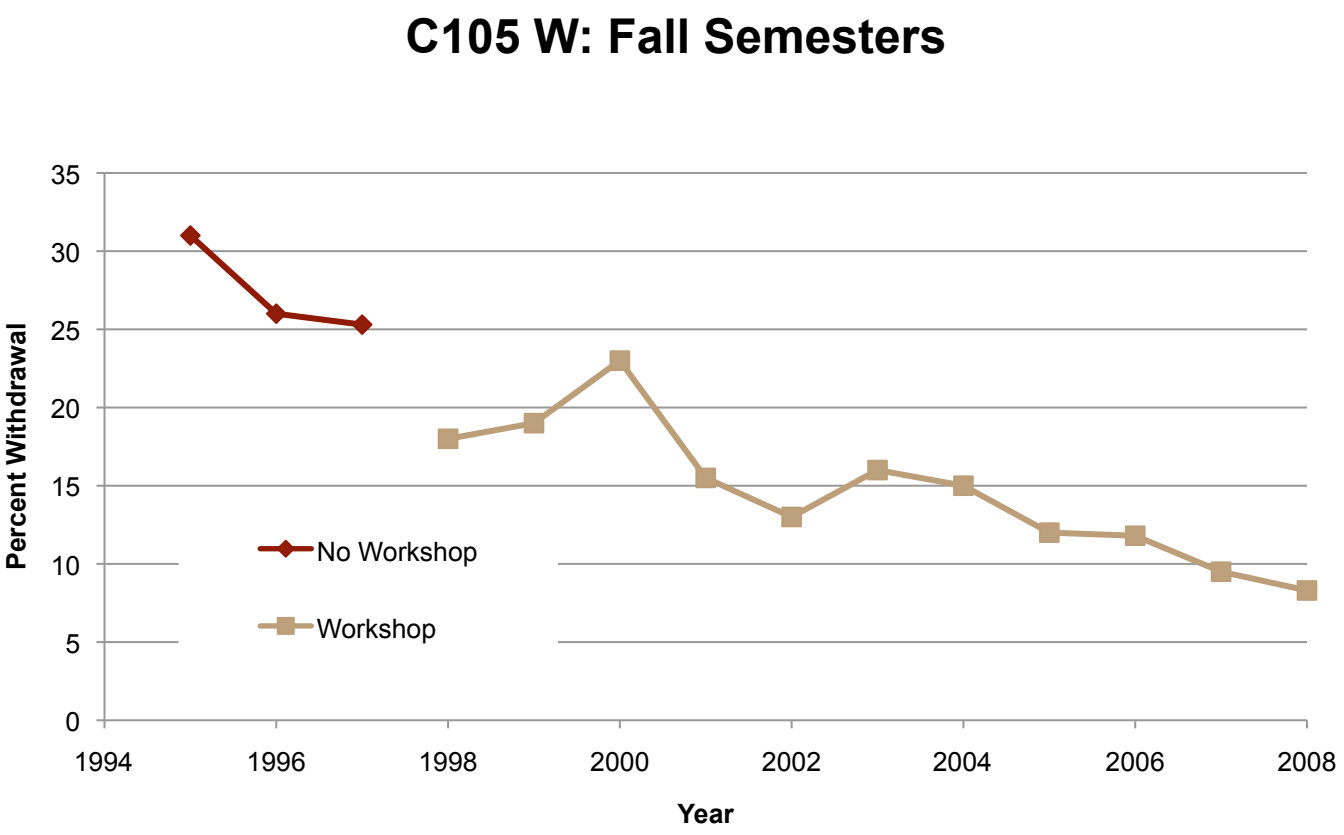
cPLTL Development at IUPUI

http://cpltl.iupui.edu/

IUPUI


C105 DFW: Fall Semesters
Percent Withdrawal
60
50
40
30
20
10
0
1994
1996
1998
2000
2002
2004
2006
2008
Year
No Workshop
Workshop

IUPUI


C105 W: Fall Semesters
Percent Withdrawal
35
30
25
20
15
10
5
0
1994
1996
1998
2000
2002
2004
2006
2008
Year
No Workshop
Workshop

Why develop cPLTL?

- Collaboration online (21st century skills)
- More students have the option of serving as Peer Leaders.
- New ways to capture data.
- Understand leader styles-useful for peer leader training

Interdisciplinary cPLTL Research Group

- Joshua Smith, Dean, School of Education, Loyola U. Baltimore
- Sarah Wilson, Ph.D. candidate, Chem
- Juliana Banks, former postdoc
- Lin Zhu, Lecturer, Chem
- Lorie Shuck,IT, IUSM
- Tom Janke, IT, CTL
- Randy Newbrough, IT, UITS

Undergraduate students

- Jordan Cagle, Bio
- Eunice Jeong, Chem
- John Sours, Chem
- Kevin Mauser, BME
- Stephanie Metcalf, Chem
- Jacob McDaniel, Philosophy

Basic Requirements for cPLTL Participation

- High-speed Internet access (wired or wireless)
- Internet browser
- Access to a computer with a web-based video conferencing service

Navigating the Technology

- Each online meeting room for cPLTL is divided into four main windows, called “pods” in Adobe Connect
- The ability to record provides an opportunity for students to go back and review a workshop topic/session at a later time as they review for upcoming exams.

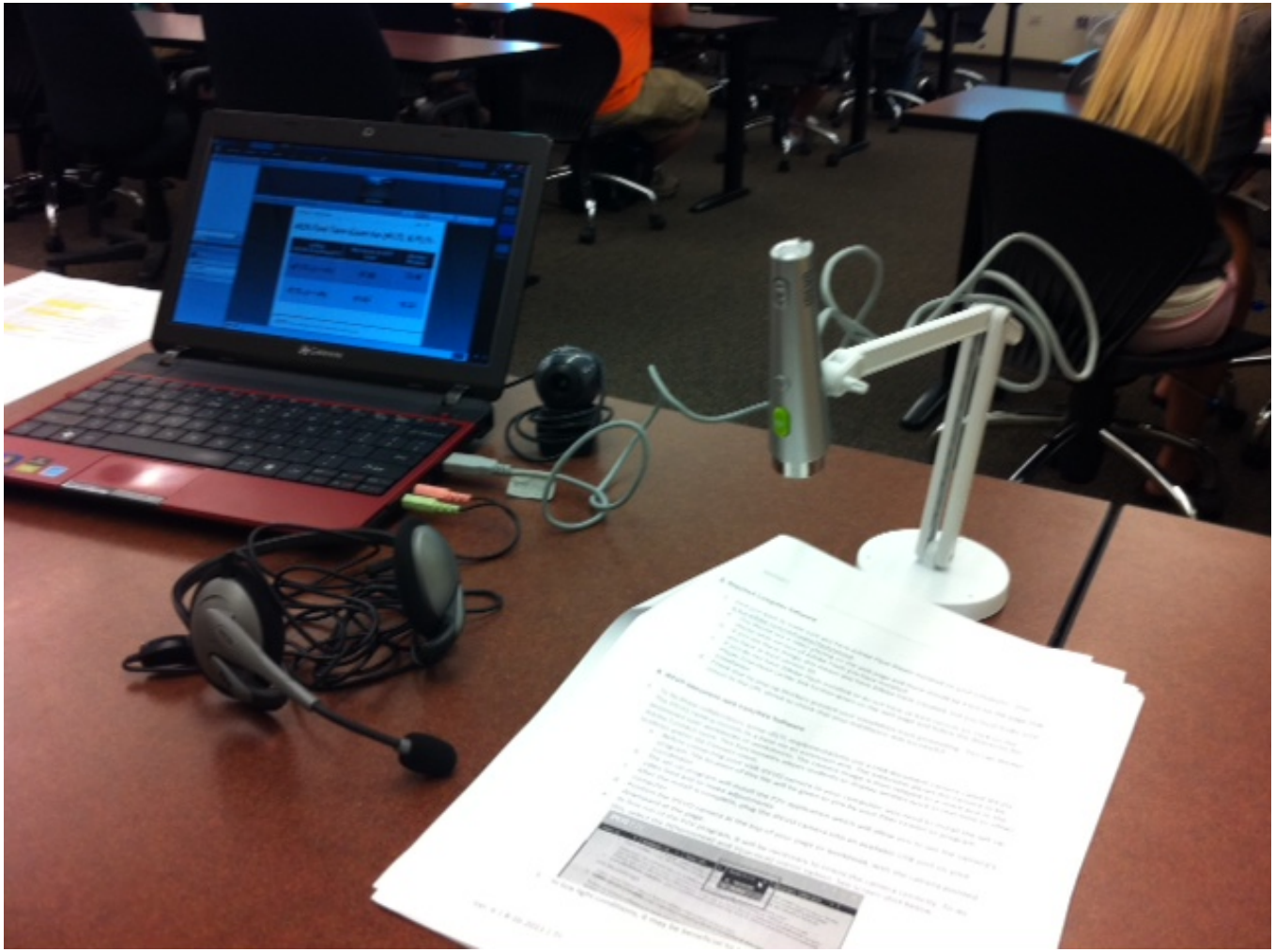
Anatomy of a cPLTL Virtual Workshop

The Audio/Video pod allows the peer leader and students to see and hear each other during the online sessions.

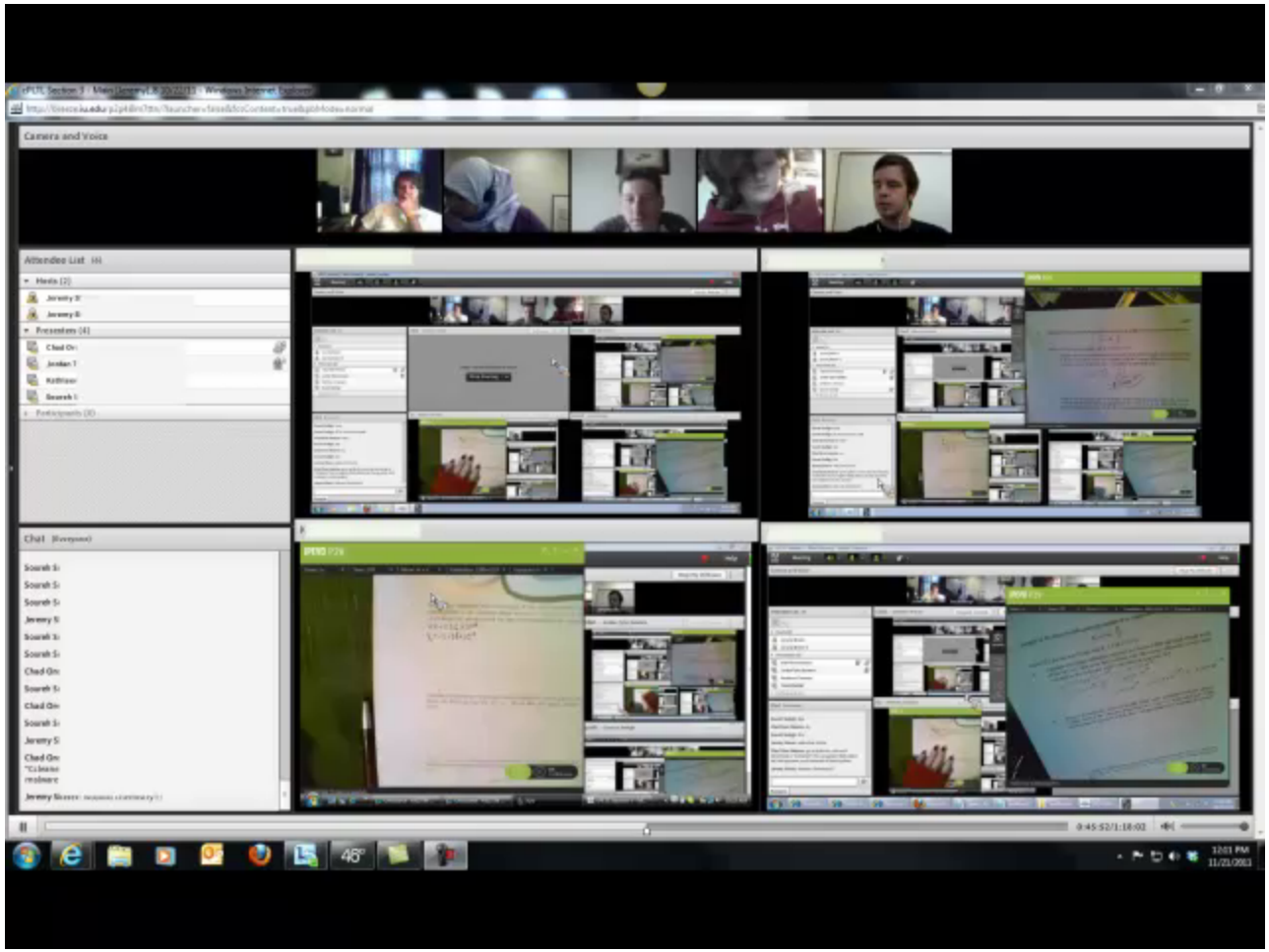
The Attendee List pod displays the names of all users in the room at any time. This allows the peer leader to see who has entered the room as well as who leaves the room during the session.

The Presentation Share pod is the primary workspace for both the peer leaders and the students. This space allows each student/ peer leader to share his or her own screen while being able to see the work that every other student in the group is doing. This provides a collaborative environment in which students complete the work.

The Chat pod is used for providing links or instructions for activities. It can also be used as an alternative method of communication in the event of a technical glitch with the headsets, microphones, or web cameras.



Students' View



Noteworthy Features

- Students have access to virtual rooms anytime, not just during scheduled cPLTL sessions
- Peer leaders automatically record all PLTL sessions

Workshop Zero

Activities supported in Cyberspace

- Brainstorming
- Round robin
- Problem Solving in pairs
- Subgroups
- Reflecting on problem solving
- Reflecting in change of understanding
- Using molecular models

Participants

- 395 students over six semesters
- Students self-selected for PLTL or cPLTL workshop sections
- Comparison groups had similar demographics

Materials

- Identical General Chemistry workbook utilized in PLTL & cPLTL
- 15-unit workbook includes typical first semester General Chemistry content
- Three part per workbook unit:
  - Self-test
  - Workshop problems
  - Post-workshop exercise

Data Collection

- Course grades
- ACS 2005 First Semester General Chemistry exam scores
- Student perception survey
- Student discourse in workshops
  - Recorded during beginning, middle, and end of semester
  - Comparison groups led by the same peer leader
- Interviews
  - Peer leaders
  - faculty

Research article

Smith, J., Wilson, S,B., Banks, J.V., Zhu, L., and Varma-Nelson, P., "*Replicating Peer-Led Team Learning in Cyberspace: Research, Opportunities and Challenges*", *Journal of Research in Science Teaching*, 51 (6), 714-740.

Data Analysis

- Descriptive statistics of course grades, retention rates, & survey data
- *t* tests to compare
  - survey responses
  - mean course grades
  - ACS exam scores
  - frequencies of deep learning discourse by category
- Chi square analysis to examine ABC vs DFW grades by ethnicity & socioeconomic status
- Coding of deep learning discourse critical incidents
- Thematic analysis of observations, transcripts, and interviews

ACS General Chemistry Exam (2005) Scores

(Fall 2010 – Spring 2013)

	cPLTL		PLTL	
	n	Mean (SD)	n	Mean (SD)
American Chemical Society Exam Score	166	62.2% (17.46)	208	63.8% (16.11)

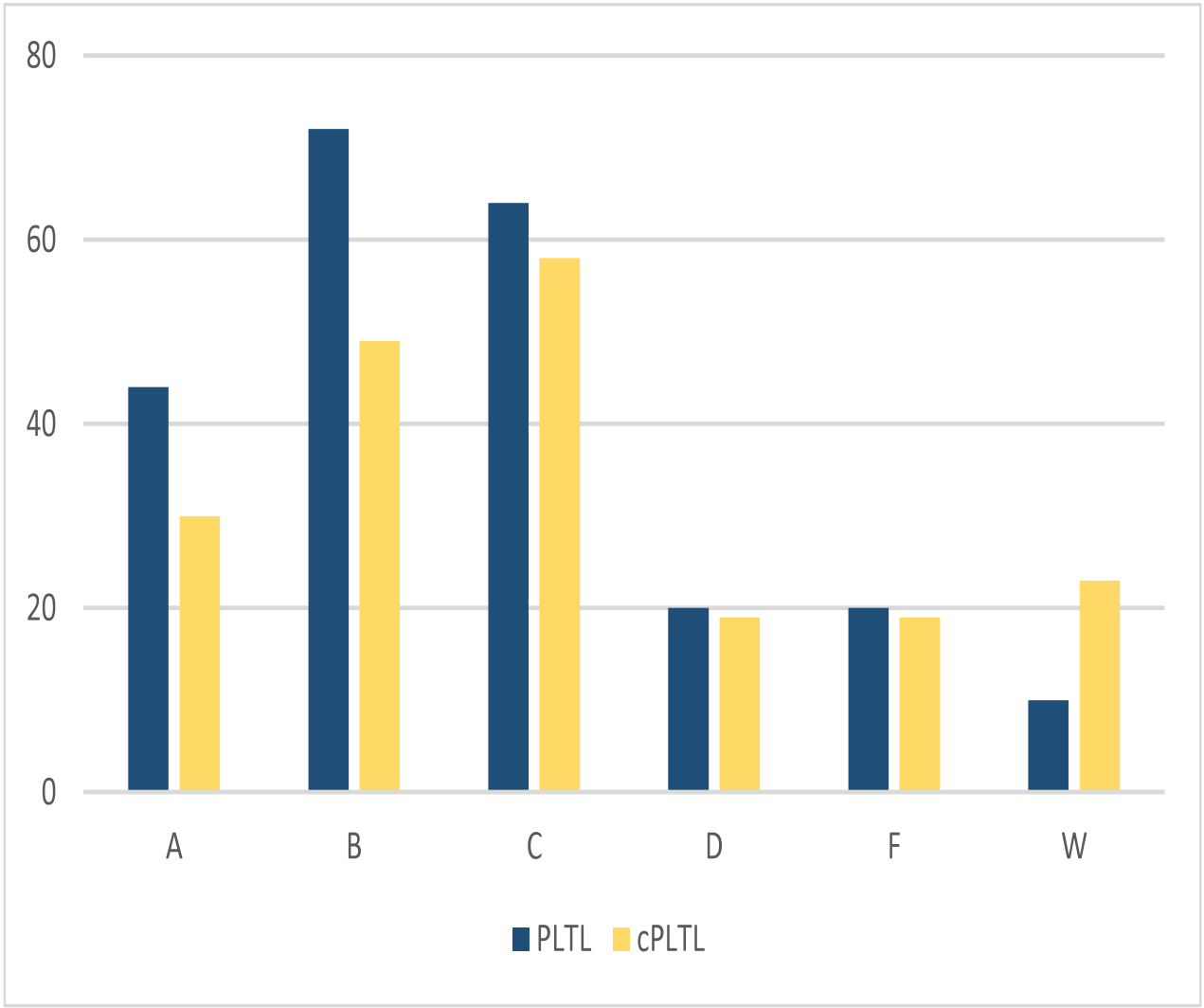
Final Course Grades *(Fall 2010 – Spring 2013)*

	cPLTL		PLTL	
	N	Mean (SD)	N	Mean (SD)
Mean Course Grades	175	2.26 (1.16)	220	2.43 (1.15)
	N	% Earned ABC	N	% Earned ABC
ABC Grades	137	69.2%	180	78.3%*
	N	% Earned DFW	N	% Earned DFW
DFW Grades	61	30.8%	50	21.7%*

*p≤.05; Effect size = 0.21

Note: Total sample size for mean course grades includes only students who completed the

Student Course Grades by Setting



Comparison of Grades by Demographics for each Setting

	cPLTL		PLTL	
	Underrepresented minority	Racial majority	Underrepresented minority	Racial majority
ABC grades	9/22 (40.9%)*	60/86 (69.8%)	18/25 (72.0%)	66/79 (83.5%)
DFW	13/22 (59.1%)	26/86 (30.2%)	7/25 (28.0%)	13/79 (16.5%)

**p<0.05; Effect size=0.75*

	cPLTL		PLTL	
	Low income	Not low income	Low income	Not low income
ABC grades	24/43 (55.8%)*	45/65 (69.2%)	32/43 (74.4%)	52/61 (85.2%)
DFW	19/43 (44.2%)	20/65 (30.8%)	11/43 (25.6%)	9/61 (14.8%)

Note: Discrepancies in *n* reflect demographic data available for participants

**p<0.05; Effect size = 0.49*

Similarities

- Comparable mean course grades and ACS General Chemistry exam scores
- Both settings featured decreasing dependence on the peer leader as students became more interdependent

Differences

- Significant difference in the probability of earning ABC vs DFW grade for underrepresented minority or low income cPLTL students
- cPLTL students accessed more online resources than PLTL students
- Peer leaders addressed groups of students to confirm understanding in PLTL, but individual students in cPLTL
- PLTL students tended to check answers first and discuss problems where students achieved different answers, while cPLTL students were more likely to discuss the problem-solving method for each problem

Implications for Practice: Faculty

- Comparable student achievement (ACS exam scores)
- An environment for social constructivism can be created online
- The time & adaptations required to implement cPLTL depend on available web conferencing platform, instructional technologist support, and PLTL experience.
- cPLTL recordings can be used for formative assessment, training, and research purposes
- Important to form partnerships with students

Implications for Practice: Peer Leaders

- Both PLTL and cPLTL peer leaders express personal and professional growth
- The development of online facilitation skills set cPLTL peer leaders apart from most undergraduate students
- Session recordings can be a reflective and professional development tool
- Different environment requires different facilitation strategies

Implications for Practice: Students

- More development is needed to modify traditional PLTL activities to the online setting
- More research is needed to investigate how to enhance social interactions for fun experiences
- Students need training on how to behave in different teaching environments

Opportunities

- Construct new problems that take advantage of all the information that is available to students
- Better leader training
- Activities to include fun in online environment
- Large database available for research
- MOOCs

What is Gained?

- Faculty use workshops to inform practice as recordings provide insight on students' content knowledge
- Allows observation of leader styles
- Allows capture of *everything*-great for research
- Personally-part of a whole different community

Gains for Students

- Referred to information in the lecture, electronic course notes and materials posted in Oncourse (learning management system)
- Used internet easily to access resources to define, support, and refute conclusions
- Easily shared work and resources with group
- Lower off-task behavior (constant view of the screens) in cPLTL

What is lost?

- Students report having less fun in cPLTL
- No relationship outside of workshops
- Alignment of assessment with what students are learning

Lessons Learned

- Students are invaluable partners in designing and implementing new ways of teaching.
- All students (majority, minority, male, and female) benefit from student centered-teaching.
- Students must be trained for new ways of learning.
- Peer leaders must be trained for their roles and responsibilities.

Lessons Learned (cont.)

- Know your students and institutional culture.
- Role models are important.
- People learn better when they know ahead of time they will have to teach.
- One size does not fit all.
- F2F pedagogies can be successfully transferred to cyber environments with appropriate adaptations.

Critical Components for a Successful cPLTL Program

- Integral part of the course
- Challenging materials (built on information available on internet)
- Trained leaders in pedagogy and technology
- Train leaders in activities that are online and fun for students
- Supportive faculty
- Train students in technology and their role (workshop zero)
- Supportive administration

Publications

Cyber Peer-Led Team Learning (cPLTL): Development and Implementation, Kevin Mauser, John Sours, Julianna Banks, Randy Newbrough, Tom Janke, Lorie Shuck, Lin Zhu, Gina Ammerman and Pratibha Varma-Nelson*, **Educause Quarterly, Vol. 34, No. 4, 2011**

*PLTL: Tracking the Trajectory from Face-to-Face to Online Environments,*Pratibha Varma-Nelson and Julianna Banks, 2013 Chapter 7, pp 95-110

Publications

McDaniel, J., Metcalf, S., Sours, J., Janke, T., Newbrough, J. R., Shuck, L., & Varma-Nelson, P. (2013).
Supporting student collaboration in cyberspace: A cPLTL study of web conferencing platforms. *EDUCAUSE Review Online, 36, 1-8.*

Smith, J., Wilson, S,B., Banks, J.V., Zhu, L., and Varma-Nelson, P., *"Replicating Peer-Led Team Learning in Cyberspace: Research, Opportunities and Challenges"*, *Journal of Research in Science Teaching*, 51 (6), 714-740.

http://cpltl.iupui.edu/

Homework

Thank you!

Questions/Comments?

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