Well documented low success rate in General Chemistry nationwide
  - Gatekeeper course?
  - Low success rate also evident in the setting of the study
  - Typical pass rate of 53%
  - How can the success rate be improved while maintaining the rigor of the class?

The setting

- General Chemistry in the “large lecture”
  - Typical class sizes around 70
- Classes meet in two 75 minute sessions per week
- Multiple classes share a common syllabus
  - Includes a common final exam
  (2002 ACS Gen Chem I exam)

The reform

- Offer classes as three 50 minute sessions per week
- One session per week is dedicated to a peer-led team learning (PLTL) problem solving session
  - Remaining two classes per week are primarily lecture
Over the past two academic years:
- 8 classes were run with the reform
- 21 classes were run without the reform (called Traditional classes)

The 8 reform classes were led by three different instructors.

Are the PLTL classes and the traditional classes directly comparable?
What are the threats to a quasi-experimental design that attempts to attribute observed differences to the effect of pedagogy?
What are the pros and cons in comparing grades between the pedagogies?

During a Peer-led Team Learning (PLTL) session:
- Students
  - 12 to 16 assigned a peer leader
  - Placed in groups of four
  - Given a set of problems created by the instructor
  - Attendance to the sessions was mandatory for class credit

Peer Leaders
- Enroll in a separate training course
- Modeled after a peer-led session
- Assigned a weekly reflective journal
- Observed by instructor
- Observed other peer-led sessions
Peer Leader Training

- Peer Leader Training: Modeled techniques for effective group work while presenting chemistry content
  - Requesting group consensus and encouraging the group to compare answers
  - Asking students to explain their work and decision making process
  - Asking students to present answers to other groups
  - Encouraging students to consult references

- Peer-Led Team Learning

  - Instructors
    - One instructor leads peer leader training class
    - As a group, instructors design a common worksheet
      - Typically worksheets deal with information recently covered
    - Observe peer leaders
      - Though not when it involved their own students
    - Reference the worksheet in class
    - Occasionally fill in for an absent peer-leader

Thoughts...

- What is an appropriate unit of analysis for measuring teaching effectiveness?
- What role does unit of analysis play in evaluating one’s own teaching?
- What outcomes should be evaluated?

Results

<table>
<thead>
<tr>
<th></th>
<th>Traditional (Std. Dev.)</th>
<th>PLTL (Std. Dev.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of classes</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>Average class size</td>
<td>65.7 (8.1)</td>
<td>68.9 (4.7)</td>
</tr>
<tr>
<td>Average on ACS Exam</td>
<td>53% (3.4%)</td>
<td>54% (2.9%)</td>
</tr>
<tr>
<td>Percent Taking ACS Exam*</td>
<td>72% (10%)</td>
<td>84% (5.4%)</td>
</tr>
<tr>
<td>Percent Passing the Class*</td>
<td>53% (10%)</td>
<td>68% (9.2%)</td>
</tr>
<tr>
<td>SAT Math Average</td>
<td>545 (13)</td>
<td>542 (11)</td>
</tr>
<tr>
<td>SAT Verbal Average</td>
<td>536 (12)</td>
<td>534 (6.4)</td>
</tr>
</tbody>
</table>

*Statistically significant difference, p < 0.05
Results: Common Instructors

<table>
<thead>
<tr>
<th></th>
<th>Traditional (Std. Dev.)</th>
<th>PLTL (Std. Dev.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of classes</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Average class size</td>
<td>66.0 (9.6)</td>
<td>68.9 (4.7)</td>
</tr>
<tr>
<td>Average on ACS Exam</td>
<td>53% (3.7)</td>
<td>54% (2.9%)</td>
</tr>
<tr>
<td>Percent Taking ACS Exam*</td>
<td>76% (8.0%)</td>
<td>84% (5.4%)</td>
</tr>
<tr>
<td>Percent Passing the Class*</td>
<td>58% (7.8%)</td>
<td>68% (9.2%)</td>
</tr>
<tr>
<td>SAT Math Average</td>
<td>537 (10.1)</td>
<td>542 (11)</td>
</tr>
<tr>
<td>SAT Verbal Average</td>
<td>530 (13.3)</td>
<td>534 (6.4)</td>
</tr>
</tbody>
</table>

*Statistically significant difference, p < 0.05

Results: Student Groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Traditional Percent Passing (N)</th>
<th>PLTL Percent Passing (N)</th>
<th>Improvement PLTL – Traditional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian &amp; White</td>
<td>55.0% (876)</td>
<td>66.0% (421)</td>
<td>11.0%</td>
</tr>
<tr>
<td>Under-represented minorities</td>
<td>47.0% (185)</td>
<td>64.7% (68)</td>
<td>17.7%</td>
</tr>
<tr>
<td>Male</td>
<td>55.8% (574)</td>
<td>68.6% (264)</td>
<td>12.8%</td>
</tr>
<tr>
<td>Female</td>
<td>51.4% (735)</td>
<td>63.7% (358)</td>
<td>12.3%</td>
</tr>
<tr>
<td>Overall</td>
<td>53.3% (1309)</td>
<td>65.8% (622)</td>
<td>12.5%</td>
</tr>
</tbody>
</table>

Thoughts...

- Are the results compelling?
  - What else (besides the difference in pedagogy) could have caused the observed gains?
  - Has the rigor in the class been maintained?

PLTL References

- Peer-Led Team Learning: A Guidebook; Prentice Hall, 2001
Learning Theories

Ultimately, a generalizable model for improving teaching effectiveness needs a vetted learning theory:
- Vygotsky’s Zone of Proximal Development
- Cooperative learning
- active engagement
- students’ self-concept

Self-Concept

- Self-Concept Inventory (SCI)*
- 40 items
- Likert-scale (1 to 7)
- Validated:
  - Factor Analysis

Five Sub-Scales
- Math
- Chemistry
- Academic
- Academic Enjoyment
- Creativity

*J. Chem Educ, 2005, 82, 1864

PLTL effects Self-Concept

Measure Self Concept of General Chemistry I students in traditional classes at the end of the semester

Compare

Measure Self Concept of General Chemistry I students in PLTL classes at the end of the semester

Note: This was only done during one semester of this study
### Self-Concept

<table>
<thead>
<tr>
<th>Groups</th>
<th>Traditional (std. dev.)</th>
<th>PLTL (std. dev.)</th>
<th>Difference PLTL - Traditional</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC Math</td>
<td>5.048 (1.374)</td>
<td>5.185 (1.203)</td>
<td>0.137</td>
</tr>
<tr>
<td>SC Chemistry</td>
<td>4.492 (1.301)</td>
<td>4.631 (1.290)</td>
<td>0.139</td>
</tr>
<tr>
<td>SC Academic</td>
<td>5.310 (0.916)</td>
<td>5.194 (0.916)</td>
<td>-0.116</td>
</tr>
<tr>
<td>SC Enjoy</td>
<td>5.657 (0.903)</td>
<td>5.418 (0.954)</td>
<td>-0.239</td>
</tr>
<tr>
<td>SC Creativity</td>
<td>4.738 (1.195)</td>
<td>4.649 (1.159)</td>
<td>-0.089</td>
</tr>
</tbody>
</table>

### Student Progression

- Is General Chemistry I a gatekeeper or just one in a series of hurdles for progression in the sciences?

- General Chemistry I (GC1) pass rate improved from 53% to 68% with reform

- “Do these students progress in the field?” is an open question.

- Currently in the setting, 66% of those passing GC1 take GC2 the following semester

- Also in the setting, GC2 has a 60.3% pass rate

For comparison:
- Organic 1 has a 71.3% pass rate
- 88.4% take Organic 2 the following semester
- Organic 2 has a 69.2% pass rate
More topics for discussion…

- Faculty resistance
  - Are you really teaching your class?
  - Incentives for initiating / participating in reform?

- Student resistance
  - I can do this on my own
  - The instructor explains better than my group or peer-leader

Cost to Benefit of PLTL reform

<table>
<thead>
<tr>
<th>Costs</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty time in leading the training class / observing peer leaders</td>
<td>Improved pass rate in the target course</td>
</tr>
<tr>
<td>Less faculty to student interaction</td>
<td>Peer leaders’ experience with communication skills and content</td>
</tr>
<tr>
<td></td>
<td>Students’ experience with communication skills and group work</td>
</tr>
</tbody>
</table>

Other goals, not addressed...

- What else would be worth measuring pertaining to reform effectiveness?
- Affective domain
  - Students’ interest in science
  - Students’ motivation to pursue science
- Learning retention
  - Does the pedagogy promote retention of concepts?
Assessments to measure retention of concepts:
- Traditional assessments given at a later point in time
- Open-ended assessments that rely on incorporating past knowledge

Pedagogical change can have a demonstrated impact on classroom success
Teaching evaluations benefit by considering:
- Appropriate Unit of Analysis
- Student retention and student success
- Additional measures of student performance

Thanks to:
- Instructors, students and peer leaders at the setting
- Supportive administration at the setting
- PKAL coordinators
- You!