Workshop Objectives

At the completion of this session, participants will make progress toward:

• Distinguishing the techniques used in various active learning pedagogies
• Evaluating each pedagogy for alignment with instructional objectives
• Identifying practical strategies to integrate active learning techniques into current practices
Agenda

- Introductions and welcome
- What the literature on active learning says
- JiTT and PI
- POGIL and TBL
- PLTL and PBL
- Reflection and exit ticket
“Adopting instructional practices that engage students in the learning process is the defining feature of active learning.”
-Michael Prince
Benefits Illustrated

http://www.physics.indiana.edu/~sdi/ajpv3i.pdf
Collaborative and Cooperative Learning

<table>
<thead>
<tr>
<th>Reference</th>
<th>Learning Outcome</th>
<th>Effect Size</th>
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</thead>
<tbody>
<tr>
<td>Johnson, Johnson and Smith [12]</td>
<td>Improved academic achievement</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>Improved quality of interpersonal interactions</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>Improved self-esteem</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td>Improved perceptions of greater social support</td>
<td>0.70</td>
</tr>
<tr>
<td>Johnson, Johnson and Smith [13]</td>
<td>Improved academic achievement</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>Improved liking among students</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>Improved self-esteem</td>
<td>0.29</td>
</tr>
<tr>
<td></td>
<td>Improved perceptions of greater social support</td>
<td>0.51</td>
</tr>
<tr>
<td>Springer et al. [43]</td>
<td>Improved academic achievement</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>Improved student attitudes</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>Improved retention in academic programs</td>
<td>0.46</td>
</tr>
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Problem-Based Learning

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Effect Size</th>
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<tbody>
<tr>
<td>(a) Individualized</td>
<td>0.23</td>
</tr>
<tr>
<td>(b) Cooperative</td>
<td>0.54</td>
</tr>
<tr>
<td>(c) Small group</td>
<td>0.31</td>
</tr>
<tr>
<td>(d) With non-expert tutors</td>
<td>-0.74</td>
</tr>
<tr>
<td>(e) Self-paced</td>
<td>-0.07</td>
</tr>
<tr>
<td>(f) Self-directed</td>
<td>-0.05</td>
</tr>
<tr>
<td>(g) Using problems</td>
<td>0.20</td>
</tr>
<tr>
<td>(h) Inquiry based</td>
<td>0.16</td>
</tr>
<tr>
<td>(i) Instruction in problem solving</td>
<td>0.54</td>
</tr>
<tr>
<td>(j) Inductive</td>
<td>0.06</td>
</tr>
</tbody>
</table>

http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/Prince_AL.pdf
Active Learning in STEM

Metaanalysis of 225 studies
- 158 studies: average 0.47 SDs better on CIs/exams
- 67 studies: average failure rate dropped from 33.8% to 21.8% with active learning

Active Learning in CS 450

Course grades in CS 450 for Fall 2012 vs. Fall 2013

Final exam performance for Fall 2012 vs. Fall 2013

Terminology Detour

Active learning
• Requires students to engage in meaningful activities

Collaborative learning
• Students work together toward common goal

Cooperative learning
• Like collaborative, but individual assessment

Flipped classroom
• Delivers content outside of classroom

Problem-based learning
• Relevant problems used to provide context

Team-based learning
• A specific teaching strategy designed by Larry Michaelsen
Survey

On a scrap of paper, respond to the following question:

What is your biggest concern about adopting an active learning pedagogy in your course(s)?
First reading
Question

Which of the following statements best summarizes the relationship between pedagogy and the gender gap in physics?

A. There is a small gender gap on the pretest, and the performance gap increases in traditional lecture.
B. Courses with interactive structures yield greater performance gains from the pretest to the posttest among women than men.
C. Cooperative learning courses improve women students’ confidence, but show equal performance gains from pretest to posttest among men and women.
Closing the Gender Gap

Cooperative learning closes the gender gap
- Pretest scores were 10% points higher for men
- Gap persisted with lecture alone
- Posttest results for cooperative classes were almost equal

PI can eliminate gender gap in physics
- T: traditional lectures
- IE: interactive lectures
- IE+: interactive assignments, lectures, tutorials

E. Mazur, “The scientific approach to teaching: Research as a basis for course design,” keynote/plenary talk at the International Computing Education Research Conference (ICER), 2011. 
http://mazur.harvard.edu/search-talks.php?function=display&rowid=1712
Closing the Gender Gap

Traditional lectures leave women behind
• Women tend to have smaller performance gains

Cooperative learning improves gains for women
• ...but men improve as well

Question

When in-class demonstrations were studied, which group of students did the **worst** in the sense that they missed the most points?

A. Students who did not observe a demo  
B. Students who only observed a demo  
C. Students who predicted the outcome before it occurred  
D. Students who discussed the outcome afterward
Demos and Engagement

Performance and understanding increase with engagement.

- Those who only observe sometimes learn it wrong.
- Those who discuss show clearer reasoning and provide partially correct answers.

<table>
<thead>
<tr>
<th>mode</th>
<th>correct</th>
<th>incorrect</th>
</tr>
</thead>
<tbody>
<tr>
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<td>30%</td>
<td>70%</td>
</tr>
<tr>
<td>observe</td>
<td>18%</td>
<td>82%</td>
</tr>
<tr>
<td>predict</td>
<td>29%</td>
<td>71%</td>
</tr>
<tr>
<td>discuss</td>
<td>30%</td>
<td>70%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>mode</th>
<th>correct</th>
<th>balances torques</th>
<th>no clear reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>no demo</td>
<td>31%</td>
<td>53%</td>
<td>42%</td>
</tr>
<tr>
<td>observe</td>
<td>42%</td>
<td>55%</td>
<td>42%</td>
</tr>
<tr>
<td>predict</td>
<td>41%</td>
<td>65%</td>
<td>32%</td>
</tr>
<tr>
<td>discuss</td>
<td>46%</td>
<td>85%</td>
<td>15%</td>
</tr>
</tbody>
</table>
Confusion and Understanding

“Please tell us briefly what points of reading you found most difficult or confusing.”
- “Nothing was difficult or confusing.”
- “I found the explanation inadequate. I don’t understand the reasoning that led to the conclusion.”

<table>
<thead>
<tr>
<th></th>
<th>Capillarity</th>
<th>Correct</th>
<th>Incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confused</td>
<td>44%</td>
<td></td>
<td>56%</td>
</tr>
<tr>
<td>Not Confused</td>
<td>25%</td>
<td></td>
<td>75%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Laplace</th>
<th>Correct</th>
<th>Incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confused</td>
<td>49%</td>
<td></td>
<td>51%</td>
</tr>
<tr>
<td>Not Confused</td>
<td>21%</td>
<td></td>
<td>79%</td>
</tr>
</tbody>
</table>
JiTT and PI

Just-in-time teaching (JiTT)
- Developed at IUPUI, Davidson College, U.S. Air Force Academy
- Goals: increase learning during class time, enhance motivation, encourage preparation, allow faculty to adapt to student needs
- Key features:
  - Online warm-up quizzes and puzzles (<24 hours before class)
  - Mini-lectures (~10 minutes)
  - Active classroom with exercises, worksheets, discussions, demos
  - Exit tickets

Peer Instruction
- Created by Eric Mazur (Harvard)
- Augment class with *ConcepTests*
  - Expose common misconceptions
  - Think-vote-pair-revote pattern
Question

Which classification(s) best describe JiTT and PI?

A. Active learning  
B. Collaborative learning  
C. Cooperative learning  
D. Flipped classroom  
E. Problem-based learning  
F. Team-based learning
POGIL and TBL

Process-oriented guided inquiry learning (POGIL)
- Developed by Richard S. Moog and colleagues (Franklin & Marshall, Stony Brook)
- Goals: teach process skills through inquiry-based learning
- Key features:
  - Teams with assigned roles
  - Carefully structured activities to build up to a concept

Team-based learning (TBL)
- Created by Larry Michaelsen
- Goals: work cooperatively to apply concepts to solve significant problems
- Very specific structure for course with 5-7 modules
  - Permanent, instructor-assigned groups
  - iRAT/tRAT - preparatory tests of reading understanding
  - 4 S’s - Significant problem, same problem, specific choice, simultaneous reporting
Wading through the Pedagogy Alphabet Soup  
JMU CFI May Symposium 2015 • Dr. Michael S. Kirkpatrick  

TBL Module Structure

Figure 1

Team-Based Learning Instructional Activity Sequence  
(Repeated for each major instructional unit, i.e., 5-7 per course)

<table>
<thead>
<tr>
<th>Preparation (pre-class)</th>
<th>Readiness Assurance</th>
<th>Application of Course Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2-5</td>
<td>6</td>
</tr>
</tbody>
</table>

- 1-4 hours of class time
- 45-75 minutes of class time
- 1-4 hours of class time

Team-Based Learning (TBL) probably relies on small-group interaction more heavily than any other commonly used strategy in post-secondary education (e.g., for comparative discussion of different approaches, see Fink, 2002, 2004; Johnson, Johnson & Smith, 2007; Millis & Cottell, 1998; Michaelsen, Peterson & Sweet, 2009). This conclusion is based on three facts. First, with TBL, group work is central to both exposing students to and enhancing their ability to apply the course content. Second, with TBL, the vast majority of class time is used for group work. Third, courses taught with TBL typically involve multiple group assignments that are specifically designed and sequenced to both improve learning and promote the development of self-managed learning teams.

This chapter begins with a very brief overview of TBL to ground readers in the basics so they can most benefit from the detailed discussions that follow. Next we discuss the four essential elements of TBL, and then walk through the steps required to implement TBL. Finally, we examine some of the benefits that students, administrators and faculty can expect from a successful implementation of TBL.

A Broad Overview of TBL

The primary learning objective in TBL is to go beyond simply “covering” content and focus on ensuring that students have the opportunity to practice using course concepts to solve problems. Thus, TBL is designed to provide students with both conceptual and procedural knowledge (e.g., Krathwohl, 2002) and, although some time in the TBL classroom is spent on ensuring that students master the course content, the vast majority of class time is used for team assignments that focus on using course content to solve the kinds of problems that students are likely to face at some point in the future.

Figure 1 outlines generally how time in one unit of a TBL course is organized.

In a TBL course, students are strategically organized into permanent groups (for the entire term) and the course content is organized into major units (typically 5-7). Before any in-class content work, students must study assigned materials because each unit begins with the Readiness Assurance Process (RAP). The RAP consists of a short test (over the key ideas from...
POGIL Handout
iRAT and tRAT
The Essential Elements of Team-Based Learning


Team-Based Learning (TBL) probably relies on small-group interaction more heavily than any other commonly-used strategy in post-secondary education (e.g., for comparative discussion of different approaches, see Fink, 2002, 2004; Johnson, Johnson & Smith, 2007; Millis & Cottell, 1998; Michaelsen, Peterson & Sweet, 2009). This conclusion is based on three facts. First, with TBL, group work is central to both exposing students to and enhancing their ability to apply the course content. Second, with TBL, the vast majority of class time is used for group work. Third, courses taught with TBL typically involve multiple group assignments that are specifically designed and sequenced to both improve learning and promote the development of self-managed learning teams.

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TBL Handout
PLTL and PBL

Peer-led team learning (PLTL)
- Developed by David K. Gosser (CUNY) and others
- Recruit and train peers from recent classes
- Course instructors design materials used during weekly peer workshops
- Goals: build community of practitioners, identify and address misconceptions quickly, give advanced students practice

Problem-based learning (PBL)
- Use relevant problems to provide context for learning
- No clear instructional pattern or strategy
- Literature is inconsistent in use
  - Evidence is dependent on definition, which varies
Reflection and Exit Ticket
Resources

Process-oriented guided inquiry learning (POGIL)
  • http://pogil.org/

Team-based learning (TBL)
  • http://learntbl.ca/

Peer Instruction (PI)
  • http://mazur.harvard.edu/research/detailspage.php?rowid=8

Just-in-Time Teaching (JiTT)
  • G. Novak and A. Gavrin, Just-In-Time Teaching: Blending Active Learning with Web Technology, 1999.
  • http://jittdl.physics.iupui.edu/jitt/