Turning Homework & Exams on their Head
–
Deeper Learning by Putting Students in Charge through Participatory Learning

Michael Bieber,
Erick Sanchez Suasnabar, Yu Xu
Informatics Department
College of Computing Sciences
New Jersey Institute of Technology
web.njit.edu/~bieber

Jeffrey Hsu
IS & Decision Sciences Dept.
Silberman College of Business
Fairleigh Dickinson University
jeff@fdu.edu

OLC-ELD Conference – June 2017
Jumping right into PL…

• About Participatory Learning (PL)
• Experience in classes 2014-2017 & demo
• Motivation & Theoretical Background
• Experimental Results
• Exercise: Applying PL
• Interesting Issues
• Future Work & Invitation to Collaborate
Traditional Assignments

Are you learning effectively?
Participatory Learning

engaging you in the full problem lifecycle

Create Problem

Revise Problem

Solve Problem

Grade Solution (x2)

Consolidate Grades

Dispute Grade

Resolve Dispute

Instructor (quality control)

Instructor (quality control)
Participatory Learning

Learning from the full problem lifecycle

Create Problem

Revise Problem

Solve Problem

Grade Solution (x2)

Consolidate Grades

Dispute Grade

Resolve Dispute

Problem-based Learning

Peer Assessment

Traditional Learning

Learning by Example

Self Assessment

NJIT
New Jersey’s Science & Technology University
Participatory Learning

Demo: PHIL 334

Create Problem
→ Edit Problem
→ Solve Problem
→ Grade Solution (x2)
→ Consolidate Grades
→ Dispute Grade
→ Resolve Dispute

Problem-based Learning
Peer Assessment
Traditional Learning
Learning by Example
Self Assessment
Assignment: Problem for IS 331

Course: IS 331 — 001 — Summer 2013

Please design 10 simple SQL queries, all working with ONE table. The queries should test your peers' ability to use "SELECT, FROM, WHERE, GROUP BY" and "HAVING" commands.

Create Problem

Problem:

Given a table "CUSTOMERS", write a SQL query that finds the occupations of all customers with the last name "Bieber", sorting by ascending order.

Create Solution

Solution:

```sql
SELECT FNAME, LNAME, OCCUPATION
FROM CUSTOMER
WHERE LNAME = "Bieber"
ORDER BY LNAME;
```

Grade Solution

You performed this task.

Correctness Grade:

50

Grade Correctness:

Very Good!

Completeness Grade:

50

Grade Completeness:

Perfect!

Dispute

The solution grade was disputed.

Proposed Completeness Grade:

50%

Proposed Completeness Justification:

I could have done better.

Proposed Correctness Grade:

30%

Proposed Correctness Justification:

I wasn't perfectly clear.

Resolve Dispute

Correctness Grade: 40%

Correctness:
The dispute points were acceptable, so I am adjusting the grade accordingly.

Completeness Grade: 40%

Completeness:
The dispute points were acceptable, so I am adjusting the grade accordingly.
Fall 2014 – Spring 2017

• Engineering Ethics
  – Discussion – Short essay questions about ethics scenarios
  – Quizzes (true/false, matching, short answer)

• Computer Ethics
  – Weekly discussion questions (short essay)

• PhD Seminar – Social Media
  – Essay questions

• Computer Science – MatLab assignments

• Business – spreadsheet assignments

• (pre-prototype) Intro to Information Systems (MS)
  – Midterm/Final Exams (essay questions)

Similar positive results from student surveys
Invitation to Collaborate!
A bit of research...

- About Participatory Learning (PL)
- Experience in classes 2014-2017 & demo
- Motivation & Theoretical Background
- Experimental Results
- Exercise: Applying PL
- Interesting Issues
- Future Work & Invitation to Collaborate
Motivation

• Deeper learning and interest in subjects

• How?
  – Learn through active engagement, involving students as active participants
  – Give students ownership of entire problem life cycle
  – Use online system to scaffold the process
    • (and streamline it)
Constructivist Learning Theory
(Piaget, 1928; Vygotsky, 1978)

• Learners are active creators of their own knowledge, learning by constructing their own understanding and knowledge of the world through experience and reflecting upon that experience (Harasim, 2012).

• Learners are encouraged to share their experiences, perspectives and questions about each other’s understanding (Tam, 2000).
Active Engagement & Deeper Learning

- empowers students to take ownership of their own learning
- increases satisfaction and persistence in learning (Joo et al., 2011)
- motivates students (Guthrie, 2004; Holocher-Ertl et al., 2013; Jones, 2009; Sircar & Tandon, 1999)

to achieve deeper or higher learning outcomes (Anderson et al., 2001; Bloom et al., 1956; Felder & Brent, 2004)
Active Engagement & Deeper Learning

• e.g., when designing problems, students must organize and synthesize their ideas, and learn to recognize the domain’s important concepts, resulting in “deep” learning

(Hargreaves, 1997; Entwistle, 2000; Keane et al., 2014)
Problem-Based Learning

• Driven by challenging, open-ended questions, collaborative learning, and constructivist pedagogies (Savery & Duffy, 1995; Swan et al., 2013).

• An instructional method in which students learn through facilitated problem solving (Hmelo-Silver, 2004).

• A learning process enabling students to generate new knowledge from real-world problems and then develop the skills of analytical thinking and problem-solving thinking (Phumeechanya & Wannapiroon, 2014).
Self and Peer Assessment

• Assessment, teaching, and learning are inextricably linked. Assessment should be integral to education in that it services to guide the teaching and learning process. (Hargreaves, 1997).

• An effective approach to encourage deeper learning, such as creating new ideas, and critical judgment of students’ works (Bhalerao & Ward, 2001).
What is Unique about PL?

• Relies on student’s active participation in every problem lifecycle stage for course activities.
  – instructors scaffold, mentor & provide quality control

• Researchers have studied, and many instructors utilize individual PL stages.

• PL *uniquely* combines these stages into a comprehensive framework for deeper learning.
Research Questions

1. Do students enjoy their learning experience with PL?

2. Do students perceive more learning with PL?
   
   *Future: do students actually learn more with PL?*

3. Do students learn from all or only specific PL stages (designing, reading, answering and grading problems)?

4. Do students and instructors accept PL? Would they recommend its continued use?
Experiment with Discussion/Quiz Questions

PHIL 334: Engineering Ethics

- undergraduate core
- e-learning sections, 200+ students
- software: PL Prototype (version 1)
- discussion questions
  - short essay
- quiz questions
  - short answer, true/false, matching
# Enjoyability

Cronbach's Alpha=0.83

<table>
<thead>
<tr>
<th>Questions</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
<th>Mean</th>
<th>S.D.</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoyed the flexibility in organizing my resources</td>
<td>41.8%</td>
<td>34.4%</td>
<td>13.1%</td>
<td>7.4%</td>
<td>3.3%</td>
<td>1.96</td>
<td>1.07</td>
<td>122</td>
</tr>
<tr>
<td>I was motivated to do my best work</td>
<td>29.5%</td>
<td>38.5%</td>
<td>25.4%</td>
<td>5.7%</td>
<td>0.8%</td>
<td>2.10</td>
<td>0.92</td>
<td>122</td>
</tr>
<tr>
<td>I enjoyed the PL approach</td>
<td>36.9%</td>
<td>38.5%</td>
<td>15.6%</td>
<td>7.4%</td>
<td>1.6%</td>
<td>1.98</td>
<td>0.99</td>
<td>122</td>
</tr>
</tbody>
</table>

SA - strongly agree (1 point); A - agree (2); N - neutral (3); D - disagree (4); SD - strongly disagree (5); the mean is out of 5 points; S.D. - standard deviation
<table>
<thead>
<tr>
<th>Questions</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
<th>Mean</th>
<th>S.D.</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>I learned from making up questions</td>
<td>27.9%</td>
<td>36.1%</td>
<td>20.5%</td>
<td>9.8%</td>
<td>5.7%</td>
<td>2.30</td>
<td>1.15</td>
<td>122</td>
</tr>
<tr>
<td>I learned from grading other students solutions</td>
<td>36.1%</td>
<td>34.4%</td>
<td>18.0%</td>
<td>6.6%</td>
<td>4.9%</td>
<td>2.10</td>
<td>1.12</td>
<td>122</td>
</tr>
<tr>
<td>I learned from reading other people’s entries</td>
<td>37.7%</td>
<td>36.1%</td>
<td>14.8%</td>
<td>8.2%</td>
<td>3.3%</td>
<td>2.03</td>
<td>1.08</td>
<td>122</td>
</tr>
<tr>
<td>My skill in critical thinking was increased.</td>
<td>19.7%</td>
<td>42.6%</td>
<td>32.8%</td>
<td>3.3%</td>
<td>1.6%</td>
<td>2.25</td>
<td>0.87</td>
<td>122</td>
</tr>
<tr>
<td>My ability to integrate facts and develop generalizations improved</td>
<td>23.0%</td>
<td>41.8%</td>
<td>31.1%</td>
<td>2.5%</td>
<td>1.6%</td>
<td>2.18</td>
<td>0.87</td>
<td>122</td>
</tr>
<tr>
<td>I was stimulated to do additional reading.</td>
<td>27.0%</td>
<td>35.2%</td>
<td>25.4%</td>
<td>9.0%</td>
<td>3.3%</td>
<td>2.26</td>
<td>1.06</td>
<td>122</td>
</tr>
<tr>
<td>I learned to value other points of view</td>
<td>33.6%</td>
<td>45.1%</td>
<td>16.4%</td>
<td>3.3%</td>
<td>1.6%</td>
<td>1.94</td>
<td>0.88</td>
<td>122</td>
</tr>
</tbody>
</table>

Cronbach’s Alpha = 0.90
**Recommendation: Do Again!**

<table>
<thead>
<tr>
<th>Question</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
<th>Mean</th>
<th>S.D.</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Would you recommend in the future that this course uses PL?</td>
<td>44.3%</td>
<td>41.0%</td>
<td>8.2%</td>
<td>4.1%</td>
<td>2.5%</td>
<td>1.80</td>
<td>0.94</td>
<td>122</td>
</tr>
</tbody>
</table>
Student Comments

I felt that in creating questions, I had to learn more and understand the concept correctly to be able to make a question that would help someone else learn.

It makes the students get involved and actually read the material.

It got the students involved in creating their own questions and answers. I believe it made the student really get into a certain part of study instead of glancing over everything just to answer a quiz.

Looking at others papers make a students understand how to answer the question even better than the first time.

I liked the overall approach of the system and how we had more than one grader, sometimes involving a third person having to resolve a grade, which is a very fair approach of grading someone else's work and assigning a fair grade.
Student Comments

I would use the [PL] approach because it allows students to dispute grades, and find ways to improve the work flow by taking advice from other students/graders.

I learnt working with others. Also taking the responsibility by making questions and grading. It was a good learning experience.

Grading other peoples responses is a good way to learn.

It was more interactive and better learning experience than normal quizzes.

It actually made me learned stuff. I didn't just answer questions and called it a day.
Instructor Comments

I think they learned both in the sense that in order to ask a question, they need to have some mastery of the material, and then I was impressed with how seriously they took with grading the other students. And I think that also requires them to really master the material in a way that is different than if they are just taking the class and know that at some point they are going to have to either answer my essay questions or my exam questions. I think it makes them more engaged with the material.

The kind of questions that I see them asking really shows that they’ve thought about the material beyond just what they’ve read…A lot of the questions they asked really involve them having thought about some kind of scenario and asking the other students what would you do in the scenario given what the chapter says.
Instructor Comments, cont.

I think the students working on the problems, creation and problem solving, and especially they can look at the solutions of other students, and maybe mistakes made by other students, are really helpful for them to learn, because they can have more opportunities to learn, not only from the textbook, but also from other students.

If you create problems, if you grade other students’ homework, it seems that these activities give students more chances to practice to learn.

In the section that we are using [participatory learning, in the recitations] the students seem to be more actively engaging… When I give them questions, they tend to give me more feedback than the [non participatory learning section] students. They are just more active [in discussion].
Experiment with Essay Exams

NJIT CIS677: Information System Principles

- Graduate level introductory core course (Masters/Ph.D.)
- Course Goal: study how IS/IT can be used effectively
- Both on-campus and distance-learning sections
- Software: WebBoard LMS (*pre-prototype*)
- Traditional Exam:
  - Three-hour, in class, 3-4 essay questions, 6 pages of notes
- Compared control groups and treatment groups
  - 220+ students in treatment group
## Enjoyability

Cronbach’s Alpha = 0.68

<table>
<thead>
<tr>
<th>Questions</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
<th>Mean</th>
<th>S.D.</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoyed the flexibility in organizing my resources</td>
<td>26.2%</td>
<td>48.9%</td>
<td>16.7%</td>
<td>3.6%</td>
<td>4.6%</td>
<td>3.88</td>
<td>1.00</td>
<td>221</td>
</tr>
<tr>
<td>I was motivated to do my best work</td>
<td>23.5%</td>
<td>42.9%</td>
<td>28.2%</td>
<td>3.4%</td>
<td>2.1%</td>
<td>3.82</td>
<td>.92</td>
<td>238</td>
</tr>
<tr>
<td>I enjoyed the examination process</td>
<td>17.2%</td>
<td>42.3%</td>
<td>22.6%</td>
<td>10.5%</td>
<td>7.4%</td>
<td>3.51</td>
<td>1.13</td>
<td>239</td>
</tr>
</tbody>
</table>

SA - strongly agree (5 points); A - agree (4); N - neutral (3); D - disagree (2); SD - strongly disagree (1); the mean is out of 5 points; S.D. - standard deviation
## Perceived Learning

*Cronbach’s Alpha=0.88*

<table>
<thead>
<tr>
<th>Questions</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
<th>Mean</th>
<th>S.D.</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>I learned from making up questions</td>
<td>17.9%</td>
<td>42.5%</td>
<td>21.3%</td>
<td>13.8%</td>
<td>4.5%</td>
<td>3.55</td>
<td>1.08</td>
<td>240</td>
</tr>
<tr>
<td>I learned from grading other students answers</td>
<td>17.7%</td>
<td>48.1%</td>
<td>19.4%</td>
<td>9.3%</td>
<td>5.5%</td>
<td>3.63</td>
<td>1.06</td>
<td>237</td>
</tr>
<tr>
<td>I learned from reading other people’s answers</td>
<td>15.8%</td>
<td>45.0%</td>
<td>22.1%</td>
<td>11.3%</td>
<td>5.8%</td>
<td>3.54</td>
<td>1.07</td>
<td>240</td>
</tr>
<tr>
<td>I demonstrated what I learned in class</td>
<td>13.6%</td>
<td>50.2%</td>
<td>22.6%</td>
<td>10.9%</td>
<td>2.7%</td>
<td>3.61</td>
<td>.95</td>
<td>221</td>
</tr>
<tr>
<td>My ability to integrate facts and develop generalizations improved</td>
<td>21.8%</td>
<td>49.2%</td>
<td>25.6%</td>
<td>2.1%</td>
<td>1.3%</td>
<td>3.88</td>
<td>.83</td>
<td>238</td>
</tr>
<tr>
<td>I learned to value other points of view</td>
<td>17.6%</td>
<td>51.9%</td>
<td>27.6%</td>
<td>1.3%</td>
<td>1.6%</td>
<td>3.82</td>
<td>.81</td>
<td>239</td>
</tr>
<tr>
<td>I mastered the course materials</td>
<td>7.4%</td>
<td>51.6%</td>
<td>31.4%</td>
<td>6.9%</td>
<td>2.7%</td>
<td>3.54</td>
<td>.84</td>
<td>188</td>
</tr>
</tbody>
</table>
Recommendation: Do Again!

<table>
<thead>
<tr>
<th>Question</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
<th>Mean</th>
<th>S.D.</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Would you recommend in the future that this exam process used?</td>
<td>20.7%</td>
<td>40.1%</td>
<td>24.5%</td>
<td>8.9%</td>
<td>5.8%</td>
<td><strong>3.60</strong></td>
<td>1.10</td>
<td>237</td>
</tr>
</tbody>
</table>
Experiment with Essay Exams

• Experimental results:
  – Students felt they learned more
  – Students enjoyed the exam more
  – Students recommend it for future classes

• What students liked best
  – Active involvement in the exam process
  – Flexibility to use any resources
  – Reduction in tension
Time to Apply PL…

• About Participatory Learning (PL)
• Experience in classes 2014-2017 & demo
• Motivation & Theoretical Background
• Experimental Results
• Exercise: Applying PL
• Interesting Issues
• Future Work & Invitation to Collaborate
Possibilities

- **Levels?** K-12, CC, UG, grad, vocational, profs
- **Subjects?** STEM, Humanities, Ed, Professions
- **Types?** homework, labs, discussion, papers, longer projects, quizzes, exams
- **Size?** small classes ↔ MOOCs?
- **Informal Learning?** hackathon, study groups
- **Structures?** Grade problem/assessment, commenting, multi-part problems
Alternate Structures

Create Problem

Revise Problem

Solve Problem

Grade Solution (x2)

Consolidate Grades

Dispute Grade

Resolve Dispute
Grade quality of company, dilemma & solution

Create Company
  └ Revise Company
    └ Create Ethical Dilemma
      └ Revise Dilemma
        └ Solve Co’s Dilemma
          └ Grade Solution (x2)
            └ Consolidate Grades
              └ Dispute Grade
                └ Resolve Dispute

Grade Company
  └ Dispute Grade
    └ Resolve Dispute

Grade Dilemma
  └ Dispute Grade
    └ Resolve Dispute
Craft Science Topic

Revise Topic

Develop Proposal

Project Report

Class Presentation

Presentation Critiques (x5)

Consolidate Critiques

Critique Proposal (x3)

Consolidate Critiques

Revise Proposal

Grade Report (x3)

Dispute Grade

Resolve Dispute

Semester Project

Grade quality of report. Get critiques of proposal (for revision) and final presentation.
S1 creates scenario

S2 analyzes scenario

S1 creates video of analysis, which is critiqued, revised & graded
S1 creates scenario

S2 analyzes scenario

S1 creates video of analysis, which is critiqued, revised, and graded
How could you use PL?

• **Levels?** K-12, CC, UG, grad, vocational, profs

• **Subjects?** STEM, Humanities, Ed, Professions

• **Types?** homework, labs, discussion, papers, longer projects, quizzes, exams

• **Size?** small classes ↔ MOOCs?

• **Informal Learning?** hackathon, study groups

• **Structures?** Grade problem/assessment, commenting, multi-part problems
Issues:

- Which problem types?
- Which subjects?
- Level (K-12, UG, Grad, T&D)
- MOOCs?
- More flexible structure
- e.g., grading problem quality
- The few who don’t participate
Issues

- Scaffolds, e.g., effective rubrics
- Fostering good arguments
- Higher levels of learning
- Calibration: learning each skill
- Groups
- Anonymity / Avatars
- Learning interpersonal skills
- Gaming: badges, leaderboard
- Trusting Peers
- Interest in “uninteresting subjects”
- Motivating articulation / further education
- Students with challenges

Participatory Learning

- Create Problem
- Revise Problem
- Solve Problem
- Grade Solution (x2)
- Consolidate Grades
- Dispute Grade
- Resolve Dispute

Read Everything
Wrapping Up…

• About Participatory Learning (PL)
• Experience in classes 2014-2017 & demo
• Motivation & Theoretical Background
• Experimental Results
• Exercise: Applying PL
• Interesting Issues
• Future Work & Invitation to Collaborate
Future Work

- Experimenting with different aspects of PL
- Researching and exploring the issues
- Collaborating with different courses & learning environments
- With you??? Looking for collaboration!
ELD Session Evaluations Contest

- [https://tinyurl.com/OLCwELD-program](https://tinyurl.com/OLCwELD-program)
- Navigate to specific session page to evaluate
- Click orange “Evaluate Session” button on the right
- Complete session evaluation*

Each session evaluation completed (limited to one per session) = one contest entry
One (1) $25 gift card will be awarded

*Contact information required for contest entry but will not be shared with the presenters. Winners will be contacted post-conference.
Invitation to Collaborate!
bieber@njit.edu
web.njit.edu/~bieber

For more on PL:
web.njit.edu/~bieber/pubs.html#p

ELD Evaluate Session:
tinyurl.com/OLCwELD-program
References