Collaborative Research: PROfessional Development and Uptake through Collaborative Teams (PRODUCT) Supporting Inquiry Based Learning in Undergraduate Mathematics

Follow-Up Report: 2019 workshops
April 2021

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This evaluation report shares findings from the follow-up surveys conducted with participants from three workshops: St. Thomas University, St Paul, MN, June 18-21, 2019 (IWS 9), at the Paramount Hotel in Portland, OR, June 25-28, 2019 (IWS 10), and at the Staybridge Suites, Torrance, CA, July 9-12, 2019 (IWS 11). After a full academic year (about 15 months) following the workshops, we surveyed participants to see if they were using IBL methods in their classes and to learn more about the outcomes from the workshop. Detailed descriptions of the project, the data set, and the research methods are available in a previous report (Hayward & Laursen, 2013). The follow-up surveys were administered through Qualtrics from October 2020 through January 2021.

This is a moderate response rate on the follow-up survey. Successful matching indicates that results shared here are generally representative of the workshop attendees. However, we cannot assume non-respondents are similar to respondents in all ways.
Outcomes

Results shared throughout this report are only for the follow-up survey respondents (53 of 78, 68%), except where noted. Implementation rates for all participants may differ from those values presented here, as we do not know if survey non-respondents implemented in the same ways that survey respondents did.

### Implementation

<table>
<thead>
<tr>
<th></th>
<th>Yes, more than 1 course</th>
<th>Yes, 1 course</th>
<th>Some methods</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>17%</td>
<td>28%</td>
<td>53%</td>
<td>2%</td>
</tr>
</tbody>
</table>

n=53 respondents

<table>
<thead>
<tr>
<th></th>
<th>Described using IBL (on listserv)</th>
<th>Unclear</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>38%</td>
<td>62%</td>
</tr>
</tbody>
</table>

n=78 participants

Spreading IBL to:

140+ classes

3600+ students

in the first year following the workshop.

<table>
<thead>
<tr>
<th>Student audience</th>
<th>Mostly math majors 25%</th>
<th>Mixed STEM 34%</th>
<th>non-STEM 19%</th>
<th>4%</th>
<th>15%</th>
<th>4%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-service teachers</td>
<td>25%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>25%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No answer/did not use IBL</td>
<td>50%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=53 respondents</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class size</th>
<th>Under 20 43%</th>
<th>20-35 42%</th>
<th>8% 4% 4%</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-50</td>
<td>25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>over 50</td>
<td>25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No answer/did not use IBL</td>
<td>50%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=53 respondents</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Typical student</th>
<th>first-year 23%</th>
<th>sophomore 13%</th>
<th>junior or senior 34%</th>
<th>mixed 26%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>No answer/did not use IBL</td>
<td>4%</td>
</tr>
<tr>
<td>n=53 respondents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Changes in Teaching Practices, Frequencies

**Initial teaching practices**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency</th>
<th>*p</th>
<th>**p</th>
<th>***p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stu work on computers</td>
<td>0%</td>
<td>8%</td>
<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>Stu present problems/proofs</td>
<td>0%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Stu write in class</td>
<td>8%</td>
<td>8%</td>
<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>Stu indiv work</td>
<td>15%</td>
<td>11%</td>
<td>13%</td>
<td>19%</td>
</tr>
<tr>
<td>Stu working in groups</td>
<td>28%</td>
<td>21%</td>
<td>13%</td>
<td>8%</td>
</tr>
<tr>
<td>Class discussion</td>
<td>11%</td>
<td>8%</td>
<td>23%</td>
<td>8%</td>
</tr>
<tr>
<td>Ins asks conceptual Qs</td>
<td>23%</td>
<td>17%</td>
<td>15%</td>
<td>17%</td>
</tr>
<tr>
<td>Ins solves problems</td>
<td>38%</td>
<td>21%</td>
<td>15%</td>
<td>6%</td>
</tr>
<tr>
<td>Interactive lecture</td>
<td>26%</td>
<td>26%</td>
<td>17%</td>
<td>9%</td>
</tr>
<tr>
<td>Lecture (some Q&amp;A)</td>
<td>13%</td>
<td>23%</td>
<td>15%</td>
<td>8%</td>
</tr>
<tr>
<td>Formal lecture</td>
<td>5%</td>
<td>8%</td>
<td>8%</td>
<td>5%</td>
</tr>
</tbody>
</table>

### Frequency Changes

- *p < 0.05
- **p < 0.01
- ***p < 0.001

**Note:** Empty data labels are < 4%

*n = 53 respondents*
### Changes in Teaching Practices, Durations

#### Initial teaching practices

- **Formal lecture**: 5% in Entire class, 13% in 3/4 class, 70% in 1/2 class, 8% in 1/4 class
- **Lecture (some Q&A)**: 6% in Entire class, 17% in 3/4 class, 21% in 1/2 class, 9% in 1/4 class, 34% in a few minutes
- **Interactive lecture**: 9% in Entire class, 17% in 3/4 class, 21% in 1/2 class, 26% in 1/4 class, 9% in a few minutes, 17% in No answer/did not use
- **Ins solves problems**: 8% in Entire class, 11% in 3/4 class, 17% in 1/2 class, 36% in 1/4 class, 15% in a few minutes, 13% in Have not taught target
- **Ins asks conceptual Qs**: 9% in Entire class, 30% in 3/4 class, 43% in 1/2 class, 13% in 1/4 class
- **Class discussion**: 5% in Entire class, 26% in 3/4 class, 30% in 1/2 class, 38% in 1/4 class
- **Stu working in groups**: 11% in Entire class, 28% in 3/4 class, 26% in 1/2 class, 8% in 1/4 class, 23% in a few minutes
- **Stu individ work**: 13% in Entire class, 30% in 3/4 class, 23% in 1/2 class, 30% in 1/4 class
- **Stu write in class**: 5% in Entire class, 9% in 3/4 class, 25% in 1/2 class, 60% in 1/4 class
- **Stu present problems/proofs**: 6% in Entire class, 9% in 3/4 class, 13% in 1/2 class, 26% in 1/4 class, 43% in a few minutes
- **Stu work on computers**: 6% in Entire class, 11% in 3/4 class, 21% in 1/2 class, 60% in 1/4 class

#### Follow-up teaching practices

- **Formal lecture**: 8% in Entire class, 23% in 3/4 class, 68% in 1/2 class, 6% in 1/4 class
- **Lecture (some Q&A)**: 6% in Entire class, 28% in 3/4 class, 28% in 1/2 class, 34% in 1/4 class
- **Interactive lecture**: 8% in Entire class, 19% in 3/4 class, 38% in 1/2 class, 19% in 1/4 class, 13% in a few minutes
- **Ins solves problems**: 8% in Entire class, 8% in 3/4 class, 30% in 1/2 class, 38% in 1/4 class, 17% in Have not taught target
- **Ins asks conceptual Qs**: 3% in Entire class, 8% in 3/4 class, 38% in 1/2 class, 45% in 1/4 class, 8% in Have not taught target
- **Class discussion**: 6% in Entire class, 43% in 3/4 class, 30% in 1/2 class, 15% in 1/4 class
- **Stu working in groups**: 13% in Entire class, 19% in 3/4 class, 32% in 1/2 class, 21% in 1/4 class, 6% in Have not taught target
- **Stu individ work**: 5% in Entire class, 6% in 3/4 class, 40% in 1/2 class, 26% in 1/4 class, 19% in Have not taught target
- **Stu write in class**: 8% in Entire class, 23% in 3/4 class, 23% in 1/2 class, 43% in 1/4 class
- **Stu present problems/proofs**: 5% in Entire class, 17% in 3/4 class, 32% in 1/2 class, 15% in 1/4 class, 25% in Have not taught target
- **Stu work on computers**: 8% in Entire class, 5% in 3/4 class, 8% in 1/2 class, 19% in 1/4 class, 55% in Have not taught target

Note: Empty data labels are ≤4%

*p<0.05, **p<0.01, ***p<0.001

n=53 respondents
Of those who responded to the survey, 98% reported implementing at least some IBL methods. Overall, this means at least 67% of the 78 workshop participants have implemented some IBL in the year following the workshop. We also analyzed listserv traffic to measure implementation. In total, 60% of all workshop participants were active on the listserv and 38% of all participants made comments indicating that they were implementing IBL.

Changes in teaching practices also revealed a shift towards IBL pedagogies with significant decreases in lecturing and solving problems, and significant increases in student-centered activities including whole class discussion, group work, and student presentations.

The instructors who did implement IBL have exposed over 3600 students to IBL methods in over 140 classes in just the first year after the workshop. Most commonly, they taught small to midsize classes (under 35 students) for math and other STEM majors of all levels. Participants implemented IBL in a variety of courses, including calculus courses, linear algebra, introduction to proofs, geometry, graph theory, and others.
Perceived Effects of IBL on Students

- Learning specific mathematical ideas
  - Negative: 5%
  - Little or no: 49%
  - Some positive: 28%
  - Strong positive: 2%
  - No answer: 0%

- Understanding math concepts more deeply
  - Negative: 1%
  - Little or no: 34%
  - Some positive: 60%
  - Strong positive: 2%
  - No answer: 0%

- Applying math to other fields
  - Negative: 1%
  - Little or no: 19%
  - Some positive: 60%
  - Strong positive: 15%
  - No answer: 4%

- Applying math to everyday life
  - Negative: 1%
  - Little or no: 38%
  - Some positive: 47%
  - Strong positive: 15%
  - No answer: 2%

- Understanding nature of math
  - Negative: 5%
  - Little or no: 40%
  - Some positive: 43%
  - Strong positive: 1%
  - No answer: 0%

- Understanding role of proof in math
  - Negative: 14%
  - Little or no: 38%
  - Some positive: 34%
  - Strong positive: 2%
  - No answer: 0%

- Thinking critically
  - Negative: 1%
  - Little or no: 26%
  - Some positive: 70%
  - Strong positive: 2%
  - No answer: 0%

- Developing skills in problem-solving
  - Negative: 1%
  - Little or no: 25%
  - Some positive: 68%
  - Strong positive: 4%
  - No answer: 0%

- Becoming more independent in problem-solving
  - Negative: 1%
  - Little or no: 21%
  - Some positive: 74%
  - Strong positive: 8%
  - No answer: 0%

- Gaining confidence in doing math
  - Negative: 1%
  - Little or no: 32%
  - Some positive: 64%
  - Strong positive: 2%
  - No answer: 0%

- Communicating math orally
  - Negative: 1%
  - Little or no: 34%
  - Some positive: 58%
  - Strong positive: 4%
  - No answer: 0%

- Communicating math in writing
  - Negative: 14%
  - Little or no: 38%
  - Some positive: 43%
  - Strong positive: 2%
  - No answer: 0%

- Appreciating beauty and significance of math
  - Negative: 5%
  - Little or no: 42%
  - Some positive: 28%
  - Strong positive: 2%
  - No answer: 0%

n=53 respondents
Knowledge of IBL, IBL skills, and belief in the effectiveness of IBL increased significantly from pre-workshop to post-workshop. IBL knowledge significantly decreased from post to follow-up. IBL skills and beliefs did not significantly change from post to follow-up. There were no significant differences between IBL motivation at any time point.

Overall, these patterns are generally consistent with other workshops, and indicate that the workshop was effective in producing gains in all areas and that these gains were sustained (except IBL knowledge) in the 16-month period following the workshops. Ongoing support may be helpful for participants to work through difficulties and continue using IBL and sustain the reported gains following the workshop.
Ongoing Support

Workshop Resources

- Active in e-mentoring via listserv/private email: 60%

Group listserv messages in one year following workshop

<table>
<thead>
<tr>
<th></th>
<th>Participants</th>
<th>Leaders</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>213</td>
<td>231</td>
</tr>
</tbody>
</table>

Helpfulness of e-mentoring activities

- Group email exchange: 25% Great help, 28% Much help, 23% Moderate help, 13% A little help, 6% No help
- Emailed resources: 19% Great help, 28% Much help, 34% Moderate help, 15% A little help, 6% No help
- Personal call/email: 6% Great help, 8% Much help, 11% Moderate help, 23% A little help, 9% No help

Institutional Support

- Colleagues in department: 60% Mostly supportive, 25% Mixed/moderate, 25% Mostly not supportive
- Department head/chair: 72% Mostly supportive, 19% Mixed/moderate, 4% Mostly not supportive
- Dean/provost: 60% Mostly supportive, 30% Mixed/moderate, 2% Mostly not supportive
- Colleagues outside department: 51% Mostly supportive, 36% Mixed/moderate, 4% Mostly not supportive

* n=78 participants

n=53 respondents
Use of IBL supports

- Received IBL support: 91% (Yes), 9% (No)
- Plan to use IBL support or events: 89% (Yes), 11% (No)

Other IBL Supports

- Attended another IBL event: 30% (Yes), 70% (No)
- Presented at IBL event: 8% (Yes), 92% (No)
- Either attended or presented: 30% (Yes), 70% (No)

n=53 respondents
Conclusion

Results from the follow-up surveys help to learn about impacts of the workshop on participants' teaching practices. At least 59% of all workshop participants (98% of the 53 respondents) reported using at least some IBL methods in the year following the workshop. The proportion from survey self-report is higher than that found by analyzing messages sent through the group listserv (38% of all participants). The most likely explanation for the discrepancy between the self-reported implementation and listserv derived implementation rate is that the listserv messages may mention implementation, but participants are not explicitly asked about implementation as was done on the survey. The implementation rates are comparable to those from Workshops 1-8 (average of 71%).

Workshop participants spread IBL methods to about 3600 students in over 140 courses in just the first year following the workshop. Participants reported implementing IBL in a wide variety of courses in respect to typical student audience and level. However, most courses had 35 or fewer students. Consistent with other workshops, participants reported that using IBL had many positive effects on their students - in fact, almost all effects reported were positive.

As with other workshops, results indicate that follow-up support is important for participants with most respondents (91%) reporting using some form of support. The workshop listserv was the most commonly used form of support, as 60% of participants were active on the listserv at least once. While staff often prompted discussions and responded to questions on the listserv, participants themselves were very active, sending an average of 2.7 messages per workshop participant. Participants either used or plan to use many of the available supports, and the variety of opportunities seems to allow each person to find one that works for him or her.

References