The Systemic Impacts of Learning Assistants

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LA Experience

**Practice:** Facilitate Small Group Learning

**Content:** Weekly Prep Meeting

- a. What student problems have LAs observed?
- b. What are the critical concepts for the coming week?
- c. Where might students encounter difficulties?

**Pedagogy:** LA Course

- a. How do people learn?
- b. What is wait-time
- c. What are mental models
- d. How do you ask open-ended questions
## Chico State (Fall ’16)

<table>
<thead>
<tr>
<th>Department</th>
<th>Courses</th>
<th>Funding Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Education</td>
<td>SCED 141</td>
<td>CRT</td>
</tr>
<tr>
<td>Biology</td>
<td>BIO 151</td>
<td>MSTI</td>
</tr>
<tr>
<td>Math</td>
<td>MATH 119</td>
<td>CRT/MSTI</td>
</tr>
<tr>
<td>Physics</td>
<td>PHYS 202A, 204A</td>
<td>CRT/MSTI</td>
</tr>
</tbody>
</table>
Measuring impact of LAs on student learning

- Existing LA Programs (International)
- Developing LA Programs (International)
- Developing LA Programs (National)
Concept Inventories vs. Typical tests

- CIs are different from typical tests
  - based on extensive research
  - in students’ own words
  - diagnose a specific level of student understanding
- Often have validity arguments
- CIs allow for normative comparisons
CONSTRUCTION OF OCI

Development Stage

Qualitative Methods

Phase 1. Develop OEQs

1. Identify critical concepts
2. Define learning goals
3. Develop and refine OEQs for IPEs
4. Interview experts and novices with OEQs for IPEs

Phase 2. Convert OEQs into MCQs

5. Administer IPE
6. Code & bin responses to IPE OEQs
7. Discard or keep OEQs
8. Use student language to write answer options
9. Convert OEQs into MCQs, and interview novices and experts with MCQs

Phase 3. Vet MCQs

10. Conduct think-aloud student interviews
11. Refine MCQs’ language and figures, and interview experts and novices with modified MCQs

Evaluation Stage

Quantitative Methods

Phase 4. Evaluate items & survey

12. Use basic CTT methods to calculate item difficulty and percent discrimination
13. Apply IRT 1-parameter logistics model to estimate item difficulty & item discrimination
14. Utilize IRT results to create a shorter version of the original 23-item long survey.
15. Analyze internal consistency of short and long versions of survey

Cycle for each IPE
Examples of Concept Inventory Items

Force Concept Inventory

6. Which path in the figure at right would the ball most closely follow after it exits the channel at "r" and moves across the frictionless table top?

Matter and Energy (Biology)

Humans must eat and breathe in order to live and grow. Are eating and breathing related to each other? (Circle one) YES NO

If you circled “Yes” explain how eating and breathing are related. If you circled “No” then explain why they are not related. Give as many details as you can.
Electricity & Magnetism Conceptual Inventory (F04, S05)

L.G. = 0.44
Literature Review

- 40+ publications
- Improve learning
  - Physics (Pollock & Finkelstein, 2008)
  - Chemistry (Langdon, 2014)
  - Math (Nelson, 2011)
- Close the gap for "at risk" students in Calculus (Nelson, 2011)
- Improved graduation rates if in >0 LA classes (n=20,642)
The Problem

- Different learning contexts
  - Institution type
  - Discipline
  - Student populations
  - LA uses

- Problem for users
  - Not enough people use Concept Inventories (CIs)
  - Additional time to administer and analyze CIs
LA Supported Student Outcomes (LASSO) tool

- Free online system (learningassistantalliance.org)
- Hosts, administers, and scores Research Based Assessments across STEM disciplines
- No LAs required
- Faculty upload information about course
- Students provide demographic data

**Assessment:** FMCE  
**Institution:** LASSO University  
**Course:** ABCD 1000 - 001  
**Instructor:** Riley Patterson  
**Semester:** Fall 2015

**Your Data**
- N (class) = 250
- N (pre) = 190 (mean = 45%)
- N (post) = 190 (mean = 75%)
- N (paired) = 130

**Learning Gain:**
\[
\frac{(\text{post} - \text{pre})}{(1 - \text{pre})} = 0.55
\]

Effect size (Cohen's d) is a common statistical measure of student improvement. It measures student improvement in units of standard deviations (%post-%pre)/SD_{pooled}. To help interpret the magnitude of an effect size, Cohen provided the following guidelines [1]:

<table>
<thead>
<tr>
<th>Effect Size</th>
<th>Cohen's d</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;small&quot;</td>
<td>~0.2 - 0.3</td>
</tr>
<tr>
<td>&quot;medium&quot;</td>
<td>~0.5</td>
</tr>
<tr>
<td>&quot;large&quot;</td>
<td>~0.8</td>
</tr>
</tbody>
</table>

N (paired) = 130  
Average Effect Size: 2.11  
Note: 1 score was less than -1.

For more information on interpreting this report, please view our explanatory screencast.

## Learning Assistant Supported Student Outcomes (LASSO)

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Assessment (Fall ’16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>Force and Motion Concept Evaluation (FMCE)</td>
</tr>
<tr>
<td></td>
<td>Force Concept Inventory (FCI)</td>
</tr>
<tr>
<td></td>
<td>Brief Electricity and Magnetism Assessment (BEMA)</td>
</tr>
<tr>
<td></td>
<td>Conceptual Survey of Electricity and Magnetism (CSEM)</td>
</tr>
<tr>
<td></td>
<td>Colorado Learning Attitudes about Science Survey - Physics (CLASS-PHYS)</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Chemistry Concept Inventory (CCI)</td>
</tr>
<tr>
<td></td>
<td>Colorado Learning Attitudes about Science Survey - Chemistry (CLASS-CHEM)</td>
</tr>
<tr>
<td>Biology</td>
<td>Concept Inventory of Natural Selection (CINS)</td>
</tr>
<tr>
<td></td>
<td>Genetics Concept Assessment (GCA)</td>
</tr>
<tr>
<td></td>
<td>Introductory Molecular and Cell Biology Assessment (IMCA)</td>
</tr>
<tr>
<td></td>
<td>Colorado Learning Attitudes about Science Survey - Biology (CLASS-BIO)</td>
</tr>
<tr>
<td>Math</td>
<td>Pre-Calculus Assessment (PCA)</td>
</tr>
<tr>
<td>Astronomy</td>
<td>Light and Spectroscopy Concept Inventory (LSCI)</td>
</tr>
</tbody>
</table>

The LASSO online data collection instrument is free and easy to use!!

[www.learningassistantalliance.org](http://www.learningassistantalliance.org)
Growth of the LASSO dataset

# of Institutions | # of Courses | # of Students w/ matched pre & post tests

<table>
<thead>
<tr>
<th>Total Number of Institutions</th>
<th>Total Number of Courses</th>
<th>Total Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring 2015</td>
<td>Spring 2015</td>
<td>Spring 2015</td>
</tr>
</tbody>
</table>
Research Questions

1. What impacts do online administrations of concept inventories have on students, if any?

2. What impacts do LAs have on student learning, if any?

3. What impacts do LAs have on classroom inequities, if any?
Data Analysis #1

1. 5 physics classes at large midwest university

2. Stratified random sampling into 2 conditions
Data Analysis #1

Participation Rates

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper</td>
<td>95%</td>
<td>72%</td>
</tr>
<tr>
<td>Online</td>
<td>54%</td>
<td>40%</td>
</tr>
</tbody>
</table>

1. Multiple reminder Emails
2. Extra credit for participation
Data Analysis #2

Physics Concept Inventories

- Pre & post scores collected at beginning and end of term.
- FCI, FMCE, CSEM, BEMA
- Calculate Cohen’s d

Data Cleaning

- More than 80% answered
- Paired Tests Only (Cohen’s d)
- Courses with > 10 Paired Tests
- Cut scores < -1.0 and > 4.0

\[
d = \frac{\text{Post} - \text{Pre}}{\text{Class S.D.}_{\text{pooled}}}
\]

<table>
<thead>
<tr>
<th>C.I.</th>
<th>Institutions</th>
<th>Courses</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCI</td>
<td>9</td>
<td>26</td>
<td>697</td>
</tr>
<tr>
<td>FMCE</td>
<td>9</td>
<td>15</td>
<td>1,592</td>
</tr>
<tr>
<td>BEMA</td>
<td>4</td>
<td>7</td>
<td>680</td>
</tr>
<tr>
<td>CSEM</td>
<td>4</td>
<td>21</td>
<td>754</td>
</tr>
<tr>
<td>TOTAL</td>
<td>17</td>
<td>69</td>
<td>3,753</td>
</tr>
</tbody>
</table>

TABLE I. Cleaned Data Counts (LASSO).
Results: Impact of LA Support

Results: Impact of LA Support

Data Analysis #3

Data Cleaning
• >80% answered
• matched pre-post tests
• >10 matched sets in course
• -2<d<4

dominant = white or asian, non-hispanic, males

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Institutions</th>
<th>Courses</th>
<th>Students (%non-dom)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCI</td>
<td>9</td>
<td>31</td>
<td>1,045 (41%)</td>
</tr>
<tr>
<td>FMCE</td>
<td>8</td>
<td>15</td>
<td>1,253 (73%)</td>
</tr>
<tr>
<td>CSEM</td>
<td>2</td>
<td>21</td>
<td>784 (46%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19</strong></td>
<td><strong>67</strong></td>
<td><strong>2,982 (55%)</strong></td>
</tr>
</tbody>
</table>
Performance gap

Gap = \( d_{\text{non-dom}} - d_{\text{dominant}} \)

<table>
<thead>
<tr>
<th>Measure</th>
<th>No LAs</th>
<th>LAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCI</td>
<td>-0.232</td>
<td>0.262*</td>
</tr>
<tr>
<td>FMCE</td>
<td>0.071</td>
<td>0.165*</td>
</tr>
<tr>
<td>CSEM</td>
<td>N.D.</td>
<td>0.097</td>
</tr>
</tbody>
</table>

\* \( p < 0.025 \)

Future Research

- Disaggregate non-dominant status
- Develop multi-level models
- Examine non-Physics disciplines

More Data!

LASSO =

1. Free
2. Easy to use
3. Saves you time
4. Awesome reports
Questions

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LASSO —> www.learningassistantalliance.org

Contribution No. LAA-034, 035, & 036 of the International Learning Assistant Alliance.

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Int’l LAC2016

Oct. 23-25
University of Colorado Boulder