Preparing Undergrads to Teach (Well): The Colorado Learning Assistant Model

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& the STEM Colorado/PhysTEC Team
University of Colorado, Boulder
Acknowledgements

**Physics faculty:**
- SJP
- Noah Finkelstein
- Carl Wieman
- Kathy Perkins
- Michael Dubson

**Postdocs:**
- Sam McKagan
- Laurel Mayhew
- Stephanie Chasteen
- Archie Paulson
- Wendy Adams

**Ph. D. students:**
- Noah Podolefsky
- Chandra Turpen
- Lauren Kost
- Charles Baily
+ recently graduated, 3 with PhD, 1 with MSc.

**School of Ed:**
- Valerie Otero,
- Kara Gray
- Bud Talbott
COLORADO LEARNING ASSISTANTS MODEL
## Participants

<table>
<thead>
<tr>
<th>Applied Math</th>
<th>Astronomy</th>
<th>Chemistry</th>
<th>Education</th>
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<tr>
<td>Jim Curry (Chair)</td>
<td>Dick McCray</td>
<td>Veronica Bierbaum</td>
<td>Valerie Otero</td>
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<tr>
<td>Mary Nelson</td>
<td>Doug Duncan</td>
<td>Margaret Asirvatham</td>
<td>Derek Briggs</td>
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<td>Adam Norris</td>
<td>Nick Schneider</td>
<td>Linda Koch</td>
<td>Lorrie Shepard</td>
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<tr>
<td>Ann Dougherty</td>
<td>John Stocke</td>
<td>Laurie Langdon</td>
<td>Laura Moin</td>
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<td>Jim Weiss</td>
<td>Fran Bagenal</td>
<td>Robert Parson</td>
<td>David Webb</td>
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<td>Susan Hallowell</td>
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<th>Geosciences</th>
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<tr>
<td>Alan Lester</td>
<td>Mike Klymkowsky</td>
<td>Steve Pollock</td>
<td>Noah Finklestein</td>
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<td>David Budd</td>
<td>Bill Wood</td>
<td>Kathy Perkins</td>
<td>Mike Dubson</td>
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<tr>
<td>Andrea Bair</td>
<td>Jennifer Knight</td>
<td>Carl Wieman</td>
<td>Ed Kinney</td>
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<td>Jennifer Stempien</td>
<td>Sylvia Fromherz</td>
<td>Carl Rogers</td>
<td>Jim Shepard</td>
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<td>Jia Shi</td>
<td>Murray Holland</td>
<td>James Nagle</td>
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<td>Michelle Smith</td>
<td>Shijie Zhong</td>
<td>John Cumulat (Chair)</td>
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<th>K-12 Teachers</th>
<th>Graduate Students</th>
<th>Mathematics</th>
<th>226 Learning Assistants</th>
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<tr>
<td>Steve Iona</td>
<td>Danielle Harlow</td>
<td>Eric Stade</td>
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<td>Mike Fuchs</td>
<td>Bud Talbot</td>
<td>Kara Gray</td>
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<td>Roberta Tanner</td>
<td>Heidi Iverson</td>
<td>Julie Schneider</td>
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<td>PhysTEC TAG</td>
<td>Mariel Desroche</td>
<td>Chandra Turpen</td>
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**Supported by:**

Provost Phil DiStefano, Dean Lorrie Shepard (Education), Dean Todd Gleeson (A&S)
Guiding Questions

How can we recruit more science students to careers in K-12 teaching?

How can science research faculty be involved?

How do we create a reasonable experience for students who might become teachers?

How do we leverage the above with our desire to improve intro courses?
red = trad, blue = interactive engagement

\[ \langle g \rangle = \frac{\text{post-pre}}{100-\text{pre}} \]

R. Hake, "...A six-thousand-student survey..." AJP 66, 64-74 ('98).
Transformation of Large-Enrollment Introductory Courses with Undergraduate Learning Assistants (LAs)

Traditional large enrollment lecture course: one instructor and a graduate TA to serve 200+ students

Course transformed using Learning Assistants to facilitate collaboration
Tutorials in Introductory Physics

Reconceptualize Recitation

Elicit, Confront, Resolve

Socratic Method
(=> 1.5 hr/wk prep/training)

(From University of Washington's Physics Education Group)
Tutorial vs. Trad'l Recitation
Force Concept Inventory

red = trad, blue = interactive engagement

\[ \langle g \rangle = \frac{\text{post-pre}}{100-\text{pre}} \]

- CU - w. trad recitations
- CU - w. LAs

R. Hake, ”…A six-thousand-student survey…” AJP 66, 64-74 (‘98).
What is a Qualified Teacher

Knowledge of Content
(physics, chemistry, biology, math, astrophysics)

Knowledge of Pedagogy
(Typically School of Education)

Knowledge of Students
(Typically psychology, class-rarely connected to content)

Knowledge of the nature of science and scientific inquiry
(Typically implicit or not present at all)

Usable knowledge for teaching students science
**The Learning Assistant Experience**

**Content:** Weekly planning sessions with science faculty member teaching the course

**Pedagogy:** LAs from all dep'ts take weekly course in science education theory and practice—led by Ed faculty and K12 Teacher

**Practice:** LAs lead weekly Learning Teams

Formative feedback for instructor to use in lecture
In the LA program, students learn about teaching while they are teaching and while they are learning science/math content.
F04 (N=319)  Post: 59%
S05 (N=232): 59%

1120 BEMA pre/post

CU upper division (trad)
CLASS F06: Comparing students & LA’s

- Phys 1120 F06
- Phys 1110 F06
- LAs, F06

Overall

Personal Interest

Overall

Personal Interest

Overall

Personal Interest

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Teaching is attractive to LAs

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<tr>
<td>5</td>
<td>13</td>
<td>4</td>
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*At 18 colleges and universities with 10,869 candidates, 385 science majors¹

LAs report that they had not seriously considered becoming a teacher until participating as a Learning Assistant

Two most frequently stated reasons for making the decision:
(1) Recognizing Teaching as a complex endeavor
(2) Encouragement and support by participating Faculty
Recruitment of LAs to Teaching Careers 2005-2008

<table>
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<tr>
<th>Subject</th>
<th>2005</th>
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<th>2007</th>
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LAs are attractive to Faculty

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<tr>
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<th>Fall 2003</th>
<th>Spring 2008</th>
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<tr>
<td># of LAs hired since Fall 2003</td>
<td>226</td>
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<tr>
<td>Average cumulative GPA (3.7 in physics)</td>
<td>3.5</td>
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<tr>
<td>Faculty</td>
<td>7 faculty (4 departments)</td>
<td>48 faculty (7 departments)</td>
</tr>
<tr>
<td>Courses transformed</td>
<td>4</td>
<td>30 courses transformed</td>
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<tr>
<td>LAs/semester</td>
<td>28</td>
<td>&gt;60 LAs/semester</td>
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<td>Impacts</td>
<td>400 stud/yr</td>
<td>&gt;7000 students/year</td>
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<td>Cost Per Year</td>
<td>$274K</td>
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<td>Cost per Impacted Student</td>
<td>$39</td>
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Growth of the LA Program Nationwide
Physics Teachers Education Coalition (PTEC) APS
104 Institutions
LA Program is a hallmark of PTEC activities
LA program support

University Commitment

• $100k private donor
• $150k university commitment
• Raising $1M for endowment

External $$

NSF, NMSI, and hopefully CU Foundation
Longitudinal impacts in upper division physics
Longitudinal

After completing upper div. E&M I or II. (Only students who took intro without Tutorials)
Longitudinal

Upper division majors’ BEMA scores

average BEMA score

f04-f05
s06-s07
Semester in upper division E&M (I or II)

No Tutorials
Tutorials

BLUE: students who had taken their freshman E&M with Tutorials
Longitudinal

Upper division majors’ BEMA scores

Grade in course

- f04-f05:
  - No Tutorials: (3.1 ± 1)
  - Tutorials: (3.0 ± 1)

- s06-s07:
  - No Tutorials: (3.3 ± 1)
  - Tutorials: (3.2)

Yellow: students who had been E&M LAs

S. Pollock, 2007 PERC Proc. 951, p.172
SUMMARY
Learning Assistant program is
- Addressing critical nat'l need
- Building on a research base
- Many impacts
  K12, students, LAs, faculty, institution...

CHALLENGES:
- costs (time, $$, growth, training)
Questions?

per.colorado.edu

stem.colorado.edu