Transforming the Preparation of Physics Graduate Teaching Assistants

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Ohio State Physics Colloquium
26 January 2021
Outline

- Background and Motivation
- Developing the “Physics GTA Preparation” Course
- Results from Program Assessment
  - The initial conditions of first-time Physics GTAs
  - Surveys and Pre/Post Tests
  - End-of-Semester Student Evaluations
- Conclusions and Summary
GTAs are key partners in education of undergrads

- Undergrads spend ~half of their intro physics class time with GTAs
  - At Georgia Tech, these are mostly first-year PhD students

- Potential for **large impact** on student learning
  - At Georgia Tech, ~1800 undergrads/semester take intro physics

- GTAs need preparation for teaching
My work: Physics GTA Preparation

- Course design and instruction
- Curriculum development
- Program assessment

- Transformed the old “TA training” into a comprehensive GTA professional development program

All the details can be found in my dissertation, E. Alicea-Muñoz (May 2020)
https://smartech.gatech.edu/handle/1853/62714
“In his inaugural oration as first president of Johns Hopkins University in 1876, Daniel Coit Gilman expressed the pious hope that graduate schools would help to develop the teaching ability of future professors. This hope has remained largely unfulfilled to date.”

Charles Süsskind, American Journal of Physics, 25(3), 1957
Logistics for teaching labs, basics of pedagogy, peer observations, video recording

1970 and earlier
- Ohio U [AmJPhys, 39, 1971]
- U Missouri [AmJPhys, 42, 1974]
- Kansas State [AmJPhys, 42, 1974]
- UC Berkeley [AmJPhys, 43, 1974]
- Temple U [AmJPhys, 46, 1978]

1980
- Carroll [J Higher Ed, 51, 1980]
- Abbott et al [New Directions for Teaching and Learning, 39, 1989]

1990
- Lawrenz et al [J College Science Teaching, 22, 1992]
- Hestenes et al [TPT, 30, 1992]
- Hake [AmJPhys, 66, 1998]
- Redish & Steinberg [Physics Today, 51, 1999]

2000 and beyond
[Hundreds of references]

First meta-analyses of GTA prep research; calls for more systematic research

PER, concept inventories, active learning; first long-lasting GTA prep programs
Research shows that...

- Training improves GTAs’ teaching **confidence** and **self-efficacy**
  - Prieto & Altmaier, Research in Higher Education, 35(4), 1994
  - Harris et al, International Journal of Mathematical Education in Science and Technology, 40, 2009
  - DeChenne et al, Journal of the Scholarship of Teaching and Learning, 12(4), 2012
  - Reeves et al, CBE-Life Sciences Education, 17, 2018
Research shows that…

- Training improves GTAs’ **pedagogical content knowledge (PCK)** and can result in adoption of learner-centered teaching styles
  
  - Gibbs & Coffey, Active Learning in Higher Education, 5, 2004
  - Lin et al, PhysRev ST-PER, 9, 010120, 2013
  - Wheeler et al, Journal of Chemical Education, 94, 2017
Research shows that...

- Science GTAs benefit more from **discipline-specific preparation** than from campus-wide initiatives
Research shows that...

- GTAs need guidance in **logistics** issues such as classroom management and grading
  - Henderson et al, PERC 2016
  - Marshman et al, PhysRev PER, 13, 010120, 2017
Research shows that…

- Teaching experience improves graduate students’ research and transferable skills
  - French & Russel, BioScience, 52(11), 2002
  - Feldon et al, Science, 333(6), 2011
A majority of physics PhDs leave academia

Employment fields for new physics PhDs in potentially permanent positions, classes of 2011-2016

Data is based on the responses of 725 new physics PhD recipients in potentially permanent positions when asked "What is your primary field of employment?"

https://www.aip.org/statistics/whos-hiring-physics-phds
A majority of physics PhDs leave academia

http://www.physics.gatech.edu/academics/graduate/careers

Not necessarily permanent positions (e.g. postdocs)
New Perspective on GTA Preparation

- We want to produce GTAs who are motivated and effective teachers.

- We want to help GTAs develop transferable professional skills they can use outside the classroom.
  - Especially important for grad students who don’t plan on staying in academia.
New Perspective on GTA Preparation

- **3P Framework**: in order to have a comprehensive program for GTA preparation that is useful and valuable for GTAs in the classroom and beyond, there must be full integration between:
  - **Pedagogy** – the methodology of teaching
  - **Physics** – content and PCK
  - **Professional Development** – transferable skills useful inside and outside academia

- The intersections of the three P’s are also important!
Research Questions

- What elements of a formal GTA preparation program do GTAs perceive as the most useful or beneficial for their professional development?

- What effect does a formal GTA preparation program have on graduate students’ teaching self-efficacy and attitudes about teaching?

- Does a formal GTA preparation program have an effect on graduate students’ teaching effectiveness, as determined by end-of-semester student evaluations?
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At GT Physics before 2013...

- **TA training before semester:**
  - General GTA Orientation (policies)
  - Meeting with GTA Supervisors (logistics)

- **TA training during semester:**
  - Weekly lab meetings and/or communication email (content)
  - Pedagogy seminars (outsourced)

- **Problems!**
  - Disconnect between pedagogy and content
  - Lack of pedagogical reinforcement
  - Lots and lots of complaining
  - GTAs provided with no motivation
  - No apparent relevance for professional goals
Physics GTA Preparation

- Started in 2013 as a collaboration between School of Physics and Center for Teaching and Learning; one credit, pass/fail

- Course design follows best practices for GTA preparation found in research literature
  - Partnership, fosters sense of professional identity
  - Ongoing endeavor, with opportunities for practice, observation, and feedback
  - Grounded in research-based teaching practices
  - Highlights transferable skills

- Curriculum development follows a yearly cycle of implementation and revision, based on assessment data and self-reflection
Course Structure and Content

**Orientation**  
(before semester starts)
1. Introduction & GT Policies  
2. Teaching Physics  
3. Classroom Management  
4. Lab Simulation  
5. Microteaching  

(~15 hrs)

**Follow-Up Meetings**  
(during Fall semester)
1. Grading  
2. Midterm Evaluations & Time Management  
3. Teaching Videos  
4. Teaching and Research  
5. Concluding Remarks  

(~5 hrs)

**Out of class activities:** Classroom Observations, Workload Surveys, Mentoring Meetings
Persistent over the years

- Microteaching
- Midterm Evaluations
- Classroom Management
- Active Learning
- Grading
- Time Management
- Georgia Tech Policies

Started as mostly pedagogy with some physics sprinkles, now it’s fully integrated within physics content and examples.
Persistent over the years

- Microteaching
- Midterm Evaluations
- Classroom Management
- Active Learning
- Grading
- Time Management
- Georgia Tech Policies

Separate sessions for the different GTA assignments

New in 2019: separate session on Gradescope (online grading)
Persistent over the years

- Microteaching
- Midterm Evaluations
- Classroom Management
- Active Learning
- Grading
- Time Management
- Georgia Tech Policies

Introduced OK/NOT-OK game in 2017, so now learning about policies is actively engaging.

OK or NOT OK?

- A student tells a TA that he's here to pick up his roommate's graded exam, and it's ok because the roommate gave him a note with written permission
  - OK
  - NOT OK

FERPA. Even if the roommate wrote a note giving permission, you're not supposed to give someone's graded work to someone else.
False Starts

- Peer Observations
- Experienced TA Observations
- Leading Discussions
- Being a Physics TA
- Teaching Philosophy
- Leadership

Love/hate, not well received

Some GTAs felt unqualified to give useful feedback

Some GTAs felt their peers were unqualified to give them useful feedback
False Starts

- Peer Observations
- Experienced TA Observations
- Leading Discussions
- Being a Physics TA
- Teaching Philosophy
- Leadership

Complete disaster mostly due to logistics issues
Only attempted once, never again!
False Starts

- Peer Observations
- Experienced TA Observations
- Leading Discussions
- Being a Physics TA
- Teaching Philosophy
- Leadership

Most of our grad students go into industry, so they felt this wasn’t useful for them.
Newer and Successful

- Classroom Observations
- Teaching Videos
- Lab Simulation
- Successful First Day/Week
- Mentoring
- Teaching and Research/Transferable Skills

Started with once per semester, now it’s twice per semester (early September, late October)
Newer and Successful

- Classroom Observations
- Teaching Videos
- Lab Simulation
- Successful First Day/Week
- Mentoring
- Teaching and Research/Transferable Skills

Like Microteaching, but for labs

GTAs take turn facilitating in a lab environment

Roleplay: secretly planted bad behaviors are a HUGE hit
Newer and Successful

- Classroom Observations
- Teaching Videos
- Lab Simulation
- Successful First Day/Week
- Mentoring
- Teaching and Research/Transferable Skills

First attempt was a disaster (2015 Follow-Up Meeting titled “How’s it going?”)

Peer mentoring by senior grad students is now included and is much better received
A note about online teaching

- In Fall 2020, the GTA prep class and the GTAs’ teaching happened remotely.
- We had to do some necessary changes:
  - Lab Simulation did not happen (needs to be in person).
  - Classroom Observations did not happen (time constraints, online limitations).
  - Microteaching still happened, via videoconference and breakout rooms.
  - Most class activities used breakout rooms, which may have resulted in less engagement.
  - Curriculum had to be tailored to helping students in an online setting.
  - Midterm Evaluations (for some GTAs) received few responses (because online survey).
- I have not looked at the data for Fall 2020 yet; it remains to be seen how effective the course was in this very different setting.
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# Enrollment in GTA Preparation

## Total enrollment 2013-2019: 152

<table>
<thead>
<tr>
<th>Year</th>
<th>Enrollment</th>
<th>Informed consent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>22</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>2014</td>
<td>13</td>
<td>8 (62%)</td>
</tr>
<tr>
<td>2015</td>
<td>34</td>
<td>29 (85%)</td>
</tr>
<tr>
<td>2016</td>
<td>23</td>
<td>19 (83%)</td>
</tr>
<tr>
<td>2017</td>
<td>26</td>
<td>20 (77%)</td>
</tr>
<tr>
<td>2018</td>
<td>16</td>
<td>13 (81%)</td>
</tr>
<tr>
<td>2019</td>
<td>18</td>
<td>pending</td>
</tr>
</tbody>
</table>

Total 2014-2018: 112, 89 (79%)

## Demographics (with consent)

<table>
<thead>
<tr>
<th>Year</th>
<th>Male</th>
<th>Female</th>
<th>International</th>
<th>Domestic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>88%</td>
<td>12%</td>
<td>38%</td>
<td>62%</td>
</tr>
<tr>
<td>2015</td>
<td>72%</td>
<td>28%</td>
<td>28%</td>
<td>72%</td>
</tr>
<tr>
<td>2016</td>
<td>79%</td>
<td>21%</td>
<td>47%</td>
<td>53%</td>
</tr>
<tr>
<td>2017</td>
<td>85%</td>
<td>15%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>2018</td>
<td>46%</td>
<td>54%</td>
<td>15%</td>
<td>85%</td>
</tr>
</tbody>
</table>

Overall: 74%, 26%, 36%, 64%
Program and GTA Assessment

**Before semester**
- *Entry Survey*
- *Orientation Survey*

**Fall Semester**
- Microteaching, Lab Simulation
- Individual Classroom Observations
- Midterm Evaluations (GTAs)

**After semester**
- *Pre Tests*
- *Post Tests*
- Thoughts on GTA Experience
- *Final Survey*
- *Student Evaluations*
- Final Reflection Essay
Assessments selected for current analysis give us a broad idea of how effective the GTA prep class has been (the forest); future work will focus on finer details (the trees).

Modified Kirkpatrick Model*

- Reaction – Orientation Survey, Final Survey
- Learning – Pre/Post ATI and Knowledge Quiz
- Behavior – Classroom Observations (future analysis)
- Results – End-of-semester student evaluations (as proxy)

Mixed methods approach (quantitative and qualitative data)

* Wyse et al, CBE-Life Sciences Education, 13, 2014
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The initial conditions of first-time GTAs

- Entry Survey (every July), not anonymous
- 83/103 responses with informed consent
- Sample is representative of full population

Prior TA experience:
- No = 59%
- Yes = 41%
The initial conditions of first-time GTAs

- Please indicate your level of agreement with the following statement:

  “I consider teaching to be an important part of my professional development as a physicist.”

- An overwhelming majority of first-time GTAs consider teaching important for their professional development
The initial conditions of first-time GTAs

- Asked to indicate top 3 concerns about teaching
- 221 total concerns (2014-2018)
- Coded into 19 categories
The initial conditions of first-time GTAs

- First-time GTAs are worried about their physics knowledge and time management
- First-time GTAs who are non-native English-speakers are also worried about language and culture issues
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Orientation Survey

- Anonymous, Likert-type statements to assess five categories: Class Activities, Guests, Materials, Timing, Usefulness
- Open-ended comments indicated GTAs felt better prepared for teaching
- Statements about class activities indicate that GTAs enjoy the interactive nature of the class and find the activities useful

<table>
<thead>
<tr>
<th>Statement</th>
<th>Score (M ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positively worded</strong></td>
<td></td>
</tr>
<tr>
<td>There was a good balance between lecture and activities.</td>
<td>4.34 ± 0.64</td>
</tr>
<tr>
<td>The pair and group activities were useful.</td>
<td>4.29 ± 0.74</td>
</tr>
<tr>
<td><strong>Negatively worded</strong></td>
<td></td>
</tr>
<tr>
<td>There were too many pair/group writing and discussion activities.</td>
<td>2.34 ± 0.86</td>
</tr>
<tr>
<td>I would have preferred more lecturing than activities.</td>
<td>2.27 ± 0.93</td>
</tr>
</tbody>
</table>
Orientation Survey

- Usefulness statements scored very high
- Top 3 highest scored Usefulness statements were the three best scored statements overall in the survey
- GTAs enjoy the interactive nature of the class and consider the Orientation useful
Orientation Survey: Preparedness

- "How prepared do you feel for your first GTA assignment at Georgia Tech?"

- **Pre**: Entry Survey ($N = 49$, not anonymous)

- **Post**: Orientation Survey ($N = 64$, anonymous)
Orientation Survey: Preparedness

- Statistically significant pre/post difference (KS test, \( p < 0.001 \))

- Very large effect size (Cohen’s \( d = 1.333 \))

\[
d = \frac{M_{post} - M_{pre}}{SD_p}
\]

\[
SD_p = \sqrt{\frac{(SD_{post})^2 + (SD_{pre})^2}{2}}
\]

- GTAs feel better prepared for teaching after the Orientation
Final Survey

At end of semester, asked GTAs to rate usefulness of lessons

**Overall top 3** most useful:
1. Microteaching (4.40 ± 0.95)
2. Lab Simulation (4.30 ± 1.09)
3. Teaching Physics (4.10 ± 1.05)

**Yearly top 3** most useful are more nuanced →

<table>
<thead>
<tr>
<th>Rank</th>
<th>Item</th>
<th>Score ($M \pm SD$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>2015</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Microteaching</td>
<td>4.38 ± 1.07</td>
</tr>
<tr>
<td>2</td>
<td>Individual Classroom Observations</td>
<td>3.79 ± 1.29</td>
</tr>
<tr>
<td>3</td>
<td>Teaching Physics</td>
<td>3.76 ± 1.06</td>
</tr>
<tr>
<td></td>
<td><strong>2016</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Microteaching</td>
<td>4.32 ± 0.72</td>
</tr>
<tr>
<td>2</td>
<td>Teaching Physics</td>
<td>4.23 ± 0.69</td>
</tr>
<tr>
<td>3</td>
<td>Individual Classroom Observations</td>
<td>4.09 ± 1.11</td>
</tr>
<tr>
<td></td>
<td><strong>2017</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Intro &amp; Georgia Tech Policies</td>
<td>4.38 ± 0.82</td>
</tr>
<tr>
<td>2</td>
<td>Microteaching</td>
<td>4.35 ± 1.07</td>
</tr>
<tr>
<td>3</td>
<td>Teaching Physics</td>
<td>4.29 ± 1.20</td>
</tr>
<tr>
<td></td>
<td><strong>2018</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Lab Simulation</td>
<td>4.80 ± 0.41</td>
</tr>
<tr>
<td>2</td>
<td>Microteaching</td>
<td>4.67 ± 0.82</td>
</tr>
<tr>
<td>3</td>
<td>Teaching Physics</td>
<td>4.33 ± 1.11</td>
</tr>
</tbody>
</table>
Final Survey: Utility Scores

- Utility score:
  \[ u = \frac{1}{N} \sum_{i} M_i \]

- Course overall: all items, all years
- Category overall: all items within each separate category, all years
- Yearly overall: all items, for each year
- Yearly categories: all items within each separate category, for each year

<table>
<thead>
<tr>
<th>Code</th>
<th>Item</th>
<th>Years</th>
<th>Q1</th>
<th>Q2</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1</td>
<td>Intro &amp; Georgia Tech Policies</td>
<td>2015-2018</td>
<td>94</td>
<td>94</td>
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<tr>
<td>O2</td>
<td>Teaching Physics</td>
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<td>93</td>
<td>94</td>
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<tr>
<td>O3</td>
<td>Classroom Management</td>
<td>2015-2018</td>
<td>93</td>
<td>94</td>
</tr>
<tr>
<td>O4</td>
<td>Lab Simulation</td>
<td>2016-2018</td>
<td>60</td>
<td>61</td>
</tr>
<tr>
<td>O5</td>
<td>Microteaching</td>
<td>2015-2018</td>
<td>93</td>
<td>94</td>
</tr>
<tr>
<td>F1</td>
<td>Grading</td>
<td>2015-2018</td>
<td>92</td>
<td>94</td>
</tr>
<tr>
<td>F2</td>
<td>How’s it going?</td>
<td>2015</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>F3</td>
<td>Midterm Evaluations</td>
<td>2015-2018</td>
<td>94</td>
<td>93</td>
</tr>
<tr>
<td>F4</td>
<td>Time Management</td>
<td>2017-2018</td>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td>F5</td>
<td>Teaching Videos</td>
<td>2015-2018</td>
<td>94</td>
<td>94</td>
</tr>
<tr>
<td>F6</td>
<td>Teaching &amp; Research</td>
<td>2015-2018</td>
<td>93</td>
<td>93</td>
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<td>F7</td>
<td>Concluding Remarks</td>
<td>2015-2018</td>
<td>93</td>
<td>92</td>
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<tr>
<td>A1</td>
<td>Individual Classroom Observations</td>
<td>2015-2018</td>
<td>93</td>
<td>93</td>
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<tr>
<td>A2</td>
<td>Workload Surveys</td>
<td>2015-2018</td>
<td>95</td>
<td>92</td>
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<td>A3</td>
<td>Peer Classroom Observations</td>
<td>2015</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>A4</td>
<td>Experienced TA Observations</td>
<td>2016</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>A5</td>
<td>GAP Mentoring Meetings</td>
<td>2017-2018</td>
<td>37</td>
<td>38</td>
</tr>
</tbody>
</table>
Final Survey: Utility Scores

- Course overall: $3.58 \pm 0.12$ (mean ± standard error)
- Category overall best: Orientation ($4.12 \pm 0.10$)
- Follow-Up Meetings ranked lowest, need improvement
- 2015 and 2016 have some specific items that were very lowly rated
- **Most useful: Orientation** (and its perceived usefulness increases every year)
Pre/Post Tests: ATI

- Approaches to Teaching Inventory*

- 16 Likert-type items in 2 scales to measure:
  - Information Transmission (teacher-centered approaches)
    - e.g., “I feel it is important to present a lot of facts to students so that they know what they have to learn for this subject.”
  - Conceptual Change (learner-centered approaches)
    - e.g., “I encourage students to restructure their existing knowledge in terms of the new way of thinking about the subject that they will develop.”

- Complete case analysis: matched pre/post pairs with responses to every item

- For each student: teacher-centered mean, learner-centered mean (in pre-test and again in post-test)

* Trigwell & Prosser, Educational Psychology Review, 16, 2004
Pre/Post Tests: ATI

- No statistical difference in pre/post teacher-centered distributions (KS test, \( p = 0.304 \))

- Statistical difference in pre/post learner-centered distributions (KS test, \( p = 0.046 \)) and means (t-test, \( p = 0.037 \)); small effect size (\( d = 0.254 \))

- GTAs adopt more learner-centered approaches to teaching after one semester of GTA preparation
Pre/Post Tests: Knowledge Quiz

- Multiple choice test measuring five categories of knowledge (Administrative, Pedagogical Content Knowledge, General Pedagogy, Professional Development, Teaching Practice)

- Analysis of matched pre/post pairs; each question is either correct or incorrect; a student’s score is percentage of correct responses

- Full test scores have consistently had higher post-test yearly class averages

- Effect size measured with Cohen’s d and normalized gains measured as:

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

<table>
<thead>
<tr>
<th>Year</th>
<th>$N$</th>
<th>$M_{\text{pre}}$</th>
<th>$M_{\text{post}}$</th>
<th>$t$</th>
<th>$p$</th>
<th>$\langle g \rangle$</th>
<th>$d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>8</td>
<td>56.70%</td>
<td>75.45%</td>
<td>4.406</td>
<td>0.003</td>
<td>0.43</td>
<td>1.595</td>
</tr>
<tr>
<td>2015</td>
<td>29</td>
<td>69.70%</td>
<td>80.54%</td>
<td>6.100</td>
<td>&lt; 0.001</td>
<td>0.36</td>
<td>0.930</td>
</tr>
<tr>
<td>2016</td>
<td>17</td>
<td>69.54%</td>
<td>76.05%</td>
<td>2.861</td>
<td>0.011</td>
<td>0.21</td>
<td>0.556</td>
</tr>
<tr>
<td>2017</td>
<td>20</td>
<td>69.76%</td>
<td>85.00%</td>
<td>7.100</td>
<td>&lt; 0.001</td>
<td>0.50</td>
<td>1.793</td>
</tr>
<tr>
<td>2018</td>
<td>13</td>
<td>76.92%</td>
<td>89.38%</td>
<td>7.115</td>
<td>&lt; 0.001</td>
<td>0.54</td>
<td>1.069</td>
</tr>
</tbody>
</table>
Pre/Post Tests: Knowledge Quiz

- **Detailed analysis:** focus on 12 questions that repeat every year with same wording
  - Post-tests always higher than pre-tests (all statistically significant t-tests)

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>$M_{pre}$</th>
<th>$M_{post}$</th>
<th>$t$</th>
<th>$p$</th>
<th>$\langle g \rangle$</th>
<th>$d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>8</td>
<td>63.54%</td>
<td>80.21%</td>
<td>3.742</td>
<td>0.007</td>
<td>0.46</td>
<td>1.536</td>
</tr>
<tr>
<td>2015</td>
<td>29</td>
<td>68.68%</td>
<td>76.44%</td>
<td>2.897</td>
<td>0.007</td>
<td>0.25</td>
<td>0.512</td>
</tr>
<tr>
<td>2016</td>
<td>17</td>
<td>64.71%</td>
<td>73.04%</td>
<td>2.432</td>
<td>0.027</td>
<td>0.24</td>
<td>0.508</td>
</tr>
<tr>
<td>2017</td>
<td>20</td>
<td>68.33%</td>
<td>81.67%</td>
<td>5.287</td>
<td>&lt; 0.001</td>
<td>0.42</td>
<td>1.269</td>
</tr>
<tr>
<td>2018</td>
<td>13</td>
<td>75.00%</td>
<td>85.26%</td>
<td>2.997</td>
<td>0.011</td>
<td>0.41</td>
<td>0.950</td>
</tr>
<tr>
<td>Course overall</td>
<td>87</td>
<td>68.30%</td>
<td>78.64%</td>
<td>7.274</td>
<td>&lt; 0.001</td>
<td>0.33</td>
<td>0.752</td>
</tr>
</tbody>
</table>

- **GTAs’ pedagogical knowledge increases after one semester of GTA preparation**
Outline

- Background and Motivation
- Developing the “Physics GTA Preparation” Course
- Results from Program Assessment
  - The initial conditions of first-time Physics GTAs
  - Surveys and Pre/Post Tests
  - **End-of-Semester Student Evaluations**
- Conclusions and Summary
End-of-Semester Student Evaluations

- **Caveat:** student evaluations alone cannot measure teaching effectiveness

- **Pre-intervention:** GTAs with first teaching experience in 2011-2012

- **Post-intervention:** GTAs with first teaching experience in 2013-2015 (first three years of GTA prep course)

- Analysis of student evaluation scores for only **first Fall** and **first Spring** semester of teaching (when each grad student was a first-time GTA)

<table>
<thead>
<tr>
<th>Item Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Oral communication skills</td>
</tr>
<tr>
<td>T2</td>
<td>Written communication skills</td>
</tr>
<tr>
<td>T3</td>
<td>Explained concepts clearly</td>
</tr>
<tr>
<td>T4</td>
<td>Familiarity with course concepts</td>
</tr>
<tr>
<td>T5</td>
<td>Respect for students</td>
</tr>
<tr>
<td>T6</td>
<td>Attitude about their teaching role</td>
</tr>
<tr>
<td>T7</td>
<td>Stimulated interest in subject</td>
</tr>
<tr>
<td>T8</td>
<td>Approachability</td>
</tr>
<tr>
<td>T9</td>
<td>Level of preparedness</td>
</tr>
<tr>
<td>T10</td>
<td>Classroom management</td>
</tr>
<tr>
<td>T11</td>
<td>Actively engaged students</td>
</tr>
<tr>
<td>T12</td>
<td>Overall effectiveness</td>
</tr>
</tbody>
</table>
End-of-Semester Student Evaluations

- Post-intervention group was **always rated higher** than pre-intervention group (most differences are statistically significant)

- Skewed ratings suggest that Georgia Tech undergrads are reluctant to give a low (1, 2) rating unless something is egregiously wrong
End-of-Semester Student Evaluations

- **Highest rated:** familiarity with concepts, respect for students, approachability, level of preparedness

- **Lowest rated:** stimulated interest in subject

- For most items, rating in first Spring is higher than rating in first Fall

- **Participating in GTA prep leads to higher student evaluations**
Outline

- Background and Motivation
- Developing the “Physics GTA Preparation” Course
- Results from Program Assessment
  - The initial conditions of first-time Physics GTAs
  - Surveys and Pre/Post Tests
  - End-of-Semester Student Evaluations
- Conclusions and Summary
Answering the Research Questions

What elements of a formal GTA preparation program do GTAs perceive as the most useful or beneficial for their professional development?

- Microteaching, Lab Simulation, Teaching Physics
- GTAs appreciate hands-on activities in which they get to practice teaching and receiving feedback on their performance
- GTAs are interested in developing the pedagogical content knowledge necessary for teaching physics
Answering the Research Questions

- What effect does a formal GTA preparation program have on graduate students’ **teaching self-efficacy** and **attitudes** about teaching?

  - GTAs report feeling better prepared for teaching after participating in the Orientation.
  - GTAs adopt more learner-centered approaches to teaching after participating in the GTA prep course.
Answering the Research Questions

Does a formal GTA preparation program have an effect on graduate students’ teaching effectiveness, as determined by end-of-semester student evaluations?

- GTAs who participate in the GTA prep course are rated consistently higher in end-of-semester student evaluations than GTAs who predated the course.
Significance to PER

- There is no “one-size-fits-all” approach to GTA preparation.
- Lots of work has been done, but most of it focuses on GTAs as future faculty – we shouldn’t ignore the ones who leave academia.
- The 3P Framework can provide universal guidance that ensures broader professional development as an integral part of GTA preparation.
- Generalized to other fields: 3P → PDP (pedagogy, discipline-specific content, professional development).
The Physics GTA Preparation course successfully integrates pedagogy, physics, and professional development.

Our GTA prep course satisfies the principles for best practices in GTA preparation, and is effective at preparing GTAs for their teaching roles.

Our method of curriculum development, the 3P Framework, can provide universal guidance for GTA preparation that is useful for graduate students no matter what their career goals are.

Curriculum materials at: https://tinyurl.com/ealiceaGTAPD

Thank you!