Integrating Group Discussion and Inquiry-Guided Learning into Physics TA Training

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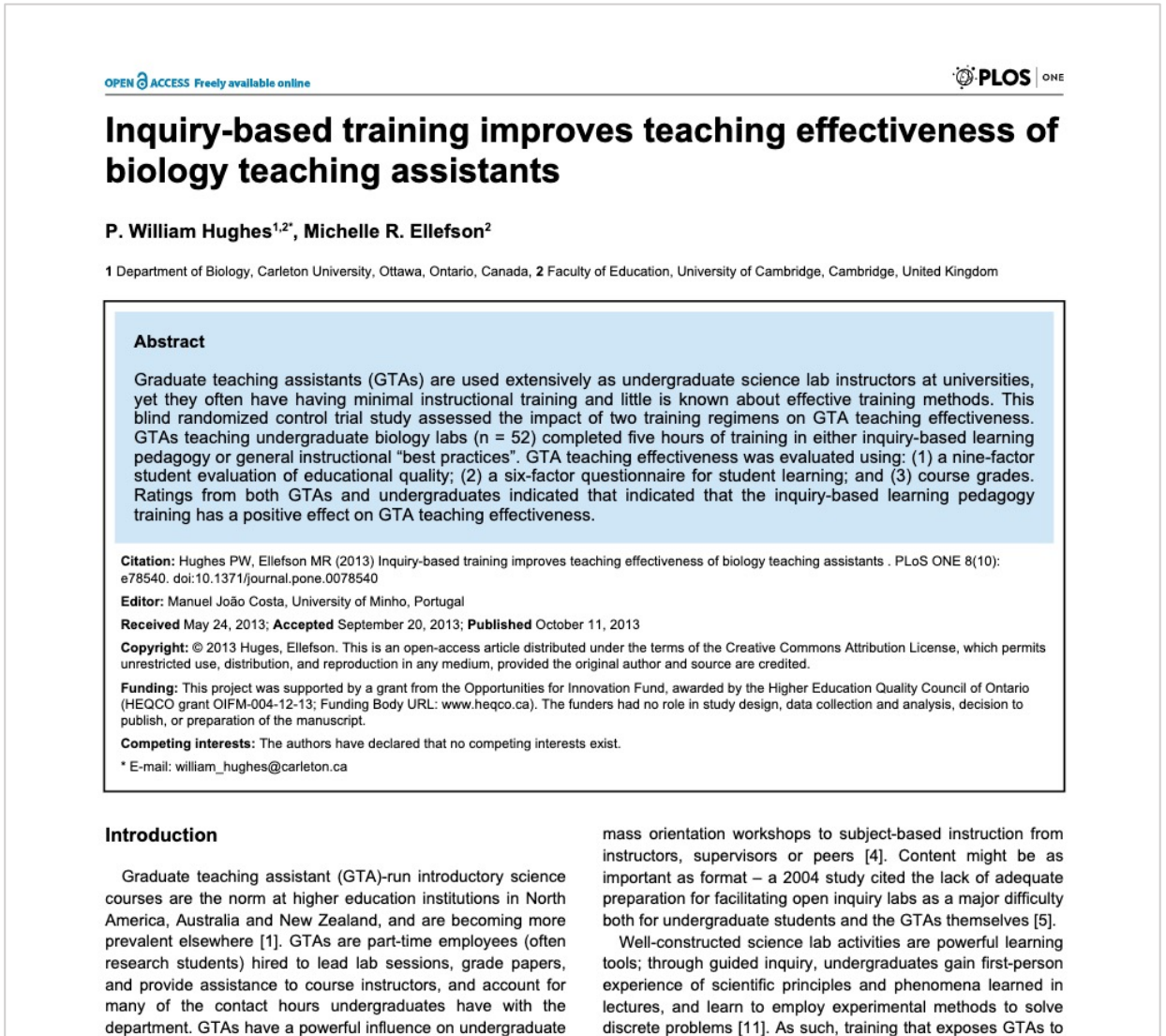
CAP Conference – Hamilton, ON
June 5-10, 2022

McGill | Office of Science Education

Introduction



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PLOS ONE

Inquiry-based training improves teaching effectiveness of biology teaching assistants

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Abstract

Graduate teaching assistants (GTAs) are used extensively as undergraduate science lab instructors at universities, yet they often have having minimal instructional training and little is known about effective training methods. This blind randomized control trial study assessed the impact of two training regimens on GTA teaching effectiveness. GTAs teaching undergraduate biology labs (n = 52) completed five hours of training in either inquiry-based learning pedagogy or general instructional "best practices". GTA teaching effectiveness was evaluated using: (1) a nine-factor student evaluation of educational quality; (2) a six-factor questionnaire for student learning; and (3) course grades. Ratings from both GTAs and undergraduates indicated that indicated that the inquiry-based learning pedagogy training has a positive effect on GTA teaching effectiveness.

Citation: Hughes PW, Ellefson MR (2013) Inquiry-based training improves teaching effectiveness of biology teaching assistants . PLoS ONE 8(10): e78540. doi:10.1371/journal.pone.0078540

Editor: Manuel João Costa, University of Minho, Portugal

Received May 24, 2013; **Accepted** September 20, 2013; **Published** October 11, 2013

Funding: This project was supported by a grant from the Opportunities for Innovation Fund, awarded by the Higher Education Quality Council of Ontario (HEQCO grant OIFM-004-12-13; Funding Body URL: www.heqco.ca). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing interests: The authors have declared that no competing interests exist.

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Introduction

Graduate teaching assistant (GTA)-run introductory science courses are the norm at higher education institutions in North America, Australia and New Zealand, and are becoming more prevalent elsewhere [1]. GTAs are part-time employees (often research students) hired to lead lab sessions, grade papers, and provide assistance to course instructors, and account for many of the contact hours undergraduates have with the department. GTAs have a powerful influence on undergraduate

mass orientation workshops to subject-based instruction from instructors, supervisors or peers [4]. Content might be as important as format – a 2004 study cited the lack of adequate preparation for facilitating open inquiry labs as a major difficulty both for undergraduate students and the GTAs themselves [5].

Well-constructed science lab activities are powerful learning tools; through guided inquiry, undergraduates gain first-person experience of scientific principles and phenomena learned in lectures, and learn to employ experimental methods to solve discrete problems [11]. As such, training that exposes GTAs to

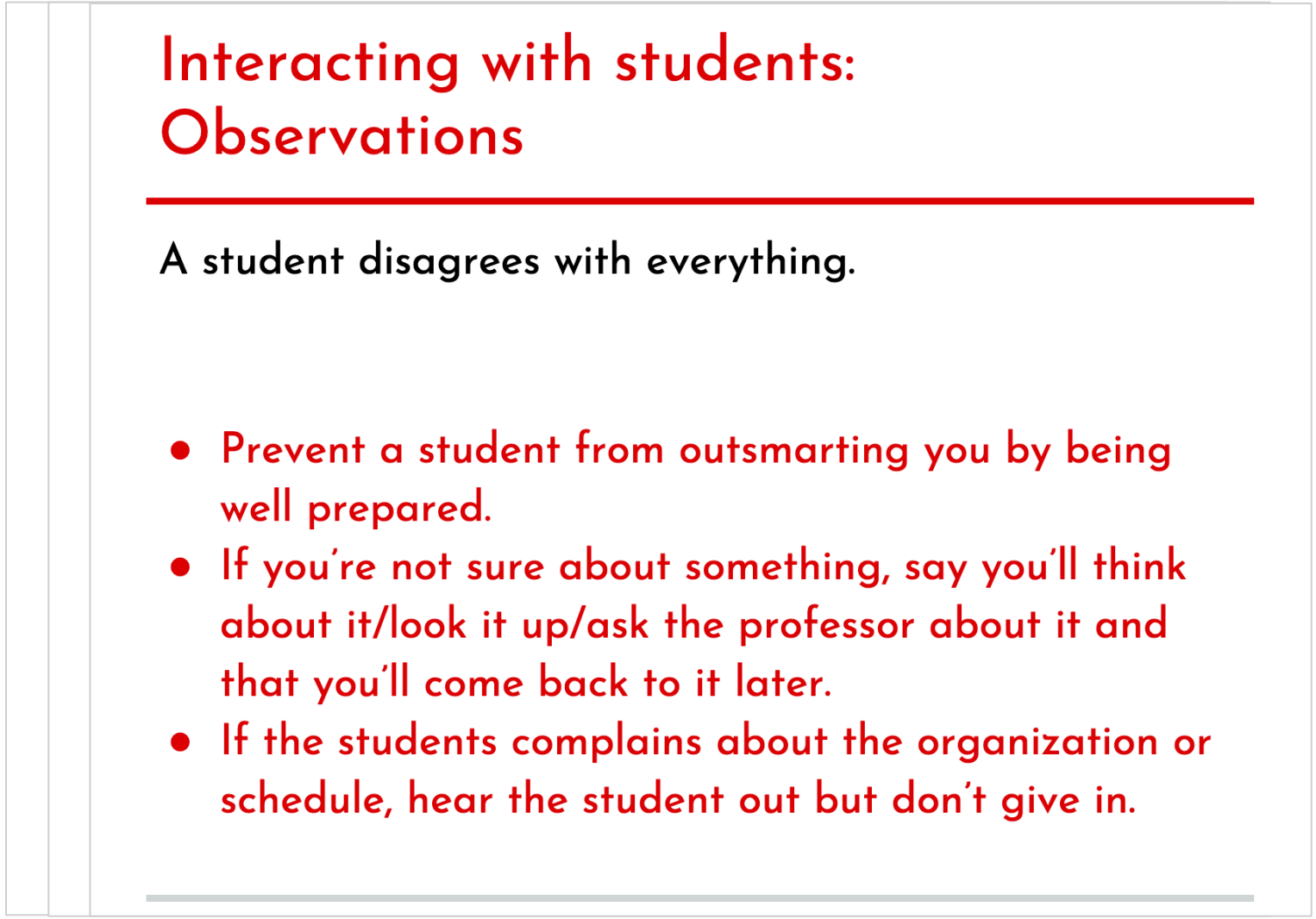
Goal:

Co-create a training program for all Physics TAs that uses an inquiry-guided approach to further promote graduate students' abilities in handling uncertainty, developing higher order thinking skills, and teaching undergraduates.

Road Map

1. Previous TA Training
2. Pilot Learning Community
3. New IGL Training Program
4. Feedback and Next Steps

Previous TA Training



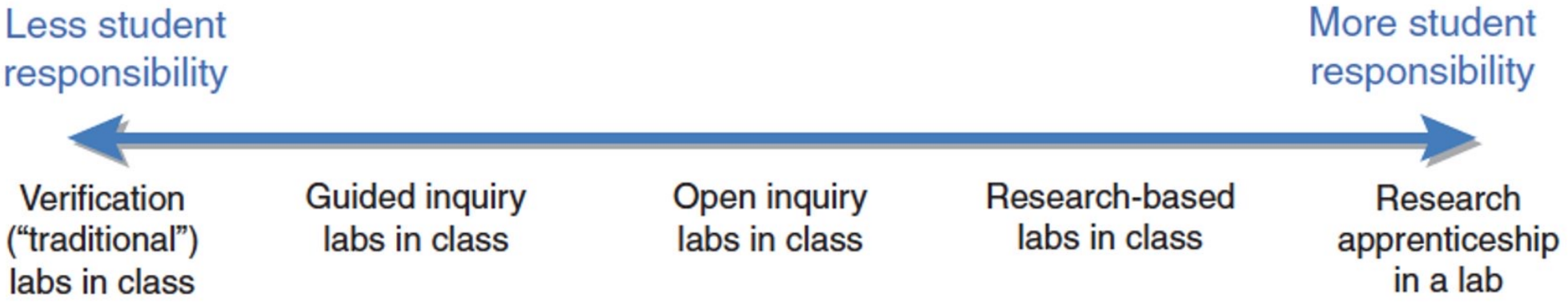
One day, all-day training

Large focus on solving problems and efficiently completing duties

Explanation of both teaching practices and TA administrative points

Pilot: TA Learning Community

Brought together 7 physics TAs to learn IGL principles and brainstorm methods to best apply IGL strategies in physics courses



Weaver 2008

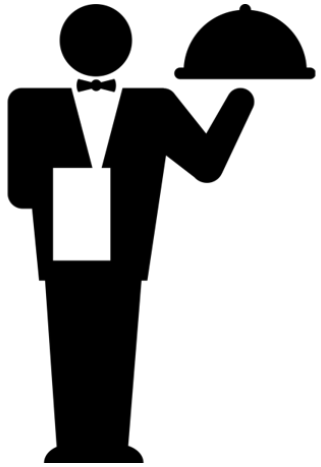
Pilot: TA Learning Community

Brought together 7 physics TAs to learn IGL principles and brainstorm methods to structure and evaluate TA actions (LOPUS)

Guide-on-the-Side

Busy Bee

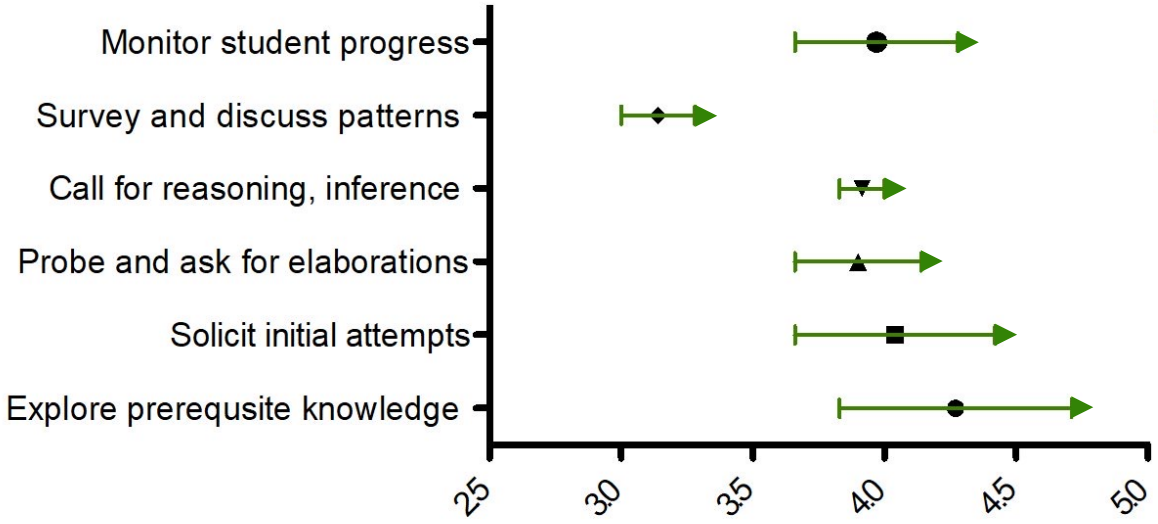
Waiter



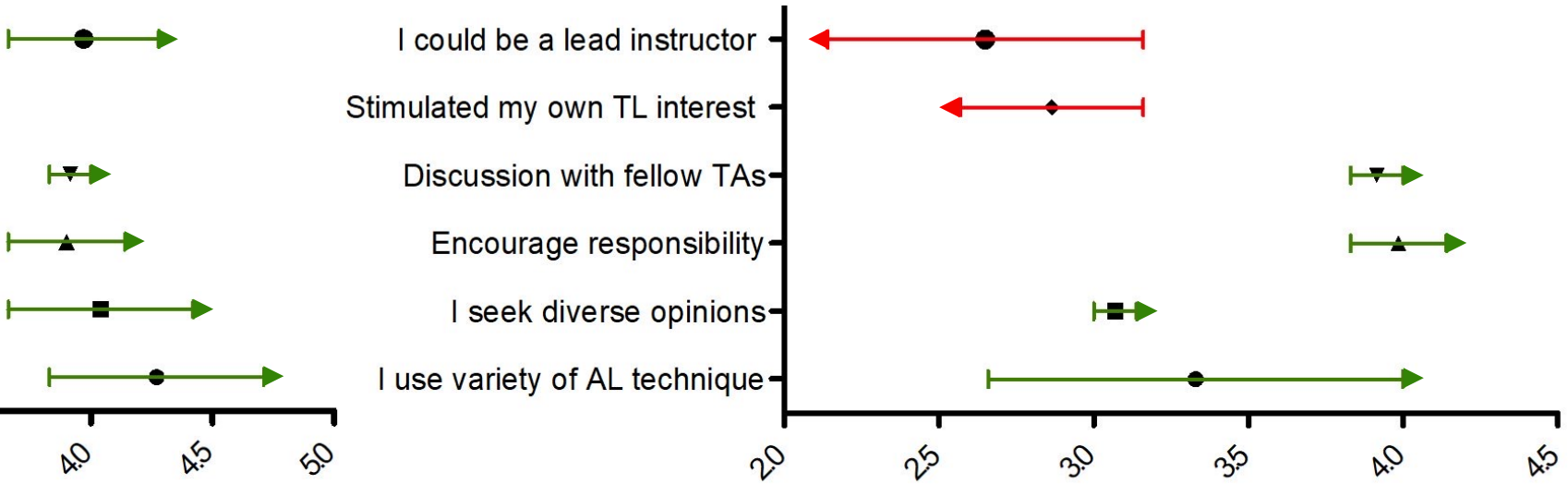
Velasco et al. 2016

Pilot: Results

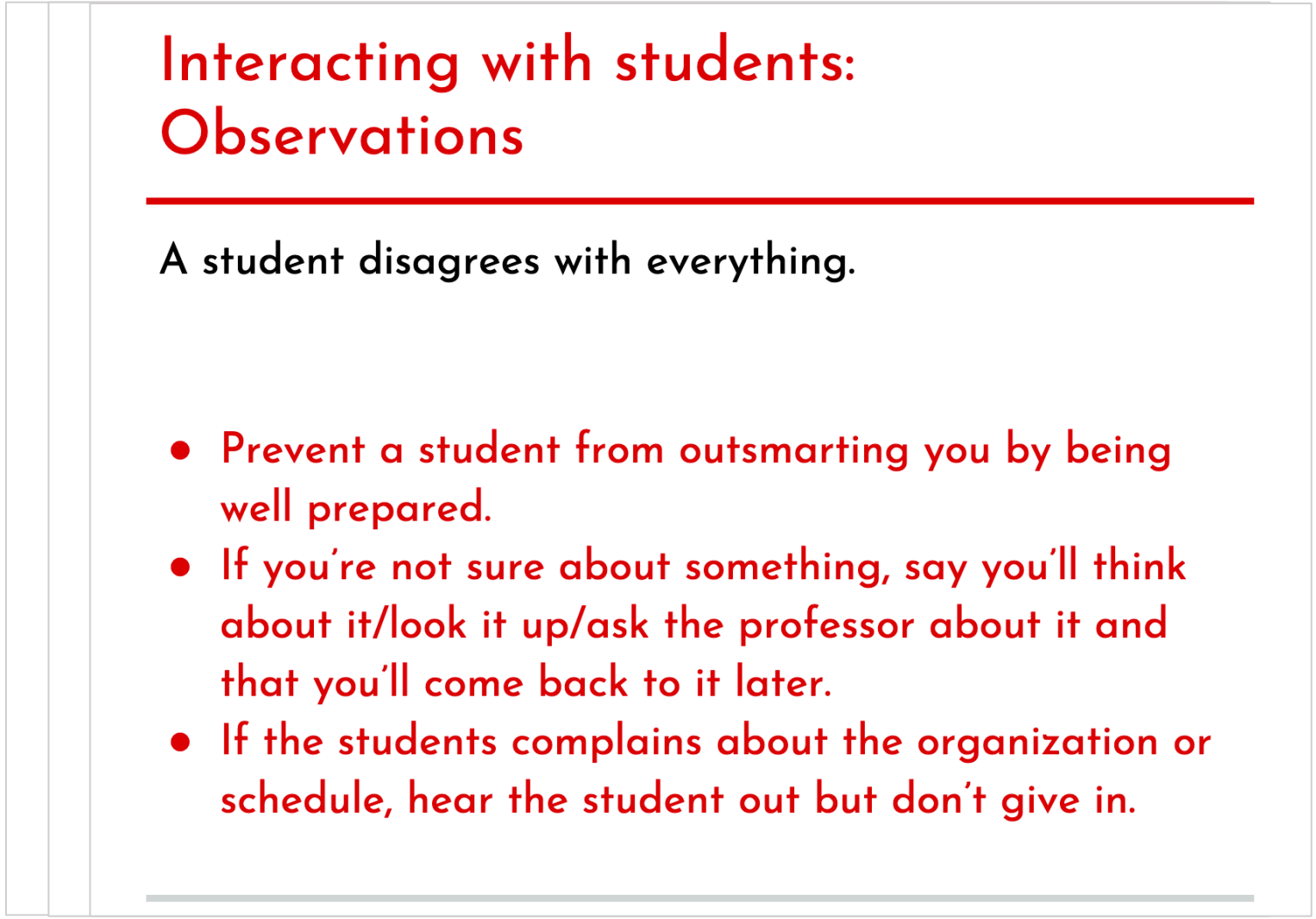
Change in Use of IGL Practices



Change in Self-Assessment Questions



Previous TA Training



Five one-hour sessions

Training focused on pedagogy and knowledge transfer

Administrative information sent in handbook document

New Training Schedule

Session		Topic
1.	Being a TA in Physics	Expectations and inquiry-guided learning practices
2.	Asking Good Questions	Guiding student thinking and making thinking explicit
3.	Answering Questions	Facilitating critical thinking and eliciting discussion
4.	Giving Effective Feedback	Promoting learning through feedback
5.	Challenging Situations	Strategies for interactions with students

Example Slides: IGL Theory

Approaches to Feedback

- Provides correct answer
- Explains why answer is correct
- Checkmarks for correct answers

- Identifies the mistake
- Tells student how to fix it
- Points out strengths

- Questions
- Suggestions on process
- Elaborates on strengths

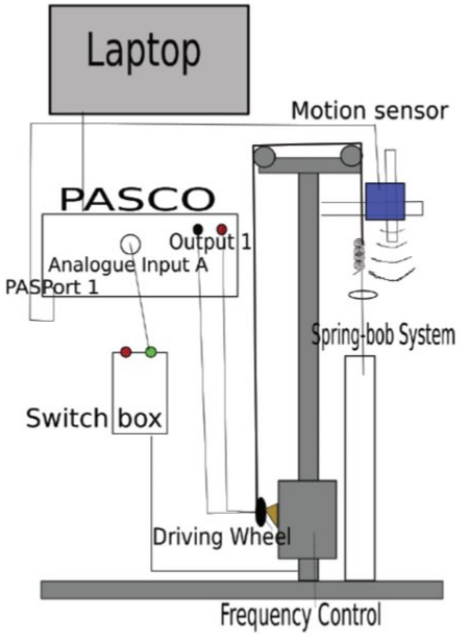
"Good explanation of potential experimental outcomes."

"Writing what you might see if your hypothesis is incorrect is a great way to approach thinking about experiments. Keep doing this for future lab reports."

Straub 1996; Nicol & Macfarlane-Dick 2004; Orsmond et al. 2013

Example Slides: Applications

Asking IGL Questions in Physics



Questions

- Could we make this experiment without the motion sensor?
- How would you perform this experiment without the presented setup?

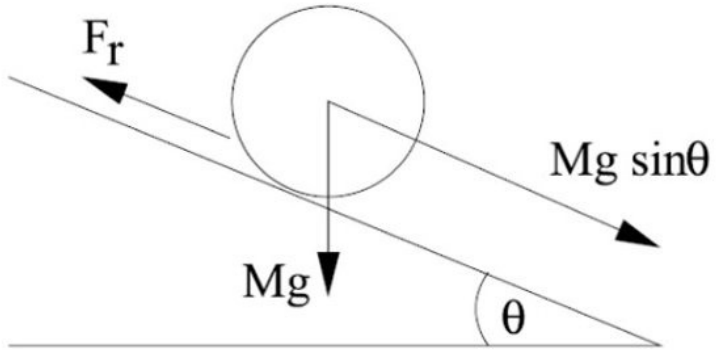
Check background knowledge | Generate ideas | **Probe further** | Challenge thinking | Involve the class

Example Slides: Applications

What does IGL look like in Physics?

- PHYS 257
  - Cylinder on an inclined plane
    - Distributions and how to deal with them

Setup of rolling cylinder is presented	The equations to describe the system are given	Record the values for acceleration encountered
Get an experimental distribution of accelerations at different distances	Compare the standard deviations	Does your data support the idea that the acceleration is constant?



Confirmation Inquiry

Traditional Learning

Structured Inquiry

Guided Inquiry

Open Inquiry

Grad Research

Example Slides: Discussion

What is the purpose of giving students feedback?

How would you change your feedback if…

This is a student who is taking the course for a second time?

How would your feedback change if you were talking with students instead of writing feedback down?

Your Turn!

Responding to Questions:

1. Just tell me what to do!
2. How do I fix it?
3. We haven't seen this yet

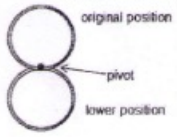
What has worked well for you when responding to student questions?

TA Handbook

Information from previous training:

Example
In the following pages, there is a sample solution sheet and several student submissions for an exam question that you can use to practice forming a grading rubric or formulating useful feedback. Think of how you would divide points among the different parts of the questions or how to guide students on where they can improve.

3) [6 pts] The figure below shows a circular hoop of radius R and mass M in a vertical position and attached to a frictionless horizontal pivot on its lower edge. If the hoop is now nudged (given a gentle push), it will swing down to the lower position shown.
   a. Calculate the torque on the hoop when it is at the horizontal position (not shown in the diagram) – that is, when its center-of-mass is at the same height as the pivot point.
   b. Calculate its angular velocity ω when it is in the lower position.
   c. If the hoop were stopped in the lower position and then gently nudged, what would be the period of the resulting oscillation?



a) Center of mass = IR From the pivot
$\tau = rF\sin\theta$ F = Force of gravity = gM
$\tau = R_g M \cos 0^\circ = R_g M$

b) $\omega^2 = \omega_0^2 + 2\alpha_2 \Delta\theta$ $\omega^2 = 0^2 + 2(9.81\ m/s^2)(\pi)$
$\omega = 7.85$ rad/sec

c) The hoop acts as a physical pendulum so this equation is used: $T_{(period)} = 2\pi / \sqrt{\frac{mass \cdot g \cdot d(distance\ from\ axis\ of\ rotation)}{I\ (inertia)}}$

To be honest I have no idea how to calculate inertia for a loop ☹

$T = 2\pi / \sqrt{\frac{M \cdot 9.81\ m/s \cdot R}{I}}$ This is the best I got

Information on IGL and updated resources:

Answering student questions
Asking good questions is essential to helping students articulate their thinking and guiding their learning, but answering students' questions is also important. When answering questions, three approaches can be used: corrective, directive, and facilitative (Chin & Osborne, 2008; Orsmond et al. 2013; Herranen & Aksela, 2019).

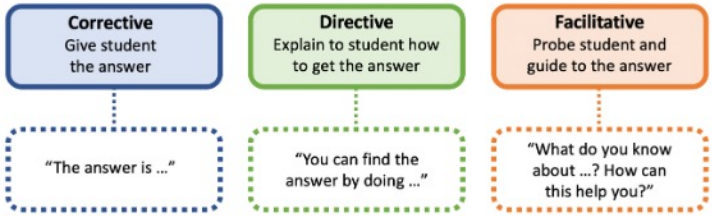


Figure 5: Three approaches to answering student questions

The facilitative approach is most suited to IGL because it:
- Identifies where students are struggling
- Helps TAs better target what support to give students
- Guides students to finding their own answer

While the facilitative approach promotes deeper learning and encourages students to be self-reliant, it might not be feasible or necessary to use this approach for answering all student questions. You will most likely use a combination of the three approaches when answering student questions.

Resource List

- **Office of Science Education (OSE)**
  - https://www.mcgill.ca/ose/
  - See Appendix for Extended List of OSE resources for TAs
- **Association of Graduate Students Employed at McGill (AGSEM)**
  - McGill's Teaching Support Union: "The Association of Graduate Students Employed at McGill (AGSEM) is the oldest Teaching Assistant Union in the province of Quebec. As a labour union, AGSEM represents TAs and Invigilators at McGill. AGSEM has bargained with the McGill administration to produce TA and Invigilator Collective Agreements, which are legal documents that protect student workers."
  - https://www.agsem.ca/

Results

Session	Attendance
Being a TA in Physics	51
Asking Good Questions	34
Answering Student Questions	37
Giving Feedback	19
Addressing Challenging Situations	22

Who Attended?
• New and returning (50:50 split)
• Lab, tutorial, and grading TAs (evenly split)
• Majority teach 100-level courses (47%)
• 57% attended 3+ sessions in the series

Feedback

Hearing ideas from other TAs

"This was technically my second training in IGL, so I was already familiar with the material. But it was an amazing refresher course with new TA's and a richer gathering of ideas."

Practical IGL strategies for TAing

"I've already integrated [IGL] into the way I grade, and it's been rather helpful. I know what to write on 'perfect' assignments, about details students can improve upon."

Multi-session format

"I'm glad the training wasn't a single day, 5-hour session, because it would have been much harder to remember much from it in that case. I learned a lot more by spreading it out and having some time to apply things in the 'real world' between sessions."

Next Steps

- Continue development of TA Training program with feedback from research group and grad association
  - Measure directly in labs using LOPUS
- Explore aspects of active writing as an added benefit to laboratory courses
  - How can TAs can be leaders in effective writing?

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