

Transforming Introductory Physics Labs (and doing them online) Using Argument Driven Inquiry

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Outline

Link to a guide to this workshop:

`sfwolfphys.github.io/f2020ADIwksp.html`

- 1 Introduction to ADI
- 2 Reaction Time Lab Activity
- 3 Argumentation Session/Reflection
- 4 Online Adaptation



XLABs Personnel

Physics

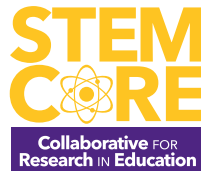
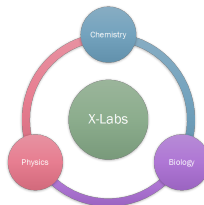
- Co-PI: Steven Wolf
- Mark Sprague

Biology

- Co-PI: Heather Vance-Chalcraft
- Co-PI: Kristine Callis-Duehl
- Taria Crenshaw

Chemistry

- Project Lead: Joi Walker
- Rosa Bell
- Kate Hosbein
- Annalisa Smith-Joyner
- Eric Eaton



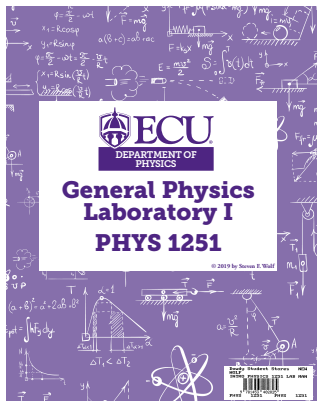
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Project page:

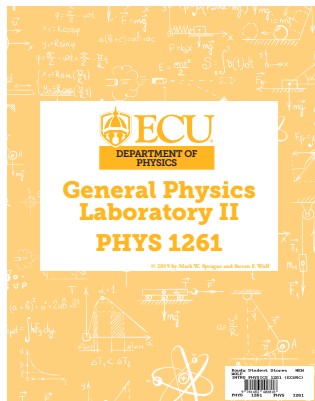
<https://bit.ly/3k3WoKf>



Science Practice Focused Lab curriculum



Piloted Spring 2018



Piloted Fall 2018



What science practices?

M.J. Ford, *Science Education* **99**, 1041 (2015).

Empirical practices:

- EP1 Locate information relevant to a scientific problem.
- EP2 Construct a relevant/appropriate scientific question for a given problem.
- EP3 Design an experiment to test a scientific question.
- EP4 Apply (or know when to apply) appropriate analytical methods to examine a scientific problem.
- EP5 Appraise an experimental design to identify elements and limitations and how they impact scientific findings/conclusions.
- EP6 Troubleshoot technical issues.
- EP7 Evaluate evidence and critique experimental designs.
- EP8 Interpret basic statistics (e.g., average and SD).



What science practices?

M.J. Ford, *Science Education* **99**, 1041 (2015).

Representative practices:

- RP1 Generate a hypothesis or make a prediction based on a scientific model.
- RP2 Construct an argument based on evidence.
- RP3 Identify additional information needed to support an argument.
- RP4 Provide alternative explanations for results that may have many causes.
- RP5 Integrate and apply knowledge across sub-disciplines.
- RP6 Represent data in a visual form.
- RP7 Interpret visual representations of data.
- RP8 Construct a Data table.
- RP9 Data Analysis.



Elements of ADI

Week 1: Pre-Lab



- Students work in pairs
- Learn a new measurement or analysis technique
- Traditional lab activity

Week 2: Inquiry Investigation

- Students work in groups of four
- Students are given a scientific question to answer
- Students design an investigation and carry it out
- Investigations must be approved by TA



Elements of ADI

Week 3: Argumentation Session



- Students work in groups of four
- Students present the results of their experiment via a “poster session”
- One presenter, three travelers

After Week 3: Peer Review

- Students turn in their first draft after the argumentation session
- We use peer review tools embedded in Canvas
- Students review 3 papers while watching a peer review calibration video



Implementation at scale

Instructional Context

Labs serve both Calculus-based and Algebra-based physics lecture courses.

Physics 1 Typically about 400 students in approximately 25 sections managed by 8-10 TAs.

Physics 2 Typically about 250 students in approximately 15 sections managed by 5-6 TAs.



Implementation at scale

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Management strategies

- Course is hosted on our LMS (Canvas) - All sections as one course
- Course is set up by lab manager (MWS) - assignments, due dates, syllabus, etc.
- All artifacts are turned in online
- TAs grade using rubrics... calibration is important!

Reaction Time Lab Activity – Background

Plan:

- You will be split into groups of 2 or 3
- Your task: Complete the workshop activity on the workshop page
- I'm planning 15 minutes for this portion:
 - ▶ Guidance we give students: 30 data points
 - ▶ We also discuss mean, standard deviation, and standard error

Link to workshop page: sfwolfphys.github.io/f2020ADIwksp.html



Argumentation Session Instructions – 15 min

Goal:

- Each group will prepare to share out briefly
- Want to give you a flavor of how this works in a class



Transition to Online Learning

Spring 2020

We had about 2 weeks to plan to finish labs. Keys to success:

- Don't forget about the physics, and your learning goals.
- Adapt, don't change.
- Get a little lucky.

Summer 2020 and beyond

We still wanted a hands on experience.

- Lab manuals were made available online
- Students purchased kits for a reasonable price

Post pandemic: We have DE students who struggle to take lab courses.

Online adaptation of ADI Elements

Week 1a and 1b: Pre-Lab



- TAs hold “office hours” at regular class time
- Students work asynchronously

Week 2a: Inquiry Investigation

- Students work in groups of four asynchronously
- Groups get proposals approved during regular class time



Online adaptation of ADI Elements

Week 2b: Argumentation Session



- Posters are power points rather than whiteboard posters
- Argumentation occurs synchronously

After Week 2b: Peer Review

- Remains unchanged



Physics 1 Online Investigations

Investigation	Topic	Guiding Question
1	1-D kinematics	Does a ball rolling on an incline have the same acceleration on the way up as it does on the way down?
2	2-D collisions	Is the collision between two marbles elastic?
3	Periodic motion	What is the nut position for which the physical pendulum small-angle period is minimum, and what is the power-law regression equation for the period of the system?

We have dropped a reaction time investigation due to our shortened semester.



Physics 1 Kit contents

Quantity	Item	Investigation(s)
1	Protractor	1
2	25 mm marble	1, 2
1	Tape measure with cm scale	1, 2, 3
1	0.6 m threaded rod	3
1	Eye nut	3
3	Nuts	3
1	Door hook	3
1	1 m string	3
1	16 mm marble	2



Physics 2 Online Investigations

Investigation	Topic	Guiding Question
1	Current and resistance	Does a light bulb behave like a resistor?
2	Time varying circuits	Do two of the lab kit capacitors have the same capacitance?
3	Diffraction of light	Are hairs from different people the same diameter?



Physics 2 kit contents

Quantity	Item	Investigation(s)
1	100 Ω resistor	1
1	330 Ω resistor	1
1	100 Ω potentiometer	1
1	E10 light bulb holder	1
1	5 V E10 incandescent light bulb	1
1	Breadboard	1, 2, 3
1	Breadboard power supply	1, 2, 3
1	USB power supply cable	1, 2, 3
1	Jumper wire set	1, 2
2	Multimeters	1, 2
1	Mini screwdriver for multimeters	1, 2
5	500 mA fuses for multimeters	1, 2
4	Alligator clip leads	1, 2
1	1 M Ω resistor	2
2	100 μ F capacitor	2
1	5 V, 650 nm laser module	3
1	Tape measure with cm scale	3



Thank You!

Any Questions?

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