Epistemological, Socialization, and Teacher Support Views of Traditional and At-Home Physics Labs

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Why do lab work?

- Physics is an experimental science
- Develop scientific habits preparing them to be 21st century citizens
- Can promote scientific inquiry (“thinking like a physicist”)
- Creates opportunities to construct knowledge

American Association of Physics Teachers, *AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum*, Report prepared by a Subcommittee of the AAPT Committee on Laboratories (2014).

American Physical Society, *Phys21: Preparing Physics Students for 21st-Century Careers: A Report by the Joint Task Force on Undergraduate Physics Programs* (APS, College Park, MD, 2016).

Need for change

- Limited resources available to schools and students
- Growing student population
- Provide accessibility
- Provide continuity of lecture/lab

President's Council of Advisors on Science and Technology, *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics* (ExecutiveOffice of the President, Washington, DC, 2012).

The iOLab Device

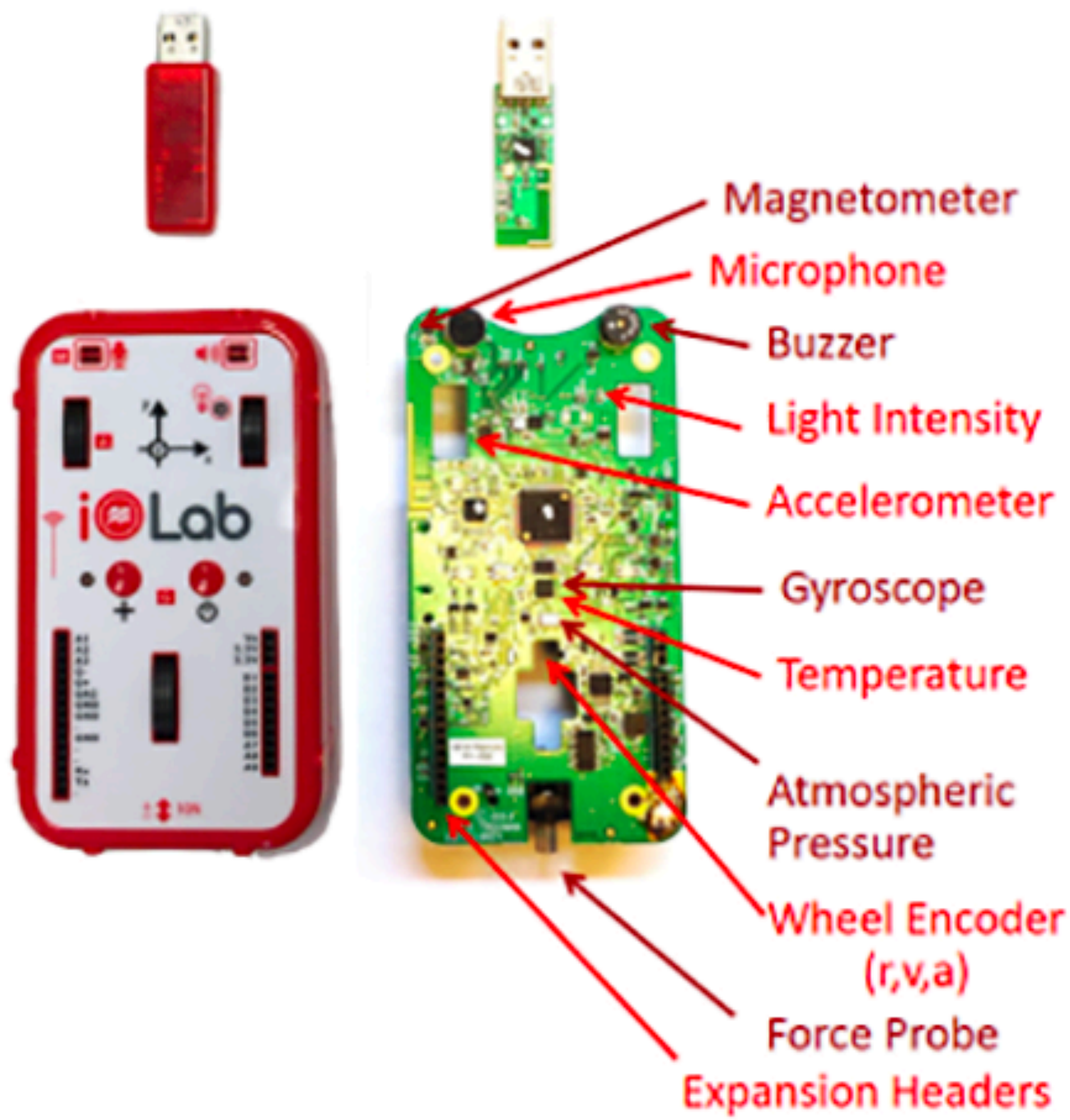


Image care of Macmillan

Labs offered

Traditional Labs First Semester - Mechanics	Online Labs
1. Pendulum	1. Linear Kinematics
2. Projectile Motion	2. Force and Acceleration
3. Acceleration	3. Force of Friction
4. Atwood Machine	4. Circular Motion
5. Conservation of Energy	5. Hooke's Law & Springs
6. Conservation of Momentum	6. Momentum & Energy
7. Angular Momentum	7. Simple Harmonic Motion
8. Standing Waves	8. Simple Pendulum
9. Simple Harmonic Motion	9. Standing Waves
10. Ideal Gas Law	10. Speed of Sound Laboratory
Traditional Labs Second Semester - Electricity and Magnetism	**Online Labs**
1. The Electric Field	1. Electric Field Plotting
2. The Oscilloscope	2. The Breadboard
3. Capacitors	3. Ohm's Law
4. Ohm's Law	4. Kirchhoff's Laws
5. Magnetic Force	5. RC Circuits
6. e/m of the Electron	6. Magnetic Force
7. Inductors	7. Magnetic Field
8. Resonance	8. Faraday's Law
9. Geometric Optics	9. RLC Circuit
10. Interference	10. Snell's Law
11. N/A	11. Diffraction

Example of At-Home Data Collection: Simple Harmonic Motion

Continue | Add run | Restart | Quit Player

Slide: 1 2 3 4 5* 6 7 8 9 10

Finding the Period and Frequency

Procedure

1. Using the paper clip and the long spring, hang the device and allow it to oscillate.
2. Measure the time between the first 5 peaks. This will represent 4 periods. Divide this time by 4 to find the period.
3. Using the period, find the angular frequency, ω.
4. Use the Fast Fourier Transform function (4096 option) to find the peak frequency. Use this to calculate ω and compare this to the value you found using the period.

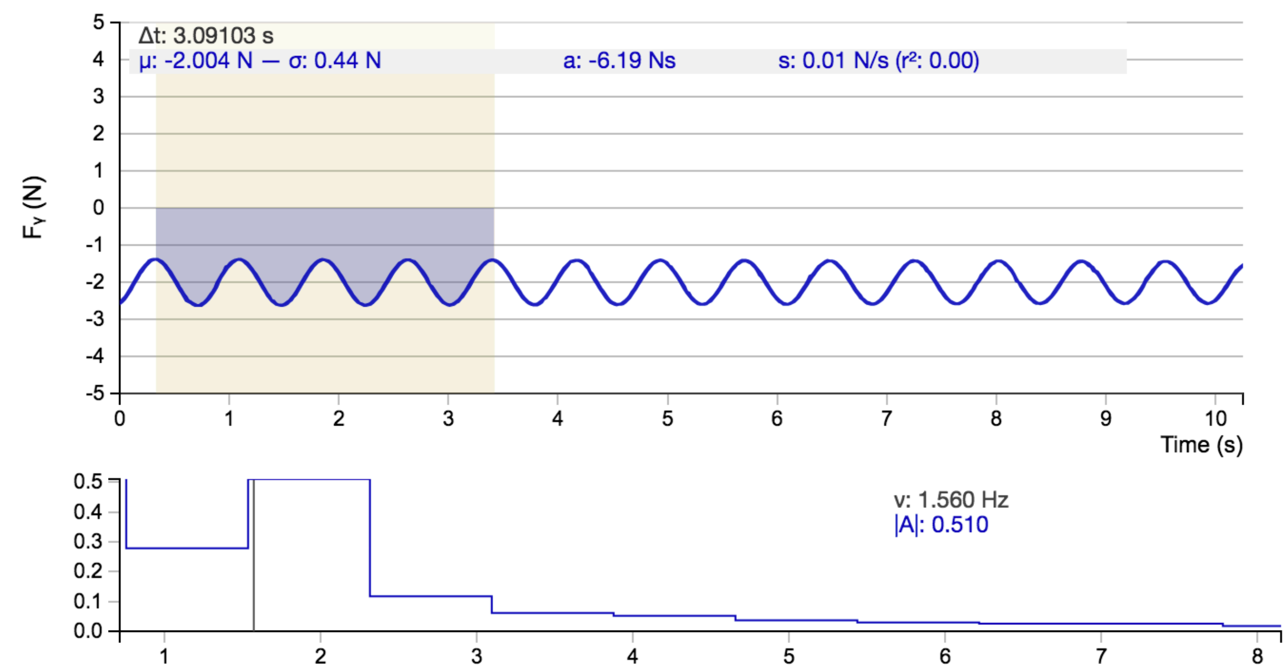
You will be repeating this for 2 more masses by adding more mass to the device (by attaching an object to the iOLab device with tape). You will be doing this in the upcoming slides.

In your lab report, show enough data plots (appropriately zoomed and highlighted) to show how the analysis is done for one mass. Include a table that shows the results for all three masses.

Acquisition Sets

Run1 (ID: 45ea18db-924c-43d1-bce0-ce2d5a299497) [Remove]

Force (200 Hz) Remote 1



Rezero sensor

Save & Go Next

Research Questions

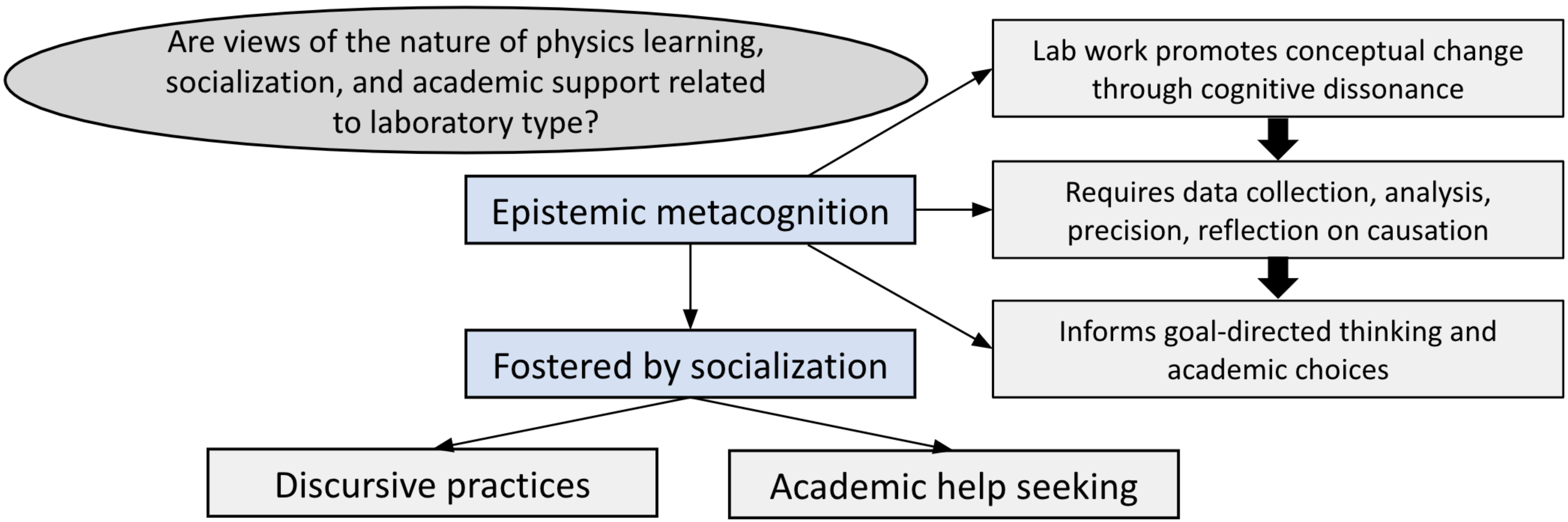
- What are undergraduate students' epistemological views of the value of laboratory tasks, socialization, and teacher support in the physics laboratory?

- What are the similarities and differences between these epistemological views when comparing students in traditional, in-person laboratory courses, and those in online laboratory courses?

Context of Study

- Study was conducted at a large, public university in northeastern United States
- Employed a quasi-experimental, non-equivalent group design
- Students were enrolled in a calculus based introductory physics course designed for first-year students during the last year
- Students surveyed were either enrolled in an in-person course with lectures and standard physics labs (n=747) or an online course with labs done at-home using a remote sensing device (n=251)

Theoretical Framework



Modified from Rosen and Kelly 2020 (Under Review)

Epistemological beliefs and attitudes about physics

1. I do not expect doing an experiment to help my understanding of physics.
2. I feel that I am learning physics while writing my lab report.
3. I feel that learning error analysis is an important part of my physics lab experience.
4. I feel the grading standards in the lab are unclear.
5. I feel that I am gaining laboratory skills that are useful outside of the physics course.
6. When doing an experiment, I try to understand how the experimental setup works.
7. When doing an experiment, I just follow the instructions without thinking about their purpose.
8. If I don't have clear directions for analyzing data, I am not sure how to choose an appropriate analysis method.
9. Physics knowledge from our regular physics lecture is integrated with laboratory activities.
10. The purpose behind a lab experiment is clear to me before I come to class.
11. Performing data analysis does not help me understand the physics concepts.
12. I better understand how to graph data because of the physics lab course.
13. I better understand how to do error analysis because of the physics lab course.
14. Before collecting data, I know what the results in an experiment are going to look like.
15. I do not enjoy doing lab experiments.
16. I am usually able to complete an experiment without understanding the related physics concepts and equations.
17. I feel pressed for time when performing an experiment.
18. When I approach a new piece of lab equipment, I feel confident I can learn how to use it well enough for my purposes.
19. Calculating uncertainties usually helps me understand my results better.

Rosen and Kelly 2020 (Under Review)

Socialization

20.	Having access to the teaching assistant (TA) while I am conducting an experiment is important to me.
21.	I am more successful performing experiments with other people than if I had to do them on my own.
22.	Working in a group is an important part of doing physics experiments.

Rosen and Kelly 2020 (Under Review)

Help Seeking

23. I usually ask other students for help with technical issues (for example procedures, equipment) before seeking help from the TA.
24. I usually ask other students for help with the data collection/analysis before seeking help from the TA.
25. I am not comfortable asking students in other lab groups for help during a lab.

Rosen and Kelly 2020 (Under Review)

Is online a viable alternate?

- Students in online labs have at least equal beliefs about physics as in person students ($\alpha = .86$)
- Students in online lab do not value socialization as high as in person students ($\alpha = .70$)
- Students have equal beliefs about help seeking ($\alpha = .71$)
- While we did not measure learning outcomes, they are often linked with attitudes

Further Areas of Study

- Interviewing students to get more nuanced responses
- How do students in online learning environments connect with one another?
- Academic factors like physics comprehension, lab skills, and persistence