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


Need for change

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

Image care of Macmillan
## Labs offered

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<th>Traditional Labs</th>
<th>Online Labs</th>
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<td>1. Pendulum</td>
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<td>7. Angular Momentum</td>
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<td><strong>Second Semester - Electricity and Magnetism</strong></td>
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<td>1. The Electric Field</td>
<td>1. Electric Field Plotting</td>
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<td>3. Capacitors</td>
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<tr>
<td>6. e/m of the Electron</td>
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<td>7. Inductors</td>
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<td>9. Geometric Optics</td>
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<td>10. Interference</td>
<td>10. Snell’s Law</td>
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<tr>
<td>11. N/A</td>
<td>11. Diffraction</td>
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Example of At-Home Data Collection: Simple Harmonic Motion

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, $\omega$.
4. Use the Fast Fourier Transform function (4096 option) to find the peak frequency. Use this to calculate $\omega$ 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.
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

Are views of the nature of physics learning, socialization, and academic support related to laboratory type?

Epistemic metacognition

Fostered by socialization

Discursive practices

Academic help seeking

Lab work promotes conceptual change through cognitive dissonance

Requires data collection, analysis, precision, reflection on causation

Informs goal-directed thinking and academic choices

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.
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.
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