Students' varying responses to instructor prompts for frame shifts in physics labs

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Epistemic framing in labs

- *Epistemic framing* is one's expectations of how knowledge is constructed[1]
- Students often hold a *confirmation frame* in lab, believing their experiment should prove a known result[2]
  - Lab instructors must shift students into frames aligned with scientific inquiry
- We examine one lab instructor who explicitly encourages students to *falsify*, or disprove, the claim being tested[3]

How do students operationalize the instructor's prompt for falsification?

Context and methods

- Focus on one lab activity: students test whether a given mechanism explains an observed amplitude dependence of the pendulum period
- Analyze video recordings to infer students' frames from their speech and behaviors[4]

Students measuring the period of the pendulum.

Findings

- Lab groups operationalize *falsification* by taking up one of two frames
  - **Verification frame: students try to verify that the claim is false**
    - Manipulate data or uncertainty
    - Hedge conclusions to satisfy instructor
  - **Open outcome frame: students try to falsify the claim, but revise this expectation if data suggests otherwise**
    - React to data with questions
    - Iterate on experiment
    - Draw conclusions supported by data
- Instructor attempts to shift student frames should prompt **uncertainty in outcomes**[5] and **epistemic agency**[6]

Group 1
Alina (A), Carlos (C), and Sarah (S)
Mechanism: Tension in the String

Aim to falsify the mechanism

S: *What does falsifiable mean again?*
A: *Uh, we're trying to see, to disprove it.*

Want to satisfy the lab requirements

S: *So we're falsifying the idea of tension itself affecting the period?*
A: *Yeah...*
S: *It's like, we could go with anything, as long as we can B.S. it.*

Manipulate uncertainty value

A: *Okay so if we use the standard, the other standard deviation, we get 0.637, but with the one, like with the little, but with the big one, then it becomes 2...*
S: *The standard deviation instead of the standard uncertainty*

Hedge conclusions to satisfy the instructor

S: *So, tension may not affect the period of the pendulum. The tension at different angles may not affect the period of the pendulum.*
A: *But we also don't know that it doesn't...Okay yeah let's just say 'may not' then cause we're trying to falsify it right?*

Verification Frame

Group 2
Henry (H) and Rylie (R)
Mechanism: Friction at the Pivot

Data collection
Data analysis

Aim to falsify the mechanism

R: *Okay so pivot friction, so we're trying to prove that this is not impacting...*
H: *We're going to assume this has impact, so we are trying to prove that it does not have an impact.*

React to discrepancy with questions

R: *1.16, 1.30, 1.22, 1.27, 1.26, 1.16.*
H: *Definitely a difference.*
R: *Yeah this is different...Why is it so different?*

Form a new hypothesis

R: *So maybe our hypothesis is that the friction has a bigger impact on smaller angles.*
H: *Yeah, well that kind of makes sense because the angle is kind of related to speed and speed is related to friction. Is speed related to friction?...*
R: *Yeah, friction does depend on the speed...Friction is higher with more speed though.*

Draw conclusions supported by data

R: *Okay, so we're going to say for low angles we have high t' and for high angles we have low t' so it's possible that friction plays a difference, but there's still something unaccounted for.*

Open Outcome Frame

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[5]N. G. Holmes, A. M. Phillips, and D. Hammer, *Connecting Research in Physics Education with Teacher Education 3* (2022).
[6]E. Miller, E. Manz, R. Russ, D. Stroupe, and L. Berland, *Journal of Research in Science and Teaching*, 55 (2018).

This material is based upon work supported by the NSF GRFP Grant No. DGE-2139899 and NSF Grant No. DUE-2000739. We thank Mark Akubo, Ian Descamps, Sophia Jeon, and David Hammer for engaging in meaningful discussions about this work. We also thank Anna Phillips and Scott Allen for coordinating the video data collection.