A case for rudimentary labs.

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Abstract

- Science education equipment has made amazing leaps forward in the last 5-10 years. It's easy to get graphs that are of near professional quality. Has any learning happened, or is it just "magic data"? In this presentation I propose that, for intro physics students, **using less prefect data collection and/or analysis often leads to more learning**. I also provide examples from my own teaching.

Intended audience

- K-12 teachers
- College lectures for intro class.

Timeline

- 5min- discussion about the purpose of labs
- 5min- giving example from my own classroom
- 5min- questions/ sharing ideas.

What is the purpose of physics research?

What is the purpose students doing a lab in an intro physics class?

- Laboratory activities in high school physics provide experience with phenomena, a starting place for the systematic development of students' ideas, and a testing ground for the predictive power of their reasoning. –AAPT Role of Labs in High School Physics.

Benefits of rudimentary labs.

- **Inquiry**
  - Better understand of the phenomena
  - More ownership of outcomes.
- Stronger data collection skills.
  - Better intuition about “good” and “bad” data
- More fun
- Easier for the instructor/lab tech

Constant acceleration w/ Vernier

- Attach a motion detector to a cart on a ramp.
- Hit play
- Let go of car
- Look at graphs on computer
- Answer questions about x,v,t

- Vernier takes 3 pages to give the directions

Constant acceleration with meter stick and stopwatch

- Pre lab:
  - Determine a way to measure the carts position every second as it rolls down a ramp.
- Lab:
  - Using the following materials, record the carts position every second, and make a x-t graph
    - Meter stick
    - Paperclips
    - Stopwatch
    - Cart (or any object the rolls) and ramp
- Data analysis:
  - Make a position-time graph, and determine the type of relationship.

Pendulum w/ Vernier

- Track motion of pendulum.
- Get a beautiful sinusoidal graph
- Measure period on the graph
- Change length and repeat.
- Plug data into excel, and click the regression analysis button.

Pendulum

- Pre lab:
  - Observe the motion of a pendulum. Draw your prediction of the x,t graph of the horizontal motion.
  - What factors do you think effect the period pendulum?
- Lab: using the following equipotent, pick one of the predicted variables as your independent variable, and test how it effects the period.
  - Meterstick
  - Stopwatch
  - Scale
  - Protractor
- Draw a graph and determine the type of relationship.

Torque activity standard practice

- Do a complicated, often 2-d, statics calculation.
- Place masses on a high precision balance or table
- Observe that it is indeed balanced.

Torque

Directions:

- Grab a meter stick, and a water jug. Place the meterstick on the water jug so that it is balanced.
- I am going to place a known mass somewhere on the meterstick, and your goal is to determine where to place another known mass to that the meterstick is balanced.
- Make any observations, and take any measurements you need to figure this out.
- Once you are ready I will come around, and ask you to balance
  - I need to see a calculation/prediction. You can't just mess around until it works.

Moment of inertia

- Buy a $200 high precision moment of inertia kit with different shapes.
- Predict and observe which shape reaches the bottom first.

Moment of inertia

- Same idea, but with soup cans!
  - Cheddar cheese (disk)
  - Chicken and rice (ring)
  - Broth (no rotation)

- Directions: Predict what order the cans will reach the bottom of the ramp and why.
- *After learning/discussing moment of inertia, and what shape each can resembles I ask :
  - What order did the finish? Using what we have learned justify why.

Online labs

- https://thephysicsaviary.com/
  - Impulse
  - Work
  - Spring energy
  - Centripetal force
- I like thephysicsavairy because it forces the students to have autonomy in data collection.

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- Of course not!
- Vernier has some excellent tools and equipment available for physics labs, but if students don't understand how data is obtained, than they're just following directions.
- Vernier has started revising how their labs so that they are more inquiry based which is great, but teachers often overlook that and assign a quick lab that immediately gives the intended data.

Downsides

- Students take more time.
- It requires guidance from the teacher...sometimes a LOT of guidance.
- Can yield ambiguous results.
- Can be frustrating for the students.

Questions/comments?

- Any questions for me?
- If you have comments or other ideas, then please share.