Impact of experience and equipment on student responses to open-ended dorm room experiments

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This material is based upon work supported by the National Science Foundation TUES program under Grant No. 1122534

Introduction

Having students do simple open-ended experimental tasks in a home setting may encourage creative and exploratory approaches, but also runs the risk of students choosing investigations that are less preferred by the instructor.

Research suggests that contextual aspects of home assignments can be used to mediate student approaches to open-ended tasks at home while still giving them room to design and make their own choices.

In this poster we present a study probing how the status of students' equipment and conceptual familiarity affect how they choose to approach an open-ended experimental task.

The study

Using data from a blended laboratory format which uses at-home experiments as "prelabs" to prepare students for classroom experiments, we focus on an assignment that asks students to explore unfamiliar equipment and conceptual contexts.

The prelab assignment consists of two activities:

Calibration activity

Students are guided to **rotate** the IOLab to check the calibration of their gyroscope sensor.

- Introduces **gyroscope**
- Uses **analysis tools** to find angular displacement

Open-ended activity

Students spin the IOLab device and choose how to investigate the spinning motion.

No preference for sensors, analysis methods, or topic is indicated.

How does the calibration activity influence student choices on the open-ended activity?

Let's switch the order of activities and find out.

Spring 2016 and Spring 2017:
Calibration task given first (N=153)

Fall 2016:
Open-ended activity given first (N=121)

Analysis of student written work

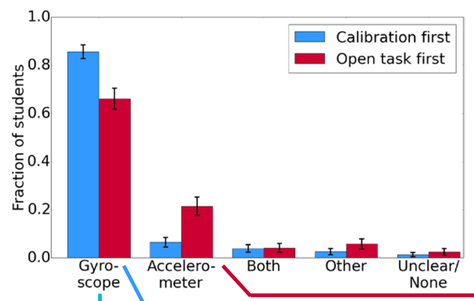
The calibration activity provides students with experience (1) using the gyroscope and (2) situating rotation in an IOLab setting. We coded student answers to the open activity task to answer the following questions:

1. Which sensor(s) did the student use to collect data?
2. What tools did the student use to extract information from their data?
3. What conceptual area did the student choose to study?

We also identified students who used the same procedure (sensor, analysis method, and specific measurement) as the calibration task.

Impact on procedural choices

Sensor choice



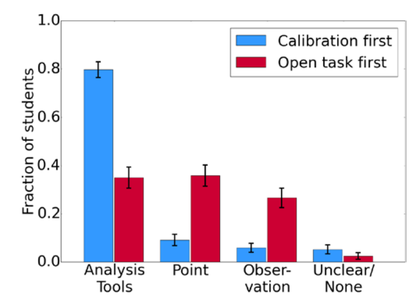
- **Gyroscope** is introduced in this assignment
- **Accelerometer** has been used previously in class and at home.

Gyroscope is most common choice for both groups.

Calibration first students are 1.30 times more likely than open task first students to use the gyroscope. (p<.001)

Open task first students are 3.29 times more likely than calibration students to use the accelerometer. (p=.001)

Method of extracting information



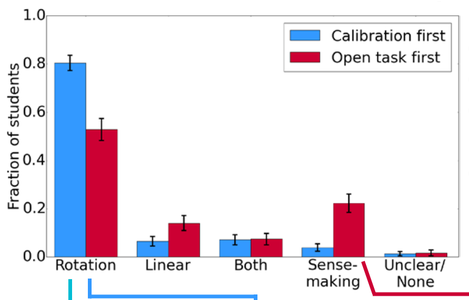
- **Analysis Tools**: Use built-in tools to find average, area under the curve, and average slope
- **Point**: Read the value of a single point off the graph
- **Observation**: Make a qualitative observation about the data

Note: both groups are equally familiar with the software analysis tools

Calibration first students use analysis tools 3.94 times more often than all other options combined and 2.30 times more than Open task first students (p<.001)

Open task first students are almost equally likely to use any of the three methods

General concept area studied



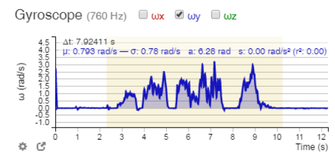
- **Rotation** – e.g. θ,ω, or α
- **Linear** – e.g. x, v, or a
- **Both** – student made both linear and rotational measurements
- **Sensemaking** – student connected the displayed data to sensor functions

Rotation is most common topic for both groups.

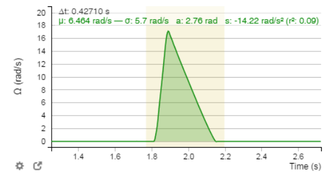
Calibration first students are 1.52 times more likely than open task first students to choose a rotation measurement. (p<.001)

Open task first students are 5.69 times more likely than calibration students to use this activity to understand the IOLab system. (p=.001)

How much does the calibration activity constrain students to the same open-ended approach?

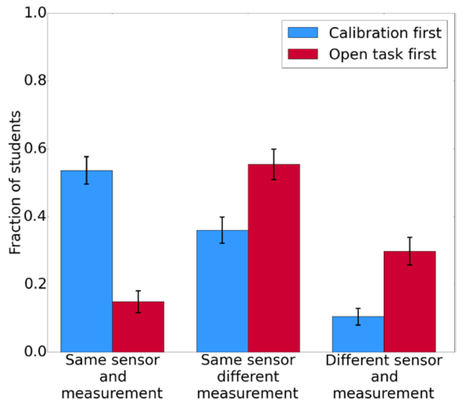


Example calibration activity data with analysis tools. Students find angular displacement using the area under the curve of the highlighted area ("a").



Example open-ended activity measurement using the same sensor and analysis tools to measure angular displacement.

Student investigations by similarity to calibration task



Doing the calibration activity first made students 3.60 times more likely to repeat the same method in the open-ended activity and 2.85 times less likely to use a different sensor. (p<.0001 and p<.001, respectively)

Discussion and Conclusions

Placing the calibration activity prior to the open-ended activity had a large effect on student approaches to the open-ended activity. Students with the calibration activity first were more likely engage with the new sensor and the new physics topic area, and used the data acquisition software to make more advanced measurements. However, more than half of the group chose to repeat the measurement procedure used in the calibration.

Students who did the open task first were somewhat less likely to use the new sensor or study the rotational aspects of the spinning motion. These students tended to use simpler analysis methods like qualitative descriptions and reading points off the graph. A portion of students from this group used the open-ended task to train themselves about rotation with the IOLab system by engaging in sensemaking about the sensor output.

The results from this study indicate that, when students are working with new tools and ideas, the context set within an assignment can significantly affect the way they approach design tasks at home. Understanding these effects provides options for instructors to encourage outcomes from at-home tasks that are consistent with their instructional goals while still giving students the freedom of choices in an open-ended context.

More information

For a copy of this poster, please visit go.illinois.edu/AAPTSM17-IOLab