Why create a new laboratory curriculum?

Traditional labs, following given protocols, do not engage students in sense-making and do not improve students’ understanding of course content. [1]

Reform labs, such as ISLE and UMD's SCL, show dramatic improvement, but fail to engage students’ primary interests and do not help prepare them for their future careers.[2]

Our Challenge: Can we create labs that students see as relevant to their interests and career goals while maintaining an epistemological focus?

Our Goals:

- Competency 2 of the HHMI-NEXUS project:
  - Demonstrate understanding of the process of scientific inquiry, and explain how scientific knowledge is discovered and validated. [3]
- Engage in Sense-making in a Realistic Science Environment

Experimental Design (Protocol Development)
Modeling (Conceptual, Physical, Diagrammatic, Graphical & Mathematical)
  - How to make a model?
  - Use of models?
  - Where and why a model breaks down? (Limitations.)
Multiple Representations
Error Analysis
Technical Skills for Biological Applications
Advantages of Group Work and Discussion
Quantification yields more Productive Biological Information than Observation

What did we do?

1. We changed the content in order to focus on physics applicable at biological scales.
2. We chose a lab format to promote coarse-grain lab skills (e.g. sense-making, exp. design, epistemological focus).
3. We chose high-tech equipment and modern analysis tools to promote fine-grained lab skills (useful to professional biologists).

These three goals are often in tension.

Lab Equipment: High-Tech Equipment with Modern Analysis Software

- Microscopes
- Spectroscopes
- Image Analysis
- Data Analysis

We want to know: How do students see the labs?

Do students see applications to ‘biology’? Are they learning useful skills to prepare for their future? How do students perceive the emphasis on experimental design / protocol development? How does this lab curriculum compare to other labs?

We have gathered survey and video data from two small test classes (max N = 31) to answer these questions.

How do students orient to the ‘biology’ in the labs?

Critical thinking and communication between peers are definitely valuable skills in the realm of biology. Using tracking programs, excel, and also using microscopes are definitely beneficial skills to have in biology.

Labs such as the neuron lab which relate to background knowledge we already know are especially interesting because we are exploring and proving an area of a subject we did not completely understand.

Comparison to ISLE labs:

Rutger’s ISLE labs have a similar student demographic. We used one of their assessment tools and compared our data to theirs. [2]

Students were asked two questions:
1. How important is each goal FOR YOU?
2. How successful were the labs in terms of achieving each goal?

Goals:
- Learn to design your own experiment
- Learn to interpret experimental data
- Prepare for your future professional career
- Understand concepts better
- Learn to work with other people
- Learn to communicate ideas in different ways

When asked to list three things they had learned in the labs, responses from students in ISLE, UMD’s SCL and NEXUS/Physics included these sense-making goals with the following frequency:

- Results for the other three goals were comparable to the ISLE results.
- We find the results for ‘Prepare for your Future Career’ especially promising.

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REFERENCES


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