Comparing first year students' attitudes to inquiry-based versus traditional laboratory experiments

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Why introduce inquiry-based labs?

Science education research literature shows that inquiry-based laboratories:

- **Promote conceptual understanding**
- **Engage, challenge and inspire students**
- **Encourage students to explore alternate approaches to investigate a problem**
- **Encourage students to critically reflect on their experiences**
- **Encourage students to take charge of their own learning**

The first year of a university experience needs to provide new stimulation for intellectual growth and a firm grounding in inquiry-based learning and communication of information and ideas.

Ref: The Boyer Commission Report on Educating Undergraduates in the Research University - 1998 page 9

Design your own experiment

Topic: Radioactivity

http://simpsons.wikia.com/wiki/Springfield_Nuclear_Power_Plant

"Tell me and I'll forget; show me and I may remember; involve me and I'll understand".

Chinese proverb

Introduction

For designing an inquiry-based laboratory activity

- Students were required to search background information from various sources.
- Critically evaluate and synthesise the gathered information
- Design and undertake an experiment in a safe manner to test their hypothesis.

This approach is consistent with the Threshold Learning Outcomes (TLOs) for science published by the Australian Learning and Teaching Council 2011.

Ref:
http://www.olt.gov.au/resource-library?text=Science+threshold+learning+outcomes

Background

- Physics 115 is a first-year non-calculus based unit offered to a wide range of students from various disciplines. (Non-major physics)
- Students with different levels of background knowledge are taught in a combined class
- It is challenging for the instructor and students to learn in a mixed cohort
- Students study six modules in a 12 week semester including five laboratories

Assessment

- One of the major assessment components of this unit is the laboratory work (worth 20%) which involves:
- Taking measurements, calculating uncertainties, performing data analysis, interpreting results and submitting formal written reports for assessment.
- Reports were assessed using a rubric already available to students on Blackboard.

The following Laboratory Activities were posted on Blackboard. Students were invited to choose only ONE of the following:

Design an experiment to:

1. Investigate variation in radiation exposure as a function of distance from a radioactive source.

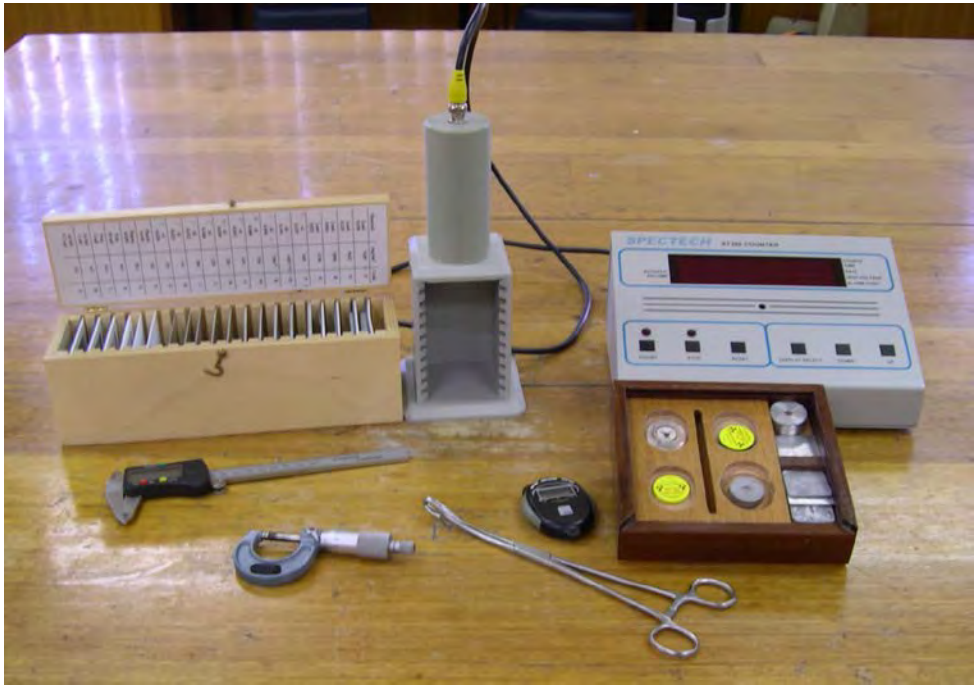
2. Measure the half-life of a given radioactive sample of long half-life such as uranium or thorium?

3. Investigate absorption of alpha, beta and gamma radiation by metals and non metals. (Comment: which material can be used for shielding against gamma radiation)

4. Estimate the activity of radioactive material contained in a smoke detector.

Students were required to plan their chosen experiment using the following headings.

1. Aim of experiment
2. Procedure
3. Setup of equipment
4. Record data in a table with appropriate headings
5. Calculations and uncertainty calculations
6. Graph (if required)
7. Conclusion (state if your results successfully tested your aim)
8. How the aim/method could be improved in future experiments
9. References



Physics Department provided

1. Geiger counter
2. Set of radiation absorbers (thin sheets of Al, Pb and Perspex)
3. Radioactive sources (alpha, beta and gamma)
4. Mineral sand in small bottles, smoke detector
5. Water in small bottles
6. Pieces of timber, tiles, rubber and glass

Evaluation

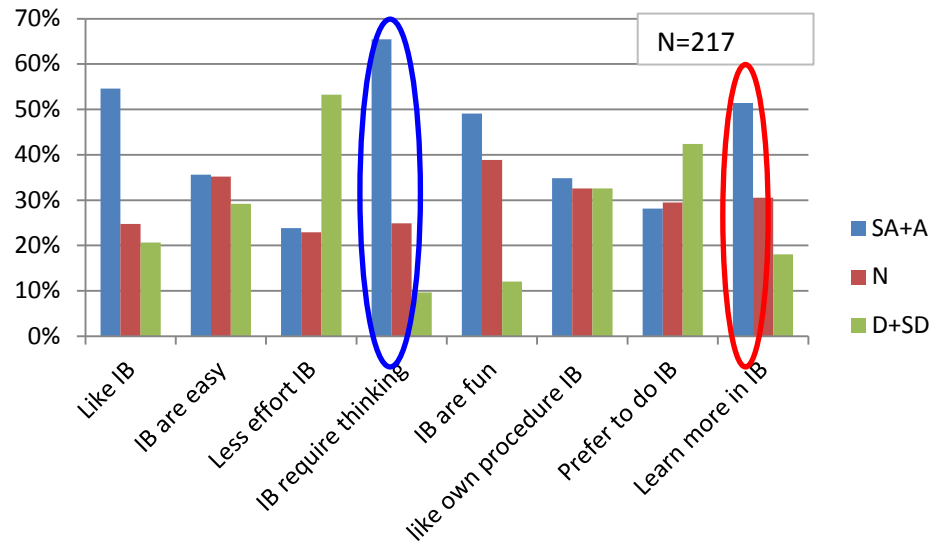
At the conclusion of the laboratory class, a survey instrument was distributed to gather students' feedback about Inquiry-based and Traditional-based labs.
Participation was voluntary.

Survey Instrument*

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I like inquiry based laboratories					
2. Inquiry-based laboratories are easy to do					
3. It takes a smaller amount of effort to complete the inquiry-based laboratory reports					
4. I have to do a lot of thinking and analysing for doing the inquiry-based laboratory reports					
5. Inquiry-based laboratories are fun to do.					
6. I like to come up with my own procedures for doing laboratories					
7. I would choose to do an inquiry-based laboratory over a recipe-based laboratory					
8. I personally think that I learn more with inquiry-based laboratories					

*Adapted from Maria Parappilly et al IJ-ISME Journal 2013

Evaluation of student feedback



Note: Q6 and Q7 are correlated Indicating student prefer to have procedure provided to them. This is reflected in the quality of students' "laboratory reports"

Comments

Q1: 55% of students like IB labs

Q2: 36% of students agree it is easy to do IBL. *(29% think it is difficult to do IBL)*

Q3: 24% of students agree that it takes less effort. *(53% don't agree)*

Q4: 65% agree that lot of thinking is required to do IB labs – *(Thinking Skills, This is expected as these are not recipe based labs- so IB labs promote higher order thinking skills)*

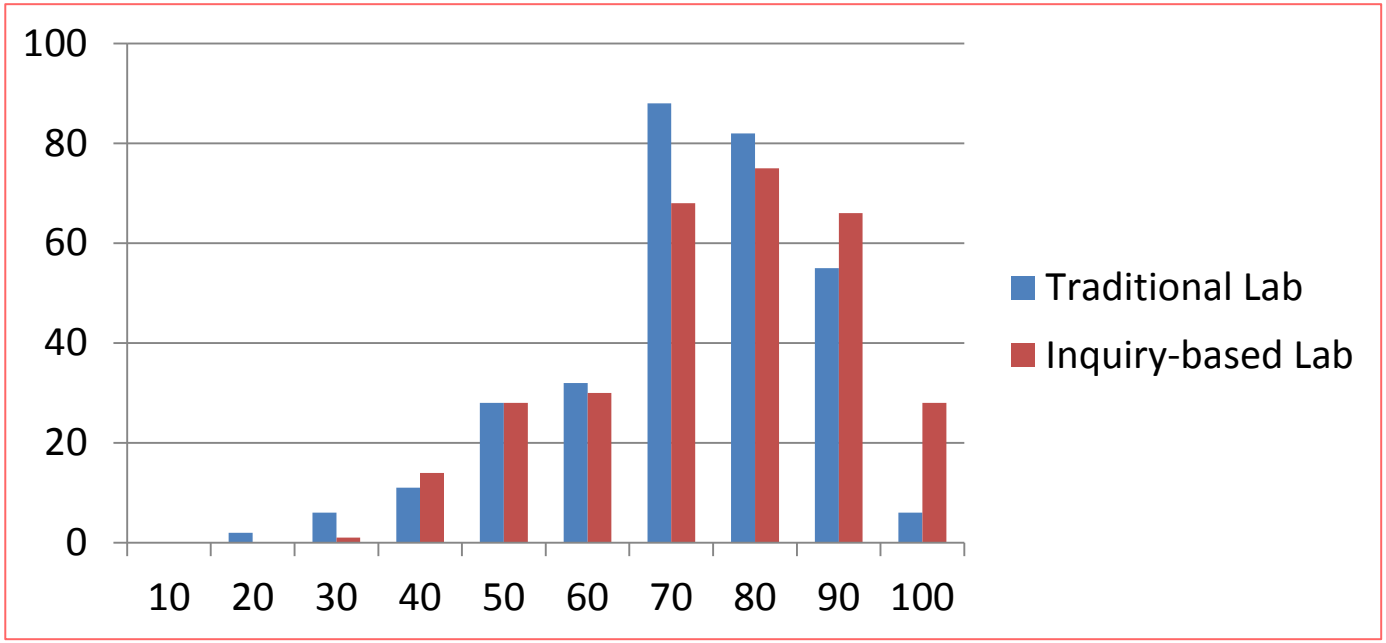
Q5: 49% enjoy IB labs. *(as students are involved in designing the lab activity)*

Q6: 35% like to design their own procedure. *(but 33% would like to have procedures provided to them)*

Q7: 28% prefer IB labs (but 42% disagree)

Q8: 51% agree that they learn more with IB labs. *(Because they are involved in searching information, critically evaluating and synthesising the gathered information-Self learning)*

Comparison of Inquiry-based versus Traditional lab



	Mean	Std	n
Inquiry-based Lab	70.9	15.5	310
Traditional Lab	66.8	15.2	310
P-value = 0.0004			

Discussion

- Most of the students who opted for the IB Labs were high ranking enthusiastic students.
- So it was expected that these students would perform much better for inquiry based lab
- However, data shows that their performance is slightly higher than traditional lab

Reason

As expressed in survey feedback, these students would prefer to have experimental procedure provided to them as in a traditional recipe-based lab manual, because they preferred not to spend more time writing the scientific report due to workload constraints.

Summary and Conclusion

The survey results in general indicate positive responses to Inquiry-based Lab. The students are learning through stimulating and engaging activities. We believe there are valid reasons to introduce IB labs to the remaining experiments.

Future program

- Retain IB lab in S2-2014
- Introduce IB labs into unit majoring in physics. Compare their performance with non-major physics students

Thank you for your attention

Questions?