Effective Closed Labs in Early CS Courses: Lessons from Eight Terms of Action Research

Elizabeth Patitsas and Steve Wolfman

University of British Columbia
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We ask...

Think: what do you wish you knew about how your labs were going? [Write this down.]
What did you come up with?

This is what we wanted to know: why is perception of our labs so poor?

**So** we set out to do that, developing an approach based on action research.

**Goal of the talk:** convince you our approach is useful to solving your problem.

**We will return** to our opening question as a means of structure this talk.
A focus group of students in 2005 identified the labs of our course as being unrewarding and unrelated to the lectures.

We were motivated to improve the labs – not only to make them more rewarding and relevant to students – but for the teaching assistants, too.

Perception is what we are concerned about here, not learning outcomes.

We made changes to the course. Things improved.
Then we wrote a WCCCE paper

As we wrote our experience report we realized we wanted more data to assess the changes we had made. And data to identify where more change could happen.
We have a big course with about 130 students a term and about 12 TAs (mix of undergrad and grad). Statistical significance!

But unfortunately there’s a large turnover in who teaches the course, both for faculty and teaching assistants.
Before we tackle methods...

We do have a positive teaching culture, and are able to engage the TAs in weekly lab meetings where they go over the labs in advance.

Those meetings matter since our TAs often have little background in digital logic.

The meetings also give the TAs social support and a sense of community in the course.
Action research differs from more traditional approaches to research (e.g. positivism and constructivism). Our approach is based on action research.

**Goal:** to enact *social change*. We used action research to identify problems in the labs, and to assess changes intended to improve them.

**Process:** through empowering the stakeholders through participatory research.

**Role of the researcher:** the researcher is a participant in the course; here we act simultaneously as course designers, assessors, and educators.
Returning to your thoughts

Remember: what do you wish you knew about how your labs were going?
Our adoption of an action research-based approach has changed the design process of the labs:

**BEFORE**

\[ \text{instructor} \]

**AFTER**

\[ \text{head TA} \quad \text{instructor} \quad \text{other TAs} \quad \text{students} \]

We now involve all stakeholders in the design of the labs **informally** soliciting feedback from staff meetings and labs **formally** soliciting their feedback through surveys and diary-like “lab documents”.

We measure perception, as this is our project’s goal.
CPSC 121 Lab Feedback

We are in the process of redeveloping many of the labs in this course to improve them. For one mark in lab each lab, please provide feedback on how you found the lab. Feedback is anonymous - after hitting submit, show the ensuing page to your TA for the mark.

* Required

What is the number of the lab you are reviewing?

I had enough time to work on this lab.

1 2 3 4 5

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

The written instructions were clear and well-written.

1 2 3 4 5

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

The lab was relevant to the lecture material.

1 2 3 4 5

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

The lab was interesting.
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Conclusions
Thank yous
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CPSC 121 End of Term Lab Survey

As part of our endeavour to improve the CPSC 121 labs, we would like your feedback on how the labs were overall this term. Filling the survey is worth one bonus mark in lab 10. Your answers, as usual, are confidential.

The labs contributed to my understanding of the course material.

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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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Strongly disagree ○ ○ ○ ○ ○ Strongly agree

The pre-labs contributed to my understanding of the course material.

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Strongly disagree ○ ○ ○ ○ ○ Strongly agree

The challenge problems contributed to my understanding of the course material.

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Strongly disagree ○ ○ ○ ○ ○ Strongly agree

Feel free to comment on any of the above questions:
As part of our curriculum development initiative, we'd like to know how you (the TAs) found the 121 labs.

<table>
<thead>
<tr>
<th>The labs were interesting for me</th>
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| Strongly disagree               | O | O | O | O | O | Strongly agree

<table>
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<tr>
<th>The labs were fun for me</th>
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<th>3</th>
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| Strongly disagree               | O | O | O | O | O | Strongly agree

<table>
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<tr>
<th>The labs were rewarding for me</th>
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<th>2</th>
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| Strongly disagree               | O | O | O | O | O | Strongly agree

<table>
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<th>The labs were of an appropriate difficulty</th>
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The Process

We solicit qualitative and quantitative data from the students and TAs are analyzed at the end of every term, to assess how the labs went that term.

Changes in term $n$ are assessed versus term $n - 1$.

We identify the source of greatest pain for the students in term $n$ and make changes in term $n + 1$ to try to counteract it.
Remember: what do you wish you knew about how your labs were going?
Example results
An example of change

In our first end of term student surveys both qualitative and quantitative data agreed: “tkgate sux!!!! [sic]”. (We also learnt that the CPU lab was poorly received, and that the students loved the regular expressions lab.)

In the next two terms we tried improving our support of tkgate. Still no change in student feedback. “tkgate is totally not user friendly.”

So we threw it out. We switched to logisim.
And then what happened?

Qualitative feedback that term, and subsequent ones, didn’t have complaints about the circuit simulator. Quantitative feedback, however, jumped up. Dramatically. And note that feedback on breadboarding has held steady without any major changes to it.
How about another example?

The TAs provided a lot of useful feedback within our community.

They complained that the sequential circuitry lab had too many new concepts in it: clocking, latches, DFFs, sequential circuitry, counters.

So we broke it up. Clocking was moved to lab 1. We added another week on sequential circuitry.

TA feedback on these labs improved. (Students were still lukewarm to sequential circuitry.)
On the note of breaking labs up

The weekly end of lab surveys allowed us to realize students liked labs more when they could complete them on time.

So we shortened our labs and when we saw the rating of “I could complete the lab in the allotted time” improve...

We also found they were rated as more fun, rewarding and interesting.

To shorten the labs we identified the goals for every lab and cut everything else out.
Trends over time

We’d like for everything to be increasing gradually like this:
Sometimes, things don’t always get better

While our approach allows us to identify problem areas in the labs, it doesn’t tell us the solution path.

We experiment by making changes through the community suggestions.
Discussion
Sustaining change

**Not only** have we produced measurable improvements in perception, we see the improvements last for subsequent terms.

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The Magic Box (breadboard kit)  
TKGate (simulator)  
Logisim (simulator)
Sustaining our change

The our improvements have lasted through five head TAs and seven course instructors.

So if you’re wondering about the Hawthorne effect – we’ve seen improvements in terms where we weren’t on the course – and the students change term to term.
A result of action research: change in the teaching community of this class. This is a deeper change than the changes we have made to the labs themselves.

We have empowered the TAs, who now freely give their input on the labs – sometimes pushing back on the instructors.
Factors for lasting change

And we know from the education literature that community approaches have more staying power.

Indeed, “proceeding with a non-threatening, incremental pace of change;” and “mutual trust amongst stake-holders” were listed as conditions that promote and sustain changes in curriculum change (Jones, 2002).

Next steps

We measure perception, and have improved it in a sustainable manner. We now want to look at student learning.

You may care about things other than perception.

Think: what do you wish you knew about how your labs were going?

Then: how could you find that out?
Conclusions

For our course we used the action research-based approach we just described.

Our goal of improving the perception of the labs has been satisfied.

The process of empowering our teaching community to improve the labs has produced lasting change.

And we hope that you can adapt our approach to improving your labs.
Thank yous

Head TAs over the years: Rachel Busby, Mark Crowley, Ian Dewancker and Vanessa Kroeker

Instructors over the years: Meghan Allen, Patrice Belleville, Dave Tompkins, George Tskiknis, Kim Voll and Bob Woodham

The many TAs over the years (they won’t all fit on here!)

And the many students over the years who gave us their feedback!

Plus Michele Ng for the focus groups, Anthony Winstanley for lab support.

And support from CSSEI, NSERC.
The end of lab surveys gave us feedback as the term progressed – not just what the students remembered at the end.

Around labs 2 and 3, students started complaining that “I still don’t get how to start using the magic box... wish we’d an actual introduction to it!”

The TAs independently concurred that their students needed more guidance from the start on how to do breadboarding.
We wrote a new lab 1 with a picture-based walkthrough on how to do breadboarding, based on this community process.

The TAs who were on the course both terms noted their students handled breadboarding better thereafter. The students had noticeably fewer complaints about breadboarding in subsequent terms. They rated breadboarding labs as more fun!