

Why do Engineering Students Attend Labs?

Stephen B M Beck, Panos Lazari, Matteo DiBenedetti

APPENDICES

Appendix A

Student Questionnaire

What makes labs valuable for you?

1. Please read the following form which describes the work we are doing, why we are doing it and how we will use the responses you are providing. [Consent form](#). Once you have read it please answer the following question so we can use (or not use) your data. I consent to the use of my data as set out in the above document.

Mark only one oval.

- Yes
- No
- I'll fill in the form, but don't use it for the research.

Your views on labs

2. Do you enjoy doing labs?

Mark only one oval.

- Yes
- No

3. Select up to three reasons that you think labs are for.

Tick all that apply.

- Measuring physical quantities
- Reinforcing lecture material
- Showing real world examples
- Introducing topics
- To get marks
- Giving me a practical experience
- Providing me with a different way of learning
- Giving experience of how the real world relates to the topic.
- Part of any engineering course
- Other:

4. Select any reasons that discourage you from attending labs.

Tick all that apply.

- No incentive if lab is ungraded
- Too hard
- Too easy
- Too long
- Too short

- Too busy doing other assignments
- Not supported enough by staff
- Irrelevant
- Boring
- Too much pre-lab work
- Labs are daunting/stressful
- Labs are too samey/repetitive
- Staff are unfriendly
- I dislike working in groups
- How I'm feeling mentally/physically that day
- The lab topic that day doesn't interest me
- I feel unconfident with the topic and want to avoid embarrassment
- I can just do the online activity instead and save time/effort
- I understand the course content well enough from just lectures
- There is an online alternative
- Other:

What do you think about The Diamond labs?

5. Is the number of labs you have
Mark only one oval.
 - Too many
 - Sufficient
 - Too few

6. What about the time your labs take to complete
Mark only one oval.
 - Too short
 - About right
 - Too long

7. What about the prelab?
Mark only one oval.
 - Too short
 - About right
 - Too long

8. And what percentage of online (as opposed to face to face) labs would you like?
Mark only one oval.
 - None
 - 20%
 - 50%
 - 80%
 - Entirely online

9. What group size do you like working in for labs?
Mark only one oval.
 - on my own

- As a pair
- In a four
- Five or more

10. What would make you more likely to attend lab (select any that apply)?

Tick all that apply.

- More open ended or investigative
- Clearer instructions
- Counting more towards my grade
- More interesting/fun
- Shorter post labs
- Better integration with lecture course
- Better staff support
- Other (fill in box)

About you

11. What department are you in?

Mark only one oval.

- Aerospace Engineering (Via IPE)
- Bio Engineering (Via IPE)
- Chemical and Biological Engineering
- Civil and Structural Engineering
- Automatic Control and Systems Engineering
- Electrical and Electronic Engineering
- General Engineering (Via IPE)
- Material Science and Engineering
- Mechanical Engineering

12. Are you a

Mark only one oval.

- Home student?
- International student?

13. What Year are you in?

Mark only one oval.

- First
- Second
- Third
- Fourth (Meng) - *Skip to question 17*
- MSc - *Skip to question 17*

Last year's labs

14. Were you in Sheffield last year?

Mark only one oval.

- Yes
- No

15. Did the labs support your learning?
Mark only one oval.
 - Yes
 - No

16. Have you any comments on last year's labs?
Any other points?
You don't need to put anything here.

17. Please tell us your most positive experience in a lab so far

18. If you would like, please tell us your most negative experience in a lab so far

19. Is there anything you'd like to add about why you do or don't attend labs?

Appendix B

Abbreviations for departments and major courses in the Faculty of Engineering

ACS	Automatic Control and System Engineering
AER	Aerospace Engineering
BIO	Bioengineering
CBE	Chemical and Biological Engineering
CIV	Civil Engineering
EEE	Electrical and Electronic Engineering
GEE	General Engineering
MAT	Materials Science and Engineering
MEC	Mechanical Engineering

Appendix C

The University of Sheffield context

In 2015, Sheffield opened a new teaching building, part of which concentrated on providing practical teaching at scale for the 6400 students in the Faculty of Engineering. The unique (at the time) approach for this was to share the laboratories and their equipment across the 10 departments and courses in the faculty. The large labs and the multiples of equipment mean that it is generally possible to get even the largest cohorts of students through a given experiment in a week. It is thus possible to position the labs very close in time to where the material is being delivered, Beck (2023). So it was decided that it would be interesting to see if students appreciate this.

The whole of the laboratory teaching is conceived to be efficient, as well as hopefully effective, the entire department uses the same approach of the 'Lab sandwich' (Garrard and Nichols, 2018). Before students come into the lab, they must complete a 'pre-lab' activity. This is not generally assessed but acts as a 'pass' to allow students access to the actual experiment. The pre-lab varies but always contains the background to the laboratory, an introduction to the equipment and the required Health and Safety to conduct the work effectively. The experiment is completed with a post-lab assessment, which can be anything from a few online multiple-choice questions to a full lab report. When the labs are integrated with a taught course, the theory for the prelab has already been delivered as part of the course and the experiment is an integrated and vital part of the course. However, a limited number of departments have the labs as part of a free-standing module.

The importance of lab marks varies enormously from constituting a complete module, through being a part of the mark (10-20%) down to pass to progress or with no marks attached to the labs. Almost all labs have an online equivalent for students who have missed a lab. Generally, lab attendance is good (90% plus), but there have been occasions when student attendance at a given session has dropped below 10%. It was a number of these sessions that inspired us to investigate student attendance at labs. Students are timetabled to attend a given session however, for most labs, students self-select into groups for a session. Staff ensure that groups are of an appropriate size for the experiment.

Part of this move to large labs entailed the creation of a department whose task is to deliver the labs for the faculty and the staff in it. For this reason, it was important to see how the staff who delivered the lectures and tutorials perceived the value and purpose of labs. For this reason, it was decided to find out whether there was a mismatch in staff and student expectations of the purpose of laboratories and how they thought students appreciated their value. So, it was decided to question staff on this as part of the research.

It will be noted that this research was carried out during the COVID-19 pandemic with consequent disruption due to the periodic lockdowns that occurred. During several periods during this time, face-to-face teaching was curtailed and online and laboratories were often substituted for these. Examples exist of some of the approaches used for this (Roda-Segarra 2021), not least by the authors' department (Bangert *et al.* 2020). Remote labs are often non-synchronous, meaning that students can do them any time. This changes the student's perception of 'attending' the lab. A recent publication (Bishop et al 2021) examined student perception of four different modes of lab provision: socially distanced in-lab sessions, remote access to in-lab equipment, take-home kits, and providing students with data. The results showed that students like face-to-face labs, with take-home kits also being popular. However, there was no report of student drivers for doing these. So, it was important to obtain their views on this in the context of labs in general.

REFERENCES

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Appendix D

Do international and home students' responses come from similar populations?

It is important to see whether the home and international populations were similar in their responses. For this, the key question 'Do you like labs?' was selected as a proxy for the whole questionnaire. Table 1 shows the breakdown between home and international students and whether or not they like labs. It can be seen that about 3% more of the international students like labs than home students.

Table 1 Home and international students' responses to the question 'Do you like labs?'

	Like labs	Do not like labs	% like
Home	108	19	85.0
International	43	6	87.8
Total	151	25	83.9

A χ^2 test was performed on this data to see if the populations were different (significance level, $\alpha = 5\%$). It was carried out under the null hypothesis that home and international students like labs to the same extent. The relation between these variables was significant, $\chi^2 (df= 1, N= 176) = 0.214, p = .643$ so the null hypothesis is upheld. Thus, international students are equally likely to like labs as home students. This indicates that the populations were similar for this question and thus is likely to be similar for the rest of the survey.

Appendix E Staff Questionnaire

What makes students turn up for labs?

- I. Please read the following form which describes the work we are doing, why we are doing it and how we will use the responses you are providing.

https://drive.google.com/file/d/1XIXIGD_VfXAh8XDPbObaZo-M4xmbjGvt/view?usp=sharing. Once you have read it please answer the following question so we can use (or not use) your data. I consent to the use of my data as set out in the above document.

Mark only one oval.

- Yes
- No
- I'll fill in the form, but don't use it for the research.
- _____
Other:

About you

2. What department are you in (please chose the closest)?

Mark only one oval.

- IPE or MEE
- Civil and Structural Engineering Chemical and Biological
- Engineering
- Automatic Control and Systems Engineering Electrical and
- Electronic Engineering Material Science and
- Engineering Mechanical Engineering
- Computer Science

Other: _____

3. Do you use laboratory practicals for your teaching?

Mark only one oval.

Yes

No

Your own labs

4. Are your labs compulsory?

Mark only one oval.

Yes

No

5. On your course with the most laboratories, how many hours does each students have?

Mark only one oval.

Less than 2 hours

2-5 hours

5-10 hours

10-20 hours

More than 20 hours

6. On your course with the most laboratories, how many hours would you like each student to have?

Mark only one oval.

- Less than 2 hours
- 2-5 hours
- 5-10 hours
- 10-20 hours
- More than 20 hours

7. Select up to three reasons why you include laboratories in your teaching.

Tick all that apply.

- Measuring physical quantities
- Reinforcing lecture material
- Showing real world examples
- Introducing topics
- To get marks
- Giving students a practical experience
- Providing students with a different way of learning
- Giving experience of how the real world relates to the topic.
- Part of any engineering course
- _____
- Other:

8. Select up to three reasons that you think students believe laboratories are for.

Tick all that apply.

- Measuring physical quantities
- Reinforcing lecture material

- Showing real world examples
- Introducing topics
- To get marks
- Giving them a practical experience
- Providing students with a different way of learning
- Giving experience of how the real world relates to the topic.
- Part of any engineering course
- _____

Other:

9. What lab group size would you like for your students?

Mark only one oval.

- Working on their own
- Pair
- As a three
- In a four
- Five or more

10. Is there anything you'd like to add about why you do or don't use labs?