



Abstract

We integrated technology and inquiry to design an experiment on 'modelling waves on a rope', a standard topic in first-year undergraduate physics. Furthermore, we investigated how students engaged with the new experiment? Using design-based research (DBR) methodology, the experiment was trialled in two tutor training sessions, and the final version was implemented in 2018, and 2019. Preliminary results indicate that the experiment engaged students in a meaningful manner with digital technologies, modelling and increased student engagement with the practical.

Student Engagement

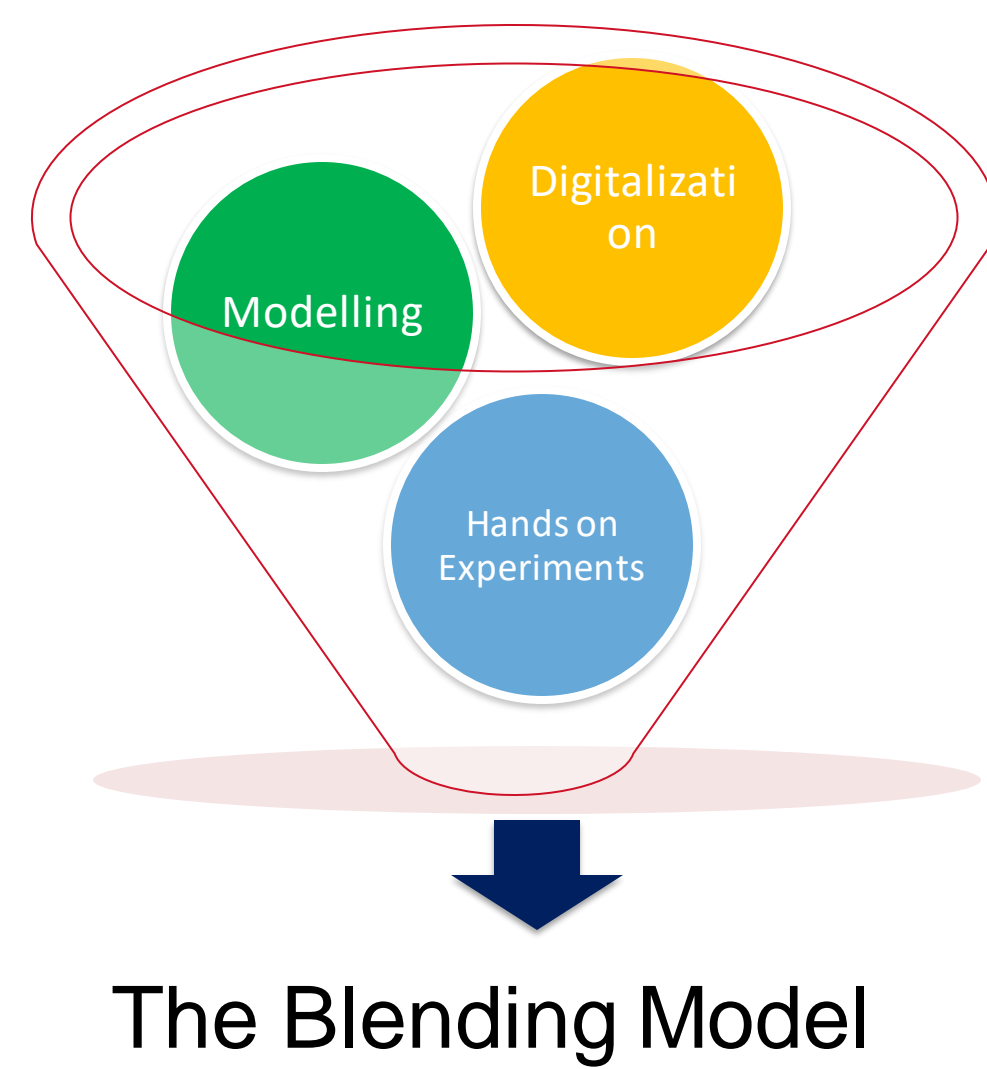
$$= \int \int \int (\text{Hands On Experiments})(\text{Technology})(\text{Modelling})$$

Designing Features of the Experiments

- Hands on Experiments
- Modelling
- Digitalization

Measuring Outcomes

- Cognitive Engagement (CE)
- Behavioural Engagement (BE)
- Emotional Engagement (EE)



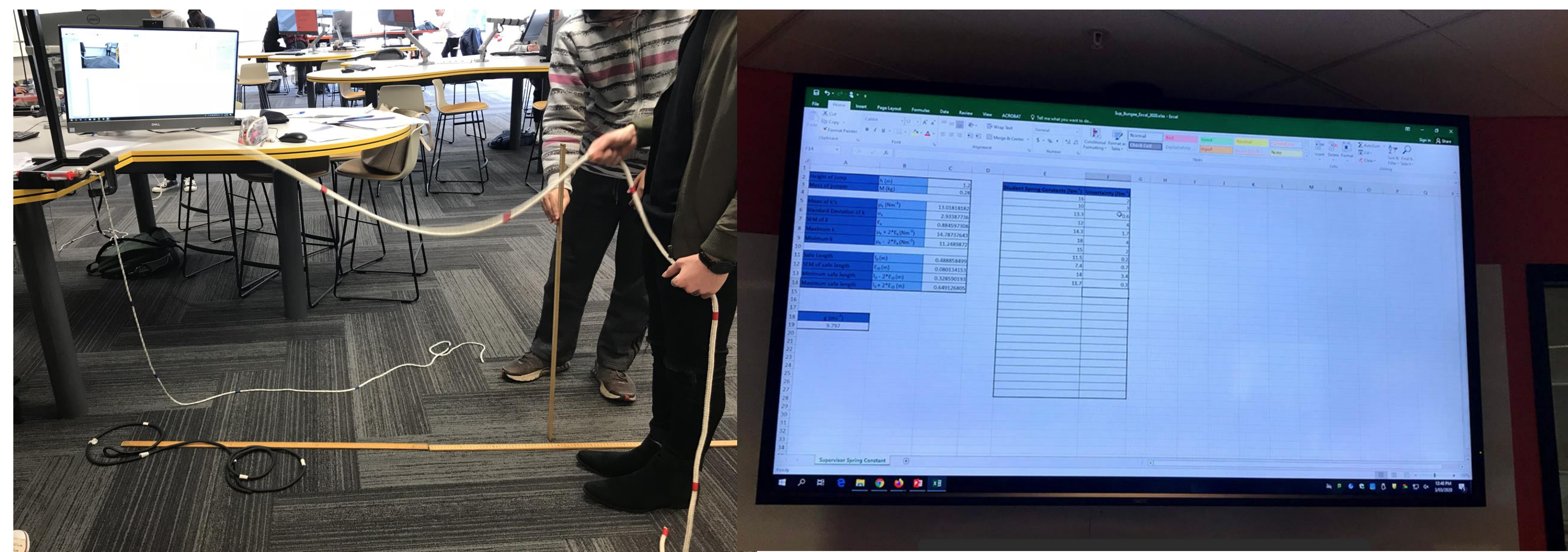
Methodology

The Experiment : Modelling Waves on a rope

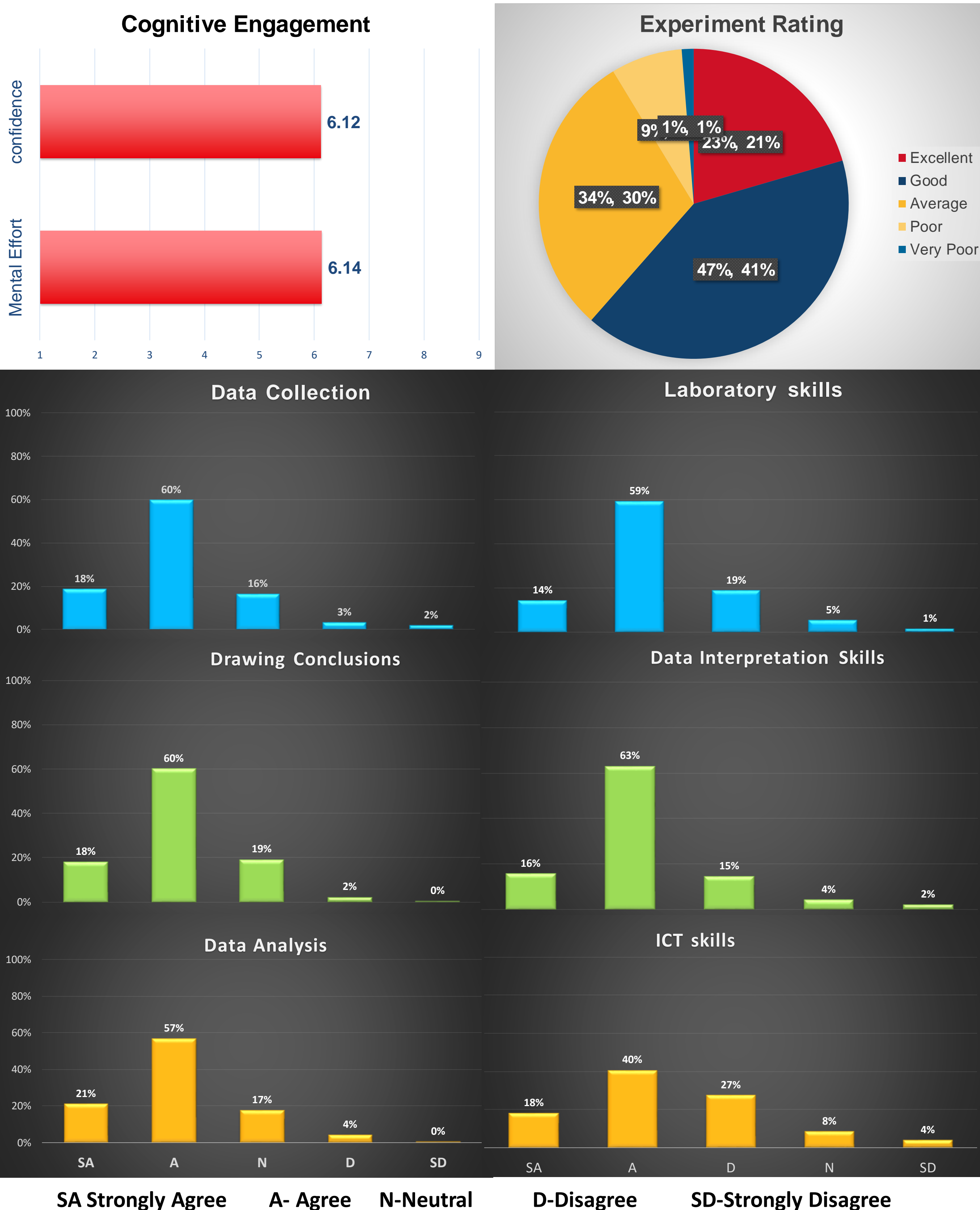
Part A: Creating standing waves on a rope

Part B: Calculating the frequency of the rope using video analysis software

Part C: Modelling using Excel worksheets and whole class comparison



Results: Quantitative



Sample: 501 students and 24 tutors. Data were collected via observational notes, survey responses, logbooks & interviews.

Instrument: Based on the ASELL Student Learning Experience survey focusing on hands on experiments, technology and other skills.

Results: Qualitative

CE:
Understanding concepts by explaining, identifying, describing

- "How different physical properties of ropes change wave properties"
- "Critical thinking in comparing experimental and theoretical values"
- "The modes, frequency and how change in variables can have a major difference in results"

BE:
Demonstrating a positive attitude and willingness to learn, concentrating

- "Yes, doing practical work and entering and collecting data is pretty interesting"
- "Teamwork. And the lab skills of physics"
- "Using more computer skills"

EE:
Taking pleasure in performing task; Demonstrating genuine interest and enjoyment

- "Very very good. A fantastic proposal. Perhaps a lot more theoretical, but it was a very very enjoyable & worthwhile practical. Please continue it!"
- "This experiment was probably one of the best experiments we have done in this course"

Discussion

The findings show that students engaged in a hands-on experiment by creating waves on a rope. Students also engaged in using technology for data analysis and developing their ICT skills. Students also reported that they could interpret the results and draw conclusions via modelling using an Excel worksheet. The experiment fostered teamwork and required investment of an appropriate level of mental effort demonstrating that the experiment did engage students in a meaningful manner. The integration of digital technologies with 'modelling waves on a rope' resulted in higher overall enjoyment of the experiment and increased student engagement.

References

- Barrie, S. C., Bucat, R. B., Buntine, M. A., Burke da Silva, K., Crisp, G. T., George, A. V., ... Yeung, A. (2015). Development, evaluation and use of a student experience survey in undergraduate science laboratories: The Advancing Science by Enhancing Learning in the Laboratory Student Laboratory Learning Experience Survey. *International Journal of Science Education*, 37(11), 1795-1814.
- Bennett, S. W. (2000). University practical work: Why do we do it? *Education in chemistry*, 37, 49-50.
- Gilbert, J. K. (2004). Models and modelling: Routes to more authentic science education. *International Journal of Science and Mathematics Education*, 2(2), 115-130.
- Hofstein, A., & Lunetta, V. N. (2004). The laboratory in science education: Foundations for the twenty-first century. *Science Education*, 88, 28-54.
- Sharma, M., Mendez, A., Sefton, I., Khachan, J. (2014). Student evaluation of research projects in a first-year physics laboratory. *European Journal of Physics*, 35(2), 1-17.

Contact

Srividya Durga Kota
Email: skot2539@uni.sydney.edu.au
Mobile: 0449080199