… *beyond* …

Active Learning

!!!

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ASELL SCHOOLS
Advancing Science & Engineering through Laboratory Learning

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Question

Is active learning the way-to-go in a world which is facing the challenge of discerning fake news?

- Tertiary science/maths education
- Bulk/mass
- Information technology

- Historical perspective

CONTEXT

Artificial intelligence, cyber, remote
Fake knowledge, mis/dis information
Who is the trusted source?
What is the role of the teacher?

Computers, information technology
Knowledge on internet
Internet as trusted source (?)
Teachers as facilitators

Industry, machines, assembly lines
Knowledge in textbooks
Teachers as trusted sources

PEDAGOGY

Valid vs fake
Trustworthy University credentials
Graduate qualities

Lectures vs small groups
Active learning
Weimann, Hake, Georgiou

Teacher centre vs student centred
Constructivism, Biggs,
Ramsden, Trigwell, Prosser
Driver, Schwab, …

Valid vs fake
Trustworthy University credentials
Graduate qualities

What am I doing?

Valid vs fake - 2020

Nature of (social, online) networks, nature of knowledge

Trustworthy University credentials – 2018, ACSME

Individual assessment, certifying students, standards,

Prac tests, Lab reports, exams, UNSW,

Graduate qualities - 2019

Experimental analysis, uncertainty ~ critical thinking

Scenarios, socio scientific, (work ready?)

ALPE: 9790 students

	Physics		Chem		Biochem		Pharmac		Biology	
	1	2	1	2	1	2	1	2	1	2
6. Understanding	.779		.761		.773		.547	X	.755	
8. Relevance	.736		.670		.750		.527	X	.693	
2. Lab skills	.642	X	.702		.747		.758		.606	
1. Data interpret	.672		.652	X	.721		.738		.643	
4. Interest in labs	.609		.610	X	.627		.682	X	.771	
7. Demonstrators	.618		.659		.607		.695			.501
								.		
10. Comm skills		.770		796		.812		.769		.789
13. Ethics		.710		.709		.716		.561	.502	
9. Teamwork		.597		.647		.679		.649		.813
11. Responsibility for own learning		.584	X	.599	X	.545		.686		.620
3. Research skills		.624	X	.619	X	.551	.615		.605	

Thanks to all those connected with me!

students

peers

networks

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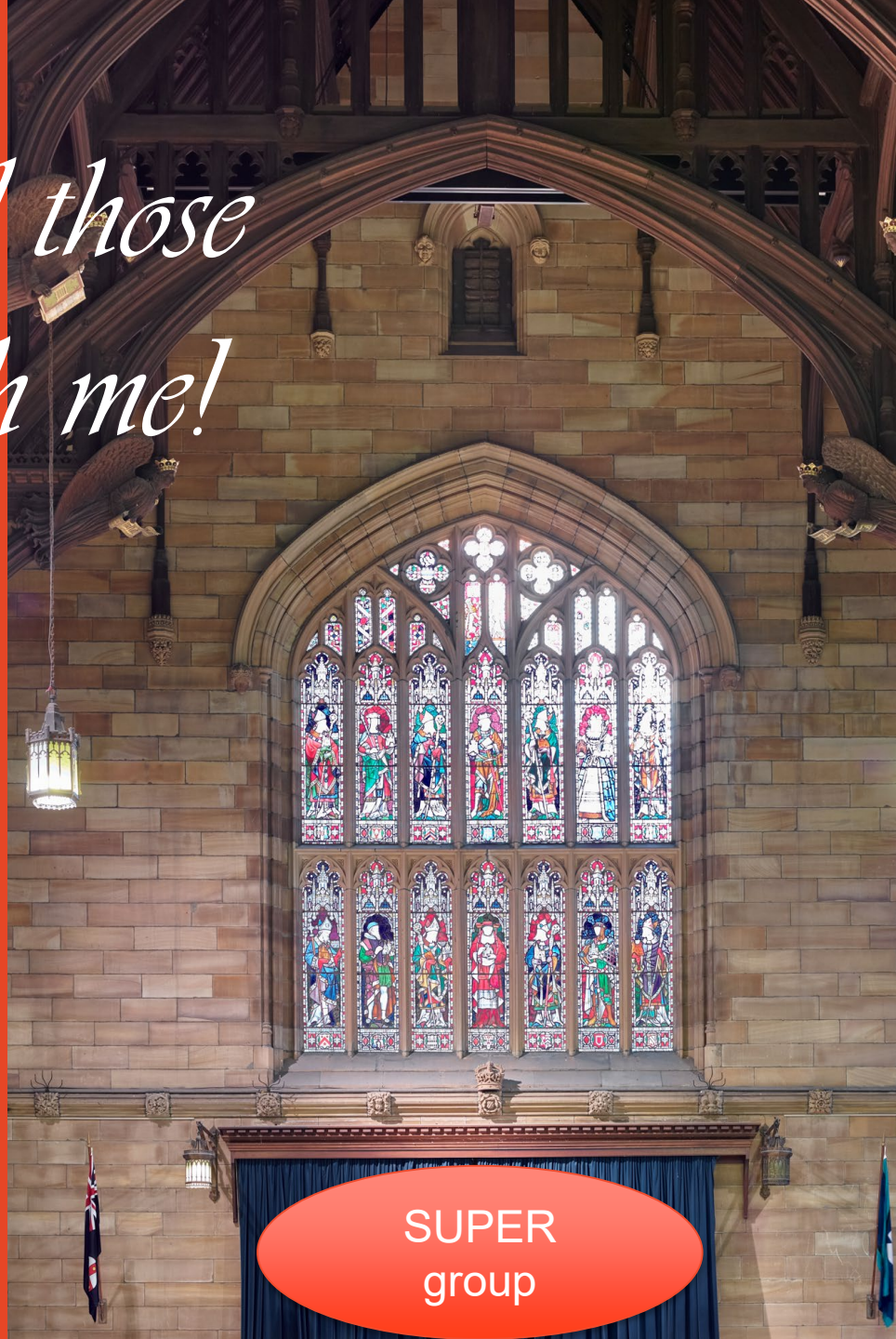
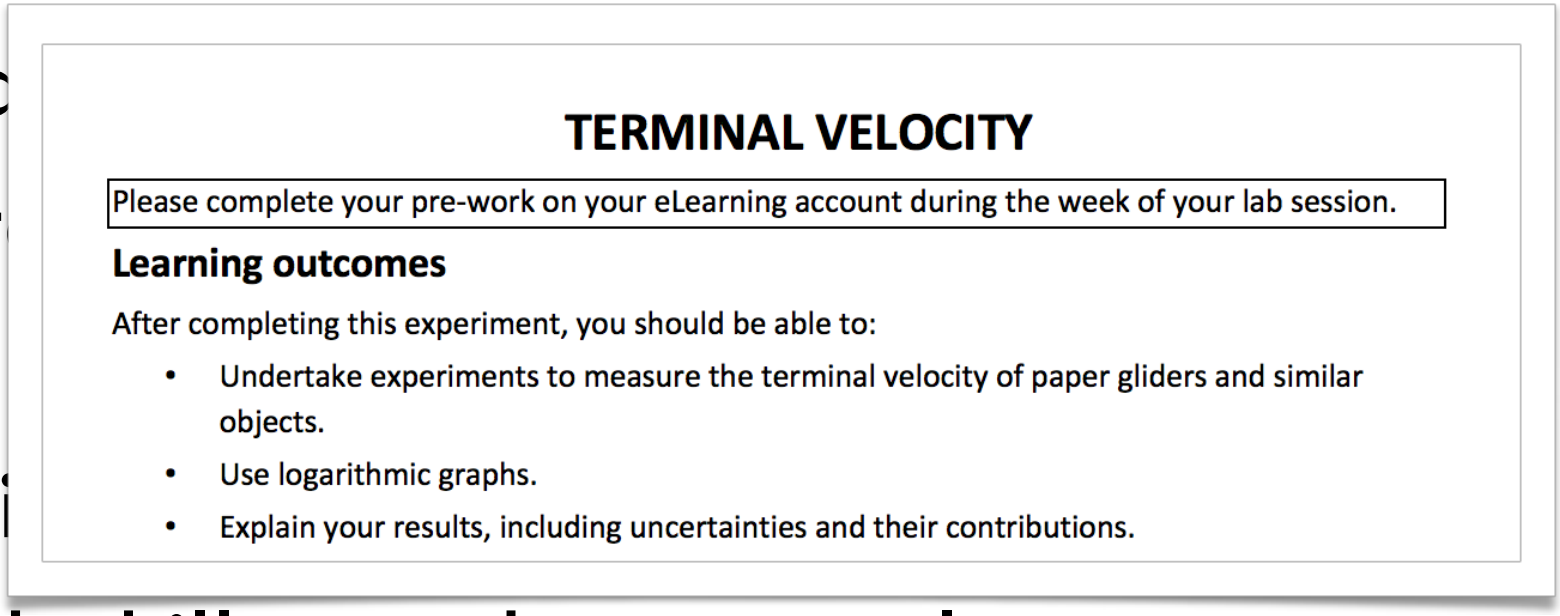


Three learning outcomes

- Conduct and collect data
- Do
- Int



TERMINAL VELOCITY

Please complete your pre-work on your eLearning account during the week of your lab session.

Learning outcomes

After completing this experiment, you should be able to:

- Undertake experiments to measure the terminal velocity of paper gliders and similar objects.
- Use logarithmic graphs.
- Explain your results, including uncertainties and their contributions.

Deli

Each skill tested separately

PRAC TEST

- Students chose one of 9 experiments, pub
- Stu
- No
- Ma
  - sketch of apparatus
  - Conduct (tutors oversee)
  - collect data and data recording
  - record uncertainties

Practical 7: Spring constant of combined springs

Aim of the experiment: To compare the spring constant of individual springs with the spring constant of springs combined in series.

Theory: The spring constant of a spring can be obtained using Hooke's Law. When springs are combined in series the spring constant of the combination is given by:

$$k = k_1 k_2 / (k_1 + k_2)$$

where k is the spring combination of springs combined in series, k_1 is the spring constant of one spring and k_2 is the spring constant of the other spring.

Lab report

- Choose an sub-set of exp done during the semester by their group
- Write individual report, with strict word limits, upload to CANVAS, similarity index:
  - provide the aim
  - provide original data, data in final form
  - interpret the analysed data to answer original question
- Marking criteria:
  - ability to formulate question, analyse data, present data, draw conclusions

What is the big deal?

- Standards, criteria based assessment
- Perceived as fair
  - No complaints, queries
  - All involved - influences team work
- Inclusive
- Individual justify learning outcomes
  - academic honesty

Skills development across years

What are students learning in practicals? A cross sectional study in university physics laboratories.

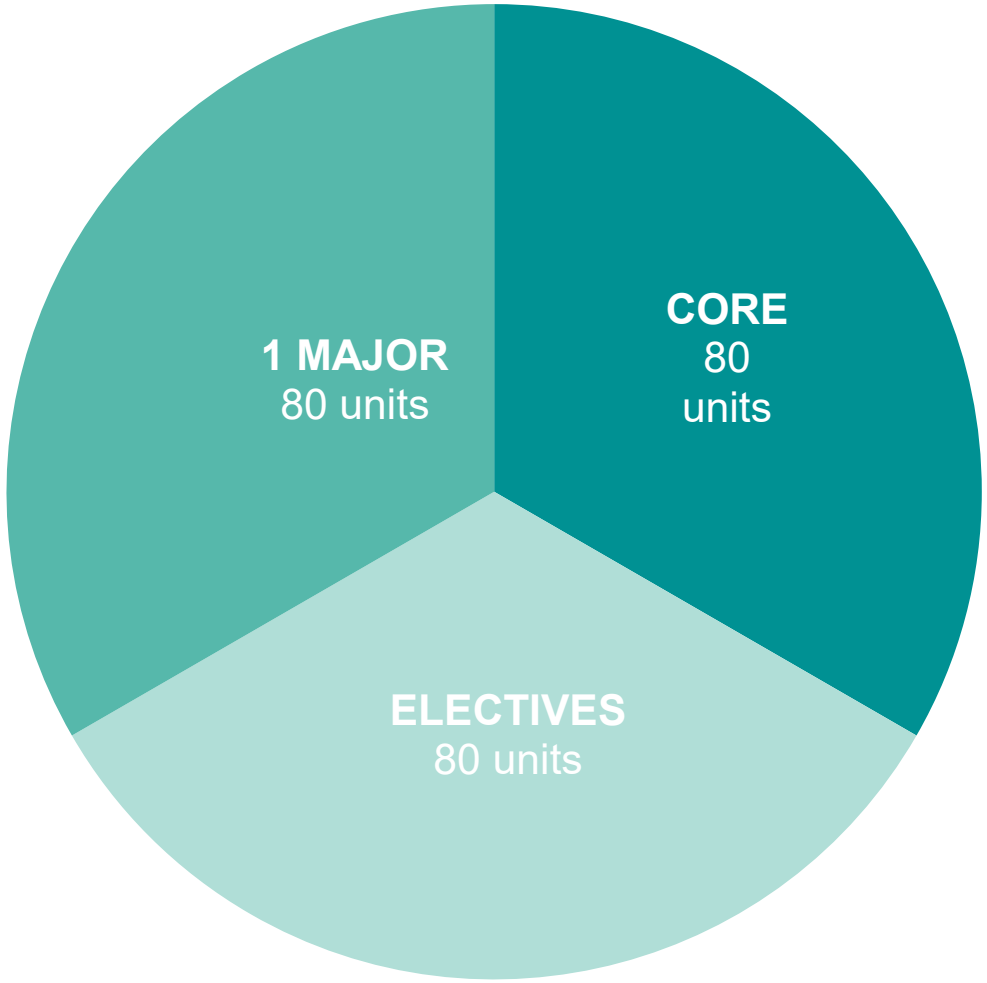
Richardson, A., Sharma, M. D., Khachan, J. (2008), *CAL-laborate International*, 16(1), 20-27.

- Yeung, A., Cornish, S., Kable, S., **Sharma, M.D**. (2019) What Can Instructors Focus on When Improving Undergraduate Science Experiments? Supporting a Cross-Disciplinary Approach. *International Journal of Innovation in Science and Mathematics Education*, 27(3), 25–40
- Barrie, S. C., Bucat, R. B., Buntine, M. A., Burke da Silva, K., Crisp, G. T., George, A. V., Jamie, I. M., Kable, S. H., Lim, K. F., Pyke, S. M., Read, J. R., **Sharma M. D**., and Yeung A. 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.
- Yeung, A., Pyke, S. M., **Sharma, M. D**., Barrie, S. C., Buntine, M. A., Burke Da Silva, K., Kable, S. H and Lim K. F. (2011) The Advancing Science by Enhancing Learning in the Laboratory (ASELL) Project: The first Australian multidisciplinary workshop, *Int. J. of Innovation in Science and Mathematics Education*, 19(2), 51-72.
- Bhathal, R., **Sharma, M. D.** and Mendez, A. (2010) Educational analysis of a first year engineering physics experiment on standing waves: based on the ACELL approach, *European Journal of Physics,* 31, 3-35.

- Gordon, T., **Sharma, M. D.** and Georgiou, H. (2015) Shifting towards inquiry-oriented learning in a high school outreach program, *International Journal of Innovation in Science and Mathematics Education* 23(6), 63-74
- Huntula, J., **Sharma, M. D.**, Johnston, I. and Chitaree, R. (2011) A framework for laboratory pre-work based on the concepts, tools and techniques questioning method, *European Journal of Physics*, 32(5), 1419-1430.
- **Sharma, M.D**., Mendez, A., Sefton, I.M., Khachan, J. (2014) Student evaluation of research projects in a first-year physics laboratory. *European Journal of Physics*, 35, (2), 025004.
- Burgess, C., Yeung, A. and **Sharma, M. D.** (2015) Integrating assessment to promote engagement in an introductory chemistry laboratory**,** *International Journal of Innovation in Science and Mathematics Education*, 23 (2), 74-91.
- Emotions new study in progress

One active learning case study…

The BSc's structure…



The BSc's core… and students' journeys across 1st to 3rd year…

3rd Year -
Transdisciplinary
↑
2nd Year -
Interdisciplinary
↑
1st Year -
Multidisciplinary

In SCIE1002 Multidisciplinary Laboratories we ask…

Water – would you drink it?

Alternative energy – how much does it cost?

P.S. – "These kinds of courses typically fail."(!)

SCIE1002 Staffing S1 2019

Day	Time		Wk1	Wk2	Wk3	Wk4	Wk5	Wk6	Wk7	Break	Wk8	Wk9	Wk10	Wk11	Wk12	Wk13	Exams
		Wk beginning	25-Feb	4-Mar	11-Mar	18-Mar	25-Mar	1-Apr	8-Apr	15&22-Apr	29-Apr	6-May	13-May	20-May	27-May	3-Jun	11-28 Jun
		Discipline		ESM	Biology	Chemistry	Chemistry	Psychology	Geography		Biology	Physics	Physics	Earth Sciences	Psychology	Make ups TBC	
		Focus	Intro & Inductions														
CALLAGHAN																	
Monday pm	1pm-4pm	Academic	Liam Phelan	Richard Yu	Brett Neilan	Clovia Holdsworth	Clovia Holdsworth	Bill Budd	Michelle Duffy		Brett Neilan	Renee Goreham	Renee Goreham	Silvia Frisia	Bill Budd		
		Demonstrator	Jennifer Baker	Jennifer Baker	Jennifer Baker	Jennifer Baker	Jennifer Baker	Jennifer Baker	Ainsley Hughes		Jennifer Baker	Jennifer Baker	Jennifer Baker	Jennifer Baker	Jennifer Baker		
		Demonstrator	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Melinda Ey		Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh		
		Technical Officer	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders		Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders		
Monday ev.	5pm-8pm	Academic	Liam Phelan	Richard Yu	Brett Neilan	Clovia Holdsworth	Clovia Holdsworth	Stuart Marlin	Michelle Duffy		Brett Neilan	Xiaojing Zhou	Xiaojing Zhou	Anthony Kiem	Stuart Marlin		
		Demonstrator	Jennifer Baker	Jennifer Baker	Jennifer Baker	Jennifer Baker	Jennifer Baker	Jennifer Baker	Ainsley Hughes		Jennifer Baker	Jennifer Baker	Jennifer Baker	Jennifer Baker	Jennifer Baker		
		Demonstrator	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Melinda Ey		Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh		
		Technical Officer	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders		Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders		
Tuesday am	9am-12pm	Academic	Liam Phelan	Alex Callen	Brett Neilan	Clovia Holdsworth	Clovia Holdsworth	Darren Burke	Kathy Mee		Brett Neilan	Renee Goreham	Renee Goreham	Silvia Frisia	Darren Burke		
		Demonstrator	Caitlin Romanis	Caitlin Romanis	Caitlin Romanis	Caitlin Romanis	Caitlin Romanis	Caitlin Romanis	Ainsley Hughes		Caitlin Romanis	Caitlin Romanis	Caitlin Romanis	Caitlin Romanis	Caitlin Romanis		
		Demonstrator	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Melinda Ey		Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran		
		Technical Officer	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh		Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh		
Tuesday pm	1pm-4pm	Academic	Liam Phelan	Alex Callen	Brett Neilan	Khay Fong	Khay Fong	Heather Douglas	Kathy Mee		Brett Neilan	John Holdsworth	John Holdsworth	Danielle Verdon-Kid	Emma Axelsson		
		Demonstrator	Caitlin Romanis	Caitlin Romanis	Caitlin Romanis	Caitlin Romanis	Caitlin Romanis	Caitlin Romanis	Ainsley Hughes		Caitlin Romanis	Caitlin Romanis	Caitlin Romanis	Caitlin Romanis	Caitlin Romanis		
		Demonstrator	Rafiquel Islam	Rafiquel Islam	Rafiquel Islam	Rafiquel Islam	Rafiquel Islam	Rafiquel Islam	Elizabeth Adamczyk		Rafiquel Islam	Rafiquel Islam	Rafiquel Islam	Rafiquel Islam	Rafiquel Islam		
		Technical Officer	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh		Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh		
Tuesday ev.	5pm-8pm	Academic	Liam Phelan	Richard Yu	Brett Neilan	Tianyi Ma	Tianyi Ma	Heather Douglas	Michelle Duffy		Brett Neilan	Matthew Griffith	Matthew Griffith	Anthony Kiem	Stefania Paolini		
		Demonstrator	Alescia Cullen	Alescia Cullen	Alescia Cullen	Alescia Cullen	Alescia Cullen	Alescia Cullen	Ainsley Hughes		Alescia Cullen	Joseph Pegler	Joseph Pegler	Alescia Cullen	Alescia Cullen		
		Demonstrator	Rafiquel Islam	Rafiquel Islam	Rafiquel Islam	Rafiquel Islam	Rafiquel Islam	Rafiquel Islam	Elizabeth Adamczyk		Rafiquel Islam	Rafiquel Islam	Rafiquel Islam	Rafiquel Islam	Rafiquel Islam		
		Technical Officer	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh		Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh		
Wednesday am	9am-12pm	Academic	Bonnie McBain	Richard Yu	Brett Neilan	Ian Van Altena	Ian Van Altena	Stuart Marlin	Michelle Duffy		Brett Neilan	John Furst	John Furst	Greg Hancock	Stuart Marlin		
		Demonstrator	Alescia Cullen	Alescia Cullen	Alescia Cullen	Alescia Cullen	Alescia Cullen	Alescia Cullen	Ainsley Hughes		Alescia Cullen	Joseph Pegler	Alescia Cullen	Alescia Cullen	Alescia Cullen		
		Demonstrator	Duong Phan	Duong Phan	Duong Phan	Duong Phan	Duong Phan	Duong Phan	Melinda Ey		Duong Phan	Duong Phan	Duong Phan	Duong Phan	Duong Phan		
		Technical Officer	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh		Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh		
Wednesday pm	1pm-4pm	Academic	Bonnie McBain	Richard Yu	Brett Neilan	Alister Page	Alister Page	Scott Brown	Simon Springer		Brett Neilan	Renee Goreham	Renee Goreham	Hannah Power	Kristen Pammer		
		Demonstrator	Alescia Cullen	Alescia Cullen	Alescia Cullen	Alescia Cullen	Alescia Cullen	Alescia Cullen	Ainsley Hughes		Alescia Cullen	Joseph Pegler	Alescia Cullen	Alescia Cullen	Alescia Cullen		
		Demonstrator	Duong Phan	Duong Phan	Duong Phan	Duong Phan	Duong Phan	Duong Phan	Melinda Ey		Duong Phan	Duong Phan	Duong Phan	Duong Phan	Duong Phan		
		Technical Officer	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh		Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh	Nguyen Trieu Trinh		
Thursday am	9am-12pm	Academic	Liam Phelan	Richard Yu	Brett Neilan	Ian Van Altena	Ian Van Altena	Emily Freeman	Simon Springer		Brett Neilan	Vicki Keast	Vicki Keast	Bill Landenberger	Andrea Griffin		
		Demonstrator	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Ainsley Hughes		Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran		
		Demonstrator	Joseph Pegler	Alescia Cullen	Alescia Cullen	Joseph Pegler	Joseph Pegler	Joseph Pegler	Elizabeth Adamczyk		Joseph Pegler	Joseph Pegler	Joseph Pegler	Joseph Pegler	Joseph Pegler		
		Technical Officer	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders		Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders		
Thursday pm	1pm-4pm	Academic	Liam Phelan	Richard Yu	Brett Neilan	Khay Fong	Khay Fong	Kristen Pammer	Simon Springer		Brett Neilan	Renee Goreham	Renee Goreham	Judy Bailey	Kristen Pammer		
		Demonstrator	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Ainsley Hughes		Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran	Thi Kim Anh Tran		
		Demonstrator	Joseph Pegler	Alescia Cullen	Alescia Cullen	Joseph Pegler	Joseph Pegler	Joseph Pegler	Elizabeth Adamczyk		Joseph Pegler	Joseph Pegler	Joseph Pegler	Joseph Pegler	Joseph Pegler		
		Technical Officer	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders		Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders	Stene Sanders		
OURIMBAH																	
Monday am	9am-12pm	Academic	Liam Phelan	Megan Huggett	Megan Huggett	Tim Kirkman	Tim Kirkman	Bill Budd	Meg Sherval		Megan Huggett	Tim Kirkman	Tim Kirkman	Tim Kirkman	Bill Budd		
		Demonstrator	Vincent Raoult	Vincent Raoult	Vincent Raoult	Vincent Raoult	Vincent Raoult	Shay Goddard	Dan Hewitt		Vincent Raoult	Vincent Raoult	Vincent Raoult	Vincent Raoult	Vincent Raoult		
		Demonstrator	Tim Smith	Tim Smith	Tim Smith	Tim Smith	Tim Smith	Tim Smith	Tim Smith		Tim Smith	Tim Smith	Tim Smith	Tim Smith	Tim Smith		
		Technical Officer	Katy Marrotte	Katy Marrotte	Katy Marrotte	Katy Marrotte	Katy Marrotte	Katy Marrotte	Katy Marrotte		Katy Marrotte	Katy Marrotte	Katy Marrotte	Katy Marrotte	Katy Marrotte		
Wednesday am	9am-12pm	Academic	Liam Phelan	Megan Huggett	Megan Huggett	Tim Kirkman	Tim Kirkman	Bill Budd	Kathy Mee		Megan Huggett	Tim Kirkman	Tim Kirkman	Tim Kirkman	Bill Budd		
		Demonstrator	Vincent Raoult	Vincent Raoult	Vincent Raoult	Vincent Raoult	Vincent Raoult	Shay Goddard	Dan Hewitt		Vincent Raoult	Vincent Raoult	Vincent Raoult	Vincent Raoult	Vincent Raoult		
		Demonstrator	Tim Smith	Tim Smith	Tim Smith	Tim Smith	Tim Smith	Tim Smith	Tim Smith		Tim Smith	Tim Smith	Tim Smith	Tim Smith	Tim Smith		
		Technical Officer	Katy Marrotte	Katy Marrotte	Katy Marrotte	Katy Marrotte	Katy Marrotte	Katy Marrotte	Katy Marrotte		Katy Marrotte	Katy Marrotte	Katy Marrotte	Katy Marrotte	Katy Marrotte		

Some immediate reflections…

- Active learning? Sure, but it probably would have been anyway, and it's fun to think about how to extend on active learning… (blended, two campuses, campus as learning laboratory, multidisciplinary, etc)
- Three key things:
  - The role of narrative
  - Community building – amongst students, amongst staff
  - Equity is for considering in every little decision ;-)…

Session 6: Hands-on Experience – Active Learning in Science

1. There do not seem to be many good examples of effective active learning in mathematics. Do you know of any?

2. Diverse examples would be great. Thank you.

3. Input on a solution: We've found that students are the most engaged in a course where the delivery is based on experiential learning AND involves both fun and social elements e.g. field trips, off-campus group projects. How can we encourage more active take-up of this approach?

4. What are the costs of 'hands on' - including time to do well and safely?

5. Can we find words for active learning (and indeed blended learning) so our colleagues see these as things they may already be doing? Because we need to accept that there have ALWAYS been innovative and creative teachers.

6. What is best practice in this context given the employment opportunities or science graduates?

7. What spaces work best?

8. A burning question: Class attendance has been shrinking over the last decade. We put a lot of effort into improving the classroom experience, e.g. by making learning (inter)active. What can we do to get students to come again given all this effort? Or should we not do anything?

9. How are Universities applying deeper and challenging hands-on experience in the online guided environment? What tools (other than video instruction, manuals and traditional mechanisms) are being employed?

10. How do we make sure best practice is shared across and within our institutions?

11. Many of my colleagues do hands-on learning, but it seems like it's just for fun. I'm not sure if they understand that there are often different pedagogies involved (i.e. constructionism). Help?