A blended learning model for first year science student engagement with mathematics and statistics

Team members

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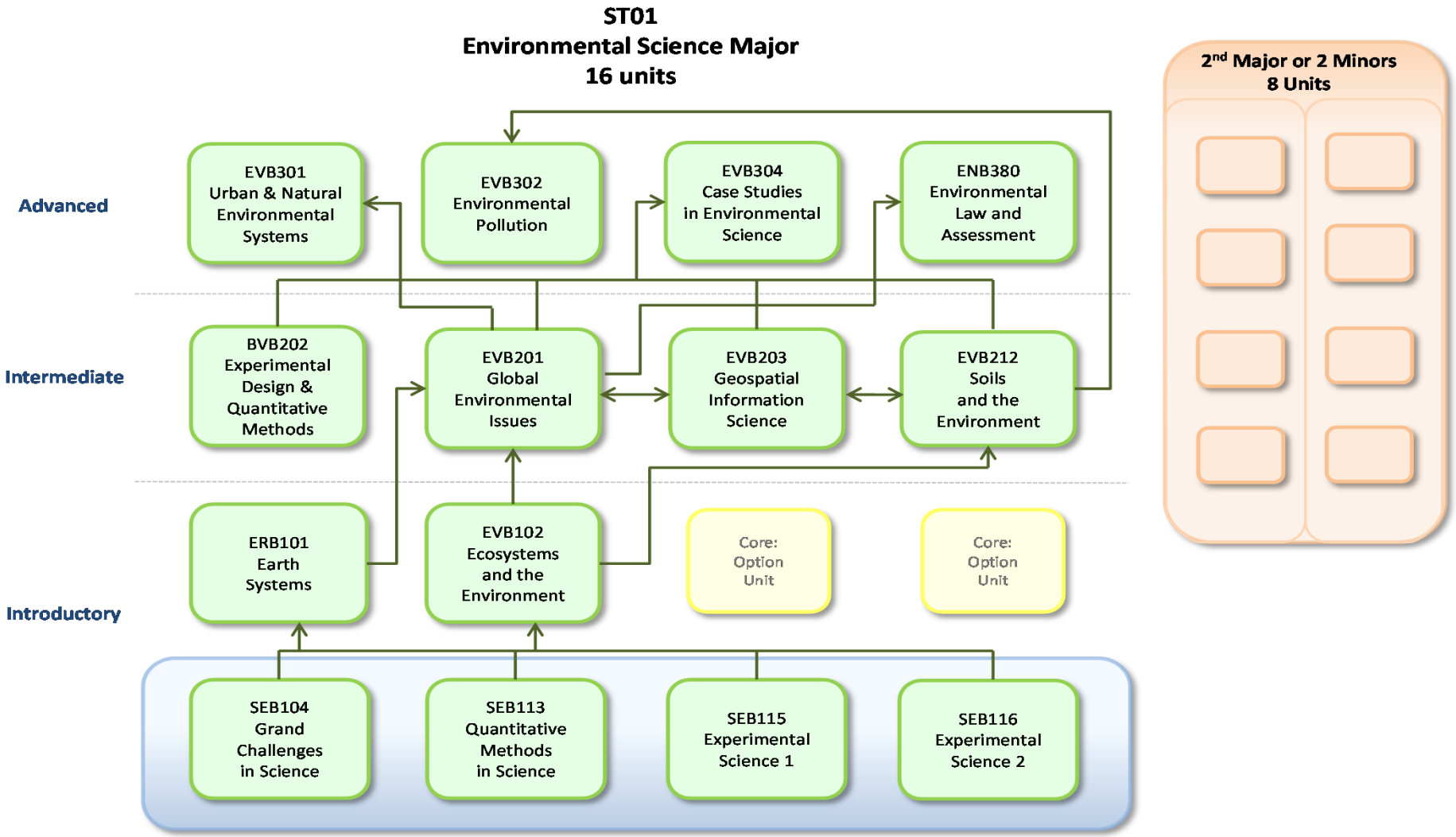
Outline of the presentation

1. Educational Context
   a. SEB113 within ST01 (Bachelor of Science degree)
   b. Challenges of the unit
2. Evidence-based, research-informed implemented changes
3. Blended learning model
4. Results
5. Further research

SEB 113 – Year 1, semester 1 core unit



Context

SEB113 Quantitative Methods in Science

- The core mathematics and statistics unit for all first-year students undertaking a ST01 (Bachelor of Science) course
- Comprised of five modules of mathematics, statistics and quantitative communication
- Builds on an assumed knowledge foundation of Mathematics B
- Teaches mathematics above an assumed foundational level and makes use of the R statistics program in RStudio which requires students to learn some R programming

Challenges – complexity

Complexity

Some characteristic properties of complex systems:

- Circular causality, feedback loops, logical paradoxes and strange loops
- Small change in the cause implies dramatic effects
- Emergence and unpredictability

Péter Ērdi, *Explaining Complexity*, Springer, 2008, p. 7

Challenges – complexity

Complexity of learning tasks: “The amount of complexity in any task changes depending on the prior task-relevant knowledge or experience and aptitudes of individual learners. […] Rather than being mainly a feature of the environment, complexity primarily seems to be in the eye and the mind of beholder”

Complexity of learning environments: “ The medium for delivering instruction may also be considered to be part of learning task. […] The availability of powerful technological tools calls for new approaches to scaffolding learners and provides new opportunities for studying learning processes” (Elen & Clark, *Handling Complexity in Learning Environments. Theory and Research.* 2006, pp. 2-3)

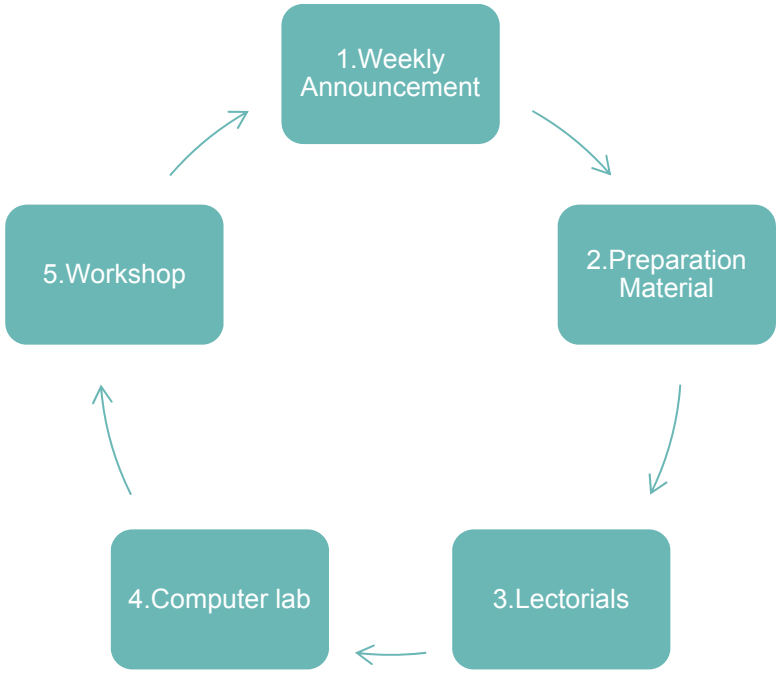
Challenges – complexity

- **Learning environment**
  - Multiple on- and off-campus opportunities for learning
  - Variable content (many of topics spread across all majors, maths/stats)
  - Authentic, active learning tasks
  - Authentic assessment
- **Social agents (learners and teaching team)**
  - Cohort diversity
  - Diverse preparedness level in maths
  - Low development of learning skills
  - Low engagement
  - Low satisfaction

Learning environment: new content and new learning routine (process)

- **New content (everyone finds something new)**
  - Maths
  - Stats
  - R Programming
  - Visualisation
  - Scientific method

- **New learning processes**



Social agents (learners)

- **Cohort diversity (after Census Day, N=89)**

Degree program	Number
Bachelor of Science or Bachelor of Applied Science	66
Bachelor of Engineering(Honours) / Bachelor of Science	11
Bachelor of Science / Bachelor of Laws (Honours)	7
Bachelor of Science / Bachelor of Information Technology	2
Bachelor of Science / Bachelor of Mathematics	2
International Exchange Semester	1

- **Preparedness level in maths (prior Census Day, N=133)**

What is the highest level of mathematics you have completed in High School? N=133				
Year 8	Year 10	Maths A	Maths B	Maths C
1	2	18	72	40

Low development of learning skills

Do you feel confident that you will succeed in this unit without additional help with maths from the University? N=133			
Yes	No	No response	Yes and No
66	67	0	1

If your answer was 'No', are you obtaining additional help with maths from the University now? N=67			
Yes	No	No response	Yes and No
31	37	0	1

If you are receiving additional help, how would you rate it? N=31					
Not useful	Somewhat useful	Neutral	Useful	Very useful	No answer
0	6	6	15	4	0

Low engagement

- **Engagement**

In its most immediate sense, **student engagement** refers to the contribution that students make towards their learning, as with their **time, commitment and resources.**
(Krause & Coates, 2008, in Kahn, *Student engagement in higher education*. British Educational Research Journal, No. 6, December 2014, p. 1005).

The key notion of student engagement is the ways students exercise their **agency** in specific learning environments (**not just about physically turning up!)**

i.e. **intellectually and emotionally present** in the learning environment

If you are not taking advantage of help provided, explain why

- *Because I also have to work. The STIMulate sessions are Friday during my working hours.*
- *False confidence (can sort of do most of the work so help isn't sought out when it is more than probably needed).*
- *Because I have no idea what's going on in every other SEB113 class. I don't know if it will ever make sense.*
- *Haven't had the time.*

Low student satisfaction

- **Pulse (mid-semester) and In-Sight (end of semester) student evaluations**

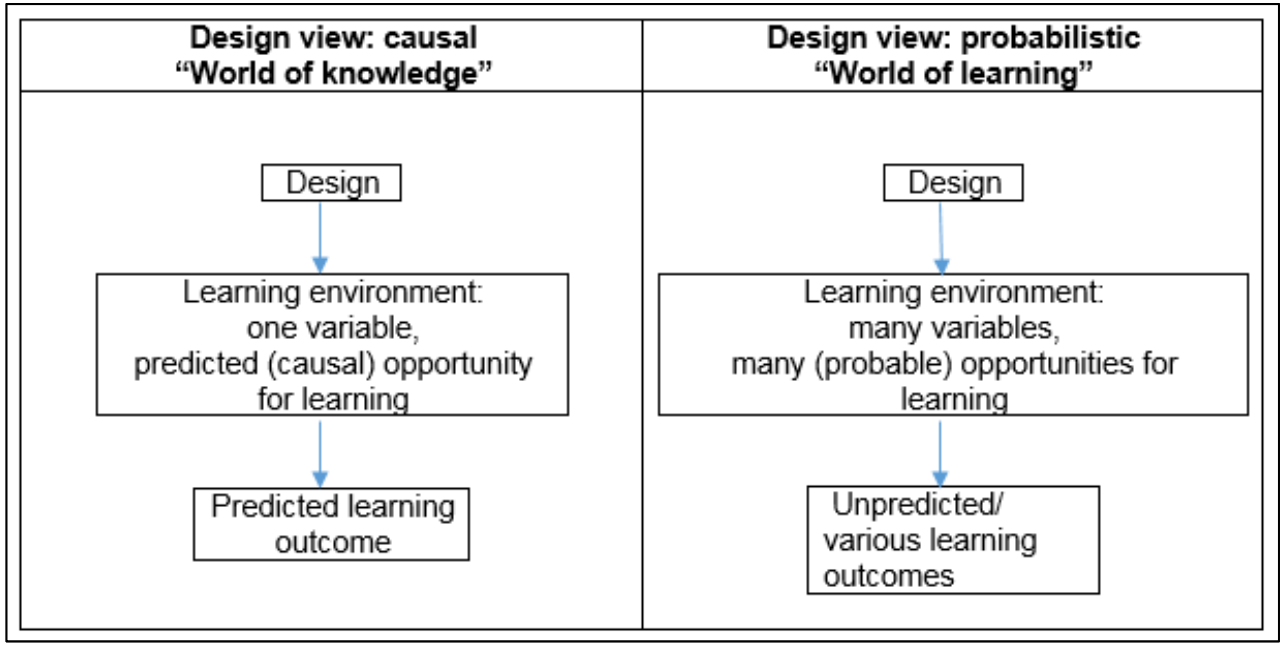
Year	Teaching Period	Total Surveyed	Total Responded	Question Text	Rating
2014	2014-SEM-1	414	63	This unit is providing me with good learning opportunities. (PS1)	2.9
				I am taking advantage of opportunities to learn in this unit. (PS2)	3.3
				I am satisfied with this unit so far. (PS3)	2.5
	2014-SEM-2	84	11	This unit is providing me with good learning opportunities. (PS1)	4.0
				I am taking advantage of opportunities to learn in this unit. (PS2)	3.7
				I am satisfied with this unit so far. (PS3)	3.5
2013	2013-SEM-1	341	82	This unit is providing me with good learning opportunities. (PS1)	2.6
				I am taking advantage of opportunities to learn in this unit. (PS2)	3.1
				I am satisfied with this unit so far. (PS3)	2.1
	2013-SEM-2	66	13	This unit is providing me with good learning opportunities. (PS1)	3.4
				I am taking advantage of opportunities to learn in this unit. (PS2)	3.5
				I am satisfied with this unit so far. (PS3)	3.0

Social agents (teaching team)

- **Changing teaching team (multiple tutors, changing Unit Coordinator) – implications for learning, teaching.**

Research-informed, evidence-based redesign

- Probabilistic approach to learning design within eLearning environments



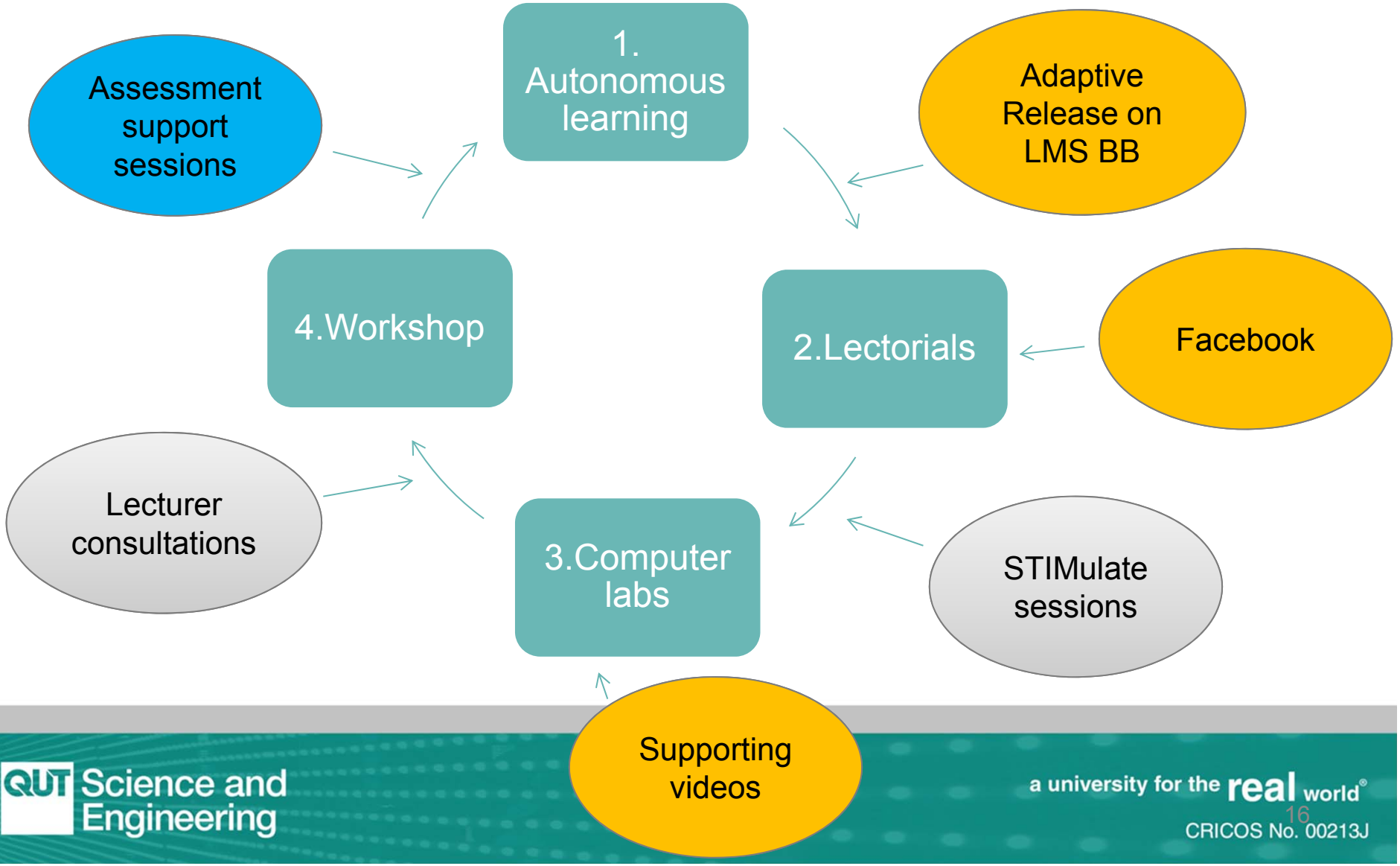
Adapted from: Strijbos, J.W., Martens, R.L., Jochems, W.M.G. (2004). Designing for interaction: Six steps to designing computer-supported group-based learning. Computers & Education, 42(4), pp. 403-424.

Blended learning

Blended learning experience is one that: “1) thoughtfully integrates different instructional methods [...]; and 2) contains both face-to-face and computer-mediated portions”. (Alammary et al., 2014, p. 443)

Alammary, A., Sheard, J., & Carbone, A. (2014). Blended learning in higher education: Three different design approaches. *Australasian Journal of Educational Technology, 30*(4), 440-454.

Blended Learning – creating a complex, organised learning environment to support learning routine



Complex, organised learning environment based on Revised Bloom's Taxonomy

The Cognitive Process Dimension represents a continuum of increasing cognitive complexity—from lower order thinking skills to higher order thinking skills. Anderson and Krathwohl (2001) identify nineteen specific cognitive processes that further clarify the scope of the six categories (Table 2).

Table 2. The Cognitive Processes dimension — categories & cognitive processes and alternative names

lower order thinking skills → higher order thinking skills

remember	understand	apply	analyze	evaluate	create
recognizing • identifying recalling • retrieving	interpreting • clarifying • paraphrasing • representing • translating exemplifying • illustrating • instantiating classifying • categorizing • subsuming summarizing • abstracting • generalizing inferring • concluding • extrapolating • interpolating • predicting comparing • contrasting • mapping • matching explaining • constructing models	executing • carrying out implementing • using	differentiating • discriminating • distinguishing • focusing • selecting organizing • finding coherence • integrating • outlining • parsing • structuring attributing • deconstructing	checking • coordinating • detecting • monitoring • testing critiquing • judging	generating • hypothesizing planning • designing producing • constructing

(Table 2 adapted from Anderson and Krathwohl, 2001, pp. 67–68.)

Iowa State University
Center for Excellence in Learning and Teaching

Revised Bloom's Taxonomy, retrieved from http://www.celt.iastate.edu/teaching/effective-teaching-practices/revised-blooms-taxonomy

Instructional method			Delivery mode On-campus environment		Delivery mode Off-campus environment
Weekly learning activities					
Type	Description	Targeted cognitive processes	In class	Out of class	Online
Autonomous learning	Preparatory material (revision and new material)	For "novices". Provide first exposure on new content to **remember** (recognise, retain, reconstruct, recall) For "experts". **Remember & Understand**: recognize, retain, reconstruct, and recall patterns of previous experiences and acquired knowledge	N/A	N/A	Adaptive Release functionality on LMS Blackboard Facebook community
Lectorials	Interactive lectures	For all learners: provide first exposure to the new content to **remember & understand**	Weekly live lectorials	STIMulate learning support Lecturer consultations	Lecture recordings Facebook community

Instructional method			Delivery mode On-campus environment		Delivery mode Off-campus environment
Weekly learning activities					
Type	Description	Targeted cognitive processes	In class	Out of class	Online
Computer lab	Individual activities – learning how to use RStudio package (R programming) for data analysis	**Remember & Understand:** recognize reconstruct, and recall patterns of knowledge provided in lectures. Also interpret, exemplify, classify, summarize, infer, compare, explain. **Apply** the acquired knowledge and skills in new environment (RStudio). **Execute & Implement.**	Individual work with assistance from more advanced peer (tutor)	STIMulate sessions Lecturer consultations	Pre-computer lab videos Facebook community
Workshops	Concept application in a real context using knowledge from lectures and labs with R statistical software	**Remember & Understand** patterns of knowledge provided in lectures and computer labs **Apply** acquired knowledge and skills (execute & implement) **Analyse** (in teams) . Differentiate, organise, attribute	Team work – solving problems tasks to be completed in teams In-class support from tutors	STIMulate sessions	Facebook community

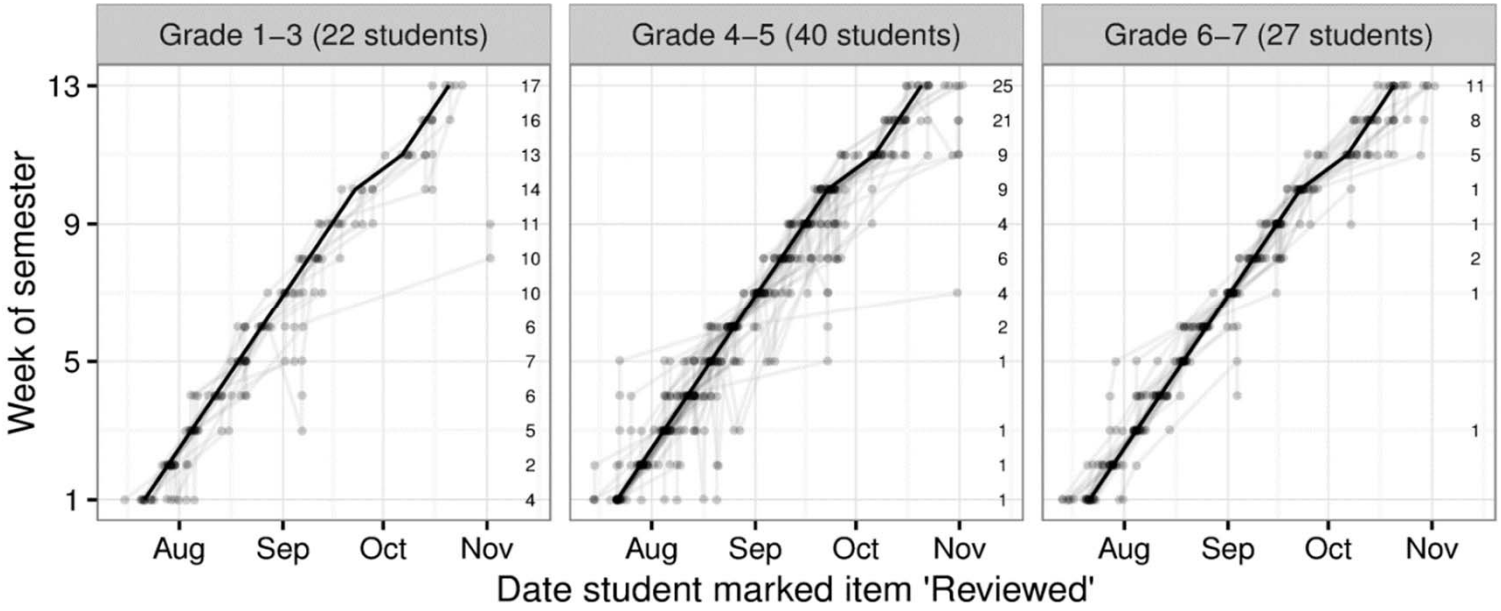
Assessment

Type	Description	Targeted cognitive processes	Support On-campus environment		Support Off-campus environment
			In class	Out of class	Online
Weekly quizzes (10)	*WeBWork* delivery (infinite number of attempts)	**Remember & Understand**	N/A	STIMulate sessions Lecturer consultations	Adaptive Release Facebook community
PSTs	- Authentic assessment following the scientific method - Focused on application of techniques learned to a scientific phenomenon - Feedback provided on each section using CRA	**Remember, Understand & Apply**	N/A	PST support sessions (but **not teaching for assessment**) Lecturer consultations	Facebook community

Type	Description	Targeted cognitive processes	Support On-campus environment		Support Off-campus environment
			In class	Out of class	Online
Maxi quiz	- In-class quiz using *WeBWork* - Open book exam in computer labs - Questions to demonstrate understanding - Answers not Google-able (e.g. setting up a matrices, etc)	**Remember, Understand, Apply & Analyse**	N/A	N/A	Adaptive Release Facebook community
Collaborative Scientific Article	- Authentic assessment - Self-selected groups - Self-selected data - Milestones for completion with feedback: Milestone 1 : data source, define aim Milestone 2: visualisation, develop model Milestone 3: Final submission	**Remember, Understand, Apply, Analyse, Evaluate**	N/A	CSA support sessions (not teaching for assessment)	Facebook community

Results

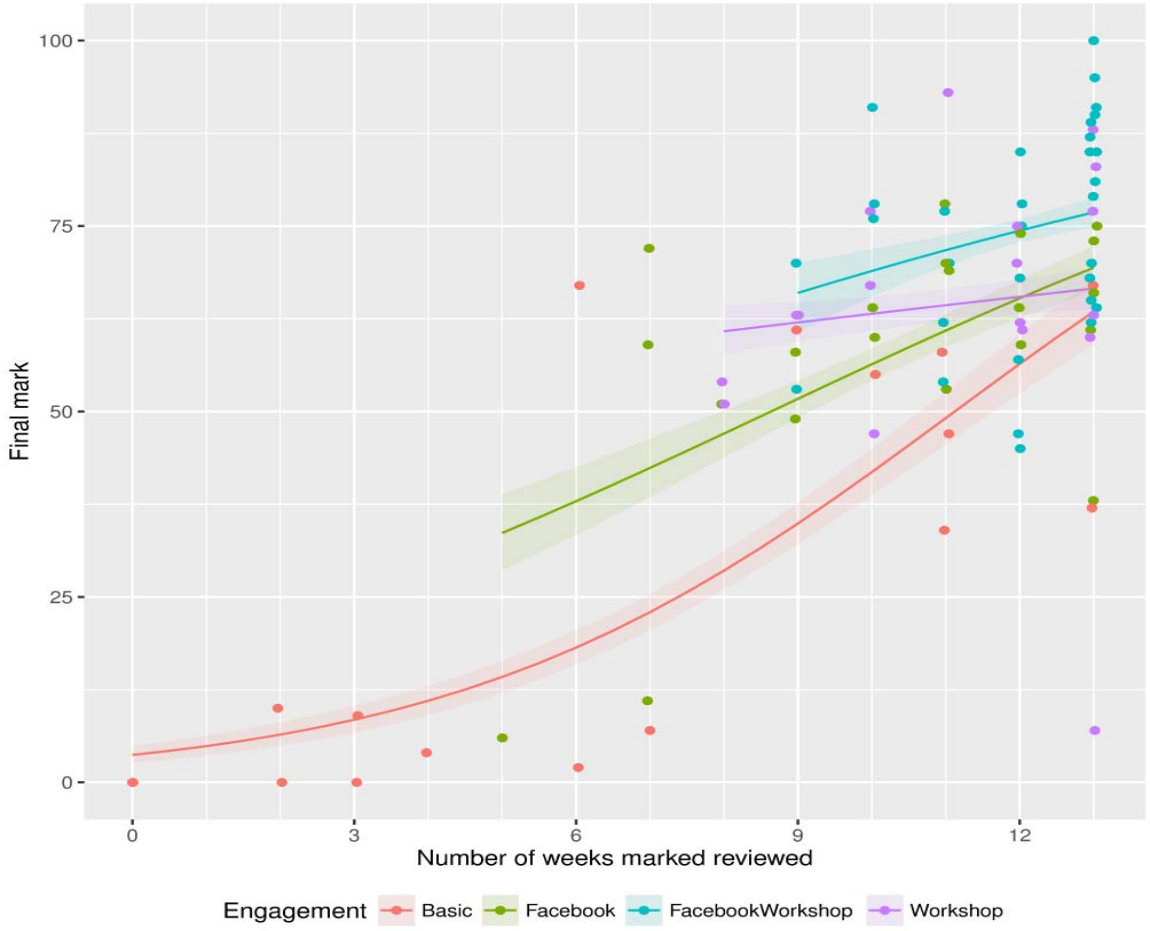
- **Student engagement – Adaptive Release**



Trajectories of students reviewing the preparation material throughout the semester, grouped by overall performance. Numbers at far right show the number of students in each group who did not review that week's material. The solid line indicates the timing of the lectures.

Results

Correlation: engagement and achievement



The trend continues (2016 student comments)

5	5	5	This was my favorite subject this semester. \r\n\r\nThe structure of the unit was fantastic - for example, the order and depth to which content was covered. The assessment built upon and consolidated knowledge given in lectures. The workshops were great. The teaching team was 10/10 brilliant and beautiful. Sam and James (tutor) are legends. Well done.
5	5	5	VERY well organised\! I was rather nervous to do a maths subject first up in the degree, but I feel really prepared and much more confident. The staff (in particular Sam) were very professional and helpful. Also, Sam is clearly dedicated to providing an excellent educational experience. To be honest, the only way I can think to improve the course is to maybe provide a little more support for the mid-term exam, I kind of struggled with that one. Otherwise, well done\!
5	5	5	Without a prerequisite on the course for maths, the assumed knowledge can be quite harsh for anyone who has not completed maths B.

5	2	5	Sam and the Tutors were fantastic. It has the most challenging material of any 1st year class. I don't think much could be done to improve the way this subject is taught. I think the main issue with student results would be to do with insufficient assumed knowledge.

4	2	4	Well designed workshops and assignments, even though they were difficult at times
4	2	3	
4	2	3	
4	2	2	I found this unit difficult

Results

Improved satisfaction

Pulse (mid-semester) and In-Sight (end of semester) student evaluations

Year	Teaching Period	Total Surveyed	Total Responded	Question Text	Rating
2016	2016-SEM-1	403	115	This unit is providing me with good learning opportunities. (PS1)	4.1
				I am taking advantage of opportunities to learn in this unit. (PS2)	3.9
				I am satisfied with this unit so far. (PS3)	3.7
2015	2015-SEM-1	418	99	This unit is providing me with good learning opportunities. (PS1)	3.9
				I am taking advantage of opportunities to learn in this unit. (PS2)	3.7
				I am satisfied with this unit so far. (PS3)	3.2
	2015-SEM-2	128	26	This unit is providing me with good learning opportunities. (PS1)	3.8
				I am taking advantage of opportunities to learn in this unit. (PS2)	4.0
				I am satisfied with this unit so far. (PS3)	3.6

Progression rate

Outcomes	2014-SEM-1	2014-SEM-2	2015-SEM-1	2015-SEM-2	2016-SEM-1
TOTAL Progress Rate	73.5%	70.5%	65.2%	64.1%	
Domestic Progress Rate	73.5%	74.3%	65.3%	64.4%	
International Progress Rate	70.0%	37.5%	60.0%	50.0%	

Further research

- **Research foci**
  - Focus on progression
  - The ways students engage with particular features of the design (e.g. Adaptive Release)
  - Learners' attitudes towards mathematics (work initiated)
  - Modularised approach (?), personalised learning (?)