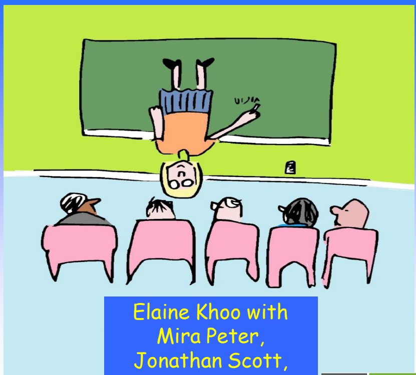
How We Flipped an Engineering Course



Elaine Khoo with
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Jonathan Scott,
Howell Round &
Bronwen Cowie

Wilf Malcolm Institute of Educational Research
Te Pūtahi Rangahau Mātauranga o Wilf Malcolm

TEACHING & LEARNING RESEARCH INITIATIVE
NĀU I WHATU TE KĀKAHU, HE TĀNIKO TAKU

Traditional Class

First year Introduction to electronics engineering

Conceptually challenging

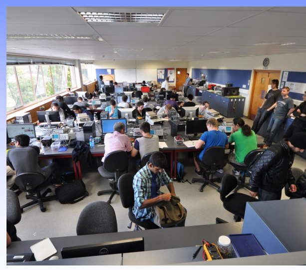
~150 students

2 lecturers (analog & digital)
6 weeks each

1 2hr face-to-face tutorial

1 lab/week

2-3 lab demonstrators



Threshold Concept Theory

"In each academic discipline, there exist special concepts -*threshold concepts*- that once grasped, reveal new and previously inaccessible ways of thinking about a subject".

(Meyer & Land, 2003)

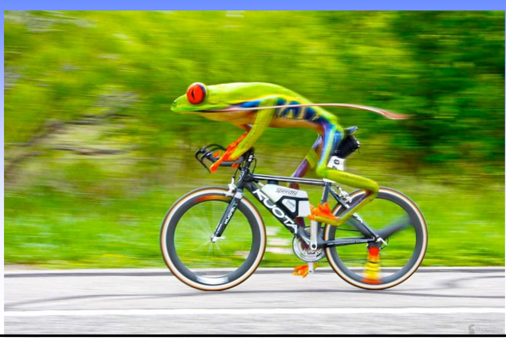
TC are:

TRANSFORMATIVE: we <u>are</u> (become) what we know

TC are:

IRREVERSIBLE: difficult to unlearn

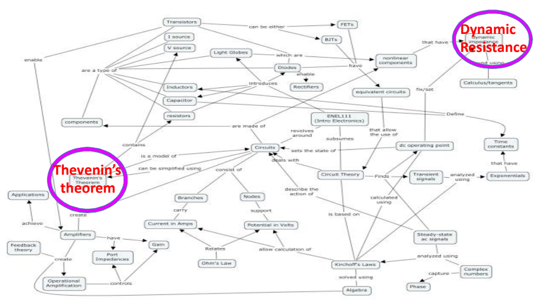
(learners cannot return to previous view of the world)



TC are:

INTEGRATIVE: cohere key aspects of the subject

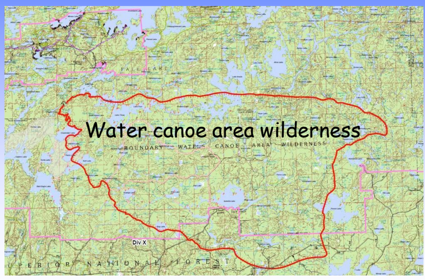
(reveal hidden inter-relatedness & connections between apparently disparate information)



TC ARE:

BOUNDED: delineate a particular conceptual space

(serving a specific and limited purpose)



BUT…

TC ARE:

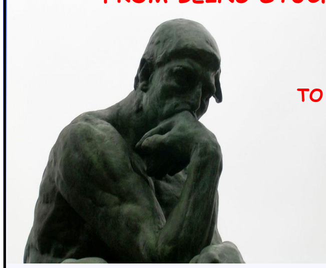
TROUBLESOME! counter-intuitive, difficult to learn,

AND…

STUDENTS GET STUCK!

How can lecturers help students to *transition…*

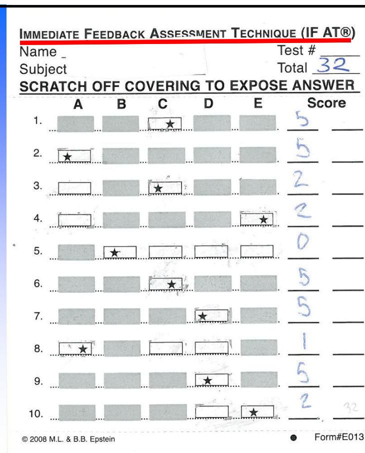
FROM BEING STUCK…



TO MASTERING TCs

2012: DE-CLUTTER THE CURRICULUM

IF AT



IMMEDIATE FEEDBACK ASSESSMENT TECHNIQUE (IF AT®)

Name ___ Test # ___

Subject ___ Total 32

SCRATCH OFF COVERING TO EXPOSE ANSWER

	A	B	C	D	E	Score
1.			★			5
2.	★					5
3.			★			2
4.					★	2
5.		★				0
6.			★			5
7.				★		5
8.	★					1
9.				★		5
10.					★	2

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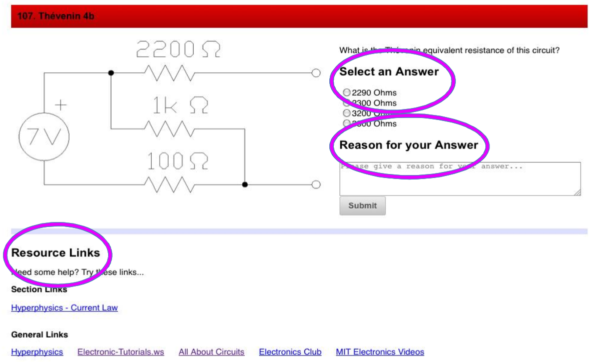
2013: E-Tutorials



Since summer 2014…

Flipped class

A move away from traditional teaching

Move away from using class time for lecturing

Engage with new class material for the first time outside of class

Part/all of instruction through videos/other media

Class time is used for the harder work of assimilating and applying that knowledge

Class time becomes dynamic, interactive learning environment

Flipped class

In-class time is "re-purposed" for inquiry, application, and assessment

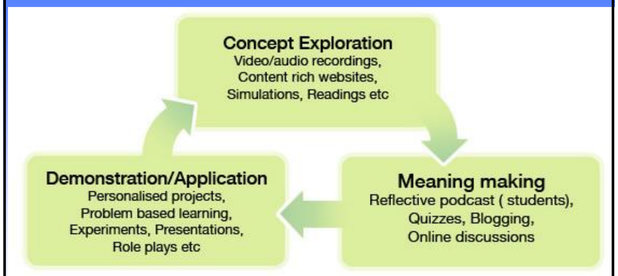
Students gain responsibility for their learning (studying course material outside of class)

Instructors = facilitators of the learning process, guides students to apply concepts and engage creatively in the subject matter

Goal = to cultivate deeper, richer active learning

Emphasis is on higher-order thinking skills and application to complex problems (through collaborative learning, case-based learning, peer instruction, problem-based learning, debates)

Flipped class

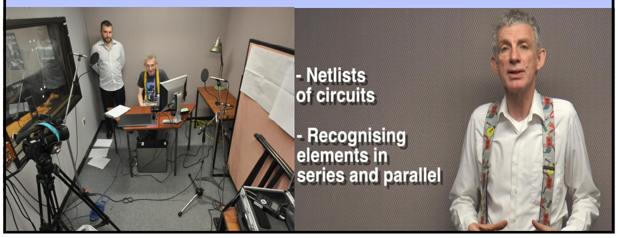


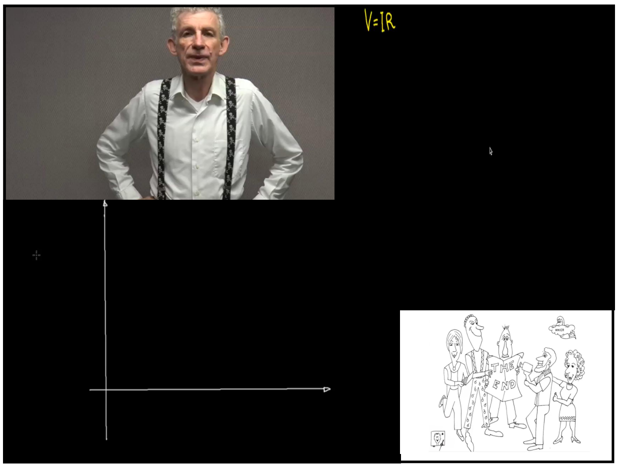
- University of Queensland, http://www.uq.edu.au/teach/flipped-classroom/what-is-fc.html

Cycle 1: Preparations…

Looked at (what makes) good videos
(e.g., coherence, redundancy, spatial & temporal contiguity)

Recorded or borrowed ~60 videos @ ~8 minutes each
(3 months learning, planning, recording, watching YouTube)





CYCLE 2

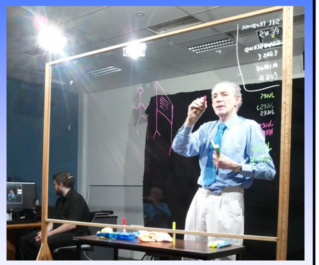
Monitored student video watching

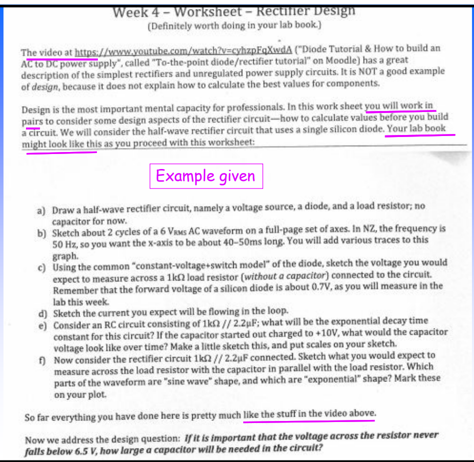
Lecturer 1 – Lightboard based videos

Lecturer 2- Panopto lecture videos

Continuous assessment

Revised problem solving questions





Week 4 – Worksheet – Rectifier Design
(Definitely worth doing in your lab book.)

The video at https://www.youtube.com/watch?v=cyhzpFqXwdA ("Diode Tutorial & How to build an AC to DC power supply", called "To-the-point diode/rectifier tutorial" on Moodle) has a great description of the simplest rectifiers and unregulated power supply circuits. It is NOT a good example of *design*, because it does not explain how to calculate the best values for components.

Design is the most important mental capacity for professionals. In this work sheet you will work in pairs to consider some design aspects of the rectifier circuit—how to calculate values before you build a circuit. We will consider the half-wave rectifier circuit that uses a single silicon diode. Your lab book might look like this as you proceed with this worksheet:

Example given

a) Draw a half-wave rectifier circuit, namely a voltage source, a diode, and a load resistor; no capacitor for now.
b) Sketch about 2 cycles of a 6 V_{RMS} AC waveform on a full-page set of axes. In NZ, the frequency is 50 Hz, so you want the x-axis to be about 40–50ms long. You will add various traces to this graph.
c) Using the common "constant-voltage+switch model" of the diode, sketch the voltage you would expect to measure across a 1kΩ load resistor (*without a capacitor*) connected to the circuit. Remember that the forward voltage of a silicon diode is about 0.7V, as you will measure in the lab this week.
d) Sketch the current you expect will be flowing in the loop.
e) Consider an RC circuit consisting of 1kΩ // 2.2μF; what will be the exponential decay time constant for this circuit? If the capacitor started out charged to +10V, what would the capacitor voltage look like over time? Make a little sketch this, and put scales on your sketch.
f) Now consider the rectifier circuit 1kΩ // 2.2μF connected. Sketch what you would expect to measure across the load resistor with the capacitor in parallel with the load resistor. Which parts of the waveform are "sine wave" shape, and which are "exponential" shape? Mark these on your plot.

So far everything you have done here is pretty much like the stuff in the video above.

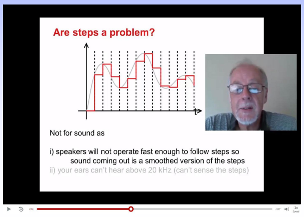
Now we address the design question: ***If it is important that the voltage across the resistor never falls below 6.5 V, how large a capacitor will be needed in the circuit?***

CYCLE 3

Revised problem solving questions

Monitored student video watching (stricter)

Lecturer 2 purpose-made videos



THE CLASS

2015, Sem. A -> PARTIAL FLIP (3 weeks) lecturer-created videos; + group problem solving activities

2015, Sem. T -> FULLY FLIPPED – 50% lecturer-created videos; + problem solving + continuous assessment

2016, Sem. A -> FULLY FLIPPED – 100% lecturer-created videos +, +

2016, Sem. T -> FULLY FLIPPED – 100% lecturer-created videos +, +

2017, Sem. A -> FULLY FLIPPED – 100% lecturer-created videos +, +

WHAT THE FLIPPED CLASS LOOKED LIKE

3/week x 50 min. lectures replaced by videos

Lecture slot allocated for group problem-solving **activities**

Labs = 3 hours; in-class mini-lectures

Continuous assessment; extra tutorials on demand

Data

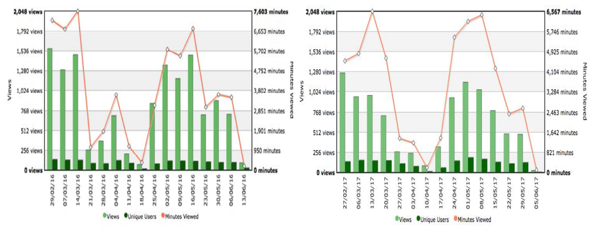
Surveys
Baseline, end of semester

Videos (Analytics from Panopto)
Who is watching, what, when, how many times

Assessments
6 quizzes (every 2 weeks), **no** exam

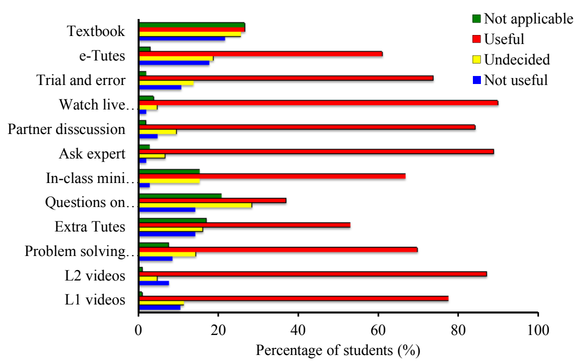
Focus group interviews
End of semester

Video viewing

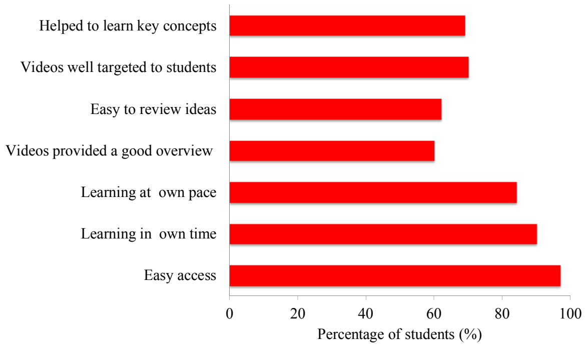


Session (top 100 by minutes viewed)	Views	Minutes Viewed	Average Minutes Viewed	Unique Users
Thevenin_Equivalent_Circuit_and_Measuring_It (default)	780	4341	6	282
Handling_Cap_in_circuits_with_DC_Sources_and_Resistors (default)	575	4167	8	246
Qualitative_Lighbulb_Circuit_Examples (default)	506	3572	8	257
Intro_and_Example_of_Superposition (default)	633	3463	6	268
Reducing_a_Circuit_Using_Series_and_Parallel_Formulae (default)	639	3370	6	287
DC_AC_and_RMS_what_and_why (default)	516	3200	7	269
Diode_Small_Signal_Equivalent_Circuit_Calculations (default)	400	2964	8	189

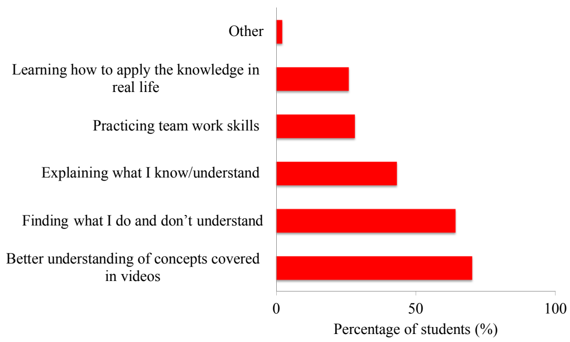
What helped learning?



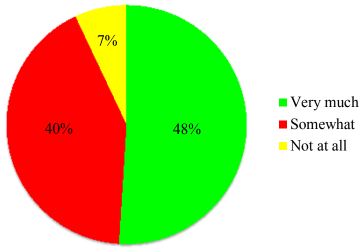
Value of videos?



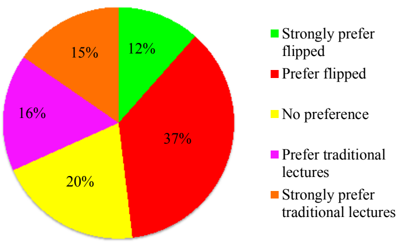
Value of group work?



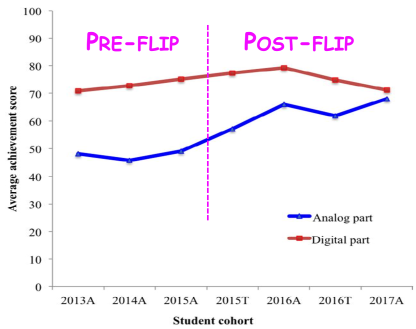
How helpful continuous assessment?



Flipped vs Traditional



Achievement



Lecturers' reflections

Lecturers liked flipping the class!

Students were more engaged and seemed to enjoy the paper more as a result of flipping.

Frequent tests were good – students had to keep up to date.

Students need guidance on the order of lecturer purpose-made videos to watch (they seemed a bit overwhelmed by the number of video clips available).

Problem solving worked well – students found some of it a bit challenging, but they help to complement the lectures.

Videos: What we learnt

Expensive facilities/equipment are <u>*not*</u> required

Time and practice <u>*are*</u> important

Pre and post-production <u>*are*</u> important

Implications

Curriculum

- Refine course content and structure
- Ensure coherence of overall course design
- Make incremental changes

Pedagogy

- Short, educationally good quality videos are essential
- Variety of learning supports
- Changing lecturer role

Implications

Assessment

- Continuous assessment

Student learning

- Changing student role
- Learning technical and non-technical skills

Institutional support

- Interdisciplinary collaboration
- Time and incentive for lecturers

Thank you

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