FLIPPED TEACHING & FLEXIBLE LEARNING IN AN UNDERGRADUATE ENGINEERING COURSE

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“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)
STUDENTS GET STUCK!
How can lecturers help students to \textit{transition}... from being stuck... to mastering TCs.
TRADITIONAL CLASS

First year Introduction to electronics engineering

Conceptually challenging

~150 students

2 lecturers (analog & digital)
6 weeks each

1 x 2hr face-to-face tutorial

1 x 3hr lab/week

2-3 lab demonstrators
2012: De-clutter the curriculum

Thevenin's TheoDynamic Resistance & TCs to KEEP
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Form#E013
What is the Thévenin equivalent resistance of this circuit?

Select an Answer

- 2290 Ohms
- 2300 Ohms
- 2200 Ohms
- 2300 Ohms

Reason for your Answer

Please give a reason for your answer...

Submit
Since summer 2014...
Flipped class

Reversal of traditional teaching
exposure to new material outside of class,

class time is used for the harder work of assimilating that
knowledge through problem-solving, discussion or debates - Center
for teaching, Vanderbilt University

Part/all of instruction through videos/other media
class time becomes dynamic, interactive learning environment

educator guides students to apply concepts and engage creatively in
the subject matter - Flipped learning network
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.

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).
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)
$V = IR$
CYCLE 2

Monitored student video watching

Lecturer 1 - Lightboard based videos

Lecturer 2 - Panopto lecture videos

Continuous assessment

Revised problem solving questions
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

Are steps a problem?

Not for sound as
i) speakers will not operate fast enough to follow steps so sound coming out is a smoothed version of the steps
ii) your ears can’t hear above 20 kHz (can’t sense the steps)
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
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
Group problem solving
ACHIEVEMENT

PRE-FLIP  POST-FLIP

Average achievement score

Student cohort


Analog part

Digital part
**What helped learning**

- Textbook
- e-tutes
- Trial and error
- Watch live
- Partner discussion
- Ask expert
- In-class mini-lectures
- Questions on Moodle
- Extra tutes
- Problem solving with
- L2 videos
- L1 videos

**Percentage of students (%)**

- Not applicable
- Useful
- Undecided
- Not useful
STUDENTS' VIEWS

Videos

I did like having the [video] intro and the summary. The intro was good because when I watched the videos I just made a decision how much I already [knew]....

Mini-lecture format

I really like the lectures that are held in the labs so we can go through worksheets and we can get explanation of what to do on the whiteboard...

Working with a partner

...if we were a bit confused about something we would talk it over and then if I thought that I had a handle on it then I would explain my thoughts to him and he would think it over and go, “oh yeah that makes sense” or if there was a flaw in my thinking he’d point that out.
Lecturers’ reflections

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

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

Students need guidance on which of the analog videos to watch as they seem 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.
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