FLIPPED CLASSROOM LEARNING IN A FIRST-YEAR UNDERGRADUATE ENGINEERING COURSE

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Flipped Classroom

A move away from using class time for lecturing

Students engage with new class material for the first time outside of class

Part/all of instruction through videos/other medium

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

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

Class time becomes dynamic, interactive learning environment
Our study

Design-based research (DBR) approach, practitioner-led cycles of planning, design and implementation

Two-year funded research project investigating the impact of using a flipped class approach on student learning in a first-year engineering course that involved threshold concepts (TCs)
“In each academic discipline, there exist special concepts -\textit{threshold concepts}- that once grasped, reveal new and previously inaccessible ways of thinking about a subject”.

(Meyer & Land, 2003)
TCs ARE:

TRANSFORMATIVE: we *are* (become) what we know

IRREVERSIBLE: difficult to unlearn
(learners cannot return to previous view of the world)

INTEGRATIVE: cohere key aspects of the subject
(reveal hidden inter-relatedness & connections between apparently disparate information)

BOUNDDED: delineate a particular conceptual space
(serving a specific and limited purpose)

BUT...
TCs ARE:

TROUBLESOME! counter-intuitive, difficult to learn, and...

STUDENTS TEND TO GET STUCK!
How can lecturers help students to transition... FROM BEING STUCK... TO MASTERCING TCs
Our research context

De-clutter the curriculum

Thevenin's Theorem & Dynamic Resistance

TCs to keep
**OUR RESEARCH CONTEXT**

**IMMEDIATE FEEDBACK ASSESSMENT TECHNIQUE (IF AT®)**

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**IF AT**
Our research context

Online Tutorials

107. Thévenin 4b

What is the Thévenin equivalent resistance of this circuit?

Select an Answer

- 2290 Ohms
- 2300 Ohms
- 3200 Ohms
- 3300 Ohms

Reason for your Answer

Please give a reason for your answer...

Submit

Resource Links

Need some help? Try these links...

Section Links

Hyperphysics - Current Law

General Links

Hyperphysics  Electronic-Tutorials.ws  All About Circuits  Electronics Club  MIT Electronics Videos
Our research context

Traditional 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
Since summer 2014...  
5 cycles of flipping
CYCLE 1: PREPARATIONS...

Looked at (what makes) good education videos
Sorden (2005) - (e.g., coherence, redundancy, spatial & temporal contiguity)

Recorded lecturer purpose-developed videos and supplemented Youtube videos ~60 videos @ ~8-13 minutes each
(3 months learning, planning, recording, watching YouTube)
$V = IR$
CYCLE 2

Building on cycle 1, we added the following:

- Monitored student video watching
- Lecturer 1 - new Lightboard-based videos
- Lecturer 2 - Panopto-captured lecture videos
- Continuous assessment
- Revised problem solving questions
CYCLE 3

Lecturer 2 purpose-developed videos

Monitored student video analytics (stricter) & Moodle usage logs

Increased support for student learning - drop-in session, Q&A forum

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 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, drop-in sessions on demand
STUDENT ACHIEVEMENT

PRE-FLIP | POST-FLIP

Average achievement score

Student cohort


Analog part

Digital part
Helped to learn key concepts
Videos well targeted to students
Easy to review ideas
Videos provided a good overview
Learning at own pace
Learning in own time
Easy access

Percentage of students (%)
VALUE OF GROUP WORK?

- Better understanding of concepts covered in videos
- Finding what I do and don’t understand
- Explaining what I know/understand
- Practicing team work skills
- Learning how to apply the knowledge in real life
- Other

Percentage of students (%)

0 50 100
How helpful continuous assessment?

- 48% Very much
- 40% Somewhat
- 7% Not at all
FLIPPED vs TRADITIONAL

- **37%**: Strongly prefer traditional lectures
- **20%**: Prefer traditional lectures
- **16%**: No preference
- **12%**: Prefer flipped
- **15%**: Strongly prefer flipped

Legend:
- Green: Strongly prefer flipped
- Red: Prefer flipped
- Yellow: No preference
- Purple: Prefer traditional lectures
- Orange: Strongly prefer traditional lectures
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.
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