

Flipped classroom learning in a large introductory undergraduate engineering course



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Despite all these purported advantages arising from blended teaching methods, the relation between usage of the blended learning environment and student's performance is not clearly understood. (Birch & Williams, H.E.R., 2015)



- This is the concluding report
- 2 x 2⁺-year TLRI-funded programs
- **Surprising** & **unsurprising** observations

Why do this study?

What's new?



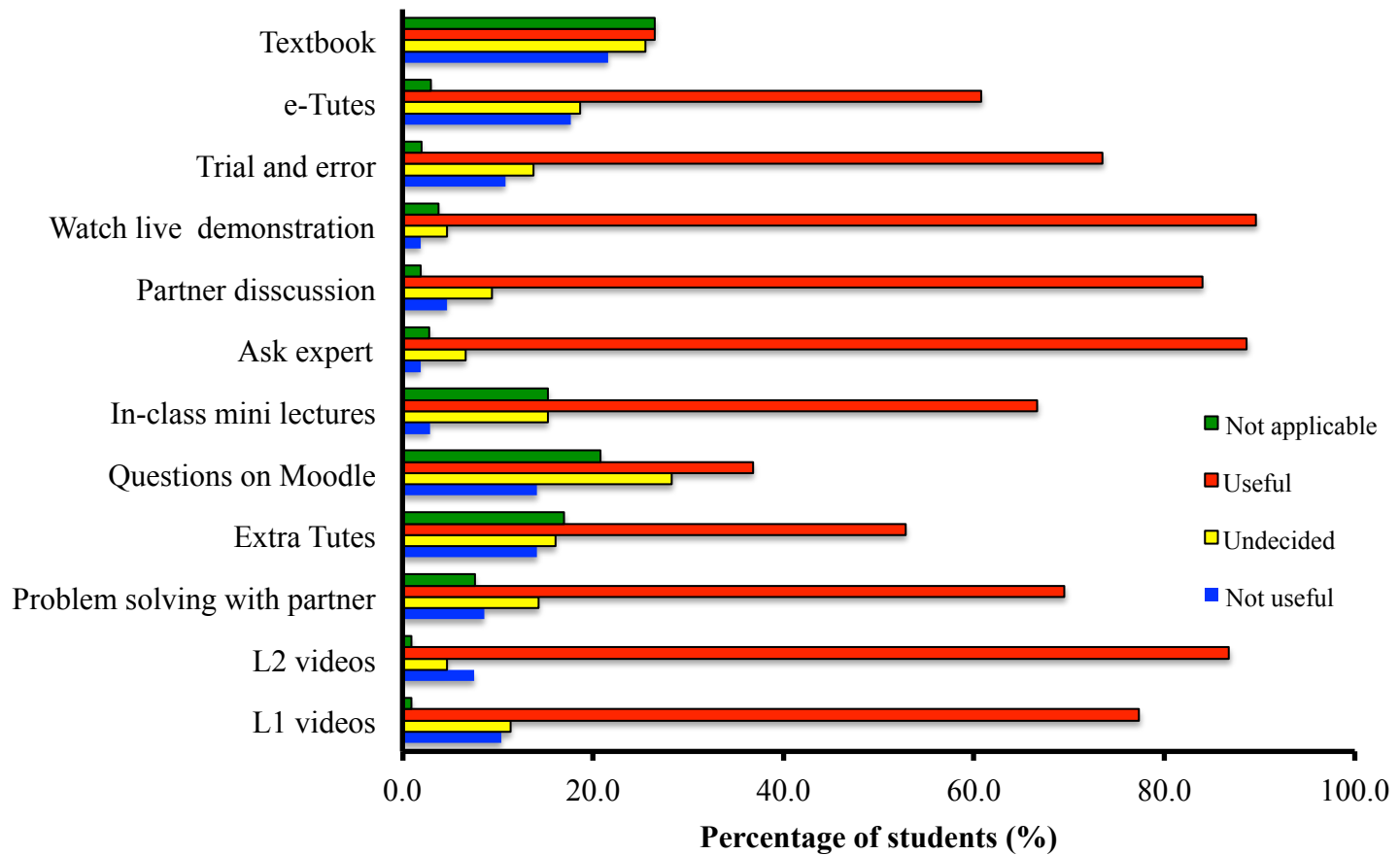
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- Intensely-benchmarked large [electronics] class
- Strong Threshold-Concept (TC) emphasis

*For **same contact-hours** (read “effort” or “cost”), does flipping give better learning in **large, multi-lab-stream**, class?*

(Turns out it is all about the labs)

Quantitative Outcomes



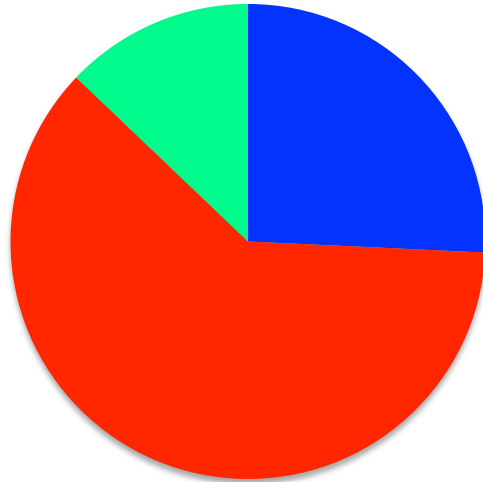


[our] videos helped me learn the key ideas in the course

Quantitative Outcomes (a telling one)

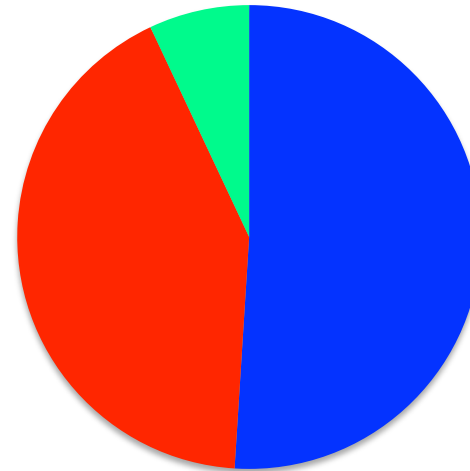


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Did flipping help?

■ Very much
■ Somewhat
■ Not at all



Did bi-weekly IFATs (tests) help?

■ Very much
■ Somewhat
■ Not at all

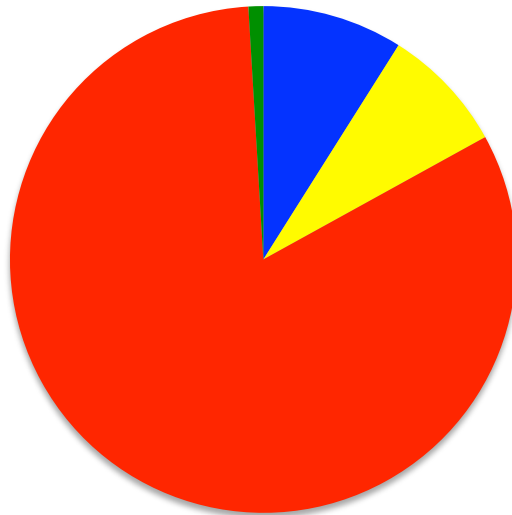
(Mini-)Lectures vs Videos



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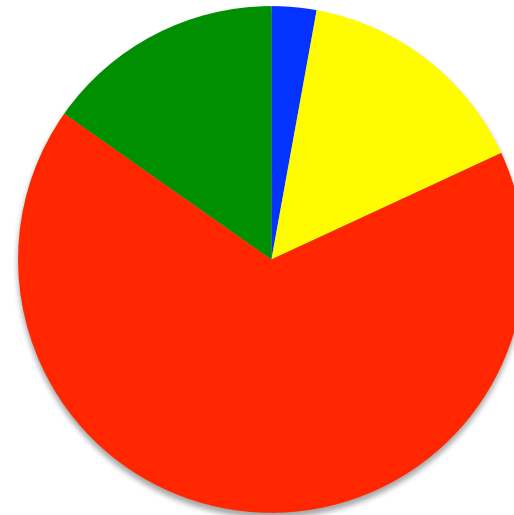


Lectures vs Videos



Lecturer videos

- Not useful
- Undecided
- Useful
- Not applicable



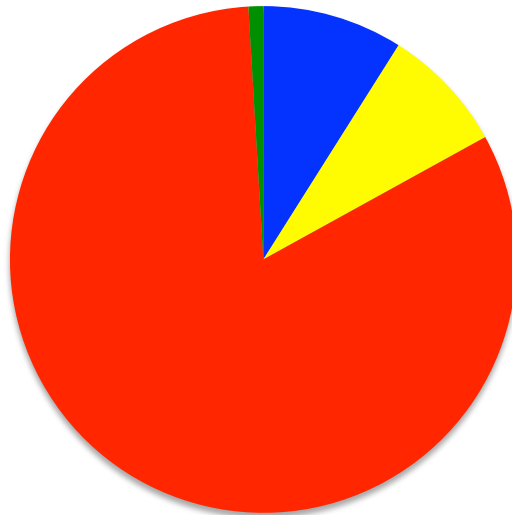
Live mini-lectures

- Not useful
- Undecided
- Useful
- Not applicable

Lectures vs Videos

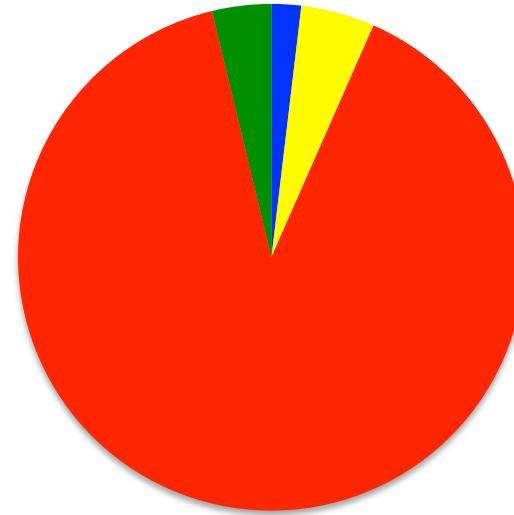


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Lecturer videos

- Not useful
- Undecided
- Useful
- Not applicable



Live demonstrations!

- Not useful
- Undecided
- Useful
- Not applicable



Quote 1:

This is a really good way of running a class...

I like watching videos, it's so much more helpful than just sitting in a lecture room...

For a video you can – you can take notes, and try pausing it if you have a question.

*It's sometimes easier to lose track [in a lecture], and also, you can make a list of questions
...and just go to your professor and ask him.*

Quote 2:

The ideal would be to have both [lectures and videos]

Surprising observations



- Public video content weak on TCs
- Worse-than-expected video “attendance”
→ grades same
- Video non-attendance
→ punished lab staff
- Solved the “phase problem”
- Not really good value (even ignoring the NRE)

Unsurprising observations



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- Low video “attendance” at lectures
- Students want BOTH lectures & videos
- Esprit de corps low
- ESL/working students especially prefer videos
- High-Q (best practice) videos appreciated

[Optional] End, Thank you...



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Wilf Malcolm Institute
of Educational Research

Te Pūtahi Rangahau Mātauranga o Wilf Malcolm

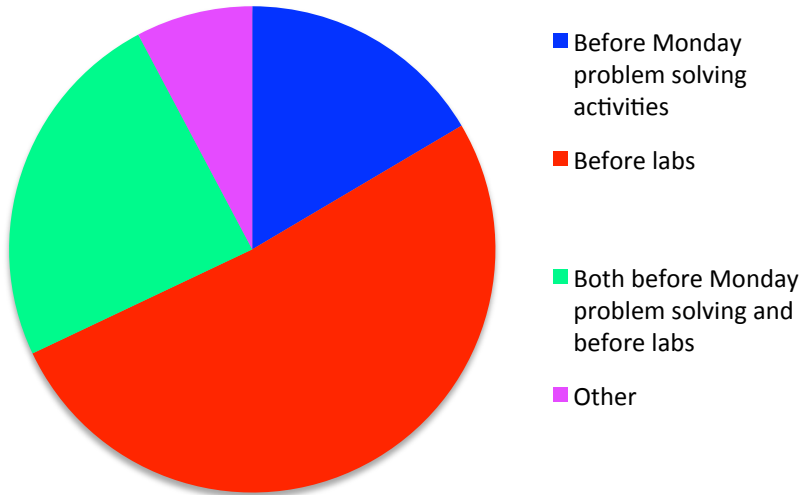
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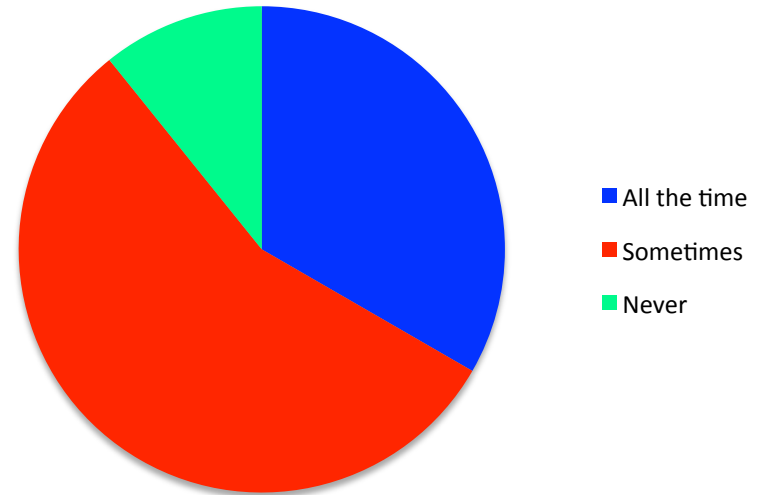
TEACHING & LEARNING
RESEARCH INITIATIVE

NĀU I WHATU TE KĀKAHU, HE TĀNIKO TAKU

Quantitative Outcomes

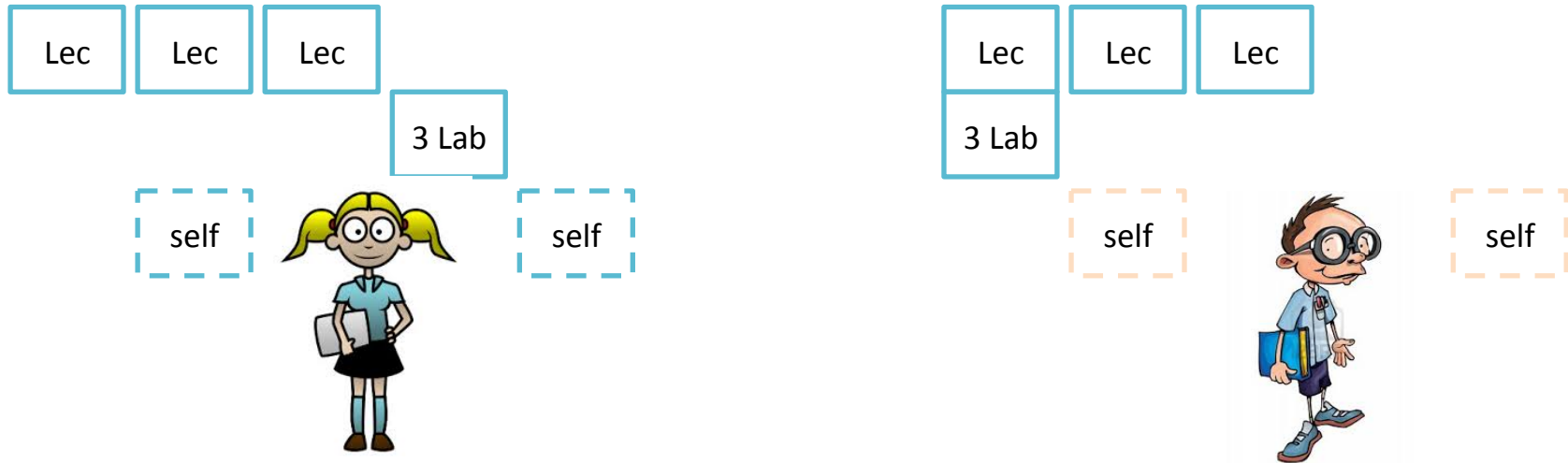


When did you watch?



Did you take notes?

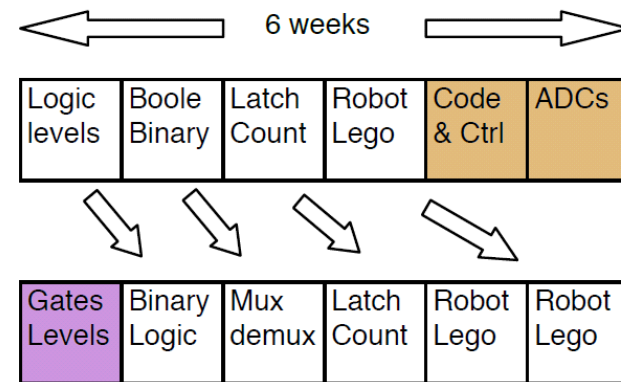
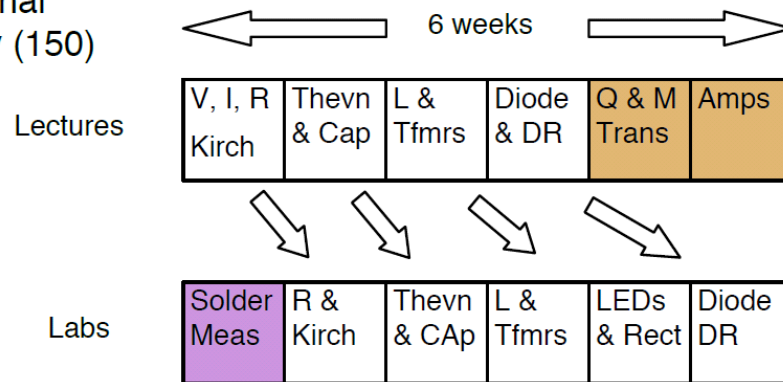
The Phase Problem



- Lectures: 135-155 people, run once
- Labs: 30 people, 5 repeats/week
- Lead time: 3—10 days per individual!

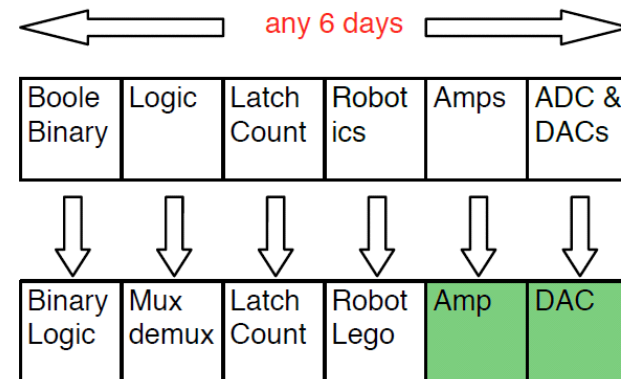
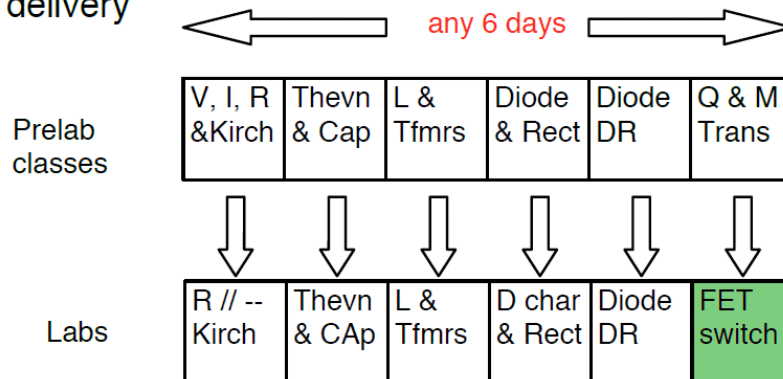
The Full Monte

Traditional
delivery (150)



Phase delay-problem & lab rate limit causes "stand-alone labs" (no prep lectures) and "hanging lectures" (no associated labs)

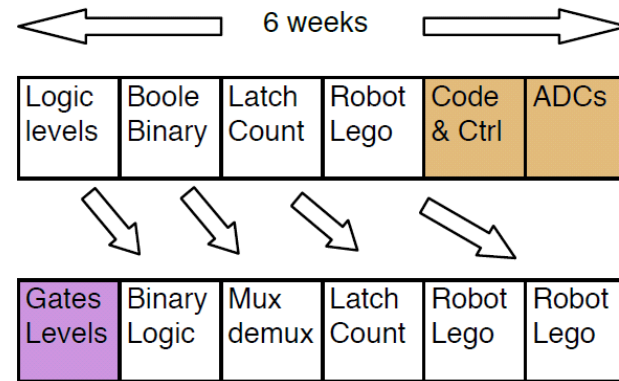
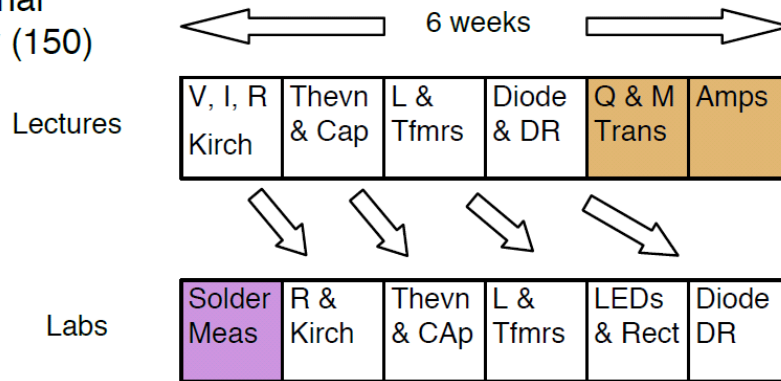
Flipped delivery
(n x 30)



Flip removes phase-delay problem; no "stand-alone labs", which in turn leaves fewer or no "hanging lectures" & permits addition of extra labs.

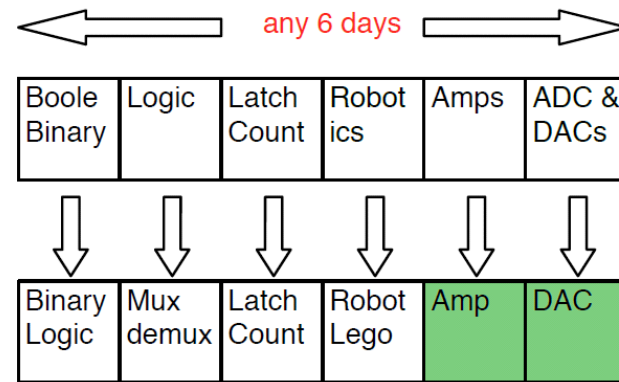
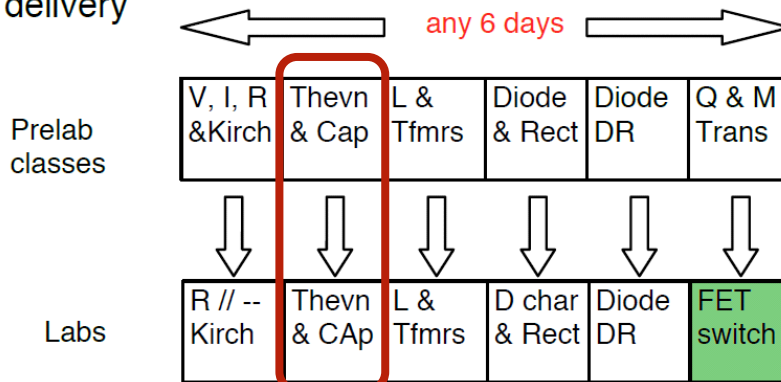
The Full Monte

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Phase delay-problem & lab rate limit causes "stand-alone labs" (no prep lectures) and "hanging lectures" (no associated labs)

Flipped delivery
(n x 30)



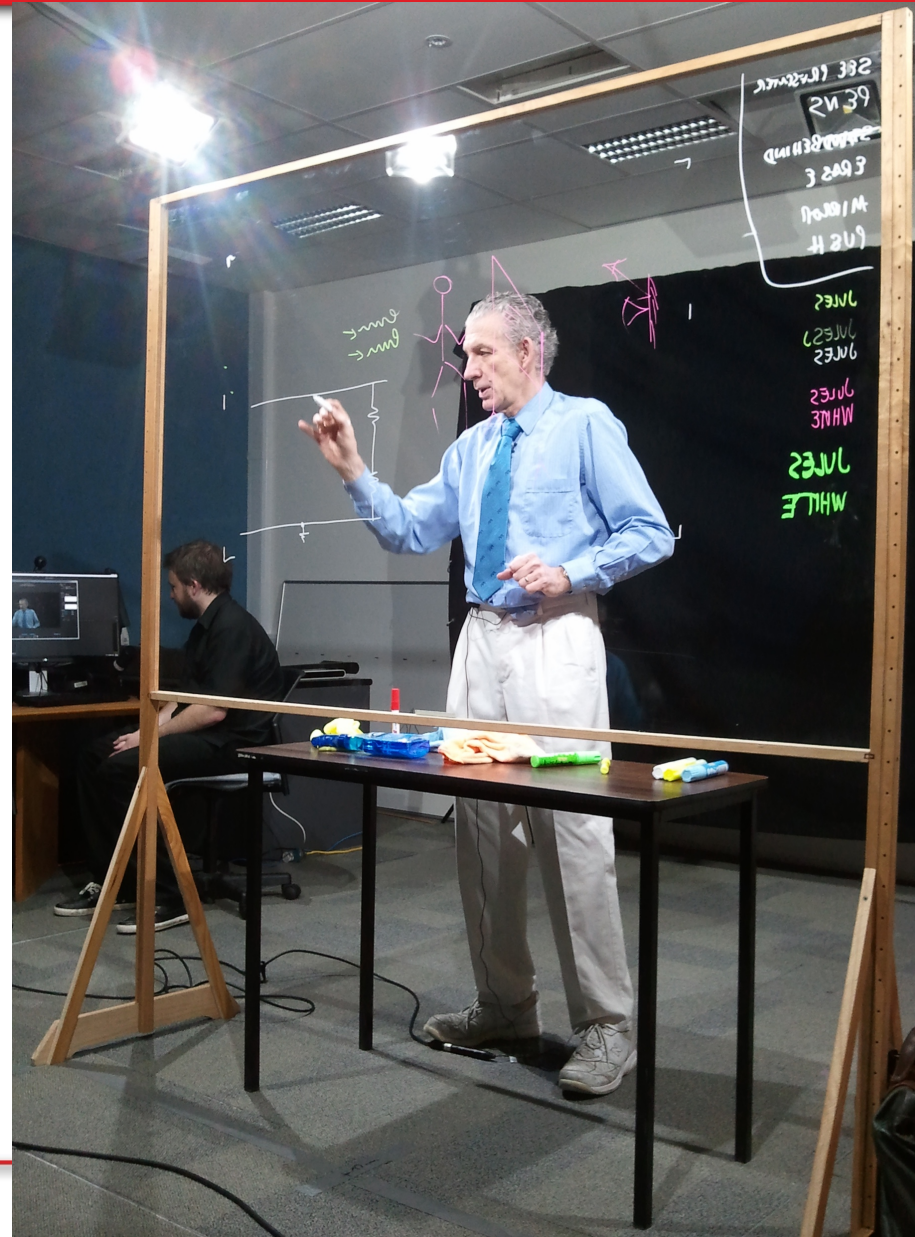
Flip removes phase-delay problem to "stand-alone labs", which in turn leaves fewer or no "hanging lectures" & permits addition of extra labs.

Happens 5 times

...that Outcome

- Sliced paper into 5 independent parts
- Could run 5 staff and rank them

Lightboard videos

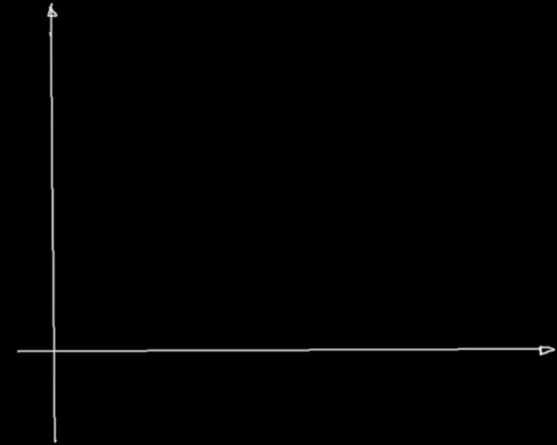


$$V=IR$$

4



+



Best Practices in “Lecture Videos”

Sorden (2008) effective methods for educational multimedia:

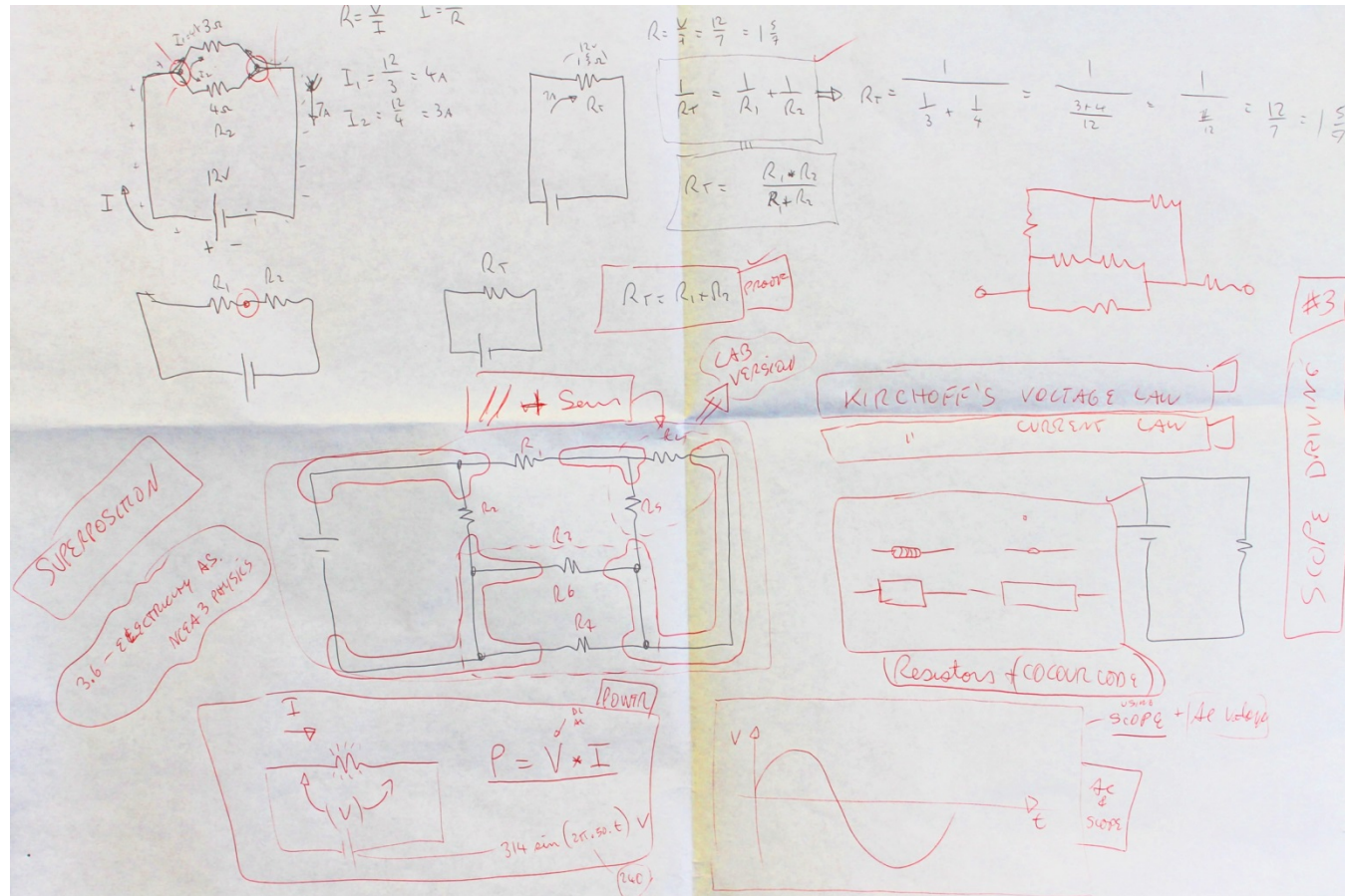
- Worked example effect
- Completion problem effect
- Modality effects
- Contiguity effect
- Personalisation principle
- Redundancy principle
- Pre-training principle
- Pacing principle

Guo, Kim & Rubin (2014) advise on creating “engaging” videos:

- Plan for and make short videos (under 6 min.)
- Use “talking heads”/human representations
- Production value might not matter
- Pre-production is important
- Declarative vs procedural videos

How we made the videos

1st step: Pre-production



Handwritten notes and diagrams illustrating the pre-production process for a video, covering various circuit concepts and calculations:

- Top Left:** A circuit diagram with a 12V source, a 3Ω resistor, and two parallel resistors (4Ω and 2Ω). Calculations show $I_1 = \frac{12}{3} = 4A$ and $I_2 = \frac{12}{4} = 3A$. Formulas include $R = \frac{V}{I}$ and $I = \frac{V}{R}$.
- Top Right:** A circuit diagram with a 12V source and a 2Ω resistor. Calculations show $R = \frac{V}{I} = \frac{12}{7} = 1\frac{5}{7}$. The formula for parallel resistors is given as $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$, leading to $R_T = \frac{1}{\frac{1}{3} + \frac{1}{4}} = \frac{1}{\frac{3+4}{12}} = \frac{12}{7} = 1\frac{5}{7}$. Another formula shown is $R_T = \frac{R_1 \cdot R_2}{R_1 + R_2}$.
- Middle Left:** A circuit diagram with a 12V source and two resistors in series, R_1 and R_2 .
- Middle Right:** A circuit diagram with a 12V source and a resistor R_T . A box contains the formula $R_T = R_1 + R_2$ with a checkmark and the word "proof".
- Bottom Left:** A circuit diagram with a 12V source and resistors $R_1, R_2, R_3, R_4, R_5, R_6$. A box labeled "SUPERPOSITION" and "3.6 - ELECTRICITY AS. NCQA 3 PHYSICS" is present.
- Bottom Middle:** A circuit diagram with a 12V source and resistors $R_1, R_2, R_3, R_4, R_5, R_6$. A box labeled "KIRCHHOFF'S VOLTAGE LAW" and "CURRENT LAW" is present. A note says "LAB VERSION".
- Bottom Right:** A circuit diagram with a 12V source and resistors $R_1, R_2, R_3, R_4, R_5, R_6$. A box labeled "Resistors (common code)" is present. A vertical box on the far right is labeled "#3" and "SCOPE DRIVING".
- Bottom Left (Power):** A circuit diagram with a 12V source and a resistor. A box labeled "Power" contains the formula $P = V \times I$ and the calculation $314 \sin(2\pi \cdot 50 \cdot t) V$ with a note "(240)".
- Bottom Right (AC):** A graph showing a sine wave. A box labeled "AC SINE" is present. A note says "SCOPE + the voltage".

How we made the videos

2nd step: Filming in controlled conditions



How we made the videos

3rd step: Reducing control over conditions



How we made the videos



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4th step: Post-production





$$V=IR$$

