Exploring Möbius: case studies from the University of Birmingham

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Contents

• Motivation – what are our needs?
• Online learning environment
• How we use Möbius
• Analysis
• Future work
Motivation

Discover through analysis
Link theory to practical
Utilise mathematical reasoning

Enhance engagement with course
Encourage independent learning
Efficient summative assessment
Effective formative assessment

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Student starting point

- A-level at least AAB or equivalent
- All have A-level standard mathematics
- Some have done no science since age 16
- Some have electronics experience
- GCSE Physics contains little electromagnetism and electric circuits
- Many are used to online learning

- Students like support for their learning
- Students like flexibility for when they do private study
- Students like clarity in instructions and deadlines
- Students like connections between parts of courses
- Students say they will spend up to 15 minutes on pre-session activities
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Online learning environment

- CANVAS
- Provides:
  - Reading lists
  - Programme
  - Gradebook
  - Videos of lectures
  - Answers
  - Discussions
  - Access to quizzes
- Plug in third-party software
Engagement with video content

![Image of a bar chart showing views by day with labels for lecture and exam.]
Engagement with video content

Revision lecture - 1 hour long

Average minutes viewed

Number of students

Average minutes viewed

Total minutes viewed

Number of students

Total minutes viewed

Revision lecture - 1 hour long

Number of students

Total minutes viewed

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Engagement with video content
Engagement with video content

Standard lecture - 2 hours long

<table>
<thead>
<tr>
<th>Number of students</th>
<th>Average minutes viewed</th>
<th>Total minutes viewed</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td>6.0</td>
<td>12.5</td>
</tr>
<tr>
<td>12.0</td>
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<td>18.0</td>
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<td>48.0</td>
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<tr>
<td>54.0</td>
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</tbody>
</table>
Engagement with video content

![View By Week Chart]

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Engagement with video content

Standard lecture - 2 hours long

- Average minutes viewed
- Total minutes viewed
What do we learn?

• Students review material close to key event
• Students use videos as part of revision
• The average minutes per view varies a lot

• We don’t know anything about the value of content
• We don’t know anything about student activity
• We have no data on the learning process
Incorporating Möbius

- Videos and reading material in Canvas
- Formative pre-lab assessments in Möbius linked to Canvas
- Summative post-lab assessments in Möbius accessed via Canvas
  One after each of the first two labs
  One at the end of term for all five labs

- Ultimately we want to:
  Enable students to be prepared
  Encourage students to interact with the content
  Evaluate the learning process
Incorporating Möbius

<table>
<thead>
<tr>
<th>Pre Lab 2 Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Waveform</td>
</tr>
<tr>
<td>Direct Current</td>
</tr>
<tr>
<td>Alternating</td>
</tr>
<tr>
<td>Voltage</td>
</tr>
<tr>
<td>Capacitor</td>
</tr>
<tr>
<td>Reactance</td>
</tr>
</tbody>
</table>

An alternating function or AC waveform is defined as one which varies in both magnitude and direction with respect to time, making it a "bi-directional" waveform, as opposed to the DC voltage source which is uni-directional. An AC waveform can represent either a power source or a signal source with the shape of an AC waveform generally following that of a mathematical sinusoid as defined by

\[ V(t) = V_{peak} \sin(2\pi f t) \]

where \( V_{peak} \) is the amplitude of the AC waveform, \( f \) is the frequency in Hz (cycles per second), and \( t \) is the time in seconds.

The sinusoidal waveforms or sine waves are one of the most important AC waveforms used in Electrical Engineering.

![AC Waveform Diagram]
Incorporating quizzes

Quick and easy implementation to test integration, student participation, minimal coding requirement
Engaging content

Quick and easy implementation to test integration, student participation, minimal coding requirement
## End of term post lab quiz

<table>
<thead>
<tr>
<th>Question</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Root mean square values</td>
</tr>
<tr>
<td>2</td>
<td>Use of oscilloscope</td>
</tr>
<tr>
<td>3</td>
<td>Analysis of a circuit diagram</td>
</tr>
<tr>
<td>4</td>
<td>Use of oscilloscope</td>
</tr>
<tr>
<td>5</td>
<td>Power in electric circuits</td>
</tr>
<tr>
<td>6</td>
<td>Calculations based on lab experiment 3 – Wheatstone Bridge</td>
</tr>
<tr>
<td>7</td>
<td>Critique of lab experiment 4 – power dissipated</td>
</tr>
<tr>
<td>8</td>
<td>Critique of lab experiment 4 – experimental design</td>
</tr>
<tr>
<td>9</td>
<td>Understanding of lab experiment 5 – circuit models</td>
</tr>
<tr>
<td>10</td>
<td>Understanding of lab experiment 5 – component characteristics</td>
</tr>
</tbody>
</table>
Analysis

• What is the time profile of student engagement leading up to the assessment deadline
• Did students revisit after the deadline?
• What is the fraction of class completing each assignment
• What proportion of students answered each question correctly?
• What proportion of students in the top quartile answered the question correctly?
• What proportion of students in the bottom quartile answered the question correctly?
• Does re-attempting quizzes lead to improvements in scores?

Audit/Benchmark/Evaluate
Engagement

- Quizzes used more than the lecture recordings
- Engagement with pre-lab materials was high (nearly 80%)
- Engagement with summative quizzes higher than formative quizzes
What fraction of the class engaged?

- Fraction of class completing assignment 3, end of term quiz
  84% completion
  Median of 9 attempts per student

- Fraction of class completing assignment 2, post lab summative
  96% completion
  13 attempts per student

- Fraction of class completing assignment 2, pre-lab formative quiz
  78% completion
  8 attempts per student
Benchmark against other assessments

Comparison of Quiz 3 and Final module marks

Post lab quiz 3 mark

Final module mark (%)
Benchmark against other assessments

Correlation between all coursework and final module mark

Coursework mark (%) vs. Final module mark (%)
Facility and discrimination of quiz questions

% of students in a quartile picking each answer

Marks range (25% blocks)

- Answer A (Correct)
- Answer B
- Answer C
- not answered
Evaluation – usability, students and staff

- Students used the formative and summative assessments
- Students were better prepared for labs than in previous years
- Integration with online environment worked for students

- Sustainability – we are reliant on coding expertise – need “scripts” to extract numerical data
- Integration – different systems in University for collecting data
Next steps

• Make better use of the power of Möbius resources
• Further reduce marking load on staff
• Replace many assessments with better assessments
• Make marking more equitable and more transparent

Thank you.
Any questions?
The circuit inside the box is shown in figure 2.

Figure 2: The circuit diagram

To calculate the Thevenin's equivalent voltage you see that \( V_{Th} \) the output voltage is \( (\text{Click for List}) \).

\[ V_{Th} = \text{Number} \quad \text{Units} \]

To calculate the Norton's equivalent current you see that \( I_{N} \) causes \( (\text{Click for List}) \) and \( (\text{Click for List}) \).

Then the current is \( (\text{Click for List}) \).

\[ I_{N} = \text{Number} \quad \text{Units} \]

Match the Thevenin equivalent voltage, \( V_{Th} \), the Norton equivalent current, \( I_{N} \), and the equivalent resistance, \( R_{eq} \), to their corresponding representation on the graph.
5. For the future

- How do we determine effectiveness in aiding learning?
  
  Define “effectiveness in aiding learning”
  
  Implementation

- Which tools are best suited to particular jobs?
  
  Formative and summative assessment
  Marking lab books
  Simple quizzes for shallow problems
  Exploration of deeper problems

Thank you – any questions?