Flipped teaching in mathematics

Sam Marsh
University of Sheffield

August 2015

Flipped classrooms

Flipped classrooms

Mathematician Robert Lee Moore thought lectures ‘mind-dulling’ over a century ago.

Flipped classrooms

Mathematician Robert Lee Moore thought lectures 'mind-dulling' over a century ago.

'Flipped classrooms' have been used for at least 30 years.

Flipped classrooms

Mathematician Robert Lee Moore thought lectures 'mind-dulling' over a century ago.

'Flipped classrooms' have been used for at least 30 years.

Recent experiments blending online and classroom-based teaching seem promising.

Our problem

We had stubborn attendance problems on our large first-year maths for engineers modules.

Our problem

We had stubborn attendance problems on our large first-year maths for engineers modules.

A standard week had

Our problem

We had stubborn attendance problems on our large first-year maths for engineers modules.

A standard week had

- two lectures (200 or more students);

Our problem

We had stubborn attendance problems on our large first-year maths for engineers modules.

A standard week had

- two lectures (200 or more students);
- one problem class (40 students, sometimes more).

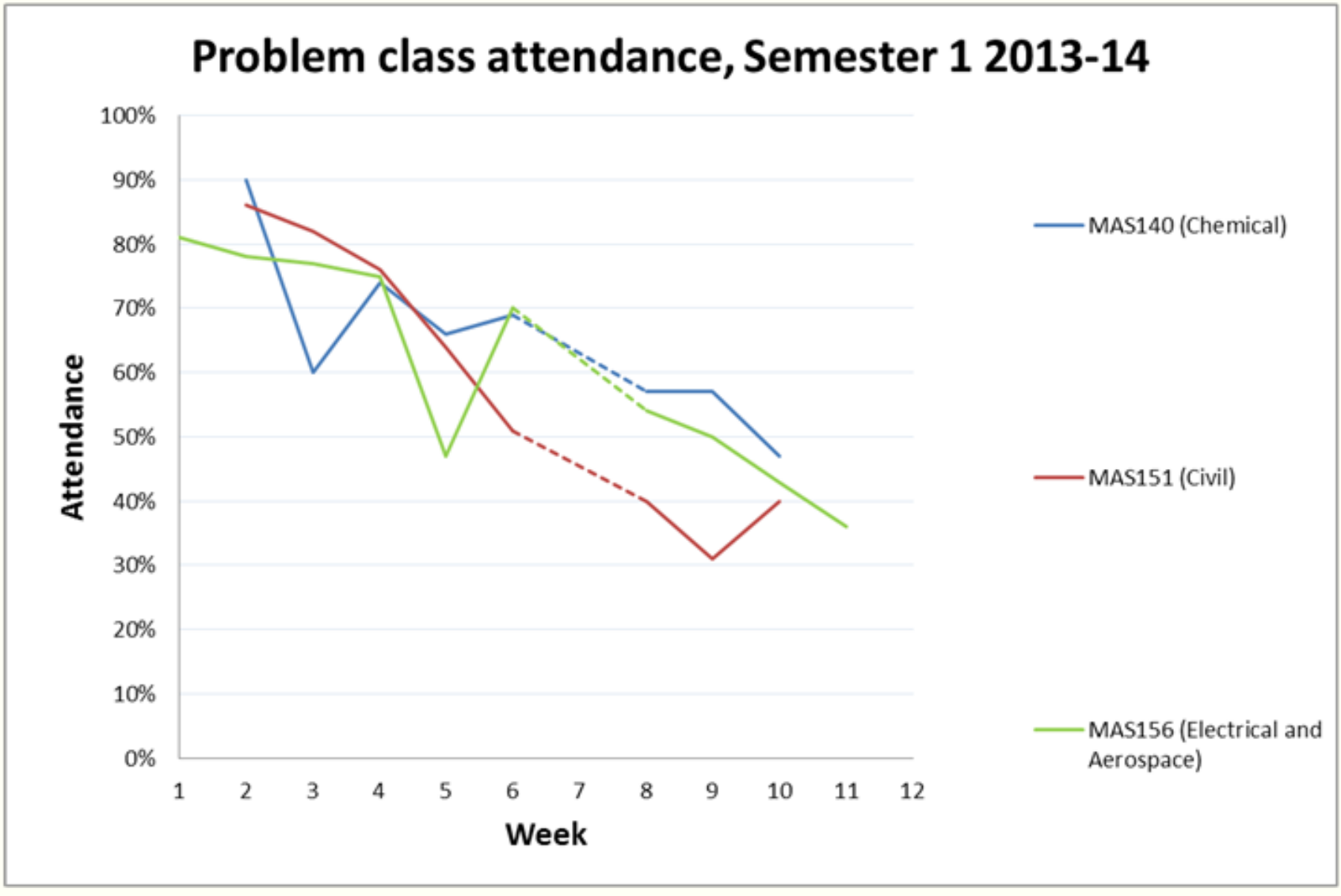
Our problem

We had stubborn attendance problems on our large first-year maths for engineers modules.

A standard week had

- two lectures (200 or more students);
- one problem class (40 students, sometimes more).

We'd often see attendance taper off; some students disengaged and failed badly.



- Week 7 was a reading week;
- MAS156 was affected by strike action in Week 5.

What to do?

What to do?

We decided to scrap lectures, and focus our efforts on problem classes.

What to do?

We decided to scrap lectures, and focus our efforts on problem classes.

Theory would be delivered with short videos, watched at home.

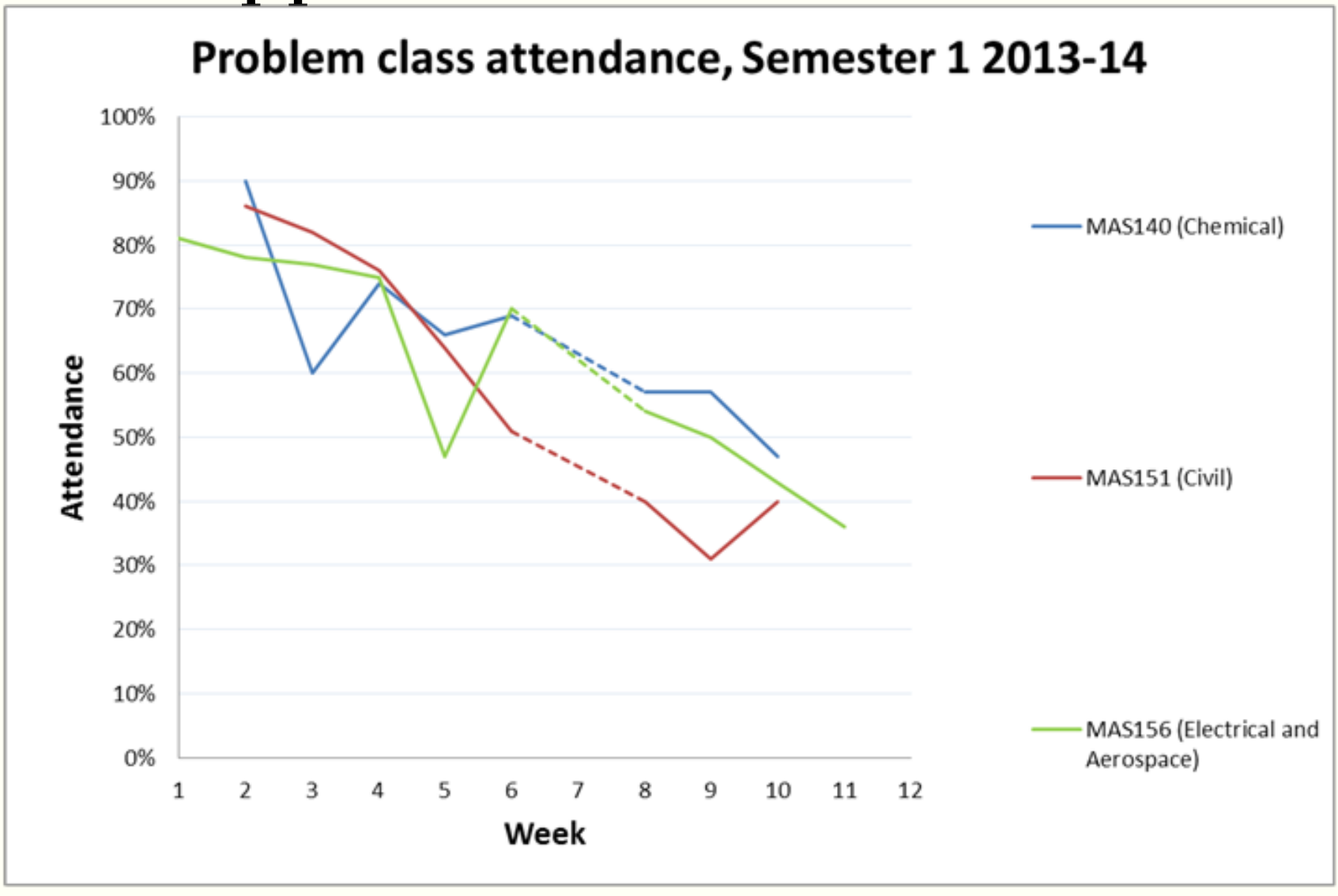
What to do?

We decided to scrap lectures, and focus our efforts on problem classes.

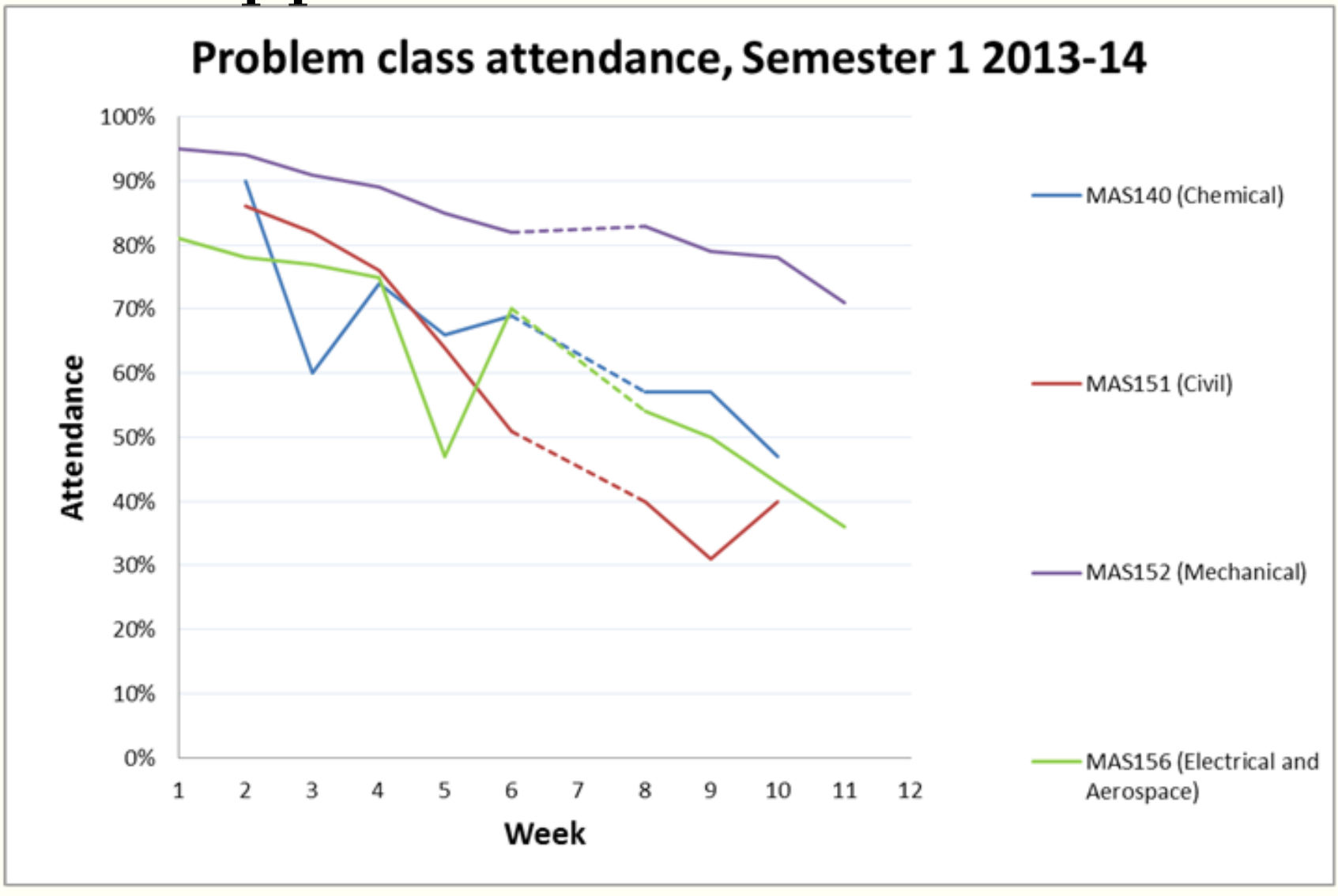
Theory would be delivered with short videos, watched at home.

We'd double the frequency of problem classes and change their character (more demonstration and peer discussion).

What happened?

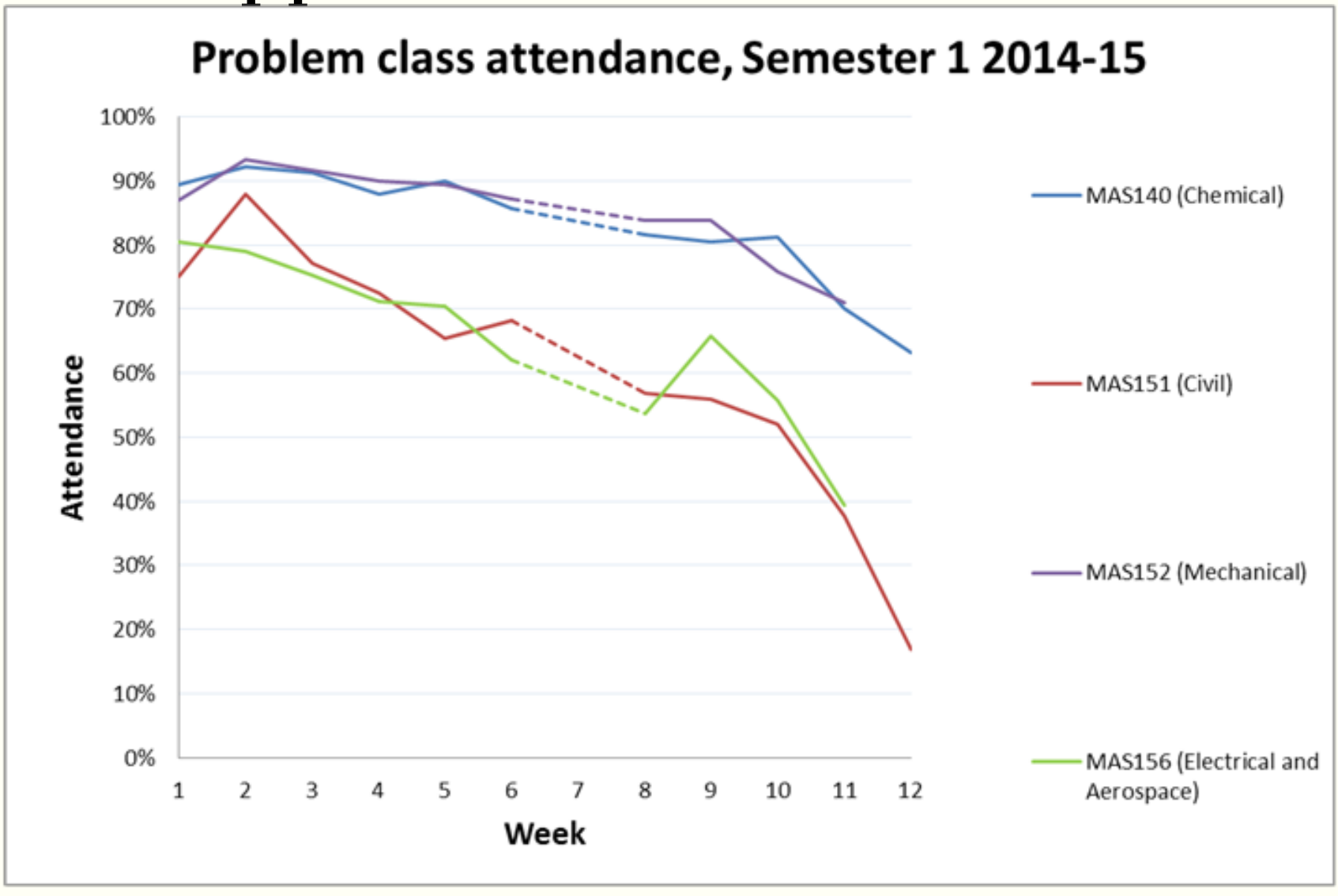


What happened?



- MAS152 is our new format module.

What happened?



- MAS140 and MAS151 now also new format.

Headline findings

Headline findings

- Three times as many problem classes attended.

Headline findings

- Three times as many problem classes attended.
- Between 4–12 marks added to the average grade of a student (based on analysis of 3 years' exam data).

Headline findings

- Three times as many problem classes attended.
- Between 4–12 marks added to the average grade of a student (based on analysis of 3 years' exam data).
- Number of 'bad fails' reduced by two-thirds.

Headline findings

- Three times as many problem classes attended.
- Between 4–12 marks added to the average grade of a student (based on analysis of 3 years' exam data).
- Number of 'bad fails' reduced by two-thirds.
- 92% satisfied or very satisfied in end-of-semester questionnaires (198 responses).

How the course works

How the course works

In a standard week students complete two iterations of the cycle:

How the course works

In a standard week students complete two iterations of the cycle:

log in to our video system

How the course works

In a standard week students complete two iterations of the cycle:

log in to our video system $\rightarrow$ watch 3 videos

How the course works

In a standard week students complete two iterations of the cycle:

log in to our video system $\rightarrow$ watch 3 videos $\rightarrow$ rewatch if necessary

How the course works

In a standard week students complete two iterations of the cycle:

log in to our video system $\rightarrow$ watch 3 videos $\rightarrow$ rewatch if necessary $\rightarrow$ complete an online test for each

How the course works

In a standard week students complete two iterations of the cycle:

log in to our video system $\rightarrow$ watch 3 videos $\rightarrow$ rewatch if necessary $\rightarrow$ complete an online test for each $\rightarrow$ attend a problem class.

How the course works

In a standard week students complete two iterations of the cycle:

log in to our video system $\rightarrow$ watch 3 videos $\rightarrow$ rewatch if necessary $\rightarrow$ complete an online test for each $\rightarrow$ attend a problem class.

Demo: `http://goo.gl/M8WwZp`

username:`engineering`, password:`letmein`

Problem classes

Each group of 40 students meets their tutor twice a week.

Problem classes

Each group of 40 students meets their tutor twice a week.

The tutor recaps the theory from the videos,

Problem classes

Each group of 40 students meets their tutor twice a week.

The tutor recaps the theory from the videos, encourages input on an example,

Problem classes

Each group of 40 students meets their tutor twice a week.

The tutor recaps the theory from the videos, encourages input on an example, then sets problems and stimulates discussion.

Problem classes

Each group of 40 students meets their tutor twice a week.

The tutor recaps the theory from the videos, encourages input on an example, then sets problems and stimulates discussion.

The tutor is given a lesson plan for each class.

EULER'S RELATION

5 minute review. Review Euler's relation, $e^{i\theta} = \cos\theta + i\sin\theta$, commenting briefly on how it follows from the Maclaurin series of exp, sin and cos. Also cover the exponential forms of sin and cos, namely

$$\sin\theta = \frac{e^{i\theta} - e^{-i\theta}}{2i} \quad \text{and} \quad \cos\theta = \frac{e^{i\theta} + e^{-i\theta}}{2}.$$

Class warm-up. Let $z = -1 - \sqrt{3}i$. Write z in polar form, $r(\cos\theta + i\sin\theta)$, and exponential form, $re^{i\theta}$. What is $\overline{z}$ in exponential form? What's the general rule here (i.e. what is $\overline{re^{i\theta}}$)?

Problems. Choose from the below.

1. **Multiplication and division formulae.**

   (a) Suppose z has modulus 5.5, argument 1.67 and w has modulus 0.5, argument 1.17. What is the real part of z/w? And the imaginary part?

Speculation

The new format seems to have solved most of our problems.

Speculation

The new format seems to have solved most of our problems. Why?

Speculation

The new format seems to have solved most of our problems. Why?

- Attendance: students only attend problem classes, so are more likely to do so.

Speculation

The new format seems to have solved most of our problems. Why?

- Attendance: students only attend problem classes, so are more likely to do so.
- Engagement: online tests act as a carrot for watching the videos.

Speculation

The new format seems to have solved most of our problems. Why?

- Attendance: students only attend problem classes, so are more likely to do so.
- Engagement: online tests act as a carrot for watching the videos.
- Flexibility: students choose when to watch videos, and can re-watch.

Speculation

The new format seems to have solved most of our problems. Why?

- Attendance: students only attend problem classes, so are more likely to do so.
- Engagement: online tests act as a carrot for watching the videos.
- Flexibility: students choose when to watch videos, and can re-watch.
- Depth of understanding: problem classes recap the material, reinforcing learning.

Speculation

The new format seems to have solved most of our problems. Why?

- Attendance: students only attend problem classes, so are more likely to do so.
- Engagement: online tests act as a carrot for watching the videos.
- Flexibility: students choose when to watch videos, and can re-watch.
- Depth of understanding: problem classes recap the material, reinforcing learning.
- Student experience: the students are effectively in a group of 40 rather than 240 and get to know their tutor well.

More information

- More detail in our application for the Guardian University Awards.
- A Guardian discussion piece 'Are lectures the best way to teach students?' written by me and Dr Nick Gurski.
- Full pedagogical paper to follow.
- The course webpage.