

Flipping the mathematics classroom

The *flipped classroom* is a teaching technique that has gained worldwide currency during recent years. In a flipped approach, the information-transmission element of students' learning is moved out of the classroom; instead, students view recorded lectures in their own study time ahead of the live session. This frees the class time for activities (such as discussion and problem-solving) in which students can apply their knowledge and potentially gives the teacher a better opportunity to detect their misconceptions. In this case study, Professor Simon Benjamin describes his successful application of the technique with students in the Department of Materials.

A digital alternative to the traditional lecture model

Having taught the undergraduate course *Vectors, Matrices and Determinants* for several years, Simon was looking for a way to free up lecture time for more interactive and interesting problem-solving discussions. Traditionally, he would explain how to work out a particular mathematical result and go through several examples on the board, and the students would copy down notes. However, he decided that this material could be better presented using short videos to be viewed before the lecture, along with some practice exercises. This way students could work through the techniques at their own speed. They would also arrive at lectures equipped with an improved understanding of the topic under discussion and (hopefully) some probing questions ready to pose to the tutor.

Videos + quizzes = flipped classroom

Simon began by filming 10 short videos and uploading them to YouTube. Each video is 5–10 minutes long, which he considered the smallest possible size to introduce a particular technique or idea. In each video Simon draws out a mathematical problem and provides an audio commentary to explain his thinking.

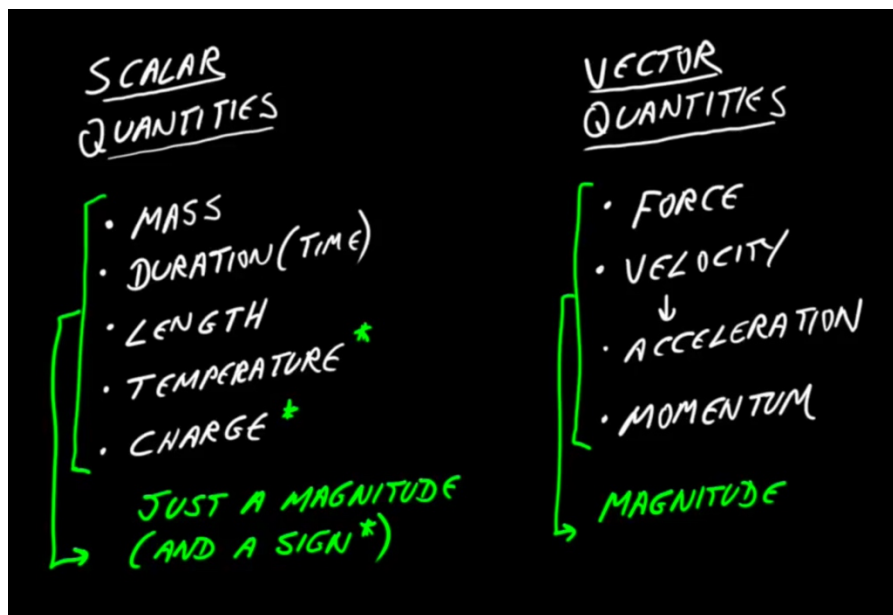


Figure 1 A screenshot from one of Simon's videos showing his teaching notes

Once filming was complete, Simon used Final Cut to edit, compose and export the videos. The next step was select problems from the course's work sheets. Working with graduate student Amir Fruchtman, Simon converted the problems into a series of online multiple-choice quizzes designed for students to test their understanding of the preceding video. If they make a mistake, they can try again and may receive a hint such as 'Close – did you forget the minus sign on the second term?' Students' performance is recorded by the quiz tool and can be reviewed by their tutors.

The materials and quiz questions were uploaded to the Moodle VLE with the help of staff from the Department for Continuing Education. Before the start of term the students were informed about the novel structure of the course, and tutors were shown how to access the system to see how their students were getting on, and to request feedback.

Greater than the sum of the parts...

Simon was pleased to find that, by moving the more rote-learning elements of the course out of the main lectures, he was indeed able to spend more time simply conversing with the students about how the techniques could be used to solve problems. Furthermore, he has found this kind of 'free-form lecturing' rewarding, as it allows for more variety: each lecture takes on a different shape from those in previous years since students' comments and questions differ. This presents an exciting new challenge in his teaching. Additionally, the videos tend to attract more views in the lead-up to exam time, indicating that students are using them to brush up on their techniques as part of their revision.

Initially, Simon was concerned that the total time students would need to commit to the course might increase; however, this proved not to be the case. Each video is typically less than ten minutes long, while the online quiz is the same material that in previous years would have been part of the problem sheets. Even though the problem sheets are shorter than before, the quality of the tuition has not been compromised.

Simon has now taught the course in this new format twice and students' feedback has been very positive – so much so that the department's director of studies, Dr Adrian Taylor, has asked him to describe his work to colleagues.

The videos are now hosted on an [open Moodle platform](#) under a Creative Commons CC BY licence available for anyone to use and learn from.

It all adds up: top tips

Simon offers the following advice for other academic staff who are considering flipping their classrooms:

- If you create and edit the videos yourself, ensure that you realistically account for editing time in your planning. Although the videos created in this work were only short, they took at least 10 times as long to edit and that is aside from any training time to become accustomed with the software.
- Consider recruiting students to help upload the online materials. Simon comments that 'Producing an interactive online quiz is time intensive; fortunately for me my department paid a graduate student to do the conversion process after I identified the problems that I wanted to be part of the quiz.'

Further information

- You can view the full set of Simon's mathematics videos in the [Vectors, Matrices, Determinants and Eigenvectors](#) playlist on YouTube, and view the videos together with their accompanying quizzes in his [open Moodle course](#).
- If you don't have access to video-recording software, you can use the University's Replay lecture capture software for the purpose. See the [Replay web pages](#).
- The [IT Learning Centre](#) in IT Services runs courses on planning, producing, filming and editing short videos.
- The [Educational Media Unit](#) in IT Services provides digital video production and editing services (chargeable).
- For more about the flipped classroom, see these articles:
 - Bogost, I. (2013). [The Condensed Classroom](#). *The Atlantic*.
 - O'Flaherty, J. & Philips, C. (2015). The use of flipped classrooms in higher education: A scoping review. *The Internet in Higher Education*, 25: 85–95 (available through [OxLIP+ e-journals](#)).



Winner, OxTALENT 2016 award for innovative teaching. The text in this case study has been adapted from Simon Benjamin's entry for the OxTALENT competition.

