

Using a tablet PC and screencasts when teaching mathematics to undergraduates

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Abstract

I use technology in my classes in a variety of ways. I use a tablet PC and a data projector to display pre-prepared slides which I annotate during classes. I also record screencasts of my classes (movies of everything that is displayed on the screen during my classes, with synchronized sound), and I make these available to the students online, along with the annotated slides and other supporting materials. I have made a selection of my screencasts available as open educational resources. Feedback on this use of technology is extremely positive.

Background

I have taught the second-year module **G12MAN Mathematical Analysis** at Nottingham for each of the last five years, to classes of up to 183 students. As students find this material hard, I have looked at various ways to assist them with their learning.

Since 2006-7, I have used a tablet PC and a data projector to display slides which I annotate during classes. In 2007-8, I also made audio recordings (podcasts) of all of my classes. For more details concerning my earlier use of a tablet PC and audio recordings (podcasts), see my previous case study [1].

From time to time, students would ask me whether I could also record screencasts of my classes. In September 2008, during a visit to Nottingham, Professor Chris Triggs (Auckland) showed me some screencasts of his own classes. The recording of screencasts in statistics classes at the University of Auckland was already routine. Much of the process is automated there, and full support is available from IT staff. This minimizes the burden on the teaching staff involved.

This year (2009-10) I have begun recording screencasts of my classes. Along with other resources, I make the annotated slides and recordings from classes available to the students from the module web pages as soon as possible after each class. Annotated slides and (audio) recordings from previous years also remain available to the students.

For further discussion of my teaching methodology, ideas and innovations, see my blog **Explaining Mathematics** at <http://explainingmaths.wordpress.com>. I use this blog to disseminate my ideas and methods, and to stimulate discussion. It is primarily aimed at other university mathematics teachers, but it is also of interest to undergraduates.

Implementation

For each class, I prepare a set of slides on my tablet PC which include an outline of the material to be covered, but with gaps to be filled in. I prepare this outline using LaTeX, and generate a PDF file, which I then import into Windows Journal in order to allow annotation during the class. I issue the students with single-sided copies of the slides (suitably scaled). This allows plenty of room for students to make their own notes during classes. As well as the gaps, I can insert additional pages at any time if I need more room to write when I am annotating the slides. See [1] for more details of the facilities I found most useful when using a tablet PC.

I use a high-quality wireless microphone kit together with the screen-capture capabilities of Camtasia Studio in order to record screencasts of my classes on my tablet. There are many other options available, but this is a very portable solution.

Along with all of the other materials on the module web pages, after each class I make the annotated slides from the class available in PDF format, and I make the screencasts available in MP4 format. The web page includes details of which material is discussed in each screencast. Within any given screencast, it is extremely easy to find the place required by scrolling through the video until, for example, the relevant hand-written annotation appears. This is a significant advantage over audio recordings, and should be particularly beneficial for dyslexic students: such students can have difficulty putting separate audio recordings together with the written notes. Students watching the screencasts can also pause or rewind the recording in order to allow more time to think about the trickier portions of the material. The synchronization of the audio and video in the recording is particularly useful where I am drawing and discussing diagrams: **the final diagram alone does not tell the whole story.**

Many of the resulting screencasts are suitable for publication as open educational resources. I am making a growing number of these available directly, and also as part of the University of Nottingham's Open Educational Repository.

Barriers

The major barriers to the implementation process were the following.

- **The cost of the hardware and software**

I am using a tablet PC running Windows Journal, a high quality wireless microphone kit, and the educational edition of Camtasia Studio. The total price comes to approximately £2000 excluding VAT.

- **The time required to learn how to use the hardware and software effectively**

Windows Journal has an excellent tutorial, and you can learn to use its basic facilities in less than an hour. Similarly, it is very easy to make screen-capture and audio recordings using Camtasia. However, finding the right hardware and software settings and developing fluency in the facilities available does take considerable time. I have described my screencasting experiences in full on my blog, and I have also given details there of the settings that have worked best for

me. I hope that this will remove some of the barriers for others. Here I mention the single most important obstacle that I had to overcome. Most of the apparent bugs that were detracting from the quality of the recordings were due to me running the tablet on battery power instead of mains power. This is because I make particularly high demands on the system when I use Windows Journal and Camtasia simultaneously in classes.

- **The time required after each class to process the materials and to make them available on the web**

I am currently responsible myself for the processing of my Camtasia-produced screencasts and other materials. However, now that I have determined all of the settings that I need, the processing itself is fairly routine. Nevertheless, the rendering of video is a long process even on a fast PC, and some patience is required before the materials are available. My computer takes approximately as long to do this as the length of the class itself. However, this processing can be done in the background while I carry on with other tasks. I estimate that the amount of my own time that I need to dedicate to processing all of the materials and making them available on the web now comes to between twenty and thirty minutes per class.

Enablers

- The School of Mathematical Sciences has been very supportive in purchasing the software and hardware that I have requested in order to develop the teaching methodologies that I have been using.
- Information Services at the University of Nottingham (Teaching Support, IT support and the Learning Team) have been very helpful by making constructive suggestions when problems arose, by providing the significant streaming media resources needed to stream a large number of videos, and by publishing a growing number of my screencasts as part of the University's Open Educational Repository. You can find links to some of my teaching resources in the reference section below.
- I found solutions to several of the technical problems I faced by searching the World Wide Web. In adding details of my own set of solutions to my blog, I hope that I have contributed to this enabler.

Evidence of success and quality assurance

In Nottingham, the popularity and success of my use of technology in teaching mathematics has inspired several other members of staff in the School of Mathematical Sciences to use tablet PC's in their own teaching. Some members of staff are now interested in recording screencasts.

Feedback from the students is extremely positive. The table below shows the average results for relevant questions from the anonymous Student Evaluation of Teaching forms for G12MAN. You can also find detailed feedback from the 2009-10 G12MAN students on the web at <http://explainingmaths.wordpress.com/feedback/>

In this table, the responses are on a scale of 1 (strongly agree) to 5 (strongly disagree).

Question	2006-7 average (78 forms returned)	2007-8 average (58 forms returned)	2008-9 average (50 forms returned)	2009-10 average (71 forms returned)
The supporting materials (exhibits/handouts/slides/overheads/computer presentation) were effective aids to my learning	1.8	1.5	1.3	1.3
The module was well-presented	1.9	1.4	1.4	1.3

Several staff and students also nominated me (successfully) this year for a University of Nottingham Lord Dearing Teaching Award for my use of IT in teaching.

Many of the positive features identified in student feedback are as in [1]. However, the screencasts appear to be even more popular than the audio recordings were.

- Students find it very helpful to have access to the annotated slides and the recordings shortly after each class. In particular, if they suspect that there may be a mistake in their written notes, they can immediately check the annotated slides online in order to avoid wasting time.
- Students who miss classes, for example through illness, strongly appreciate the opportunity to have access to the annotated slides and the recordings at times convenient to themselves. They find this far superior to having only a copy of the notes.
- Students appreciate having the opportunity to revisit portions of the classes where they feel that they may have missed some useful spoken explanation. This is especially helpful for students who are not native English speakers.
- Students find large and clear writing helpful. This makes using the tablet particularly effective in rooms with large data projection screens. For some interviews relating to the benefits for dyslexic students, see the web page <http://www.nottingham.ac.uk/dyslexia/video/browse/person/361/>

Recommendations

If you are prepared to invest the effort required, these methods of teaching are highly rewarding. Your students will strongly appreciate the provision, and you will be able to produce high-quality learning materials which can be made available to a wider audience.

The following recommendations and issues are worth considering.

- A data projector can only display one screen at a time. If necessary you can scroll back through the preceding material, or display the slides at a smaller scale. To some extent you can use dual projection facilities where these are available (though the recorded screencast will only show one screen). Even so, the amount of material visible at one time is far less than there would be on a good set of blackboards/whiteboards.
- The microphone generally only picks up the voice of the teacher, and not the students' responses and questions. It is best to repeat what the students say both for the sake of the recording, and also for other students.
- While many students appreciate and take advantage of the materials available in order to improve their understanding, other students may stop attending classes, and may fall behind. (Even some students who **are** attending my third-year classes have said that they are a long way behind, but they are planning to catch up later.) As a result, some students may end up doing worse than they would have done if less material had been made available. One way to address this problem may be to have appropriate class tests or assessed coursework to discourage students from falling too far behind.

On the technical side:

- If sufficient technical support is available, it is best if you can concentrate on giving the class, and leave the settings and the processing of files to staff with the relevant training.
- Otherwise, be prepared to invest a significant amount of time determining the software and hardware settings which work best for you, and processing the resulting files. You may find it helpful to read my blog entries in order to facilitate this process.
- **Make sure that you run your tablet on mains power and not on battery power during classes!**

References

Publications

- [1] J.F. Feinstein, *Using a tablet PC and audio podcasts in the teaching of undergraduate mathematics modules*, case study, in *Giving a Lecture*, Exley and Dennick (April 2009)

This case study is also available in adapted form from the web page

<http://www.maths.nottingham.ac.uk/personal/jff/Papers/>

Web links

- A selection of my screencasts can be found on the page <http://explainingmaths.wordpress.com/screencasts/> or from the University of Nottingham's YouTube channel mathematics playlist at http://www.youtube.com/view_play_list?p=A9721D7E1FB7CD34
- Several of my presentations are available from the Nottingham U-Now pages at <http://unow.nottingham.ac.uk/>
- My blog, **Explaining Mathematics**, is on the web at <http://explainingmaths.wordpress.com/>