The Use of Screen-Capture Video as a Learning Resource

Graham Currell
Faculty of Applied Sciences
University of the West of England, Bristol
Frenchay Campus
Coldharbour Lane
BS16 1QY

Graham.Currell@uwe.ac.uk

Abstract
This paper discusses the use of informal screen-capture video clips as learning resources in mathematics and statistics for first year undergraduate science students who possess a minimum grade C in GCSE mathematics. The videos are quick and easy to produce and provide a valuable extension of the personal tutor-student interaction. Hand-written text, as well as data analysis in suitable software, can be recorded to provide a permanent record of the solutions to many different types of problems.

The underlying approach of learning provision for skill-based modules in the first year is to meet a diversity of intake with a diversity of learning provision, and this paper highlights the variety of roles that this particular form of video material can play.

Introduction
First year science students often struggle with mathematics. This article reports developments within two modules that provide the main mathematics and statistics input for first year science students at the University of the West of England. In 2006/2007 the 20 credit module, Scientific Inquiry had 185 students, and the 10 credit module, Scientific Data Analysis had 142 students.

The essential problem, within a resource-limited environment, is to provide appropriate learning resources for the weak 'tail' of the student distribution, whilst at the same time giving the capable students a coherent and satisfying experience.

There is a very diverse intake to these modules, from mature students who last struggled with mathematics many years previously, to school leavers with reasonable A-Level passes in mathematics. The median student typically completed formal mathematics at GCSE level some two or three years earlier.

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With feedback from previous years, it became clear that the two main problem areas were:
- A common lecture, being used to present an overview of new material, was failing to reach the weak students and was still boring for the capable students.
- Students were reluctant to access the worked answers (in pdf files) that were available on the website for the course textbook[1].

From the students' points of view, the input of new material was not well designed, and the feedback for worked problems was not user-friendly.

The author had recently started investigating the use of the screen-capture software Camtasia[2], with the intention of developing educational videos. However, a decision had to be made: whether to produce
- substantial videos to present new material in support of the lectures, or
- many short informal video clips to present user-friendly answers to student questions?

It was felt that the video clip answers would provide the solution to a problem that could not be solved easily in any other way. The weak students could re-run videos of difficult problems as often as they wished in order to understand the answers. The capable students may only need to check that they have the correct result, or possible skim through the video to check the method.

The remaining problem of presenting the new material was addressed by abandoning the common lecture for tailored lecture/tutorial sessions for smaller groups, selected on the basis of an initial diagnostic test.

On balance, the new developments have been time-neutral for staff, in that extra time is spent delivering the new

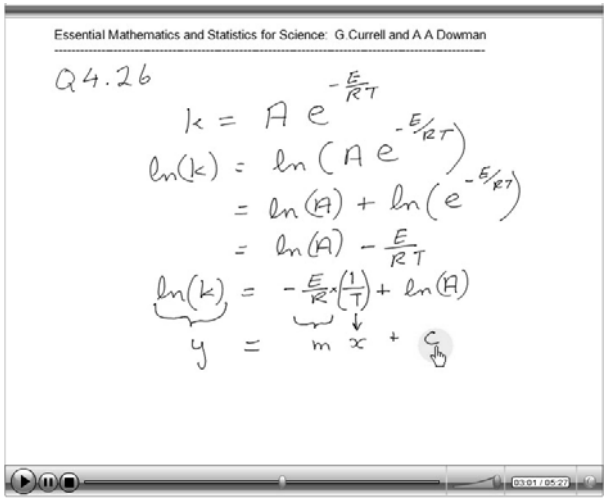

Figure 1: Video frame: Answer to a linearisation question

material in a more 'tutorial' environment, but less time is spent in providing repeated answers to a succession of individual enquiries. Overall, this also gives a more satisfactory interaction with the students.

The videos were designed to replicate the situation whereby a student might ask the lecturer for the answer to a problem. The lecturer would give a verbal explanation, together with a hand-written answer, and the student would typically ask to keep the 'hard-copy' version. These videos record a hand-written answer using a tablet PC, together with an audio commentary. With the video, both the audio and the 'hard-copy' versions are permanently available for the student to review the answer.

The videos last for only a few minutes and can be accessed directly as flash videos via a hyperlink on a web page. A cursor bar in the video 'screen' enables the students to drag the recording to any point on the video for repeated viewing.

Some examples of the prototype videos can be viewed at: http://science.uwe.ac.uk/mathsstats/videolink/video.htm

Video Production

The software, Camtasia, can be used to record any activity displayed on the computer screen, and, together with the recorded audio track, is able to produce video files in a number of standard video formats. It can be used, for example, to make specific recordings from PowerPoint[3] or to produce step-by-step recordings to demonstrate the use of any software such as Excel[3].

The editing functions in Camtasia allow recording of an additional audio track, the inclusion of some useful effects (callouts, zoom and pan), as well as (for flash format) interactive quizzes and hyperlinks to other resources.

In the production of the 'feedback' videos, the 'hand-written' text was produced by using a tablet PC to record the writing with a screen pen on an open Word[3] document. It was also possible to add any printed material, text, graphs, etc, by importing it into the Word document from other software.

An important issue was whether to prepare a written script, or just to speak 'off the cuff' when working through the problem. A fully drafted script can sound quite flat unless recorded by someone with excellent presentational skills, and, additionally, can often appear to lose its close link with the working on the screen. On the other hand, a 'speak as you write' approach comes across as a more personal and realistic delivery, but can be very frustrating to record as frequent hesitations, ambiguities, and errors creep into the recording, and need to be edited out or re-recorded.

Experience now suggests that the balanced answer to scripting involves:

- good preparation in anticipating each step that will be followed in demonstrating a solution,
- detailed scripting of particular phrases that are key to the mathematical reasoning and cannot be allowed to become ambiguous, and then
- a relaxed and impromptu commentary for the rest of the answer.

Finally it is necessary to choose an appropriate video format from the main options: Windows Media, QuickTime, AVI, Adobe Flash. The types of videos recorded in this project have only a limited amount of changing information between each 'frame', compared with full screen motion video.

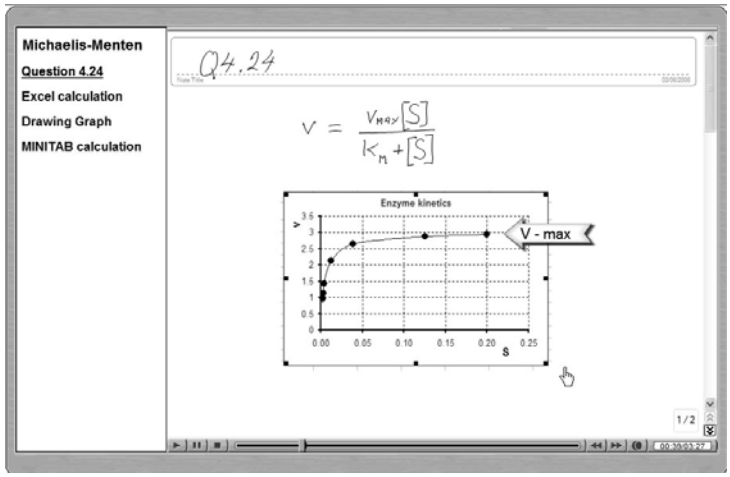

Figure 2: Video frame: Camtasia 'theatre' incorporating several linked video clips

Consequently they can be conveniently delivered as 'swf' flash videos viewed directly from the internet using relatively small file sizes – typically less than 1Mb for a 2 minute video. However, with the flash format it is not convenient to provide a download facility for later viewing, but this has not proved to be a major disadvantage as far as most students are concerned.

During 2006/2007 video clip answers were produced for:
- 185 questions in the course textbook,
- 80 questions in 8 self-assessment tests,
- 40 questions in an initial diagnostic test,
- 48 questions in two specimen examination papers.

In addition, videos were developed to illustrate the use of various software techniques based on Excel and MINITAB[4].

Student Feedback
The students were very enthusiastic about the videos, and the overall pass rate for the modules increased significantly. The videos had a particular value for the weaker students, who recognised the importance of being able to pause and rewind them to concentrate on understanding key steps in the answer.

In feedback from 26 students, their mean ratings for the values of various learning resources were recorded on a scale of 1 to 4:

Video answers to questions from the textbook.	3.58
Video answers to self assessment test questions	3.16
Video answers to specimen examination questions	3.55
Course text book	3.04
Lectures/tutorials	2.80
Computer workshops	2.24

Values (rated 1 – 4) of various learning resources

The high value placed on the videos was gratifying, although it should be noted that these were responses to a questionnaire posted via email and the internet and may represent a more 'IT sympathetic' sample of students.

The relatively lower response for the value of the lecture/ tutorial resource shows that it is still necessary to improve the initial delivery of material. In addition, there are already plans in place to improve the computer workshops, whose purpose is to develop data analysis and data presentation skills.

When asked to suggest possible improvements to the videos, there were very few suggestions other than to increase the range of skills covered by video instruction, particularly in the context of teaching skills in using Excel and MINITAB. This is consistent with the known difficulties that some (often mature) students have in the computer workshops with these skills.

Beyond concluding that these videos have been very useful, it has been difficult, within an evaluation questionnaire, to establish which characteristics of the video are actually relevant to the effective learning of the student. For example, some staff commented that the videos were too slow, but, when specifically asked, no student agreed with this view, and indeed there was a suggestion that some videos should take more time over detailed calculations. Similarly, many professionals compare the videos to the expensive, polished, productions available on DVD, but in fact it may be the very informality of simple presentations that provide a comfortable environment for the student to learn.

Future Developments
The main directions for future development involving the video technology include:
- improving the integration between the course textbook and the video answers,
- developing more interactive self-assessment testing using direct links to videos within the tests themselves,
- using video technology to share skills amongst staff as well as students,
- researching the characteristics that make an educationally 'good' video, and
- developing both the technology and the pedagogy into other disciplines.

The interaction between book and video is being addressed by writing a second edition with an upgraded website to provide integrated feedback available for all the questions in the book.

Hot Potatoes[5] software is also being used to develop learning packages accessible via the internet. These packages will be based around self-assessment questions which themselves interact with video overviews and feedback. The compatibility of these packages with major VLE (virtual learning environment) systems is being investigated.

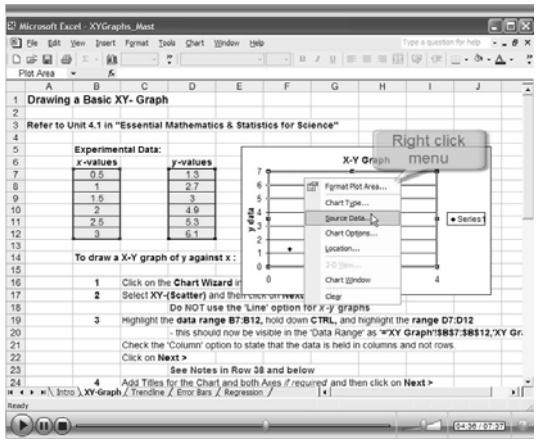

Figure 3: Video frame: Step-by-step instructions for editing an x-y graph in Excel

It is intended to develop a website to host short video clips that demonstrate specific software skills that are relevant to both students and UWE staff. Examples could include the use of various software packages for aspects of scientific data analysis and presentation, the preparation of flash videos, and the development of web-based learning and self-assessment packages.

In 2007/2008, it is anticipated that four final year project students will begin to investigate which content and production characteristics have the greatest influence over the effectiveness of different types of learning support videos.

Finally the University of the West of England is also contributing to the CFOF (Chemistry for Our Future) project (funded by the Royal Society of Chemistry) by developing interactive videos which will support students starting chemistry courses in their first year undergraduate studies.

References

1. Graham Currell and Tony Dowman (2005) *Essential Mathematics and Statistics for Science*, John Wiley & Sons.
2. Camtasia Studio 4 software, © TechSmith Corporation.
3. Component of Microsoft Office software, © Microsoft Corporation.
4. MINITAB® software, Minitab Inc.
5. Hot Potatoes software, © Half-Baked Software Inc.

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