

Creating Screen Capture Videos to Enhance the Study of Mathematics

Jonathan Lewin

Kennesaw State University, Kennesaw GA, USA
lewins@mindspring.com, www.math-movies.com

Abstract

This presentation is a sequel to other presentations I have made discussing the role of video content as a companion to lecture notes and textbooks in the learning of mathematics. My previous presentations showed how video content can help students who follow their course material as it is presented in the classroom but then find it much more difficult to read from their lecture notes.

In this presentation, I shall demonstrate techniques for producing study material in video form. Two separate kinds of video making will be discussed: recordings of lectures given in the classroom, and more polished videos made outside the classroom.

For recordings made in the classroom, the main priority is speed. It is necessary to be able to export the video, master a CD, upload the image to a computer that drives a CD duplicator, and to have the disks ready within a few minutes for students who are waiting for them.

For more polished videos made outside the classroom, the principal priority is quality of the product. For such videos, I shall demonstrate the use of sophisticated editing features, importation of special effects such as callouts, hotspots, embedding a video into an HTML file to endow it with a dynamic table of contents, and use of a DRM service to protect the work from piracy. I shall also discuss how to choose the right kind of hardware to ensure that video and audio quality will meet professional standards.

Finally, I shall demonstrate some of the videos that I have made.

The Role of Videos as a Learning Resource in Mathematics

To me, one of the most exciting features of the technological tools that have become available to the teaching community in recent years is our ability to supply mathematical learning materials in the form of videos. These videos address the problem experienced by many students that, although they may have appeared to understand material as it was presented in the classroom, it may appear to be much more formidable or cumbersome later when the student is alone. No matter how clearly it has been written, material in a text or in lecture notes is not always an ideal learning resource for an undergraduate student. When a student is unable or reluctant to take on the active role of reading, a video version of the material provides the opportunity of entering a virtual classroom. A video does not merely present the material. It actually teaches the material.

I would suggest that the ideal way in which mathematical content should be supplied to students is a careful combination of on-screen documents and videos. A student should go to the documents first and should enter the video version of any particular document only when and where it is needed. I am certainly not advocating that a student should attempt to study by watching hours of continuous video. Apart from the fact that the act of watching too much video at any one time is guaranteed to induce sleep, the process of watching video also puts the student into too much of a passive mode. Since the best mathematical learning takes place while the student is in the driver's seat and is writing out the material himself, the video should be watched in short bursts of at most a few minutes at a time. Then it should be paused and the student should return to the document and also to a blank page where he will take the active role of working the problem himself.

In this paper, I shall describe the techniques for the production of two distinctly different types of video. The first type is a video recording of an actual classroom lecture. The second type is the more polished

video/document combination that would be produced in a studio. Both kinds of video are made by recording the activity in a computer screen together with an audio track. This paper is not concerned with the kind of video that is made with a camcorder while an instructor writes either on a conventional or electronic whiteboard because, in my opinion, such video is much less effective than screen capture video as a learning medium.

Options for the Document Version of Video Material

As I have said, I believe that a good mathematical learning resource should be a blend of documents and videos. Regardless of whether one is making video in a classroom or in a studio, the source material of the video must also be available in document form. The process of creating a video must therefore be based on fluent use of an effective mathematical word processor such as the MacKichan Software¹ product *Scientific Workplace*. There are several ways in which the document form of the material can be supplied:

1. The documents can be supplied as HTML files. Documents of this form are easy to produce using the *Export as HTML* feature of Scientific Workplace and can be read directly in a web browser. However, I have never been satisfied with the quality of mathematical HTML files and do not use them.
2. The documents can be supplied as PDF files for reading in Adobe Reader. Documents supplied in PDF form have very high quality and are easy to produce. Furthermore, documents typeset as PDF in Scientific Workplace 5.5 in a document style, to which the Scientific Workplace hyperref package has been added, will have an automatically generated dynamic table of contents. Finally, if one is using Adobe Acrobat Professional 9, one has the option to embed the videos into the documents in such a way that they do not have to play in a separate window. Although the PDF option is the option of choice of many authors of mathematical material, it is not my own choice because it does not allow for inclusion of mathematical symbolism in the tables of contents, and also because I require my documents to have much more sophisticated hyperlinking than is possible in PDF files.
3. The documents can be supplied in Scientific Workplace L^AT_EX form for reading with any MacKichan Software product, including the free product, *Scientific Viewer*, which most of the students would have to install. This approach requires the tables of contents to be made manually and I have to add that the process of creating a multilevel set of tables of contents is long and painful. But the results are excellent as can be seen in the sample from my level 4 table of contents in my *Virtual Calculus Tutor* that appears in the following figure.

9.3.6 Some Applications of the n th Term Criterion for Divergence

A Ratio Criterion for Divergence
 Testing the Series $\sum \frac{n!}{6^n}$
 Divergence of the Series $\sum \frac{(2n)!}{(n!)^2}$
 Divergence of The Series $\sum \frac{(-1)^n 4^n (n!)^2}{(2n)!}$
 A Problem that We Cannot Solve Right Now: Test the Series $\sum \frac{(2n)!}{4^n (n!)^2}$
 A Limit Form of the Ratio Criterion for Divergence
 Divergence of the Series $\sum \frac{3^n}{n^{10}}$
 Divergence of the Series $\sum \frac{(3^n)(n!)}{n^n}$

One other advantage of this approach is that, instead of using the full product, Scientific Workplace, the instructor has the option of using the lower priced product *Scientific Notebook* for creation of the source material. For a free download of the document version of Virtual Calculus Tutor, go to

<http://www.math-movies.com/VCT-Document-Version1.exe>

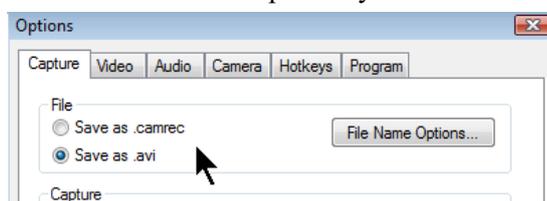
¹ www.mackichan.com

Recording Lectures in the Classroom

Recordings made in the classroom are “warts and all” reproductions of the actual proceedings of a lecture. Speed of production is the primary consideration. There is no time for editing, and classroom conditions do not allow for the creation of a high quality audio track. Nevertheless, any instructor who has developed the skill to type rapidly and efficiently into a Scientific Workplace (or Scientific Notebook) document has the option of providing the students with a valuable screen capture sound video of each lecture.

The considerations involved in the making of such recordings are as follows:

1. The instructor’s computer must be set at a screen resolution of not more than 1024 by 768 and, at this resolution, it is safe to record the entire computer screen. The instructor’s machine needs to be running Camtasia Studio² and the instructor will begin each lecture by opening Scientific Workplace to the appropriate document and then opening *Camtasia Recorder* which is the recording device in *Camtasia Studio*. My recommendation is to set Camtasia Recorder to record as AVI as shown in the next figure. Be sure to uncheck the option in Camtasia Recorder to capture layered windows.



2. For inclusion of the audio, my approach is to use a microphone that can be attached to my clothing and that leads to a USB port. There is no point in using a high quality condenser microphone. Furthermore, I do not recommend a microphone that plugs into a microphone jack or line-in jack of the computer.
3. If you want to supply your lecture video in a streamable form from a website, you will have to import the video into Camtasia Studio and then produce the video in a form such as Flash or WMV. Even the best computers will take several hours to produce the video in this way.
4. My own approach is to supply my video almost immediately in AVI form. I supply it on CDs which are ready for the students to pick up about 10 minutes after each lecture ends. Apart from the speed with which AVI video can be prepared, its quality is unequalled and it can be bundled with the excellent Camtasia Player which is an ideal viewer for this kind of material. There are two main options for supplying a video recording of a lecture:
 - (a) The AVI file can be bundled with Camtasia Player into a self executing ZIP file using the *Pack and Show* feature of Camtasia Studio. This method is well suited for shorter videos but, for very large files, may involve an undesirable delay before the video starts playing. I am supplying two short excerpts from my lecture material with this paper, both made with the Pack and Show feature. For an excerpt (15 MB) of a precalculus lecture, go to

<http://www.math-movies.com/atcm/excerpt-from1113.exe>

and, for an excerpt (9.7 MB) of a calculus lecture, go to

<http://www.math-movies.com/atcm/excerpt-1-math2203.exe>

As you will see, the entire file has to be downloaded before the video starts playing and so this method is not suitable for downloading long videos from a website.

- (b) The AVI file can be bundled with Camtasia Player and other course materials using the *MenuMaker* feature of Camtasia Studio. This is my method of choice. After MenuMaker has mastered my CD, I upload the disk image to my office computer that is connected to my CD/DVD duplicator. Even very long videos start playing immediately when they are supplied in this way.

² <http://www.techsmith.com/camtasia.asp>

Recording Lectures in a Studio

In contrast to screen capture recordings made in the classroom, recordings made in a studio for professional distribution have to be of the highest possible quality. They must be produced in an ideal environment using quality hardware and must be edited using the advanced editing features that exist in state of the art software. The produced video recordings will be converted to Flash, WMV, or some other form that can be embedded into an HTML file with a dynamic table of contents that makes it possible to jump to any chosen topic by means of a single mouse click.

These videos may be provided in a streamable form on a website but my own choice is to bundle them with the document version of the material into a unified software product that will be installed from a DVD into the student's hard drive.

In this paper, I am supplying two short excerpts of my studio recordings. To access these, go to the following:

<http://www.math-movies.com/atcm/VMT-Demo-Video-Excerpt.html>

<http://www.math-movies.com/atcm/VCT-Demo-Excerpt.html>

In watching these excerpts, you may notice that the sound quality in the second one is a little better than that of the first one. The second recording was created after I had made some improvements to my hardware.

Hardware Considerations for Studio Recordings

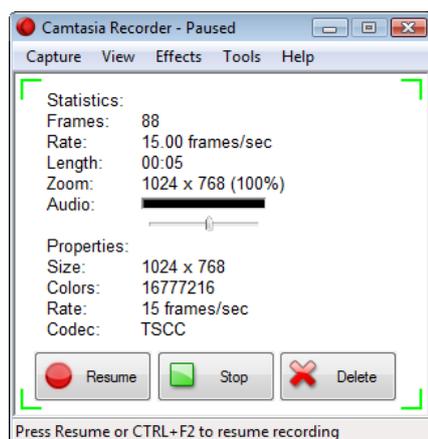
Provided that the computer being used for the recording has enough power and has a quality video card, the recording process will run smoothly and quality of the video image will be fine. However, audio quality can be much more difficult to obtain and all of the hardware considerations in the present discussion are focussed on audio quality.

1. The studio must be free from outside sound interference. This includes, above all, sound interference from the computer into which the recording is being made. Ideally, this computer should be a laptop or, if not, then a very quiet desktop and should be placed in a separate room behind a closed door. The studio itself should contain sound absorbing screens and possibly sound absorbing material on the walls and ceiling.
2. If there are computer sound cards that provide the option of controlling treble and bass while a recording is being made, I have no knowledge of them. After several unsuccessful and expensive attempts with sound cards, I went into a music store and bought an Alesis Multimix 8 that gives me the important option of boosting treble and suppressing bass. The Alesis plugs into a USB port in the computer and bypasses any sound cards that may exist. I find the sound quality achieved in this way to be distinctly superior to anything I could achieve by plugging a microphone directly into the computer.
3. I recommend the use of a high quality condenser microphone that will be securely mounted on a tripod and fitted with a pop filter to prevent any rush of air from the speakers mouth from reaching the microphone.
4. Significant improvement in sound quality will be achieved if the microphone is plugged into a compressor rather than directly into the Alesis Multimix. The compressor, suitably adjusted, will prevent undesirable overload sounds. The compressor I have chosen for this purpose is a dbx 266XL Compressor/Gate. The gate feature is supposed to prevent low level background noise from interfering with the recording but, important as the gate may be for the recording of music, I have found that the use of a gate is not well suited for the recording of speech. I recommend that the gate be adjusted in such a way that it is permanently open.
5. A condenser microphone requires a power source, known as *phantom power*, and so, unless the microphone has its own power source (possibly from a battery), it is necessary to place a small preamplifier between the microphone and the compressor. The preamplifier that I use at present is an ART Tube MP Power Server. However, I have recently been informed by my brother Gabe Lewin, who is a professional sound engineer, that this tube amplifier is designed for use with an electric guitar and may not be giving me the best quality. I am planning to replace the ART with something more suitable.

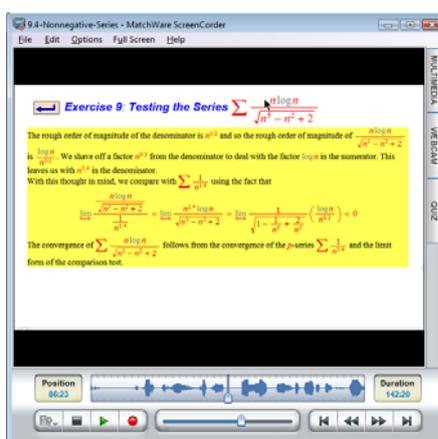
Software Considerations for Studio Recordings

The software considerations in this discussion focus on editing of the video. This editing is all-important in the creation of a professional quality product.

1. In my description of the process of creating classroom video that I gave earlier in this paper, I mentioned that my classroom recordings are made with Camtasia Recorder, the recording utility in Camtasia Studio. There is no doubt that Camtasia Recorder is an outstanding product but, for my professional quality studio recordings, I prefer to use *ScreenCorder 5*.³ My reason for this choice is that ScreenCorder 5 allows “on the fly” editing during the recording process. The following figure provides a comparison of the Camtasia Recorder and ScreenCorder 5 dialogues that appear when the recording process has been paused.



Camtasia Recorder



ScreenCorder 5

ScreenCorder 5 allows me to play any part of what has already been recorded in a session. One can choose to overwrite from any point onwards or to insert video and audio, or to insert audio with video frozen or to overwrite the audio track. ScreenCorder 5 also allows the project to be saved at any time. One may therefore come back at any time, even after the computer has been turned off, and resume the recording process. The ease with which one can perform fairly extensive editing functions during the actual recording process makes it possible to produce a much higher quality product.

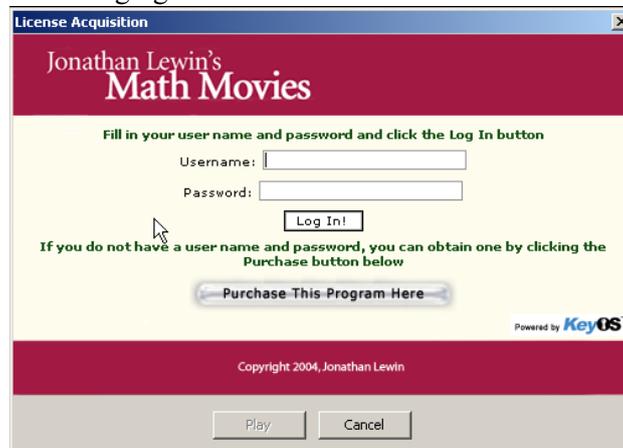
2. After the initial recording session has been completed, one has an AVI file or a set of AVI files that must be edited in the Camtasia Studio time line after which the final video and its table of contents will be produced by Camtasia Studio. In addition to the obvious editing activity, such as cutting and splicing, adjustment to the audio, adding in markers to be used in the generation of the table of contents, there are several advanced features of Camtasia Studio that can make a significant difference to the effectiveness of the produced video. One of these is the ability of Camtasia Studio to add *callouts* to the video. There are many kinds of callouts but the one I use most often is a *highlighter* callout that adds highlighting to selected items in the video. The two excerpts from my studio recordings that I have provided in this paper demonstrate my use of these highlighter callouts.
3. There are many other Camtasia advanced editing features that are too numerous to list here and that can make a big difference to the quality of the finished product. I shall mention only the *audio enhancements* feature that I have used to obtain significant improvement to the audio of some of my older movies. However, I must emphasize that no use of audio enhancements can be as good as proper audio conditions during the recording process.

Protecting Video from Piracy

To protect your intellectual properly, you can create the movies as WMV files or as Silverlight files and then use the Microsoft DRM process to encrypt them. Then, when the customer plays a movie, it will check for the

³ <http://www.matchware.com/en/>

presence of a license in the computer. If no license is found, the customer will see a license acquisition screen such as the one shown in the following figure.



After the customer types in the user name and password, the DRM provider's server will issue a license and one may play the movie.

The DRM method presents several striking advantages.

1. It is inexpensive.
2. It is easy to use if one has a good provider.
3. It is flexible. For example, one can choose to make the movies pay per view or to make the license valid for a fixed time or to make it permanent.

The first step in applying DRM to your video material is to open an account with a DRM provider. Unless you are already an expert, I recommend a full service provider, such as the one I use. My provider, BuyDRM,⁴ has given me great service.

Conclusion

In this paper, I have given a brief overview of the process of making videos. I believe that many instructors could enhance their teaching effectiveness by producing at least some of their course material in video form. My suggestion is that one should begin slowly by becoming skilled in the production of Scientific Workplace on-screen documents. Then buy a copy of Camtasia Studio and a simple USB microphone and you will be poised to enter the world of video making.

⁴ <http://www.buydrm.com/>