The Creation and Significance of Study Resources in the Form of Videos

Jonathan Lewin

Professor of Mathematics, Kennesaw State University, USA

lewins@mindspring.com

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The purpose of this article is to describe my use of technology as a means of communication with students. Specifically, I describe the use of a scientific word processor as a whiteboard and the process of capturing the activity of my computer screen to create study materials in the form of sound movies.

A History of my Involvement in the Making of Videos

Using a Mathematical Word Processor as a Whiteboard

Several years ago, I discovered that my typing skills in the mathematical word processor and typesetting utility **Scientific Workplace** (www.mackichan.com) exceeded my ability to write on a blackboard or whiteboard and I made a radical change in my teaching style. Instead of writing on a board, I began to type my lecture notes and to project the contents of my computer screen onto a large screen that was visible to the students. I found that I could type lecture notes more clearly, rapidly, and fully than I had ever been able to write them on a board.

In the following shaded region, I provide a short excerpt from a set of lecture notes that I created in the classroom. The superiority of these typed notes over handwritten notes is clear and I must emphasize that all the material shown here, including the figure, was created in the lecture room during an actual lecture.

Our job is to decide how to make the green rectangle have the greatest possible area.
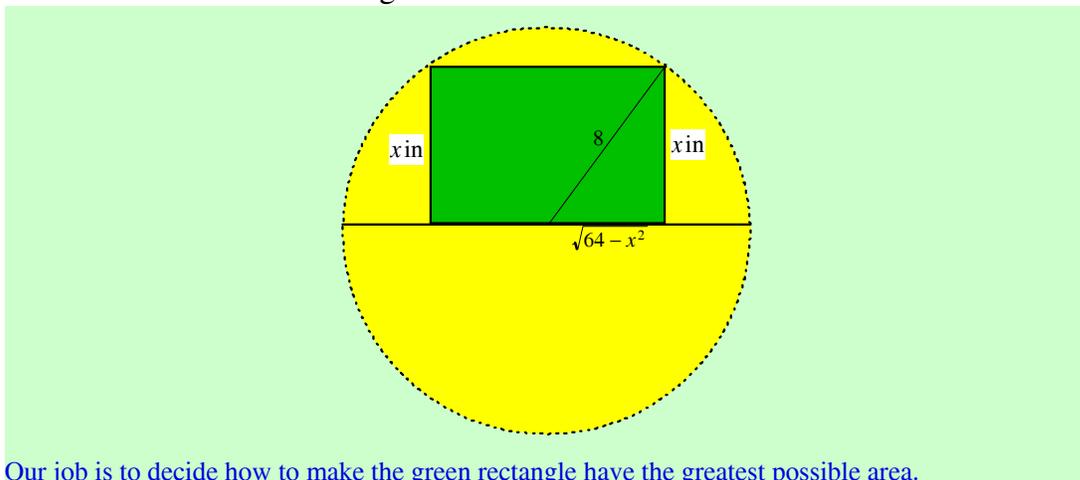
In this figure we have $0 \leq x \leq 8$ and the length of the base of the rectangle is $2\sqrt{64-x^2}$ and, if $f(x)$ is the area of this rectangle, then

$$f(x) = 2x\sqrt{64-x^2}$$

For each x we have

$$f'(x) = 2\sqrt{64-x^2} + (2x)\left(\frac{1}{2}(64-x^2)^{-1/2}(-2x)\right)$$

$$= 2\sqrt{64-x^2} - \frac{2x^2}{\sqrt{64-x^2}}$$

$$= \frac{2\sqrt{64-x^2}\sqrt{64-x^2} - 2x^2}{\sqrt{64-x^2}}$$

$$= \frac{2(64-x^2) - 2x^2}{\sqrt{64-x^2}}$$

$$= \frac{128 - 4x^2}{\sqrt{64-x^2}}$$

Thus the equation $f'(x) = 0$ says that

$$\frac{128 - 4x^2}{\sqrt{64-x^2}} = 0$$

and holds when $128 - 4x^2 = 0$ which gives us $x = \pm 4\sqrt{2}$.

The creation of lecture material in this way does, of course, require extensive training but, for those who take the trouble to develop the skills, there are many rewards:

◆ As I have shown, the notes are very clear and readable. They have the appearance of having been pasted in from a textbook.

◆ With the help of special features in Scientific Workplace, one can type very rapidly and effortlessly and one there has an incentive to make the lecture material very complete.

◆ I type my lecture notes while facing my students. In order to write on a board, one must present one's back to the students.

◆ An instructor may choose to provide the course materials in the form of PDF files so that they can be read automatically in all computers in which **Adobe Reader** has been installed. For my own students, however, I provide the course materials in their original form as created by Scientific Workplace or by its simpler version, **Scientific Notebook**. Such materials can be read with the free MacKichan Software product, **Scientific Viewer**, and one advantage of this method is it allows me to build in a very sophisticated hyperlinking structure that helps the students to browse easily through my materials. A second advantage is that those students who have their own copies of Scientific Workplace or Scientific Notebook can read the materials interactively with the help of the computer algebra system that is built into these products.

Recording The Activity in the Computer Screen

A few years after I began to use Scientific Workplace as my whiteboard, I took the next logical step. I was concerned with the fact that, all too often, students find the process of reading lecture notes to be a formidable task. They find that the material is not nearly as easy to follow as it seemed to be in the classroom. So I began to record the activity of my computer screen and all sound while I am teaching. This recording supplements the lecture notes that I create in the classroom with a sound movie that shows these notes as they are being created and that gives the students the option of entering a virtual classroom where

they can re-experience the actual lectures that they have attended in the course.. From the time that I began to provide my students with movie recordings of their lectures, I have seen rising grades and falling drop rates. Not surprisingly, I have become an enthusiastic proponent of the production of study materials in video form.

Over the past two or three years, I have begun to supplement my classroom recording activity with a second kind of video recording that I do in my own home. Recordings of this type are made more carefully and are designed for inclusion in a commercially released product.

My Present Video Recording Activity

The Software Products that I Use

When I began my video recording activity, I experimented with several software products for recording the screen but found most of them to be very inadequate. Then, about six years ago, I stumbled on two excellent products, **Camtasia Studio** (www.techsmith.com) and **ScreenCorder** (www.matchware.com). Each of these two products has its own important role to play in the making of videos. When I record in my classroom, I use the recording utility in Camtasia Studio. However, for the movies that I record in my home for commercial release, I use ScreenCorder for the actual recording and then Camtasia Studio for the editing.

My Recording Activity in the Classroom

When I enter my classroom at Kennesaw State University, I connect my laptop computer to a keyboard and mouse, to the university network, to the projector built in to my classroom, and to my microphone. I open my mathematical word processor, Scientific Workplace, my drawing utility, **SmartDraw** (www.smartdraw.com), and I open Camtasia Recorder which is the recording utility of Camtasia Studio 4.
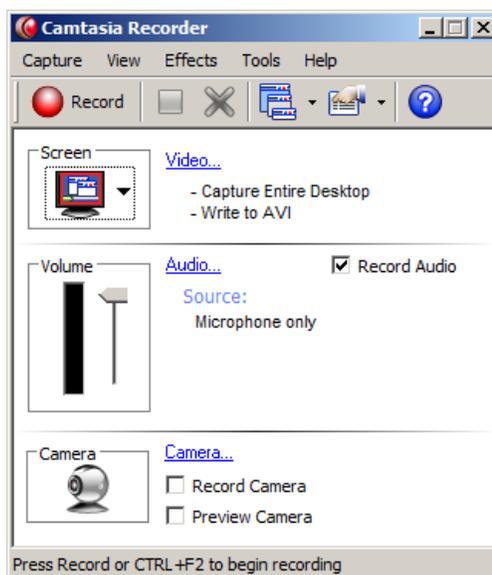
Before I start teaching, I set Camtasia Recorder to make an AVI recording that will capture my computer screen in full color and with sound and I start the recording. In this way, I record my entire lecture. No camera is involved. All I record is my actual computer screen. The playing time of the movies that I make in this way varies from 75 minutes to over 3.5 hours, depending on the length of the lecture.

When the lecture ends, I stop the recording and Camtasia Recorder takes about three minutes to export it as an AVI file. During this time, I open the menu file for the class in the Camtasia Studio MenuMaker utility. It comes up looking something like this:
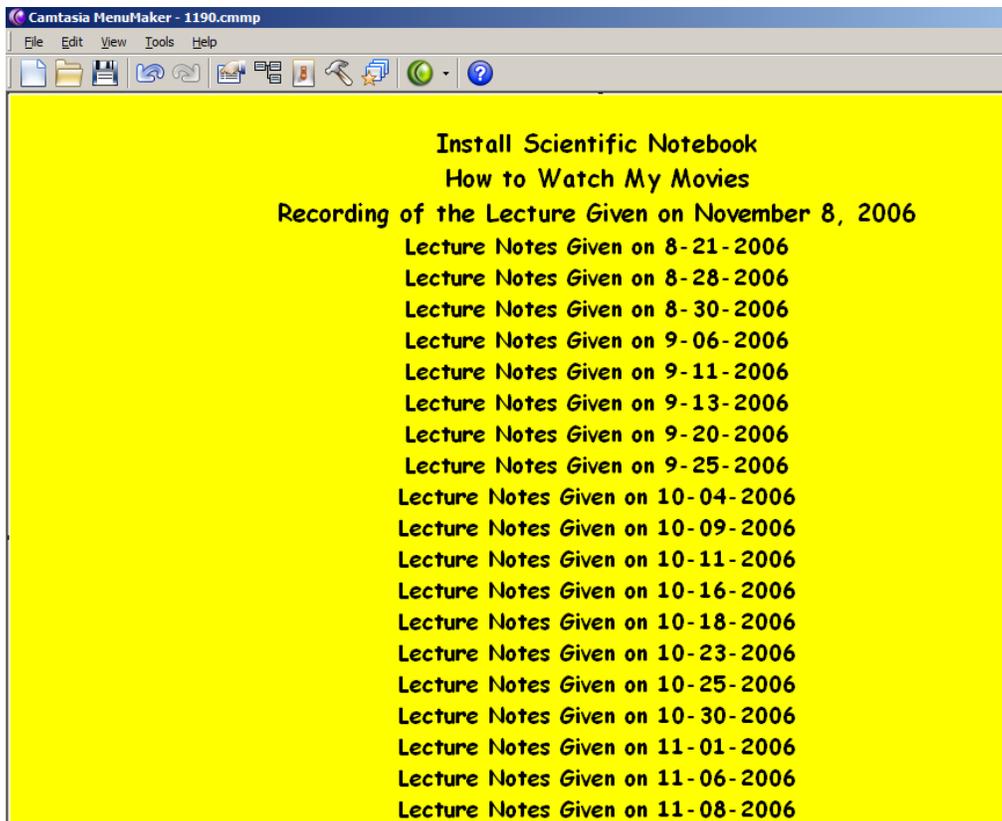
My menu for each lecture contains the recording of that lecture and all of the lecture notes given in the course up to that date. It also contains a few utilities that the students need.

As soon as the menu is complete, I access my office computer with Remote Desktop

When my office computer comes up, I open a file management utility such as **PowerDesk Pro** (www.v-com.com) and use it to copy my Camtasia MenuMaker material into the office computer. This takes two to three minutes.
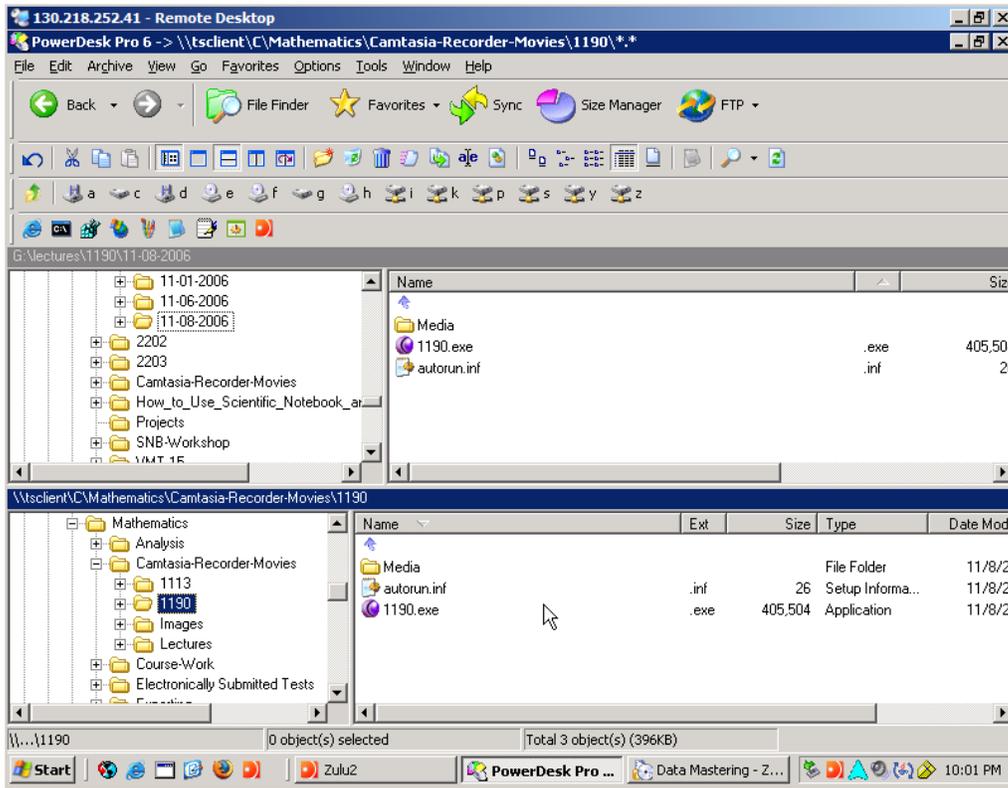
Then I open the software that is used by my office computer to drive the CD/DVD duplicator that is attached to it.
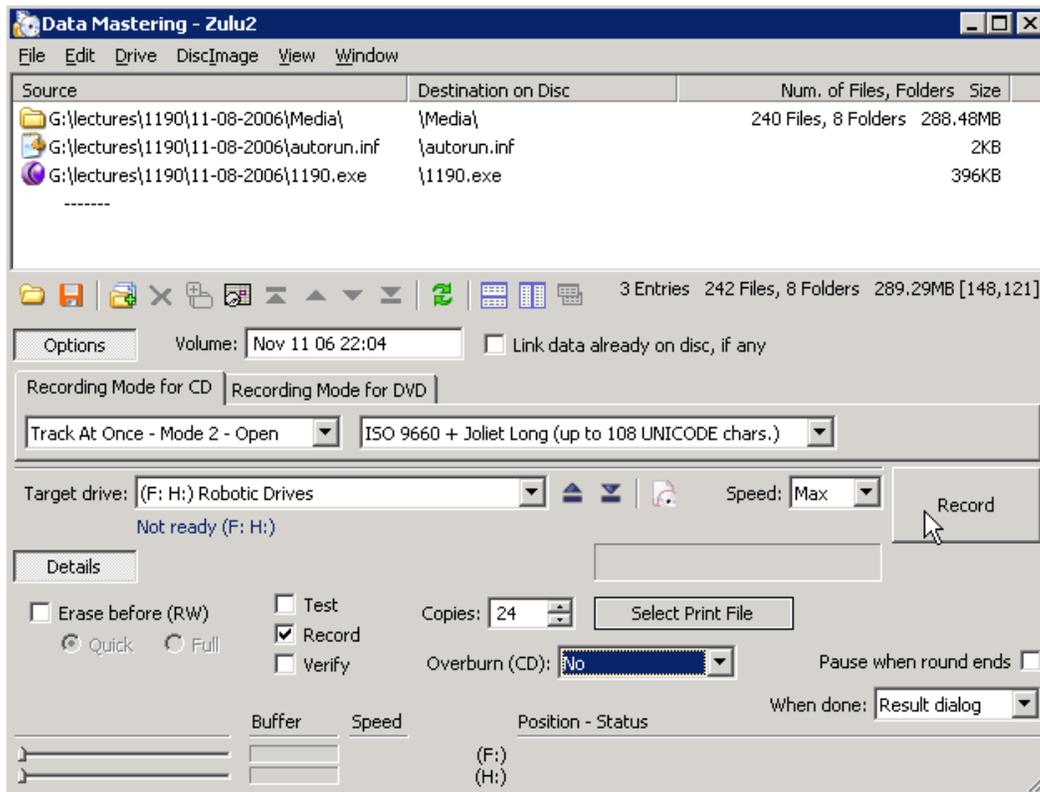
I select the Camtasia MenuMaker files that I have made, select the number of disks to be made and click on *Record*. The entire process of exporting my movie, mastering my disk, uploading it to my office computer, and starting the duplicator has taken me about seven minutes.

I still have nearly ten minutes to come up for air before my next lot of students enter the classroom.

I hand my office keys to one of my students who then goes upstairs to my office and starts handing out CDs to the students who are waiting there. On the wall outside my office, I have a wooden rack (made for me by my colleague, Ron Hoover) and I keep a supply of lecture CDs there for students to pick up.

Virtual Math Tutor and Virtual Calculus Tutor

My commercial products, **Virtual Math Tutor** and **Virtual Calculus Tutor** are recorded in my own home. The method I use to record to record the videos in these products is similar to the method I use for my classroom recordings but there are important differences.

◆ The movies made for these commercial products are much more polished than those I can make in a classroom. Instead of using Camtasia recorder to record these movies, I use ScreenCorder which allows me to edit what I am doing during the actual recording process. As can be seen from the illustration shown below of the ScreenCorder work screen, it includes a time-line. Whenever the recording has been paused, one can drag the cursor to any desired point in the time-line and replay from that point on. One may choose to record at that point in such a way that all previous recording from that point onward is overwritten or one may choose to record in insert mode at that point.
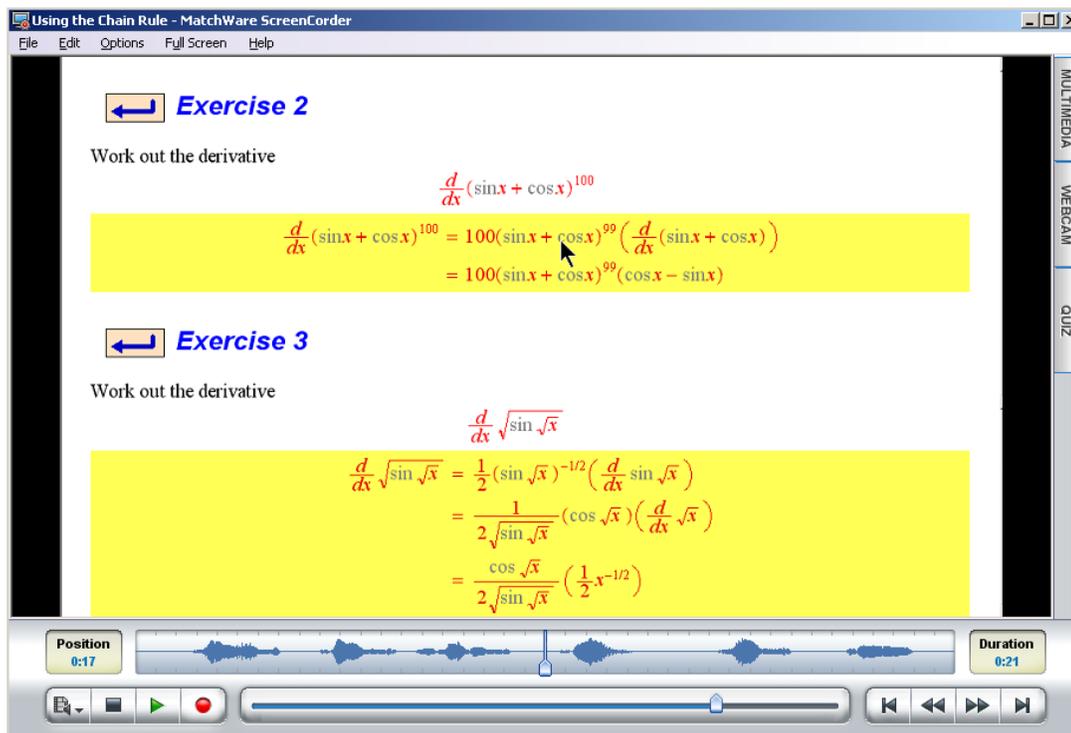
◆ When the recording is complete, I use the ScreenCorder export feature to create the movie file in AVI form using a lossless codec like the TechSmith TSCC codec. Then I import the movie into a Camtasia Studio project, perform further editing, create a table of contents and produce the movie in its final form. Then I use Camtasia Studio or Windows Encoder to convert the movie to WMV form, embed it into an HTML file with a table of contents, and add DRM encryption to protect it from piracy. My DRM Provider is Buy DRM.

Virtual Math Tutor

Virtual Math Tutor (**www.math-movies.com**) has been on the market for about two years and is being used by high school and college students in a variety of places. Virtual Math Tutor is not designed to match the syllabus of any particular course. Instead, it is designed as a resource for study in a wide variety of courses. So, for example, high school students may use it to overcome their difficulties in elementary algebra while students in a calculus course may use it to review the inverse trigonometric functions. There is a large amount of material in Virtual Math Tutor. It contains 65 separate movies that have a combined playing time of 55 hours and, apart from presenting the development of the material, it presents complete solutions to about 900 exercises. To help students and instructors navigate such a large quantity of material, I have provided the **Virtual Math Tutor Companion** which is in document form. The sophisticated hyperlinking structure of the Virtual Math Tutor Companion allows for instant and effortless surfing of the mathematical content of Virtual Math Tutor. The companion makes it easy to determine which movies are appropriate for a given course or student.

For some free demos of the movies in Virtual Math Tutor, please click on any of the following links. When the movie starts playing, you may have to wait a couple of minutes before you can operate the links in its table of contents.

You can optimize your view by pressing the function key F11 to hide your browser toolbars and also by setting your screen resolution to 1280 by 1024.

Complete Movie: Using Factors to Solve Equations

Complete Movie: Introduction to Logarithms

Excerpt from Analytic Trigonometry in Several Variables

Excerpt from Introduction to Functions

Virtual Calculus Tutor

Virtual Calculus Tutor, is under construction. In some way, its presentation will resemble that of Virtual Math Tutor but it will be much more elaborate. Virtual Calculus Tutor will be designed to provide university students with an alternative and friendly study resource for the entire calculus sequence. Like my lecture movies and Virtual Math Tutor, Virtual calculus tutor will take students into a virtual classroom and actually teach the material to them.

I invite anyone who would like to be kept abreast of the development of Virtual Calculus tutor to write to me to request sneak previews of its source material. Letters should be addressed to Jonathan Lewin.

Strategy for Using Videos as a Study Resource

A typical lecture at Kennesaw State University lasts 75 minutes or 100 minutes. I advise my students that the wrong way to use my lecture recordings is to watch the entire movie from beginning to end (unless they are seeking a cure for insomnia). Instead, I suggest to them that their initial focus should be on the lecture notes that they have received on my CDs or from my website. They should work through the lecture notes with pencil in hand and make sure that, at each stage, they are able to rewrite for themselves whatever they are seeing in the notes.

From time to time, they may experience difficulty reading the lecture notes. Each time this happens, they should let the movie take them into a virtual classroom where they can attend, again, the particular portion of the lecture where they are experiencing the difficulty. They should expect to watch no more than a few minutes of movie material in any of these sessions. When they have watched the movie to overcome a specific difficulty, they should pause the player and return to the notes. Finally, they should verify that they are able to write the item themselves.

Products such as Virtual Math Tutor and Virtual Calculus Tutor should be used in a similar way. So, for example, a person who wants help with the method for finding the area of a triangle in terms of its sides and angles should browse to this item first in the Virtual Math Tutor Companion. This item can be found in the table of contents as shown below.

Then, by clicking on the item, one may see the item itself as in shown in the followin figure.

↵ *Area of a Triangle Using Sides and Angles*

Our present task is to show that, given any triangle $\triangle ABC$
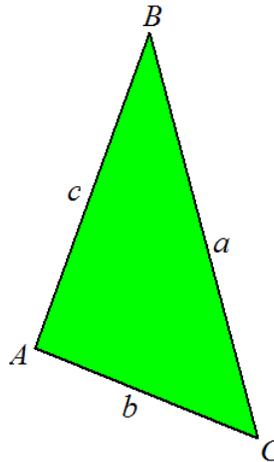
the area of $\triangle ABC$ can be found using the formulas

$$\text{area}(\triangle ABC) = \tfrac{1}{2} ab \sin \angle C$$

When the process of reading the item, begins to become burdensome, one should open the movie

Angles in Trigonometry	Worksheet
Introduction to Trigonometry	Worksheet
Trigonometry in a General Triangle	Worksheet

and then click on the appropriate item in the table of contents of the movie.

11. Area of a Triangle Using Base and Height
12. Area of a Triangle Using Sides and Angles
13. The Law of Sines
14. **Exercises on Finding Sides of a Triangle**
15. Exercise 1
16. Exercise 2
17. Exercise 3
18. Exercise 4
19. Exercise 5
20. Exercise 6
21. Exercise 7: The

Area of a Triangle Using Side

Our present task is to show that the area of any given any t found using the formulas

$$\text{area}(\triangle ABC) = \tfrac{1}{2} ab \sin \angle C$$
$$= \tfrac{1}{2} ac \sin \angle B$$
$$= \tfrac{1}{2} bc \sin \angle A.$$

Once again, my advice is not to play too much of the movie in any one session. One should constantly browse back to the companion and read it with a pencil in hand.

Summing Up

Software products such as Scientific Workplace, Scientific Notebook, Camtasia Studio, and ScreenCorder have offered us the opportunity to revolutionize the teaching of mathematics and to produce many happy, motivated and achieving students. While I accept that the use of a scientific word processor as a whiteboard and the making of screen capture videos are not feasible options for every instructor, I do think there is ample evidence to support my contention that some mathematics instructors should consider undergoing training in the use of the products listed above. Those who succeed will benefit from the unprecedented level of communication between instructor and student that has been made possible by modern technology. Finally, the presentation of course materials in video form may give an instructor the opportunity to demonstrate the use of computer algebra systems without having to require that the students have such software on their own computers.