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An Inexpensive Method for Recording Lectures Without Use of a Video Recorder

Recording lectures for later use is a method used by instructors for some time as a means of helping students learn course material and prepare for exams. Except in distance education courses where recorded lectures may be necessary, the method has not been widely adopted, however, probably due to the extra effort and resources required to produce instructive recordings and make them available to members of the class. Unless lectures can be held in studios settings with permanently installed video and audio equipment, a luxury few of us have, instructors face the daunting task of setting up, testing, operating and taking down the considerable amount of equipment needed. In most cases, a "crew" of experienced technicians needs to be present in the classroom to assure consistent, quality production. Where adequate resources are available, good quality recordings have been produced benefiting students in introductory chemistry [1]. Our experience suggests, however, that relatively few schools offer the level of support needed for conventional lecture recording.

With the expanding availability of LCD data projectors in classrooms has come a trend toward preparing chemistry lectures in digital format employing software such as ChemDraw© [2] and using PowerPoint© [3] to present the material on an electronic data projector in class. We have been using digital presentations in some sections of our freshman chemistry course for science majors during the past several years. Copies of the presentation files were made available in electronic format for students' use. A high percentage of our students support themselves by working and surveys suggested that actual

recordings of the lectures and workshops/reviews might be more effective as study aides.

Given our support circumstances, it was evident that any viable recording procedure would have to be simple, so as to add as little as possible to the pre- and post-class routine of the instructor, be transparent to the students to avoid distraction, need no studio or "crew" and be digitally based so the media produced could be prepared for web dissemination with a minimal amount of effort. The only technique we found that met these requirements was a dynamic screen and audio capture program running in the background on the computer used for the presentation. One lecturer (RG) was using a Macintosh© computer for which a suitable screen capture program, Snapz Pro X© [4] was available. A comparable Windows© program, Camtasia© [5], is also available. The Snapz Pro X utility, described hereafter, has the capability of recording sequential screen captures and an audio (microphone) track while running in the background under MacOS X© (v. 10.2) then assembling the images and sound into a QuickTime© video clip. In our implementation, the clip file was compressed and converted to MPEG-4 format with suitable preparation for streaming from an Apple Streaming Server©. Details of the implementation, a link on which the results can be viewed, and a discussion of the results are presented in the following sections.

Description of the Method

The recording method requires that lectures have been prepared in digital format, in our case, as PowerPoint slides. Figure 1 is a diagram of the components and connections of the system used to present and record the slides. A useful enhancement that we employ is annotation on the slide images using a digital tablet (15" Hitachi Starboard EM Panel) but this is not required for recording. To record a lecture, the Snapz Pro X program is first launched and runs in the background. The lecture file is opened and PowerPoint is placed in presentation mode displaying the first layer of the first slide. Recording is begun with a keyboard combination that brings Snapz Pro X to the foreground where the full screen area is set for recording and video and audio capture is initiated. At this point, Snapz Pro X disappears and begins to capture screen "snapshots" and the audio signal as fast as the computer will support. Several

factors have been evaluated with respect to making optimal recordings.

In our 300-seat classroom, a large screen is needed for all students to have a workable view of the display. To reduce pixelation, we use a 1024 x 768 pixel screen resolution and, since photographs are frequently used in the lectures, the display is set to millions of colors (24-bit) for reasonably faithful reproduction. Thus, each screen image consists of approximately 2.36 mb that the computer must process rapidly enough, in the background to give an acceptable frame rate for the recording. Snapz Pro X must simultaneously capture the audio channel (mono, 16 bit, 22 kHz). In order to achieve a minimally acceptable frame rate (2-4 fps) with these conditions, we found it necessary to use the fastest available Macintosh computer, at the time, a dual 1.0 Ghz processor Power Macintosh G4. It may be assumed that current, faster machines would deliver proportionally higher frame rates but the stream files currently produced have educationally acceptable quality.

When the lecture is complete, other keyboard sequences halt capture and begin assembly of the movie clip. We find it advantageous here to compress the video in MPEG-4 format available with QuickTime© Version 6.x because it affords considerably higher quality streams from the Apple Streaming Server©. Audio is compressed in IMA 4:1 format. Compressing 50 minutes of video and audio on our system requires about 15 minutes and produces a file of about 50 mb. ("Raw" files, compressed only with simple codec's, approach 200 mb in size) If the computer is available, this processing can be done immediately after class, or, if it will be used in the next period, processing can be delayed (but no further recording can be done until the existing data is processed). The resulting MPEG-4 file is transferred to the streaming server immediately after first-stage compression is complete and we use QuickTime Player Pro© to further process the file as need for streaming [6]. Typically the stream file can be viewed approximately one hour after the class period. The current system does not lend itself to live streaming but that is a function that we do not desire at present.

Table 1 gives the sources of the hardware and software. Aside from the computer itself, system costs are quite modest. We find that considerable educational advantage accrues from live annotation using the LCD screen

digital tablet, although it is not necessary for recording and similar benefit can be achieved using a less expensive Wacom® tablet [7]. If the computer used has a built-in microphone input, the USB audio adapter may not be needed. The sound quality of the iMic adapter was quite satisfactory.

Another faculty member, working with a PC, employed the program Camtasia Studio [5] to capture video and audio with results that roughly paralleled those obtained with the PowerMac G4 system but it has not been extensively evaluated. Another trial recording, carried out with a borrowed TabletPC, was promising with especially facile pen annotation but it was necessary to convert the PowerPoint slides into another format before use.

Results and Discussion

The lecture recordings made with this system in the classes of one of us (RG) may be viewed on-line using Internet Explorer with the QuickTime® Version 6 plug-in [8]. They consist of all the material presented on the screen, i.e., the PowerPoint slides and the annotations made on the slides using the digital tablet, and the audio captured from the lecturer's microphone. These files have not been edited for content, only compressed and prepared for streaming, so they lack editorial polish. No presentation script was used – the prepared slides simply being presented serially with occasional digressions for “workshops” or detailed answers to questions from students.

The absence of a “talking head” in our recordings conserves bandwidth allowing for a 512 x 384 pixel widow and good clarity for broadband connections (DSL or cable modem). A smaller, but still usable, window (384 x 288 pixel) is provided for 56k modem users. The use of MPEG-4 compression is essential for the attainment of adequate video quality. Audio compression is also very important and the Qualcomm codec gave the best results [6]. A survey of student preferences at the end of the semester revealed that 45% of responding students viewed at least some of the streamed lectures.

Comparison with Other Methods

Most streaming chemistry lectures currently viewable on the web are captured using conventional video and audio recording equipment [1]. These require a

support staff to operate cameras, sound recorders, lighting, etc., but the result can be effective. Most lecture halls, however, are not optimal for such recording, with audience noise and student movement as examples of various distractions that can occur. Processing the resulting media for streaming is demanding in both effort and time. Although AV studios are available on our campus, they are not large enough for freshman chemistry classes. Since we lacked the resources for conducting conventional recording in class, we sought other recording methods.

One method that we considered was developed by Craddock and Mendrela employing an inexpensive webcam, coupled with an electronic whiteboard and a microphone connected to a PC laptop computer [9]. The webcam video signal is electronically combined and synchronized with the whiteboard and microphone outputs using a software application that feeds a Real Streaming Server®. The method is relatively inexpensive, except for the whiteboard, but it has two important disadvantages. First, even though the authors sought to create a system that required “zero-effort” on the part of the lecturer, we saw set up and take down as troublesome. Second, the quality of the webcam video was too marginal to justify the bandwidth it consumed.

Before developing the method described here, we used a PC-based recording system that incorporated a special video card and an external hardware scan converter and microphone mixer [10]. In this system, a special software interface allowed live streaming of lectures that were also archived for on-demand viewing. In this system, however, only a relatively small “live” window could be provided because the effectiveness of file compression was limited. This method had the advantage that messages and a (static) picture of the presenter could be included in the unused part of the window that was streamed. The main disadvantage was that the initial cost of the system was increased by over \$4000 for the extra hardware. The lecturer also had more equipment to deal with and the level of IT staff support needed was greater than the current method.

Summary

The lecture recording method described here involves background capture of

screen “snapshots” coupled with microphone audio melded together into a QuickTime© movie file. It requires that the lecture material be prepared in digital format and lends itself to inclusion of annotations, in-line workshops and detailed answers to students’ questions by use of a digital tablet. A microphone input, either integral or external (USB) is needed. The critical component is software that carries out the screen capture and audio recording while running in the background. The cost of this software on both Macintosh and PC platforms is modest. The operation of such software is processor intensive, however, so the method will only produce acceptable quality recordings on a computer with substantial processing power. Once set up, the recording process is initiated by one keyboard combination, brief use of the mouse to set the capture area and terminated by another key combination, coming close to “zero-effort” on the part of the lecturer. Three 50-minute recordings a week have been made over the course of two semesters with very minimal disruption, which attests to the robust nature of the components of the system.

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References and Notes

1. Examples of what can be done using conventional media recording of lectures in introductory chemistry include the work of John I. Gelder: <http://intro.chem.okstate.edu/1515SP01/DigitalLectures/DigitalLectures.html> and the multimedia streamed chemistry lectures of Berkeley’s CHEM 1a), <http://webcast.berkeley.edu/courses>
2. CS ChemDraw, CambridgeSoft Corporation, 100 CambridgePark Drive, Cambridge, MA 02140; (800) 315-7300; www.camsoft.com
3. PowerPoint, Microsoft Corporation, 205 108th Ave NE - Suite 400 Bellevue, WA 98004; (425) 705-1900; www.microsoft.com
4. Snapz Pro X, (v 1.0.7) Ambrosia Software, Inc., PO Box 23140, Rochester, NY 14692; (800) 231-1816; www.ambrosiaSW.com

5. Camtasia Studio; www.techsmith.com.
6. Streaming (hinted) parameters for a) DSL/cable/broadband: MPEG-4, high quality, 2 fps, key frame 20, 512 x 384 pixel window, Qualcomm 19:1 audio at 16-bit, 11 kHz, mono; b) 56 kbs modem: MPEG-4, low quality, 0.5 fps, key frame 20, 384 x 288 pixel window, Qualcomm, 19:1 audio format, 16-bit, 5 kHz, mono. QuickTime Pro©, Version 6.x (\$30), www.apple.com.
7. Digital tablets that can be used to annotate on PowerPoint are available at: www.wacom.com.
8. CHEM 1331 streaming lectures may be viewed at www.vnet.uh.edu. Click "Vclass" to start, followed by the link to "Russell Geanangel". Enter the username "guest" and the password "guest". The most current streaming files are in the folder with the most recent date.
9. I. Craddock and G. Mendrella, "Electronic Recording and Delivery of Lectures", www.ltss.bris.ac.uk/interact22/in22p08.htm
10. Tony D. J. Haymet, "Streaming Media for Introductory Chemistry", Symposium on Chemical Education, IUPAC 2001 Conference on Chemical Education, Queensland University, Australia, July 2001.

Tables and figures

Table 1. Hardware and Software Used for Recording Lectures

1. Macintosh© G4, dual 1 Ghz processors, 512 MB memory, 80 GB HD, Apple Computer, Cupertino, CA, www.apple.com.
2. iMic USB Audio Adapter, (\$40) Griffin Technology, 1619c Elm Hill Pike, Nashville, TN 37210 (615) 339-7000, www.griffintechology.com
3. StarBoard EM Panel, with 15" LCD display and Wacom digital pen for annotation, Hitachi Software, 601 Gateway Blvd., Suite 500, So. San Francisco, CA 94080 (888) 615-9600, www.hitachi_soft.com.
4. Snapz Pro

X, (\$49) Ambrosia Software, Inc., (585) 325-1910 www.ambrosiasw.com

Figure 1. Hardware and Software Diagram for Recording Lectures



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