Hartsell, T., & Yuen, S. (2006). Video streaming in online learning. *AACE Journal, 14*(1), 31-43.

Video Streaming in Online Learning

TARALYNN HARTSELL AND STEVE CHI-YIN YUEN

The University of Southern Mississippi
Hattiesburg, MS USA
taralynn.hartsell@usm.edu
steve.yuen@usm.edu

The use of video in teaching and learning is a common practice in education today. As learning online becomes more of a common practice in education, streaming video and audio will play a bigger role in delivering course materials to online learners. This form of technology brings courses alive by allowing online learners to use their visual and auditory senses to learn complex concepts and difficult procedures. This article offers an overview of using streaming video in the online educational environment and discusses the various formats of streaming media. The various hardware and software programs used to create streaming video are also examined along with the advantages and drawbacks of using streaming video in online instruction. Finally, a discussion of how streaming video can be used in online instruction and its curricular applications are addressed.

Instructional tools for delivering materials to learners have improved since the conception of the Internet and World Wide Web (WWW or Web). Learners today have increasing access to instructional materials that have been traditionally distributed in the classroom. Materials such as lecture notes, communication tools, assignments, visual graphics, and so forth, are now easily obtainable through the Internet. In addition, the Internet can provide media-rich environments such as digital video (Garrison, 2001).

With advances in software and networking technology, streaming digital video across the Internet has become easier and more effective.

Streaming media such as video and audio can help learners understand complex concepts and procedures that are difficult to explain with simply text and graphics (Klass, 2003). This ability is important for distance learning instruction in that most online courses still use primarily text-based materials to deliver instruction, and multimedia can add interactivity to these stagnant text-based materials (Michelich, 2002). Most online courses today lack creativity and/or interactivity when it comes to delivering instructional materials. Cognitivists believe that the addition of multimedia can help improve and augment the learning process of students as they see the concept in action (Michelich, 2002). By using visual and auditory messages, students can process the information quicker, which in turn, helps foster their learning acquisition of the material. The old saying that "a picture is worth a thousand words" holds true in this case in that moving images add authenticity and reality to the learning context (Joint Information Systems Committee, 2002). Video's face-to-face context engages the students, and can effectively capture cultural context to enhance the learning experience (Stilborne & MacGibbon, 2001). In addition, a moving image can help students visualize a process or see how something works. Video can take tacit information or knowledge that may be too difficult to describe in text into an articulate, vivid description through the use of images. Furthermore, videos have visual appeal that can evoke emotional reactions from students that would help in increasing motivation (Joint Information Systems Committee). With these benefits in mind, streaming video is a new opportunity for educators to bring online courses alive.

This article presents an overview of video streaming on the Internet and how it can be used in online course instruction. Online learning is a practical tool for educators to meet the needs of their students and the academic institutions that offer such types of courses. Video streaming can help augment text-based materials in online courses that would stimulate the subject matter being discussed. However, when integrating video and audio streaming into online courses, one must consider the advantages and limitations. These will be also discussed in this article. Finally, suggestions will be offered to help educators better prepare themselves in the design of such digital instructional materials to provide the most effective means of communication.

OVERVIEW OF VIDEO STREAMING

Educators are always looking for effective ways to create productive learning environments. With increasing network bandwidth, user connection speeds, and the availability of powerful and user-friendly hardware and software, audio and video have become practical media solutions for delivering instructional materials (Martindale, 2002). Streaming video can be used for live instructional broadcasts or recorded instructional activities and can grab learners' attention and present information that is easy to absorb. Streaming media is also highly effective in motivating, training, and instructing (Joint Information Systems Committee, 2002). The streaming video technology is currently in place and widespread availability of video streaming is increasing. With adequate access and support, online instructors will be able to better help their students comprehend hard-to-understand concepts and become engaged in the learning process (Klass, 2003; Reed, 2003).

Streaming video is a term applied to the compression and buffering techniques that allow one to transmit and view video in real-time through the Internet (AboutVideoEditing, 2003a). Instead of downloading an entire video file, learners can download small portions of digital video files from the Internet (Weiser, 2002). Video files not streamed can be quite large in size. This large file size can take a long time to download before it begins to play on the user's computer. In streaming video, however, the program downloads the file in smaller size buffer packets. When the appropriate number of buffer packets is reached to begin playing the video, the client-side's media player (e.g., QuickTime player) displays the packets into one seamless stream (Lorance, 2003; Zachariah, 2001). In other words, streaming media is the simultaneous transfer of digital media files such as video, audio, and data through a server application that can be displayed in real-time by client applications. Once a streamed file has been downloaded and viewed, the physical file is no longer present on the user's computer (Reed, 2003). In short, the video/audio data is projected to the user as it is being received and does not remain on the computer's hard drive. The operation is similar to a televised show as the receiver presents the images/sounds before the audience can see or hear them (Kennedy, 1999). Once the user closes the client-side application, the file is automatically discarded and can only be retrieved again from the Internet site.

THE TECHNOLOGY BEHIND VIDEO STREAMING

Before creating digital video for streaming purposes, the instructor needs to be certain that several factors exist. These include ensuring that the developer has: (a) made the video in the proper format, (b) access to a streaming media server, and (c) adequate bandwidth to download and upload the video file. The hardware for creating video streaming materials requires much of the same equipment for creating traditional digital video no matter how the material is being used on the Web. These hardware and software components include a video camera (analog or digital), video capture card (e.g., Pinnancle System, AverMedia), video editing program (e.g., Adobe Premiere, Final Cut Pro), video encoding software (e.g., Real Producer Plus, Discreet Cleaner), a computer with a lot of storage space to store the video files, and a high-speed network connection (Zachariah, 2001). Other equipment considerations include (a) obtaining a tripod for reducing the amount of movement that helps reduce the amount of work the encoder will have to do to compensate for the movement, (b) obtaining a directional microphone that is windproof to help reduce background noise, and (c) ensuring adequate lighting (Joint Information Systems Committee, 2002). It is also important to make sure that the computer is powerful enough to meet the demands of digital video development. According to the Joint Information Systems Committee in its Click-and-Go Video Streaming guide, the computer should have the following specifications to adequately manipulate digital video for streaming purposes:

- A high end PC (Intel or AMD Processor) or Macintosh (G4/G5) with a processor speed at least 1.2Ghz+ for the PC and 1Ghz+ for the Macintosh.

- At least 256MB RAM with a recommended of 512 MB.

- A large and fast hard disk drive with a recommended of 80GBs+ and an RPM of 7200+.

- A good quality graphics card with at least 32 MB of RAM.

Most streamed video comes in one of three popular formats: (a) RealNetworks' RealMedia (b) Microsoft Windows Media (ASF or Advanced Streaming Format), and (c) Apple Quicktime. These three formats are proprietary in that media produced by one of the formats can be displayed

by a supporting player. However, each vendor does provide a free player that can be downloaded from the Internet. All three have specific advantages and support the Real Time Streaming Protocol (RTSP). To stream files created in these three formats, the video files must be placed on a streaming media server that has the server-side software to stream the video. In addition, that server must have enough capacity and bandwidth to support the number of simultaneous video streams by multiple users (Giaconia & Hein, 2003). Other formats for streaming video include MPEG-2, and more recently, MPEG-4. MPEG-4 is a newer standard specifically developed to address Web and mobile delivery. MPEG-4 is backward-compatible with MPEG-2, a video compression standard used on billions of DVDs and millions of satellite receivers.When selecting a streaming format, an instructor may have to offer the video file in at least two of the three major formats and at three different bandwidths at 56K and higher to ensure that the needs of the largest possible audience is fulfilled.

Steps to create and deliver files are relatively simple. First, the instructor must record the content to be used in the course (e.g., lecture) with a variety of video technologies such as a camcorder, digital video camera, digital still-frame camera, or any other specialized software or hardware. To produce the audio, a microphone connected to a computer or video recording device can be used. The next step is to edit the video and audio using specific software or video editing devices. However, the audio/video files must be digitized first. If the video had been captured with a digital video camera, this digitizing process was already accomplished. If this is not the case, then the analog medium (e.g., VCR) will have to be connected to a computer with a video capture device and software to digitize the media file (Giaconia & Hein, 2003). A video capture card/device translates the analog video file into digital signals that a computer can read. The digital video then needs to be compressed through an encoder that uses modern streaming media codecs (compressors /decompressors). These video codecs help reduce the amount of data to the smallest possible amount that is required for streaming by eliminating unnecessary repetitious data (Klass, 2003; Marioni, 2004). When encoding videos into a streamable format, the instructor needs to consider how the video is to be compressed. There are basically three criteria that make up the quality of a streaming video. The three criteria are (a) frame rate that designates the number of still images that make up one second of video, (b) color depth or the number of bits of data the computer assigns to each pixel, and (c) the resolution that is measured by the numbers of pixels (AboutVideoEditing, 2003a; Marioni,

2004). These three parameters can highly affect the file size and the quality of video that will be seen by the student.

A final consideration for creating streamed videos is the server. Media is a cross platform. The RealPlayer is free and available for all major OS platforms. The RealNetworks' Helix Servers are available on Windows, Linux, and Unix-based operating systems and support all major file formats, including RealMedia, Windows Media, QuickTime, MP3, MPEG-4, and others. The Helix Basic Server is free for up to five simultaneous streams. The paid version of Helix Universal Server is a full-featured server that allows 100 simultaneous streams. Windows Media server and player are free, but they are only available for Windows OS only. Also, both the QuickTime server and player are free. The QuickTime player is available for most OS platforms, but the QuickTime server is supported natively in MAC OS.

A server is needed to store the media file and software that can stream the data over the Web. The file must be uploaded to the server and linked to a web site so that students can watch the video (Giaconia & Hein, 2003). The user selects a file and the streaming process begins by sending small packets of information over the network to the client-side computer. Once enough data has been received, the player streams the video while the player acts like a buffer and collects the data at an uneven rate from the server (Klass, 2003). A generic streaming server would require the following specifications to properly house and run the videos: 1GHz+ processor, 1GB+ RAM, large hard disk storage capacity, and fast network connectivity (Joint Information Systems Committee, 2002). If the connection speed will not support the server, there is no point of having a fast server. Thus, choosing the fastest option available in terms of bandwidth is important because if the server does not have enough bandwidth to cope with the demands of the users, then students will receive poor video quality feedback such as jerky images, broken sound, and even loss of connection.

ADVANTAGES OF USING STREAMING VIDEO

There are many advantages of using streaming video. Some of the advantages include (a) instant play, (b) distributing live events, (c) delivering long-forms of media, (d) multicasting to multiple viewers, and e) the easy

creation of streamed files (Schmerbeck, 2000; Weiser, 2002). Other advantages that streaming video files can offer educators are creating visually driven materials that are more appealing to learners, helping educators handle volatile or quickly outdated materials (e.g., CD-ROMs, tape) that can be stored into a searchable database, and create synchronized presentations by having audio accompany still images, graphics, or text (College of Extended Education, 2003). However, individual control of pacing is the main advantage of incorporating streamed videos into distance learning courses. Control includes access, choice, and manipulation by the students (Joint Information Systems Committee, 2002). With streamed videos, students can access the material asynchronously and independent of their location. Students are no longer bounded by the traditional classroom or the library to view visual materials provided by the instructor. With streamed videos, students can access the visual materials at home and at any time. Another control element is the choice over which material to observe on-demand. Finally, being in charge of when to start, pause, skip, and review the visual material is another way that students can contend with the material. In short, the primary advantage of streaming video is the ability for students to self-pace their learning.

LIMITATIONS TO CONSIDER

However, there are drawbacks of streaming video that the instructor must consider. Inadequate bandwidth to retrieve streamed files is one limitation (Reed, 2003; Schmerbeck, 2000). Video streams can be bandwidth intensive. Depending upon the Internet traffic, users who have 56K modems or even cable/DSL connections may have difficulty in terms of retrieving and playing streamed video. Internet congestion can cause playback delays, and even living on a particular road or street can influence the reception of streamed video connection (College of Extended Education, 2003). In addition, competing technologies to control standards is another obstacle for video streaming. Different vendors have set their own standards in terms of video streaming and this has caused a problem in that if a user does not have the right player, the video cannot be seen. Finally, lack of training and technical support can prevent effective video streaming use (Burnett, Maue, & McKaveney, 2002). If support and training are not readily available, it is difficult to sustain streaming video in academic institutions because of limited access to technology and knowledgeable experts who can assist in

maintaining and developing streamed video (Shepard, 2004). Equipment requirements, technical support, and network infrastructures need to be firmly in place before any quality video streaming projects can occur. Therefore, it is vital that these resources are made available to take advantage of what streaming video can offer to education.

GUIDELINES AND RECOMMENDATIONS

If an instructor decides to use streaming video in online courses, several things should be considered. When using media in a course, it is important to keep in mind that students at a distance do not always get the same personal feel as those who are on campus. Recording the video in a studio setting instead of the classroom can help alleviate some of this feeling by creating an environment that makes the online viewer feels as if the instructor is personally addressing him/her (Klass, 2003). Keeping the video short and to the point can also help maintain interest than watching long, dull videos of lectures. It is recommended to use short 15-minute clips that incorporate PowerPoint slides and demonstrations to present course materials (Boullart & Matar, 2002). This adds variety to the video, and thus, helps maintain learner attention by removing the "talking head" element. However, in some cases the "talking head" element is an advantage when it comes to encoding. The "talking head" is a tight shot of the person's head, and if this were to be streamed over the Internet, the picture quality would be higher. If movement was incorporated, the video would become jumpy and hard to watch because during the compression process the information had to be refreshed more often (AboutVideoEditing, 2003b). Thus, panning and zooming should be kept to a minimum to avoid the compression compensating for the motion. Use motion only where it clearly compliments the learning experience. Close shots with minimal movement work better than far away or action shots of the subject. In addition, it is important to focus more upon the presenter and remove an unnecessary background much as possible. Finally, avoid rapid cuts or changes of scenery because each time the scene alters, the compression has to reload a whole new image that can lead to choppy video. With these suggestions in mind, the video file can become smaller, and in turn, streamed faster for the user.

Other considerations when recording digital videos for streaming include the use of colors and patterns (AboutVideoEditing, 2003b; Joint

Information Systems Committee, 2002). Bright colors are best while darker colors can confuse the compression process because the colors will start to blend with the subtle shadows. However, use of over-bright colors such as whites, blues, and yellows can create distortion because of glare and bleeding. Contrast of colors is another important production consideration, so be sure that the presenter stands out from the background. When it comes to the background, solid colors are best because patterns need to be refreshed constantly and they are often lost anyway. The same applies to the clothing of the presenter. Patterns, stripes, and multiple colored clothing distort the video and tend to bleed. In addition, patterns and stripes need to be refreshed every time there is a slightest movement. Thus, avoid patterns and stripes and areas of high contrast or intensively bright backgrounds whenever possible. This also holds true for flashy jewelry and watches. Remember, every time a movement occurs within the video, the encoder has to work harder to compensate for the movement and file sizes can increase.

The instructor should also keep in mind the quality of the video (Kennedy, 2001a; Segal, 2001) and make these resources clear and viewable (Kennedy, 2001b). Considering the speed of the students' connections, an instructor could make two versions of the video presentation: one for high-speed connections and one for dial-up connections. If the player that an instructor uses supports Synchronized Multimedia Instruction Language (SMIL), the SMIL tag would allow the user's connection to be checked, and that way, provide the appropriate presentation (Klass, 2003).

CURRICULAR APPLICATIONS

Integrating streamed media into online instruction can have numerous benefits for distance learners. Primary methods of content delivery in online courses predominantly consist of text/reading and communication tools such as e-mail and chat. However, streamed media can offer online learners more diversity and visually appealing forms of instruction beyond just reading and communicating through e-mail. Some ideas for curricular applications of streamed video and audio can be organized into two main categories: delivery of information and demonstrating a process. In the information realm, instructors can use various means of streamed video to ensure that learners grasp and understand the concept being taught. For instance, instructors can record a PowerPoint lecture with a voice-over narration and

include a short video segment in the beginning of the slideshow to introduce learners to the objectives of the material (Klass, 2005). An example of a process demonstration with streamed video could include a scenario in which an archeologist explains and exhibits to the students how to properly excavate a historic native gravesite. The difference between the later example and the first is that the video on excavation is used to demonstrate a skill or process rather than just delivering content material.

Another use of streamed media is to combine video and audio with other forms of instruction such as print, communication tools, and software programs. As for printed materials, instructors have provided virtual handouts and interactive study guides to accompany streamed video segments to explain the concept further and help learners focus on the necessary material. In addition, a printed text version of the streamed video is useful for learners who benefit from written information and/or for taking notes. Using any of the communication tools to augment ideas presented in streamed media can help stimulate learner interaction. If discussion and participation are part of the course, then short video segments intermingled with online discussion and chat can promote interactivity among and between instructors and students. Finally, using software programs to supplement the instruction delivered through the streamed media is beneficial for making learning interactive. For instance, requiring learners to view short case studies on purchasing and selling stocks in streamed video and then complete example worksheets in Excel or another spreadsheet program can help learning become more relevant than just viewing the videos. Thus, the practical instructional applications of streaming video and audio are dependent upon individual creativity and resourcefulness.

Using video streaming as a form of feedback is another instructional application to help distant learners understand problem solving procedures and abstract concepts. Computer screen capture programs such as Camtasia are useful when the need to record step-by-step operations concerning computer software programs exists. These short videos can be streamed online to help distant learners follow complicated software operations to complete computer-related assignments. However, this method goes beyond just being instructional. Video streaming can also serve as a form of feedback. For instance, students who may have difficulties with a particular software program can record their own step-by-step procedures on personal computers using Camtasia and then e-mail that Camtasia video to the online instructor. The online instructor can review the video that the student

recorded to see what he/she may have done wrong such as using an incorrect function or an improper image file format. After reviewing the procedures that the student has used, the instructor can record the correct way of performing an operation through Camtasia and post the streamed video online that could be seen by everyone in the course. This form of feedback helps distant learners problem-solve solutions to complete online assignments. In addition, such video streaming application can help increase online interactivity and communication between instructors and students. In short, curricular applications of video streaming is limitless and depends upon how the medium can be used to augment teaching and learning.

CONCLUSIONS

Streaming video and audio can offer exciting opportunities for online teaching and learning. As learning online becomes more of a common practice in education, streaming video and audio will play a bigger role in delivering course materials to online learners. This form of technology brings courses alive by allowing online learners to use their visual and auditory senses to learn new concepts. Learning how to incorporate such media can be acquired through online tutorials and workshop training. Many advantages and disadvantages are associated with streaming media that must be weighed by the instructor. Instructors are the ones who can decide what will work in their courses, and they must choose to do so after thoroughly investigating streaming video's effectiveness. When the decision is made, adapting some of the techniques mentioned in this article can help promote a positive experience for the distant learner. In all, video streaming allows online instructors the opportunity to deliver alternative course materials to students who are not campus-bound.

References

AboutVideoEditing. (2003a). *Streaming video over the web*. Retrieved November 4, 2005, from http://www.aboutvideoediting.com/articles/web-streaming-video.shtml

AboutVideoEditing. (2003b). *How to shoot streaming videos for the web*. Retrieved November 4, 2005, from http://www.aboutvideoediting.com/articles/shooting-streaming-video.shtml

Boullart, L., & Matar, M. (2002). *Challenging streaming video in e-learning*. Retrieved November 6, 2005, from 2002 EDEN Annual Conference Proceedings (Grenada, Spain) at http://www.eden-online.org/papers/publications/toc-gran.pdf

Burnett, A., Maue, D., & McKaveney, E. (2002). Planning and implementing instructional video. *Syllabus, 15*(11). Retrieved November 4, 2005, from http://www.syllabus.com/article.asp?id=6394

College of Extended Education. (2003). *How are instructors using streaming media*? Retrieved November 4, 2005, from http://asuonline.asu.edu/FacultySupport/FAQ/action.cfm?ID=29

Garrison, W. (2001). Video streaming into the mainstream. *Journal of Audiovisual Media in Medicine, 24*(4), 174-178.

Giaconia, J., & Hein, J. (2003). *Developing streaming video: A prime*r. Retrieved November 4, 2005, from http://cvc3.coastline.edu/streamingprimer.htm

Joint Information Systems Committee. (2002). *Video streaming: A guide for educational development*. Manchester, UK: JISC Click and Go Video Project.

Kennedy, T. (1999). What is streaming media? *Streaming Media World*. Retrieved November 4, 2005, from http://smw.internet.com/gen/tutor/whatis

Kennedy, T. (2001a). Streaming basics: Shooting video for streaming. *Streaming Media World*. Retrieved November 4, 2005, from http://smw.internet.com/video/tutor/streambasics1

Kennedy, T. (2001b). Streaming basics: Editing video for streaming. *Streaming Media World*. Retrieved November 4, 2005, from http://smw.internet.com/video/tutor/streambasics2/index.html

Klass, B. (2003). Streaming media in higher education: Possibilities and pitfalls. *Syllabus*, *16*(11). Retrieved November 4, 2005, from http://www.syllabus.com/article.asp?id=7769

Klass, B. (March 15, 2005). Streaming media in higher education: Possibilities and pitfalls. *Campus Technology* (in print). Retrieved November 4, 2005, from http://www.campus-technology.com

Lorance, J. (2003). Webcasting and web streaming. *TechSoup*. Retrieved November 4, 2005, from http://www.techsoup.org/howto/articlepage.cfm?ArticleId=522&topicid=2

Martindale, T. (2002). Understanding computer-based digital video. *TechTrends, 46*(4), 19-22 & 57.

Marioni, R. (2004). *Streaming video for the masses*. Retrieved November 4, 2005, from http://hotwired.lycos.com/webmonkey/templates/print_template.htmlt?meta=/webmonkey/

Michelich, V. (2002). Streaming media to enhance teaching and improve learning. *The Technology Source*. Retrieved November 4, 2005 from http://ts.mivu.org/default.asp?show=article&id=941

Reed, R. (2003). Streaming technology improves student achievement. *T.H.E. Journal, 30*(7), 14-20.

Schmerbeck, A. (2000). *Streaming video*. Retrieved November 4, 2005, from http://www.edb.utexas.edu/multimedia/Streaming%20Video.pdf

Segal, N. (2001). Creating quality streaming video. *Streaming Media World*. Retrieved November 4, 2005, from http://smw.internet.com/video/tutor/videotips/index3.html

Shepard, K. (2004). Questioning, promoting, and evaluating the use of streaming video to support student learning. In J.J. Hirschbuhl & D. Bishop (Eds.), *Computers in education* (pp. 124-130). Guilford, CT: McGraw-Hill/Dushkin.

Stilbore, L., & MacGibbon, P. (2001). *Video/video conferencing in support of distance education*. Retrieved November 4, 2005, from http://www.col.org/Knowledge/ks_videoconferencing.htm

Weiser, C. (2002). Video streaming. *Media & Methods, 38*(4), 10-14.

Zachariah, K. (2001). A technical view: Streaming Web video. *Syllabus, 15*(4), 30-31. Retrieved November 4, 2005, from http://www.syllabus.com/article.asp?id=5666