Video and Learning Redux: New Capabilities for Practical Use
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Film and video have long been advocated as powerful adjuncts to classroom instruction. The combination of moving images and multiple sound tracks offers instructional designers a powerful medium for crafting mutually reinforcing explications of concepts while providing learners with content that engages multiple senses. Video has been particularly important in distance education with more than half of all distance education programs in 1995 using some form of video content (National Center for Education Statistics, 1999). *Digital* video adds possibilities for making learning interactive and this interaction has been powerfully leveraged for more than a decade in videodisc-based projects such as the Jasper series that actively 'anchored' learners in adventures that give rise to 'authentic' problem solving situations (Cognition and Technology Group at Vanderbilt, 1997). The Internet offers significant new possibilities for delivering video even more broadly and easily in both traditional and distance education venues. Thus, educators at all levels have yet another opportunity to incorporate audiovisual and interactive materials in their classrooms.

The engineering fields driven by home video markets and on-demand video applications for home and business have driven research and development related to hardware, software, retrieval, segmentation and indexing, and compression and transfer. On the design side, digital video is easy to create with low-cost digital cameras and relatively easy to edit and enhance with digital editing tools. Although crafting good content requires significant expertise, the technical requirements have become less demanding and expensive, thus more educators and students are able to create their own video content. Even larger ranges of educators and students are able to use and modify existing video if it is made available to them. From a delivery point of view, digital video can be streamed to learners with mid-range Internet capabilities. Emerging infrastructures such as Internet 2 provide a basis for high-quality, real time video file transfer. Thus, the technical requirements for incorporating digital video in instruction and learning are mainly in place. The greatest challenges, however, are in acquiring specific classroom content, assembling content and developing instructional strategies and tools that teachers and learners can find and apply quickly and easily.

Desiderata for Incorporating Digital Video in Teaching and Learning
The possibilities for distance learning as well as classroom-based on-demand usage have spawned many projects that aim to enable teachers to incorporate digital video in instruction (e.g., the Video Development Initiative http://www.vide.net/, and the Baltimore Learning Community (BLC) http://www.learn.umd.edu/. Our experience in the BLC project showed that a small number of teachers are willing to invest time and effort to use and contribute digital multimedia and lesson plans, but most teachers do not have the time or inclination to adopt new techniques given the extant pressures of teaching five classes a day. Research and development efforts serve as a necessary base for the technical elements of digital video adoption. They are not, however, sufficient to insure that digital video will be widely used in education. Several other developments are required for busy teachers to incorporate digital video into their teaching. These requirements include:
- diverse and easily accessible libraries of digital video content;
- easy to use tools for finding and previewing video;
- tools for presenting and discussing video individually or collaboratively;
- tools for students to use in studying and discussing video individually and collaboratively;
- tools for integrating video segments into presentations and lesson plans linked to local and national curriculum guides and standards; and
- instructional strategies for integrating video into teaching and learning.

This article describes a project that directly addresses the first four requirements and provides an environment for designers and teachers to address the last two requirements. Many of the design decisions for the project are based upon the assumption that discrete video segments can be used as building blocks for instructional modules that include a variety of media resources. Although complete productions (e.g., documentaries, taped or broadcast lectures and demonstrations, etc.) will continue to play important roles in education, new possibilities exist in reusing discrete video segments drawn from these productions (or created purposefully on their own) as part of a larger instructional experience. We believe that assembling such content, and giving teachers and students tools to easily access and reuse video chunks will generate new interest and activity in integrating video into teaching and learning. Thus, our design philosophy aims to empower teachers and learners to create and share new resources as well as use existing ones in a digital video library.

The Open Video Digital Library
The Open Video Project (www.open-video.org) is an on-going effort to develop an open source digital video library that can be used by researchers, teachers, students, and the public. As of the Spring of 2002, the collection indexes almost a half terabyte of content from more than 1600 video segments, drawn from over 1100 different titles. The primary goals are to create and study an open source repository of digital video and use the repository as a testbed for our video browsing interface research. The interface work and user studies are detailed in various papers (e.g., JCDL 2001; CHI 2002). The project sprung from our experience in the Baltimore Learning Community and represents an instantiation of a digital library as a sharium, where people collaborate and may contribute as well as use materials and expertise (Marchionini, 1999).

The OV provides multiple ways to find video segments and preview them before downloading. Several important design decisions were made with instructional usage in mind:

- Emphasize files rather than streams;

- Emphasize short segments rather than full videos;

- User interfaces are crucial to adoption;

- Systematic and extensive databases and metadata are crucial to flexible user interfaces; and

- Tools for easily manipulating video are needed for effective classroom or individual study use.

Although streaming media can minimize client-side requirements, we feel strongly that providing people with manipulable files that they can download, manipulate, and reuse is especially valuable in educational setting. The flexibility files provide does add costs of storage but end-users could simply choose to stream the files and not store them if they wish to use an entire segment with existing commercial playback tools. More importantly, providing files raises intellectual property issues because anyone can redistribute and edit the files. The OV aims to archive video that people or institutions want to share with the education and research communities. Thus, people are encouraged to download, reuse, and contribute video files.

Unlike the video-on-demand services in hotels and homes, our goals are to help teachers integrate specific video scenes or segments into instructional packages, and to help students study and focus on specific concepts and skills. Although teachers may wish to download a full documentary for use in class, we aim to empower teachers to create new, multimedia modules that integrate the realism of multi-channel video with the interactive media of computers. Likewise, although students may wish to watch and annotate an entire documentary or lecture, we aim to empower them to isolate key segments and make them part of their notes and presentations.

Agile Search and Browse Capabilities
To achieve these goals, we are developing agile interfaces that allow users to manage multiple levels of granularity as they search and browse video. The current interface provides three kinds of search and several ways to browse. Attribute search provides pull-down menus or radio buttons for key attributes such as genre or producer. This provides a quick way to partition the database into videos with specific characteristics of interest. Two word search options are also provided. A text box is provided for user-entered queries that are matched on the full text search of bibliographic records as well as transcripts for those videos that have transcripts available. A pull-down menu of keywords is also available. Browsing is supported at all levels of the interface. At the top level, a selection screen provides indexes on genre, duration, color/sound, and contributing organizations. In all cases, the number of segments in any index is provided (see Figure 1).   All search and browse functionality is database driven and is thus scalable to very large collections.

Once users have partitioned the database through top-level search or browse tools, increasingly detailed overviews for partitions and previews for specific segments are available. Techniques for 'looking ahead' before moving to a more detailed level or beginning to download a video file are an important part of the agile views interface framework. These 'look aheads' are particularly crucial to practical work with video libraries containing many very large files. Figure 2 illustrates part of a display once the user selects the 'educational' genre from the browse page. When the user 'hovers' (places the mouse) over a details icon, a brief description appears in a pop-up box. Clicking on the details icon yields the full bibliographic record that includes a tab option for the bibliographic record for the full video to which the segment belongs, and a tab to a visual preview for the segment (see Figure 3). At any of these points in the interaction, the user can begin to download the complete segment.

Design and Development Directions
All of the above functions are available in the WWW version today. Our research prototypes include a variety of alternative surrogates to the storyboard layout of keyframes. We are conducting user studies with slide show and fast forward alternatives, each with textual or audio keywords options. We also are testing cascading mouseover mechanisms that allow people to see any of these alternative views through mouseovers rather than clicks. Additionally, we have created storyboard and dynamic collages that serve to give overviews of subcollections (e.g., the results from a search) of segments. These overviews use poster frames (a single representative keyframe for a segment). We are creating both preview and overview indexes on features such as faces and text superimpositions. Thus, users could see poster frames of all segments that contain faces (overview) or a story board of all frames in a segment that contain faces (preview). Our work aims to automate the creation of these surrogates and we are using open source tools and algorithms as well as creating custom routines that will be added to open source software libraries.

To support these dynamic interfaces, extensive metadata is required. The current scheme uses twelve relational tables for 64 different linguistic and visual characteristics. These data provide the basis for the various indexes that give users different 'views' into the library. The Open Video digital library is an Open Archives Initiative provider which allows any other project or individual to 'harvest' the metadata for use in related libraries or collections. Our expectation is that educational projects acquire Open Video metadata and import them into education-specific schemes (e.g., IMS Global Learning System XML scheme http://www.imsproject.org/metadata/). Likewise, curriculum specialists and teachers can begin to use these generic metadata to locate video segments that they can then characterize according to specific local or national instructional objectives or benchmarks (e.g., AAAS Project 2061 benchmarks for science http://www.project2061.org/default.htm).

The current Open Video system provides teachers and learners with access to digital video. The next requirement is tools for easily using the video extracted from the digital library. Using a film or analog video in a classroom offers teachers little control. To illustrate a point with a specific scene or invite

questions there are few controls other than start/stop and fast forward/rewind. Digital video offers additional possibilities, but current presentation tools give little more control than traditional VCRs or projectors. Ultimately, it should be as easy for teachers and students to find, cut and paste, annotate, and aggregate video as it is for them to manage words. We have prototyped a video usage environment that allows learners to collaboratively study video from remote locations or allows instructors to multicast video streams to remote learners. The Interactive Shared Educational Environment (ISEE) allows users to interact with live multicasts, a shared web browser, shared video/audio with thumbnails for quick navigation, and text chat (http://ils.unc.edu/idl/isee/ISEE_tech_report.pdf). This environment begins to address the classroom and student study uses of existing video, including simple annotations, however, it does not provide editing and production tools. Nonetheless, it is provides a first glimpse of how multiple channels of video, text, and webpages can be integrated for instruction and study purposes.

Toward Seamless Use of Digital Video
Ultimately, teachers and students will determine how best to use video content in the Internet environment. A beginning set of capabilities digital video environments might provide includes:
- View
    - Frame-object level
    - Frame-level
    - Segment-level
    - Audio track(s) level(s)
- Jump
    - Within segment
    - Across segments
- Cut and Paste
    - Frames
    - Segments
- Study/Annotate
    - Text
    - Audio
    - Draw/gesture
- Send (various formats, with or without annotations)
- Edit
    - Aggregate
    - visual/sound edits
    - Text/special effects

These basic display and manipulation capabilities will enable learners and teachers to begin to develop instructional strategies for tasks such as preparing lessons, assembling presentations, and conducting interactive discussions. For example students or teachers should be able to easily incorporate a frame from a video (e.g., a graph or shot of an object) to illustrate a point; use a short clip (e.g., 10-60 seconds) to illustrate a point, serve as an advance organizer, or generate discussion; hyperlink from one segment to another to illustrate contrasting or reinforcing themes; and paste frames or clips into webpages used for any purpose. These capabilities will evolve if teachers and students have easy access to raw materials. This is a primary goal of the Open Video Project.

An assumption of much of this work is that making video access and use easy will encourage teachers to incorporate video into their instruction and students will incorporate it into their assignments and presentations. Using video in instruction and learning should be no more special than using textual resources. Reaching this state will require good examples and good instructional strategies. One way to achieve this state is to provide access and tools for use. If we do so, it is likely that students and teachers

will discover new ways to express themselves through the interactive video medium. Having video in small chunks that are well-indexed, easily manipulated and incorporated into lessons, and remotely discussable is a first step to realizing the potential that decades of research and development have promised.

References

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Figure 1. Top-Level Browse Display

Figure 2. Results Display with Details on Demand

THE OPEN VIDEO PROJECT
a shared digital video repository

Find Video | Contribute Video | Project Info

Find Video Results

Displaying **1** to **36** of **36** records found.

Segment Title		Details	Duration	MPEG-1	MPEG-2	MPEG-4
	Ben Shneiderman's introduction of early projects		00:01:39	16.30 MB		
👁	Bringing treasures to the surface		00:07:44	76.00 MB		
	Browsing Anatomical Image Databases: The Visible Human					
👁	Browsing and annotating digital photographs with Photofinder					
👁	Designing PETS: A personal electronic teller of stories					
👁	Designing the Classroom of the Future		00:06:50	101.00 MB		
👁	Dynamap: Dynamic queries in choropleth maps		00:01:51	18.20 MB		
👁	Dynamic Queries Demos		00:09:44	95.70 MB		
👁	Elastic Windows: Improved spatial layout and rapid multiple window operations		00:06:50	67.10 MB		
	Filter/Flow metaphors for Boolean queries		00:06:36	64.90 MB		

We worked with a team from the Library of Congress (LC) to develop interface design components for LC's American Memory collections of historical multimdeia materials. Our prototype illustrates the benefits of previews (such as samples, collections of thumbnails, and video previews) and overviews (such as timelines and automatically generated tables of contents) to facilitate the browsing of search results or entire collections. [click for more details]

Figure 3. Storyboard Preview for a Segment