Looking through Three 'I's:
the Pedagogic Use of Streaming Video

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ABSTRACT

Although the pedagogic use of film and video has a long history, its widespread use has always been limited by production costs and delivery difficulties. In recent years costs of production have fallen and the web has emerged as a mainstream educational distribution medium. Video itself can be used in many ways: 'talking head', interviews, video diaries, video labs, simulations, instructional sequences, 'fly on the wall', video help etc. Through the browser, 'streaming' video sequences can be linked to slides, text conferencing, whiteboards, video conferencing, shared applications, online assessment and third party web sites. A major element of the JISC/DNER Click and Go Video project is to move beyond the current understanding of video as a purely presentational tool. The seamless combination of digital video with other tools offers an opportunity to experiment with video as a focus for networked learning. However there is an acute lack of pedagogic resources, research and evaluation on the use of video streaming for teaching and learning. The pedagogical challenge faced by teaching staff and practitioners is not only to choose the appropriate streaming technology but also to design meaningful learning events. In this paper we introduce a way to analyse video use through what we have named the *Three 'I's Framework* – image, interactivity and integration. This conceptual framework seeks to provide a practical decision tool to help teaching staff and practitioners with the pedagogic design and development of video streaming resources for online learning. Our aim is to provide a way of understanding the role of video as it changes from a presentation tool to a focus for networked learning.

Keywords

Video streaming, pedagogic framework, web-based learning, multimedia, networked learning

INTRODUCTION

The creation and use of digital web-based video is now open to non-specialist educators and even learners themselves, with the potential of becoming a routine component of online education and networked learning. Although conventional (analogue) film and video has a long history in tertiary education, its widespread use has always been limited by production costs and delivery difficulties. However production costs have now fallen with the emergence of high-quality, easy-to-use cameras and desktop video editing software aimed at the domestic market. Delivery has similarly been revolutionised by the growth of the web as an educational medium together with the rapid uptake of web-based streaming video technologies. 'Streaming' is a method of making video, audio and other multimedia available over the Internet, with little download wait and no file to take up space on your hard disk. Streaming offers the promise of easier and more responsive 'on demand' access to multimedia resources.

From a teaching and learning perspective, the challenge for academics is how to use these new technologies in ways that are pedagogically appropriate and sensitive to their students and the learning context. The choices with streaming video are intrinsically different from those of earlier video technologies, the main choice being the crucial compromise between image quality and accessibility to remote users. Even with the latest hardware and software, at the moment broadcast-quality video is not possible over the types of internet connection (largely modems), available to most home users. Video designed for modem use tends to have a low frame rate and resolution i.e. it appears to the viewer as jerky and fuzzy. The question of 'how low can you go' in quality terms without losing the educational value reoccurs throughout the project and this paper. This in turn raises questions such as what is the value of the moving image itself in education. In contrast to the technological advances, research into the pedagogic uses and value of web video has lagged behind. Although the literature on educational uses of standard video (i.e. broadcast television and video tapes) may provide clues, the nature of the video has itself changed as it cannot now be treated in isolation.

The JISC/DNER Click and go Video project was established in 2000 to begin to address these issues and focus on the alignment between technology, pedagogy and infrastructure (Asensio, Strom, Young 2001). The project has developed a web site for the academic community that aims to stimulate the use of video streaming. Within the project we clearly believe video streaming can enhance the teaching and learning experience. The project however sees the technology as a focus for educational innovation, not a driver. How the academic community conceptualises, adopts and adapts the technological opportunities on offer is just as important as the production process itself.

One of the key problems uncovered by the JISC/DNER Click and Go Video project has been that participants do not have either a pedagogical conceptual framework or a shared vocabulary to describe the ways they envision using digital video with their students. The lack of an established literature and lexicon for visually based forms of learning is particularly marked in comparison with other areas of networked learning such as text-based conferencing. An unexpected part of the project therefore has become the development of a framework to attempt to interpret the academics' actual or intended use of video streaming. This framework was seen as a necessary prerequisite to the evolution of a decision tool to help educators not only to evaluate streaming video for their own teaching needs but also develop technically appropriate solutions. This paper reviews the different approaches to categorising video use and explores the 'value' of video in education. We introduce a way to analyse video use through what we have named the *Three 'I's Framework* – image, interactivity and integration. This framework seeks to provide a way of unravelling the often complex ideas academics have for using video and provide a route to help the design and development of the resources themselves. The principles of the framework are grounded mainly on our experience with the work on the three distinctive case studies of the project: the Department of Textiles (UMIST), the Hospitality and Tourism Management Department (Manchester Metropolitan University), Department of Surgery (University of Manchester). We have in addition drawn on the discussions with and contributions from participants from project workshops to develop and illustrate the framework.

frameworks for video use

One of the primary tasks for the project was to find out how streaming video was being used in universities and colleges. Quantitative information on use is almost impossible to obtain at the moment, but qualitative and descriptive models are beginning to appear. For example Peters and Collis (2000) describe five categories of learning resources and activities associated with streaming video in what they describe as constructivist learning environments:

Capturing and re-using a communication event (such as a lecture or a presentation)

Giving access and depth to real events (by inclusion of original material)

Supporting a learning process (documentaries, tutorials, interviews etc)

Developing and accessing a library of cases or units of learning material

Constructing and sharing ones own resources

The authors then explain how these can be used to support communication and can be linked to other information and re-used as part of a learning environment. The first three categories in particular indicate the actual content of the video resource. Discussion with practitioners through a series of Click and Go Video workshops suggests that the capture of educational events (Category 1) such as lectures, seminars, workshops, or conferences (sometimes characterised as 'talking heads') to be archived as educational and consultation resources is probably the most widely used technique at the moment. The intention of Category 2 video is to bring real life events to the context of the formal classroom so they can be observed, analysed, interpreted and discussed. This might apply to a wide range of phenomena taking place in external locations such as field trips, linguistic samples or dramatic performances. Again this is a relatively common activity and libraries of such materials are growing. For example Lifesign, another JISC funded project, offers 40 life science video streams free to UK universities and colleges.

The third category warrants some elaboration. Purely instructional approaches ie showing the process of demonstrating something concrete, the procedures, the different stages we can think of a variation of this is to simulate an event such as a laboratory experiment where safety is at risk or to engage in a role playing situation where the students can experiment with different roles and behaviours. Video here seems to fulfil a number of functions. Hempe (1999) refers to the strengths of video as visual demonstration, dramatisation, presenting visual evidence and making an emotional appeal. Certainly it helps to describe visually an explanation of a procedure or process through a 'show and tell' style but also it reinforces and helps students visualise what the lecturer is saying. In addition video may validate knowledge through a moving image or representation. Hempe also draws attention to the 'emotional' resonance of video. Academic developers often refer to the motivational aspects of video i.e. it can bring subjects 'alive'.

Peters and Collis' Categories 5 and 6 put potentially both the lecturer and the students as creators of their own teaching and learning material. Goodyear and Steeples (1998) within the SHARP project focused primarily on using digitised video clips to explore ways in which knowledge that is tacit and embedded in working practices can be shared among practitioners for collaborative professional learning. They linked different kinds of video representations of practice with different kinds of representational purposes. Their category of video use ranges to increasing abstraction from real-world practice with the use of scripted text to a more unstructured approach. Examples are as 'fly on the wall' (the camera is set up to capture an event *in situ*, an spontaneous event without script) or 'think aloud' (a subject describes his/her thoughts or actions while undertaking a process).

Although categories of use provide us with a useful checklist of ideas and applications, it does not help us to think about how our video should be shot and digitised, to what quality, how it should be presented to the student and how the students themselves can be involved in the process. These turn out to be key questions when academics think about constructing their own libraries of resources. For this reason the project needed to deconstruct the use of video a little further to explore the pedagogical value and utility of video streaming.

THE VALUE OF VIDEO STREAMING AND THE THREE 'I'S FRAMEWORK

Although nowadays the technologies are relatively easy-to-use and affordable, the development of video resources proposed by Peters and Collis still represents a considerable time investment by an individual or institution. In the absence of any widespread evaluations of learning outcomes of this medium the question arises as to what is the real 'added value' of the moving image for any pedagogical setting. Broad descriptions such as 'giving access and depth to real events' and 'making an emotional appeal' are not really detailed enough to inform design decisions. For example, what specific elements of the video give depth or appeal to the emotions? Essentially we are trying to explore the interface between pedagogical value and the practical utility of the technology to deliver those values.

One way to start is to reconsider the list of technologies from a historical perspective. Something that film, television, videotapes, videodisks, digital desktop video, multimedia, CD-ROM and web media all have in common is the focus on the moving image itself. However from the late 80's to the mid 90s the selling point for videotapes, videodisks, digital desktop video, multimedia, CD-ROM was actually the promise of 'interactive video'. The image was still important, but was overlaid with the idea that the user could have easier and more controllable access to the resource. In the mid 90's the web reinforced

further accessibility and interactivity, but added a new element, 'integration'. This meant interlinking with other web materials and of course communication and collaborative tools. This is partly a case of new technical opportunity, but also the influence of prevalent pedagogical theory interpreting the tools in new ways and seeing opportunities in them for curriculum reform.

Thus in the purely historic context we can see three overlapping phases of interest in video accompanied by a subtle change in the control over the resources;

> image (film, television, videotapes - teacher in control)

> image and interactivity (videodisks, digital desktop video, multimedia, CD-ROM - learner in control)

> image, interactivity and integration (web media - distributed control).

However, we were interested to know if there was any connection with the educational value of video as perceived by the participants of our Click and Go Video workshops. Participants were asked to write down the different values they saw video in education. These values suggested the three categories of image, interactivity and integration had a resonance in the way individuals conceptualised their current or planned use of video. The following table illustrates a selection of the thoughts expressed by the participants.

Image	Interactivity	Integration
•Video is more appealing •Allows me to work outside the classroom and illustrate how theories/techniques can be applied in real life •People take in more information when it is presented visually compared with text and voice alone •Able to see technical experts / examples / demonstrations •Looks nice – may encourage those lazier users •It grabs attention, it's new •It's a good way to get students ideas across without the need for writing •It adds to the entertainment value •Pictures can quickly give information whereas words can take longer	•Student ideally has control •Students can re-wind, replay in their own time and at their own speed. •Ability to repeat/pause •Can learn anywhere, anytime •Can select what is of use •To provide the personal 'chemistry' between lectures and students that are remote •Students can view in confidence •Greater audience numbers can be reached •Greater access to learning for disabled students •Provides interactive teaching environment	•Allows for dynamic presentations •Adds value to text •Support for teaching and learning, not instead of •Mix of media for students studying at a distance •To widen participants and address different learning styles •Video can work alongside lectures and compliment the students' module •Being able to split video into parts and relate to exercises •Integrating with web resources •Student support and feedback •Feedback to staff etc

Table 1 examples of the value of video in education as expressed by JISC/DNER Click and Go Video workshop participants

If as we suggest ideas of image have been current longer than those of interactivity or integration we might expect participants produce more responses relating to the value of image. Indeed in our ad hoc survey 'image'-related responses outnumbered 'integration'-related responses two to one, with 'interactivity' somewhere in between. In the next section we will describe these three values on more detail.

IMage, Interactivity, integration

The moving image has long been a feature of education, from the earliest 'magic lanterns' over a century ago to latest web streaming technologies. However when we consider the changes in media over this period through film, television, videotapes, videodisks, digital desktop video, multimedia, CD-ROM and now web media we should remember that none of these technologies were primarily designed for education. Over the years educators have looked at each technology as it has become available and tried to find a 'meaning' appropriate to the contemporary pedagogic and cultural context. Thus early uses of film and video were often used as part of a classic 'instructional' pedagogy, while the digital 'desktop' technologies that emerged in the 1990's both enabled and were interpreted within more constructivist paradigms then gaining currency. This trend has become more pronounced with the emergence of streaming video in the late nineties. The current pedagogical challenge for educators using this medium seems to move beyond the 'mere' instructivist, to encompass the collaborative, contextualised and conversational modes familiar to networked learning. Web-based video offers all the advantages of traditional video, for example the ability to include educational events such as lectures, lab experiments, demonstrations, interviews and recordings of events and locations outside the classroom. However, the ability to combine digital video seamlessly with other tools offers an opportunity to move our concept from video as a purely presentational tool to video as a focus for student activity and communication. Unfortunately this adds to the cognitive load of the individual

academic who has to choose and assess the technology available and to use it in ways that are pedagogically rich and appropriate. Dividing the value of video use into three categories may help to clarify the complexity

Value of video: Image

As the most established and indeed the underpinning 'value', the role of image is clear: to complement and add visual richness learning resources. Duchastel and Waller (1979) observed that the use of illustrations in text attracts attention, aids retention and recall and is explicative when written or verbal forms are not enough. Goia and Bass (1986) noted that students had grown up in an intensive environment of television, movies and video games, have developed learning styles where comprehension occurs through visual images. Several researchers have made the connection between visual clues, the memory process and the recall of new knowledge e.g. Shepard and Cooper (1982), Mayer and Gallini (1990). Referring specifically to video, Goodyear and Steeples (1998) note that video can provide vivid descriptions to articulate tacit information and knowledge difficult to articulate through text and verbally. It would be wrong to consider only the visible educational messages of video, however. Undoubtedly it also carries hidden or semi-hidden messages such as narrative, emotion, authority, authenticity and symbolism. These may be more important than the explicit visual message.

However any focus on the image element of streaming video is faced with the drawback that many users (particularly those off-campus) still do not have sufficiently good Internet connections to receive streaming video in anything like the quality even of digital CD-ROM materials, let alone broadcast quality. One of the main concerns about streaming video by academics, therefore is that of compromised visual quality. Does the value or quality-related message of a fuzzy, jerky image interfere with the educational message intended? This worry implicitly refers to the sophistication of viewers in reading the 'hidden messages' mentioned above. Orton (2001) cites studies by Byron Reeves and Clifford Nass of Stanford University that even slight mismatch between the audio and video tracks (a common problem in streaming) caused viewers to consider the material to be significantly "less interesting, less pleasant, less influential". The question arises as to how familiar the viewers were to the streaming media format. Nevertheless Nielsen (1999) suggests that; it is rare that current-quality streaming video could not be replaced by a few still images and a transcript.

The response of JISC/DNER Click and Go Video is not to retreat to this minimalist approach but to think about the appropriateness of the image for the educational message it is carrying. If high definition, true colour images are needed for example in medicine or the visual arts, high quality video and careful compression is required. However the output may only be accessed on-campus or by users with very good home Internet connections. Orton's reservations aside, a 'talking head' supporting a slide presentation or a filmed interview where the message is authority and enthusiasm may not require the same level of quality and streaming may be quite appropriate.

Value of video: Interaction

Although conventional film and broadcast television are far superior in visual quality they have a major drawback in education. As Rosenberg puts it "…the main reason why television did not become everyone's teacher was because it lacked the very essential quality of teaching: the ability to interact with the learner…"(2001:22). Thus the advent of interactive video in the eighties was met with some enthusiasm.

"The potential applications of interactive video technology in educational and training fields is virtually unlimited." Thus concluded a contemporary report sponsored by UK Department of Industry (Duke, 1983:104). The key to ineractivity was the linking of computers to video technology (initially VCRs and videodisks), allowing control over the pace and direction of the video programme. This control enabled self-paced learning leading, according to Palmer (1987), not only to time saving and standardised results, but also distributed learning to a large numbers of learners. 'Interactivity' in the original sense was not confined to computer-human transactions but included

> Access – availability of the material asynchronously and independent of location
>
> Choice – a library of materials to view 'on demand'
>
> Control – ability to start, stop and review material

This should be contrasted with the more narrow view of computer-centred interactivity e.g. Kistof and Satran (1995) where interaction is seen only in terms of control of pace, sequence, media, variables etc. rather than wider access to the resources themselves.

Even with early primitive interactive video systems the educational potential for searchable random access to previously video linear resources with facilities to freeze frame, forward and reverse and multiple audio tracks was recognised. The materials could support more user-centred and independent modes of study. Some systems also allowed branching from decision points or tests along paths laid down when the programme was designed (Parsloe 1985). In a series of meta-analyses of educational outcomes, Fletcher (1990) noted that interactive videodisk-based instruction fared much better overall than the computer-based instruction studied by Kulik and Kulik (1987). Wetzel *et al* (1994) felt that "the effectiveness of interactive video was related to its being a form of computer-based instruction" and that this effectiveness in turn was explicable in terms of "the greater interactivity and individualization afforded by the variable control of pace and course of instruction, an active participation in advancement" (1994:204). It was not until the early nineties that the combination of desktop digital video and CD-ROM enabled the high levels of control and integration with other computer-based learning materials we are familiar with today. The rise of the web in the late nineties promised even greater access and choice but, as described above, resulted in problems of video quality. The video streaming compromise between image quality and access is particularly acute in terms of interactivity. One of the principle justifications of streaming media is its use in asynchronous, distance modes, yet ironically the nature of the web as a distribution medium is also digital video's main limiting factor.

Value of video: Integration

Although video can be used on its own, more frequently on the web it is interlinked with slides, supporting texts, discussion boards, chat, resource links, self assessment quizzes and so on to form or as part of a 'virtual learning environment'. This brings the possibility of designing novel learning experiences and ways of interacting with the media. The assumption is that adding an additional channel of communication to transmit a message will increase the quality of communication itself. This notion is based on two theories that support the use of several communication channels.

Multi-channel communication supporters claim that learning is effective when cues presented across channels are related or 'redundant' (not in the negative sense but complimentary or parallel). Thus Severin (1967) argued that multiple-channel communication is effective when the cues have meaning. Interestingly redundant information presented across channels increases the dimensionality of the information and the stimuli for one channel provides reinforcement for the other, which improves the quality of communication (Hsia 1971). The dual code theory also supports the effectiveness of multiple-channel communication. Paivio (1971, 1991) argues that information that is supported by both aural and visual cues should increase recall and retention. Studies by Mayer and Anderson (1991) have also shown that visual information helps to process and remember verbal information and vice versa. Critics to multiple-channel communication have contested that overloading the senses through multiple channels could result in less efficient learning, and that addition of cues in a second channel or even excessive cues within the same channel can be distracting and detrimental to learning. We could ask whether learners nowadays are used to deal with even more stimuli than those of a decade ago. Showing video is not only a question of running video and audio together. Integration is permitting the ability for a learner to associate the video with the other media on the screen, thus allowing the learner to find the relationship between the video and the other media. With the opportunity of combining video with other interactive elements such as communication and assessment tools, learning environments nowadays can now be far richer than the multiple channel theorists could imagine 30 years ago. The impact of these new combinations of video and networked applications has still to be explored and evaluated.

TOWARDS A DECISION TOOL

The purpose of the Three 'I's Framework is as a design, not a descriptive tool. We believe the framework is the first step towards a decision tool that could help academic developers make informed and effective decisions on their use on streaming video that encompass both pedagogical and technical considerations. This can be illustrated by an analysis of the three case studies of the JISC/DNER Click and Go Video project.

Hospitality Here the lecturer wishes to use video to introduce kitchen and cooking techniques. The resource will be used on campus prior and subsequent to a practical session. The lecturer is concerned that the video is able to capture the subtle colour changes that occur during cooking. From the perspective of the framework we can see that the important aspect here is the *image*. Interactivity is less crucial, though the students may want to refer to the archive later. There is some integration with other online resources, particularly recipes, but again these are of secondary importance. The lecturer therefore has concentrated on the production of the image, with much emphasis on high quality filming and lighting. The consequence is that the material is much less suitable for off-campus delivery.

Surgery Here the lecturer wishes to produce a set of archive lectures, including slides, self-assessment quizzes and video content. The focus here is much less on the video image of the lecturer himself, rather than the asynchronous access to the resources. The lecturer expects the students to be able to retrieve the archive both on and off campus. Much of this case study has focused therefore in ensuring that students can *interact* successfully with the material.

Textiles Video in this case is used to support an Excel-based simulation of retail buying that involves group work and negotiation skills. The lecturer wishes to use the simulation with remote students rather than its current classroom format. Again the video image quality is of much less consequence, as it only has to convey the enthusiasm and authenticity of the lecturer rather than carrying any significant detailed message itself. The key here is the i*ntegration* of the video with Excel and conferencing.

We believe this simple method of splitting up a proposed video application into its components of image, interactivity and integration greatly clarify the otherwise complex design decisions associated with streaming video and reach compromises appropriate for a range of specific learning outcomes. The next stage in the project is to elaborate this method to include more detailed technical and learning design decisions e.g. what format to use, what to include in the video, how long to make the video sequences and so on.

conclusion

The ability to combine digital video seamlessly with other tools offers an opportunity to move our concept of video as a purely presentational tool to video as a focus for student activity and communication. However there is little research and evaluation in the area to inform teaching staff and practitioners that envision using video streaming with their students. There is a need to construct the lexicon to describe the pedagogic value and use of video as well as to develop frameworks and tools to help on the pedagogical and technical design. From our experience, pedagogy and technology are so interrelated that is difficult to separate them out; in fact we find that learning design is a dialogue between the two. By trying to devise a decision tool we are exploring in depth the added value of video itself for education purposes. This can provide to the larger community with a tool to help in the conceptualisation and design of video streaming resources. This ultimately would lead us to better ways of evaluating media rich learning environments and the student's learning experience. The challenge for networked learning is to consider the value of video itself as a technology that can be part of a rich learning environment and can enable dialogue between the students, teaching staff and learning resources.

ACKNOWLEDGMENTS

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