Requirements for videolectures: which system is the best for you?

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Abstract: Videolectures over the Internet are becoming more and more diffused. There are several different systems in use for recording and diffusing the lectures. They are similar, but differ in details. How should you choose one to suite your needs? In this paper we present various aspects that need to be considered.

1. Introduction

The terms “Internet” and “Television” were once quite separated, but there is little doubt that in future they will merge at least to a large extent. We are already seeing a contamination of the two media: short video clips are becoming more and more common – some news sites for instance only show you the content after you’ve finished watching a relatively short advertisement, and since some time some Internet access providers sell on-line events, much like cable or satellite TV do, on a pay-per-view or on a subscription basis. The main difference with the traditional TV approach is in the ease in producing and distributing content, as shown by the YouTube success. This fact boosts several research streams, ranging from quality of service on the Internet to indexing and extraction of knowledge from videos, to the many new applications that can be invented by using this not new but now really accessible media. Among the possible applications, those in learning are certainly of interest. Actually the field of e-learning has been a precursor in using the videos over the Internet. The first report (Heyes 1998) on the application of video-streaming to teaching we are aware of dates back to 1998. At that time, the first attempt to substitute a VHS based system for delivering lectures to a geographically remote place (from USA to France) was based on transmitting an audio stream with synchronized power point images. This approach can be considered a sort of precursor of podcasting, a technology that is becoming very fashionable in these days, with 2 papers published in the AACE library on such topic in 2005, 11 in 2006 and 35 in 2007. Shortly thereafter Heyes’ approach evolved into a video transmission that included both the teacher and the slides with a technique called chromakey that is commonly used to deliver weather reports on TV. While standing in front of a blank screen, the image of the instructor is overlaid on top of a the slide, giving the student the sense that the instructor is standing in front of a large screen onto which the slide is being projected.

In the following years several custom systems were developed, some were commercialized, some were put in the public domain. Still today people come out with new initiatives that often reinvent what was done by other, sometimes though adding a slightly different twist.

In this paper we intend to review the different requirements that emerged from ten years of experimentation, and we try to systematize le lessons learnt over time, so that people wishing to embrace this technology can decide what is important to them. We do not intend to review the whole literature because it is dispersed in several communities and it is difficult to find an exhaustive list of the work done. Our goal is rather to discuss the main ideas we are aware of.

2. Video technology and learning

The use of video technology in education started very early. Even before TV became a mass phenomenon, there were instructional movies – for instance to demonstrate scientific experiments that were too complex or to lengthy to be performed in a school laboratory. The TV introduced some educational programs (and later channels). After the second world war for instance in Italy the newly born television had a very successful show that was based on lectures on how to learn reading and writing, to help fighting the analfabetism plague. Also today there are educational TV channels, like

1 http://www.edtlib.org
Teachers TV\(^2\); a digital channel for everyone who works in schools. Teachers TV’s programmes cover every subject in the curriculum, all key stages and every professional teaching role. It can be accessed on digital cable and satellite. Programmes are also available on their website (albeit with some geographical constraint, as for copyright reasons many of the contents available on the web are restricted outside the UK).

Cinema and TV differ for several reasons, but one of the most important is the distribution channel: TV is synchronous while Cinema is asynchronous. Therefore TV was not really used in schools until the invention of the VCR, which brought the asynchronous modality to the “small screen”. VCRs were used as a distribution channel for videolectures, but such initiatives never really took off in a significant way. It is therefore somehow surprising to see a rather vivid interest on videolectures offered via Internet. It is therefore interesting to investigate what motivates this different attitude.

Computers came into such scene as soon as they had powerful enough CPUs and large enough memory to be able to store and play a stream corresponding to a digital movie. Even earlier than that, at the end of the 80’s, a system that implemented a rather mechanical process of individualized instruction was patented (Abrahamson 1989). Part of the system consisted in the ability to use some ad hoc hardware to play movies. Then, as we mentioned, at the end of the 90’s the first experiments of computer and Internet based videolectures took place.

It has to be noted that videos always assume a rather passive role for the learner: some material is presented, and the flow is unidirectional, going from the “knowledge owner” to the “knowledge seeker”. It is true that short videos can be an ingredient of a more balanced and blended approach, in which the student is stimulated with the video and then is expected to perform actions of some kind (e.g. to participate in a discussion). It is however interesting to consider if videos could be more interactive in themselves. Video-based simulations and virtual reality might be a response to this question, but this topic would lead us outside of the scope of this paper. Here we intend to restrict ourselves to the version of videos called “videolectures”, i.e. a surrogate of a traditional, frontal lecture obtained by creating ad-hoc a video.

3. The revival of the videolectures.

Didactic videos have never been an outstanding success. It is therefore somehow surprising to see a flourishing of attempts to revive them from the Internet perspective. We believe there are good reasons for this. One of them is that digital technology is more flexible than the previous ones. In particular, it is much easier to navigate a video and to find an interesting spot by using digital videos than it was with VHS cassettes or –even worst – with films. Moreover digital videos can be semantically annotated – an operation that was impossible with the previous technologies. In the simplest form, annotation can occur in the form of images (e.g. copies of a PowerPoint slide) that characterize one particular section of a lecture. Titles of the slides can be extracted, and in most cases they give a very good indication of what a section of a lecture is about. Moreover, the full text of the slides can be mined, indexed and searched, so that it becomes easier to find relevant information. Some prototypes also use speech recognition techniques to align the text of the lecture with the video (see e.g. Fogarolli 2007), which empowers the search further more.

In fact, in literature there is evidence (Ronchetti 2003) that while a minority students use videolectures for recovering lost lectures, most of them use videos to review fragments of a lecture – e.g. to check their notes, to resolve disputes with their peers, or to review some poorly understood section. The main advantage remains therefore the idea of being able to break spatial or temporal constraints.

Another advantage of digital technology is that distribution is much easier: videos can be viewed or downloaded through the Internet. Even producing them is easy, and although Video production was also possible starting from analogical registrations, the amount of required post-processing was vastly superior.

An indirect benefit obtained from the ease of the production comes from a shift from studio-based recordings to real-life registrations. A very discouraging fact in the pre-digital era was that

\(^2\) [www.teachers.tv](http://www.teachers.tv)
videolectures tended to be extremely boring – still some are! In most cases they were recorded ad-hoc in a studio, with the teacher presenting a “fake” lecture in front of a camera. During such lectures (often with a “talking head” that was starring the camera) the teacher was not having a feedback from a real audience, and the results of those very costly productions were flat. In some cases, the videolecture was intended as a series of slides that were read aloud by a reading voice. It is hard to imagine a more annoying and uninteresting way to deliver content!

A very interesting study from Fritze and Nordkvelle (Fritze 2003) compared the effectiveness of lectures prepared in a studio versus those taken in a real environment. They “found that humour was primarily what was developed in the situational context of the lecture theatre. This quality disappeared in the studio. The wit of the videotaped lecturer was seldom furnished with adequate pause or gestures to signal the plausibility of the joke, and the vacuum that arose from this situation turned ‘jokes’ into ‘statements’. (...) Self-deprecating or self-ironic humour did not occur in the videos. In the lecture theatre, however, this form was used, and used to appeal to identification, sympathy or empathy with the listener. (...) The live lectures quite well furnished with humorous elements, wit, stories and ironies that contributed to a sense of ‘light heartedness’ that are more or less absent in the (studio) videos. The elements contribute quite substantially to the sense of immediacy in the lecture theatre.”

We believe that the humour they mention is in part a resort that teachers use to lighten a lecture when they realize that they are “loosing the audience”. Moreover, teachers can repeat a concept if they have feedback from students – all teachers know that they can learn a lot from the facial expressions of the students. All this is impossible in “canned” lectures. The possibility to easily produce lectures in a real environment allows avoiding the “studio trap” that was responsible for the failure of many previous attempts to make a large use of videos as a didactic support.

4. Features of a videolectures production system.

Following the above discussion, we restrict our focus on the recording of real lectures that take place in a traditional classroom. Even in this case however, our claim is that one size does not fit all, and therefore if you want to venture in this land you’d better know what would work for you.

Traditional lectures can be held with very different styles, and different kind of technical support. Even without considering learner-centred activities in an active and constructivist approach, the degree of involvement of the pupils can vary a lot: they can pose questions, they can be solicited to express their point of view and participate in discussions. If the participation of the students is an important part of the pedagogical process, the experience that a student can have through recorded lectures will be severely limited. Also, the recording process will be much more difficult: multiple cameras and multiple microphones will be needed. A non-trivial point is that the recording itself will be a perturbation. Shy pupils will refrain from intervening even more than they would normally, and the level of participation to the discussions will suffer from the interference induced by the recording. If students’ intervention plays only a minor role during the lecture, or if it is temporally localized (e.g. at the end of the talk like in seminars at conferences), then lecture recording might be an appropriate and useful technique. The teachers should be aware of the problems of audio, and if there are no extra microphones are available for the students’ questions, they should always repeat the question before giving the answer.

Even traditional, frontal lectures where the main (or sole) actor is the teacher offer a wide variety of types. They can vary a lot in the use of different presentation techniques and in the stimulation of different perceptive and cognitive channels. Robert Gaskin, the creator of PowerPoint, discusses in a recent paper (Gaskin 2007) how PowerPoint aimed originally at supporting three different presentation styles: bullets, slide views, multimedia. Still, in certain communities, these three styles are not an exhaustive list: for instance mathematicians tend to use extensively the blackboard. Some technology-oriented lectures focus on real time demonstrations of two types: live events or computer-generated actions (with the computer’s screen being projected on a wall). Running a real experiment (e.g. in physics or chemistry) falls into the first class. Instances of the second class include coding on a computer, using computer-aided productivity tools, showing web sites, running computer simulations. A computer today mediates all the use of multimedia that was once upon a time obtained with slide or movie projectors and audio devices.
Capturing a generic lecture therefore requires the ability to adapt to the teaching style and to support in the best possible way the cognitive channel and the technological support used. If possible, the impact on the teacher should be minimal. For instance, in a technology-driven approach one could request math teachers to write on a tablet instead of using a traditional blackboard. The handwriting would be projected on a large screen and recorded for asynchronous fruition. However, such a request would have a strong (negative) impact on the teacher. We collected anecdotic evidence that writing on such a device is felt as a separation from the class. The gesture style (e.g. to indicate a point on the screen) would be perceived as unnatural and artificial, and all this would negatively affect the lecture. Even the use of interactive whiteboards does not solve the problem, in that it puts limits in the available space: mathematicians use very large traditional blackboard, and feel restricted on such a small real estate. Our point here is that the technological support should be invisible, according to Norman’s theory (Norman 1998). For instance, the Eya approach (Canessa 2007), based on continuous automatic recording of whatever happens in a classroom offering a video plus high resolution (10 Megapixsel) video snapshots taken every 15 seconds is based exactly on this idea – however it may come short of some other desirable properties, like semantic annotation.

4.1 Choosing your product

It is now time to analyze the different parameters that play a role in choosing a videolectures-based system. This analysis will be presented as a guide to choose a suitable software for producing videolecture. It will help you to recognize the available (and missing!) features and to evaluate the relative importance of them when applied to the scenario that you envision.

First of all, a system that is intended for a general audience should put as few technical constraints on the client as possible. Browser independence is one of the issues. Not every browser on every operating system is able to correctly decode arbitrary video streams. For instance, some Microsoft proprietary formats are not readable on an Apple Macintosh, nor a plug in is available for viewing QuickTime movies in a Linux browser. Micromedia Flash (owned by Adobe) is instead visible on Macs, Linux and Windows machines. With this we do not claim that Flash is the right choice – we only warn the reader about choosing technologies that would cut off the set of potential users. Also, it should be considered how easy or difficult can be for the user to configure her/his machine or browser so as to satisfy the needed requirement. Users may not be technology-savvy, and a complex set-up might hinder their capability to actually use the system. Most plug-in based technologies can automatically recognize the need of downloading pieces of software and automatically install them without user intervention but their consent.

An important issue is to understand why do you need a video, and what cognitive channel you want to enable. Maybe the recorded audio is enough? Then you might just go for podcasting. Or you might want to give the user a sense of presence. In such case a low-resolution video might suffice – and maybe even only some fragments. For instance, only a few minutes of video at the beginning might be enough for the student to “know” the teacher, and then the bare audio can suffice. On the contrary, you might believe that a video captures the attention more than the bare audio – simply because it avoids that the student get external visual stimuli that might distract her/him. Moreover, the teacher’s gesture and facial expressions carry non-verbal clues that can help getting a better understanding.

We were not able to find scientific comparisons among these modalities in literature: it would certainly be interesting to gather statistics on them. In the meantime, you will have to choose according to your believe of what is best for your students: our point here is to make the various possibilities explicit. More objective facts might help deciding. For instance, the video may carry more detailed information, like when the teacher writes on a blackboard. In such case the quality of the image is at premium.

Similarly, you should consider what other elements are important in the lecture. For instance, the lecture might be supported by the projection of slides in the classroom. Do the slides carry essential information? We found that in many cases the are more useful to the speaker than to the audience. Often in fact they’re used only as a guide for the orator, and the whole lecture can be fully understood even without glancing at them. In other cases they carry essential information – like when they show some graph, or sample of code, or relevant pictures. In the case slides are important, you might either enclose them in the video (by recording slides and teacher together, maybe through the above mentioned chromakey technology), or you might decide to activate a special channel. In the simplest case this second channel will show still images (e.g. a JPEG copy of the PowerPoint slide). If you do so, who decides the relative importance of the two visual channels (video and slide)? Does the software
allow the user to see the two of them at the same time, and to change their relative weight (e.g. by allowing her/him to dynamically resize the two images)?

In a more complex situation the teacher might show a video or demo a computer application, or just perform some operations on his computer while this is projected on the wall. In such case, again there are at least two options: to capture what happens in the lecturer’s video (by zooming on the projected image on the wall) or by directly capturing the video signal coming from the lecturer’s computer. Solutions of this problem can rely for instance on frame grabbers that capture a split SVGA output from the computer and re-input the corresponding data stream through a USB port, so that the whole video stream can be saved. Suitable software can then use this signal as the video to be shown at the final user. Again, there are options. Is the resulting video replacing the camera recording of the teacher? If so, is there any way to choose at production time which of the two videos to use? Or is the final user able to choose which of the two videos to watch?

Another issue concerns the distribution channels. We were assuming that lectures are to be distributed via Internet – but an important point is whether all your intended users actually can access this channel. Limitations might be linked to bandwidth issues, or with the availability of a connection at all. The second issue tends to be always more marginal – at least in the developed world. Also, large enough bandwidth is becoming more and more available (e.g. through DSL technology), but again this might only be true for a subset of countries, and even there can be locally notable exceptions. Moreover, one should consider also the bandwidth problem on the source site – what if your server gets hundreds concurrent requests for videos? Will your bandwidth suffice? A possibility is to upload videos on an external server – more and more universities are putting their videos on YouTube. Of course though this is limited to pure video, without the double channel (video + slide) that we mentioned above. A way to reduce bandwidth is to reduce the video resolution, but of course this may end up in such a low quality that the video is not useful any more. In such cases you might want or need a system that can be adjusted for different bandwidths – and the choice could be done either by the user or by the system. Also, such choice could be static (i.e. defined at the beginning and unmodifiable) or dynamic (i.e. adjusted on the flight to respond to the instant needs).

It might also be worth considering alternative distributions – like giving the user the possibility to download a zip file containing a lecture to be later played locally on the user’s computer. Transferring a zip file can happen at a lower speed – it only takes longer to download, but once is at the destination there is no more network requirement and it can be played multiple times as needed. Also, one can opt for a peer to peer distribution style (e.g. by using “torrent”), which has even lower impact on the network – even though it typically requires even longer time. Yet another alternative is the possibility of mastering and distributing DVDs – on a DVD it is possible to easily fit 50 hours of video, that correspond to a full typical academic course.

Also, a possibly different type of client is a mobile device. Power and capability of small devices is increasing every day. Telecommunication operator started selling services for TV reports suited to small video-cell-phones. Of course bandwidth is in this case an even more delicate issue, however this device have reached impressive storage capabilities and hybrid connectivity options (e.g. the recent Apple i-phone offers up to 16 GB of storage, and the possibility to connect via GSM and via wireless Ethernet). a preview of what state-of-the art devices can deliver. Some experiments in delivery of video-lectures on cell phones have already been reported in literature (Ronchetti 2008). So when checking what a videolecture production system delivers, you should consider if this modality is important for your case, and if this is the case, you should examine again the bandwidth issue and the delivery options. Does the system support delivery in a user friendly way like podcasting does?

4.2 Defining the acquisition process and the related cost

So far we’ve discussed the whole matter from the “product” point of view, but there is another perspective whose importance is certainly not minor: the “process” prospect. In our previous discussion we have been facing several choices: whether the video should focus on the speaker or rather on the projected matter, whether one should be able to zoom on the whiteboard for portions of the lecture. Some of these choices need to be taken at production time: that means that one needs a video-operator who moves the camera and zooms, and maybe also a movie director that chooses among different video sources. What all this means is “labor”, or in other words, “money”. The running cost of production can vary greatly, being minimum in the case of a fixed camera that is
pre-installed in a classroom, and without operator and director (therefore offering a minimal quality of the product) to a maximum when movable multiple cameras are used with operators and with a director. Also, the recorded videos need to be post-processed to compress their size, to possibly annotate them (e.g. with copy of the slides used by the teacher at any given time), to upload them on the servers, possibly in different sizes and with different delivery options, and preparing web pages for the videos. Such post-processing can be fully automated or not. All these are very important variables when choosing a system, as they can present widely variable running costs and personnel requirements. In our experience, a high level of automation can make the difference between a successful project and one that is not sustainable. On the other hand, some product requirements may impose constraints on the process. If you really need flexibility (zooming and moving the camera on demand whenever needed) then there may be little choice but having a human operator. Solutions like the EyA system try to solve the focus problem by allowing the final user to manually focus on a region in the high resolution static wide-angle picture that encompasses the classroom podium, whiteboard and screen. Even such a clever idea however does not fully solve the problem of showing at higher resolution videos or computer simulations that might be projected in the classroom.

Once you decide to have a human operator - but you should really be well convinced of such need – you might try to have her/him doing as many operations as possible – e.g managing the camera, having her synchronizing the PowerPoint slides (i.e. performing video annotation) and checking that everything (including sound level) is right in real time. In a well-designed system these operations should be easily compatible. In some cases the person doing these operations could even be a student – our experience shows that the cognitive load of these operations is reasonably compatible with listening and understanding the lecture – except maybe for some very tough and demanding topic.

Another approach is to delegate some operations to the teacher. In part it is possible to capture some of the teacher-generated events and capture them – e.g. it is possible to capture the slide transitions in a PowerPoint presentation and use these events to automatically annotate the videos. A drawback is that typically this means either to ask the teacher to use an ad-hoc machine, or to install some software on the teacher’s laptop. The problems with this approach us that both options might be annoying for the teacher. This is a problem that can be alleviated with a school policy that imposes that everyone has to use the ad-hoc machine. In absence of such a policy there is little hope that things “will go well”. Policies can also be important in convincing people to be recorded: if it is a free choice there will always be teachers who refuse it. The psychological impact of being recorded on a teacher is also an issue that would need a discussion that is beyond the scopes of this paper, which focuses only on the technical aspects and on the economic cost of the process.

Even more radical approaches ask the teacher to do even more, i.e. to be the movie director of himself for instance by choosing the video source (e.g. camera vs. computer screen), and partly the operator (stating and ending the recording process). In our opinion this is a very bad idea, as it is distracting the teacher from his mission, and it even puts haphazard the product (e.g. if the teacher forgets to start the process!).

Another point regarding teacher flexibility concerns the support of lectures based on slide projection, but obtained by other means than PowerPoint. Teachers use PDF files, LATEX, HTML, OpenOffice and possibly other sources. If you intend to automatically annotate the lectures, you should make sure that you system is able to deal with these beasts. An approach based on the request that the teachers adapt to the system (converting their tools or their style) rather than vice versa is doomed to failure.

A fully automated acquisition process is certainly desirable, and even possible – but difficult to achieve without lowering the quality level. For instance, even a seemingly simple operation like making sure that the audio is good may be difficult – and audio is very important! A bad video quality can annoy the user, but a bad audio quality is imply unbearable. To capture the audio there are a few options: a static microphone, an intelligent array of microphones, or a radio-microphone. The static microphone is an easy and cheap solution, and does not hinder automation. However it is far from optimal, especially if the teacher moves around during the presentation. An intelligent array of microphones can tolerate a peripatetic teacher, at least up to a point, but it can be very costly. A radio-microphone is the best option from the point of view of quality, but it requires some maintenance: you must make sure that the battery level is good, and especially that the teacher remembers to wear it and to turn it on! Since the teacher does not have a direct feedback on these (missed) actions, there is no guarantee that he’ll remember!
Automation can however be achieved for certain tasks. For instance, by using image-processing techniques it would be possible to automatically extract from the video which PowerPoint slide is currently presented, therefore achieving automatic annotation of the video.

A last issue on the acquisition process concerns the devices used for capturing the lecture. One can range from sophisticated, fixed installations (e.g. several cameras per classroom remotely controllable by an operator in a centralized, dedicated room) to very light equipment (a laptop, a digital movie camera, a tripod and a radio microphone). Our choice was to go for the second option, which gave us the possibility of easily transporting the equipment even when travelling by plane – so that we were able to record events in Spain and in Korea. The drawback is that the equipment has to be put on place before every lecture, thereby adding some extra labour. So again you should understand what requirements apply to your case.

4.3 Moving beyond recording

We’ve discussed several issues regarding the product that enables the video recording and the needs of the process that enables the production of videos. The next step is to consider what will happen when you’ll have collected a lot of videos. How shall you organize them? How will the user be able to find what he needs? Which services will you be able to provide on top of your video collection?

A first, simple answer is that since the videos belong to courses they’ll be managed through a learning management system (LMS): as they provide access to the PDF files containing notes provided by the teacher, they’ll contain the videos – or links to the videos. While this looks like a sensible answer, it has been argued (Ronchetti 2004) that LMSs may become cages, which imprison their content. Reuse, references and even hyperlinks among material belonging to different courses is not favoured or encouraged by LMSs. Visibility and indexability can be severely restricted by the use of closed LMS. Of course an important issue to be considered is whether the collected videos should be publicly available or instead they should be somehow restricted to a selected set of users (e.g. enrolled students, paying customers, etc.).

You might look for a more sophisticated solution, Whatever your set of users is, it would be nice to provide tools that allow creating a living community in the Web 2.0 style. Examples of the features that might enable this goal are the possibility to grade the lectures, to leave comments, to ask questions (to the teacher or to the community), to create personal categories and share them with other users (folksonomies), to see if other users are using the system and to be able to interact with them. Since videos have a temporal dimension, it would also be nice to mark a particular time instant or section with annotations to bookmark them.

An interesting point of view is to consider the whole body of videos as a repository of knowledge, and to offer to the user the possibility to scavenge into it. While the LMS provides a reasonable perspective, arranging the material according to the notion of course, different dimensions (structured and unstructured) are possible. Semantic annotation would allow exploring the available material using an ontological viewpoint, and creating thematic catalogues. Keyword annotation and automatically generated summaries could help the user understanding the match between her/his needs and the content of a lecture. User ranking could let the best lecture emerge making them even more popular and easily findable, and choosing among similar resources. Browsing images extracted from the material (e.g. PowerPoint slide images or snapshots of demos, blackboard drawings etc.) would allow a visual way of digging the available material.

5. Discussion and conclusions

In this paper we examined the revival of videolectures, summarizing their history and trying to understand why the seem to become more fashionable nowadays. We tried to help the reader understanding the many factors that come into play when deciding to acquire (or build) a system for producing the videolectures and to put in place a process for recording and distributing them. In summary, we think that in first place there are set of questions to be answered and actions to be taken. In the body of the paper enter into details, which should help defining one’s own requirements. In
summary, the top level issues that help defining the strategy are:

- What do you want to achieve? (Define your goals)
- Who is your target audience?
- How you will be reaching them? (and which constraints/resources do they have?)
- What do they need? (and how would they benefit from your initiative?)
- Which costs can you afford? (Think not only of acquisition/installation costs, but especially of the running costs and the amount of labour needed on a day-to-day basis!)
- Can you define your process?
- Can you define policies for your users (teachers?)

After responding to these top level questions, and after being entered into the various technical and procedural details outlined in the paper, you should be able to examine the market. Like it happen when buying a house, you will probably find that there is not a solution that fits all your dreams and constraints, and you will have to sacrifice some aspect to get the best possible match. Our hope is to have been able to help you making an informed and sensible choice.

References


