

Assessing a new methodology for using video-lectures.

Marco Ronchetti
Dipartimento di Ingegneria e Scienza
dell'Informazione Università degli Studi di Trento,
Italy marco.ronchetti@unitn.it

Abstract: We recently proposed a new methodology called VOLARE for using video lectures. The methodology essentially consists in replacing frontal lectures given in class with video recordings (with synchronized slides) of the same, and using the available time in class with activities where the students can be more protagonist of their learning process. In the present paper we report an assessment *in-itinere* of the methodology, and we find it to be effective and well accepted by the students.

1. Introduction

When the incandescent light bulbs were first introduced, they simply replaced combustion-based lighting systems. Combustion-based lamps however had their own requirements: they had to be easy to reach for maintenance (e.g. for refilling), and they could not be placed close to the ceiling because it would have been dangerous. For these reasons they were placed at mid height on the walls of the rooms: a position that is far from optimal for their main purpose (i.e. lighting the room), but that was dictated by a compromise among contrasting needs. It took years until people realized that a better place was on the ceiling, in the middle of the room. Although the constraints were not there any more, they had remained in people's head. The same pattern can be found over and over with almost all the technologies: it took time until we were able to exploit their full potential, because we remained prisoners of the so-called "paradigm paralysis", i.e. the inability to see beyond the current models of thinking.

Digital video lectures are a relatively new technology, and we believe that we are not yet able to exploit their full potential. In a recent paper [RON10a], we suggested a methodology called VOLARE (Video On Line As Replacement of old tEaching practices) that deploys video lectures as a tool that favors the transition from the traditional, frontal teaching approach to a more interactive teaching style. In the present paper we report an assessment of the VOLARE methodology.

The present paper is organized as follows: in section 2 we summarize the VOLARE methodology; in section 3 we discuss the assessment of the methodology presenting the experiment and the results; finally we discuss our findings and present our conclusions.

2. The VOLARE methodology

The methodology is motivated by the fact that the recording of frontal lectures can be used as a reasonably good surrogate of the lectures themselves. Evidence is provided by a wealth of literature (for a review see [RON10b]).

Also, introductory university courses (especially at Bachelor level) evolve very slowly. A course in Mathematical Analysis given today for example is probably rather similar to the same course given twenty years ago. It is reasonably safe to state that a course recorded in year N (say SomeTopic 101) is good also during the next academic year N+1, probably with only minor changes if any.

The next observation is that in the frontal lecture style most – if not all – the time spent in class with the teacher is devoted to passing knowledge to the student. The resistance to a transition to "more modern" and pedagogically grounded teaching styles derives from many factors. One is the belief that a constructivist approach is more time-consuming. Another is that, many teachers think that students need to have some background knowledge and a basic understanding of the problem domain before they can effectively engage in problem-solving or collaborative learning. So they feel that they need to supply knowledge as the first step, and this ends up consuming (almost) all the available time by teaching "*ex cathedra*".

We can summarize the above section in two statements:

- a) video-lectures are a good replacement for frontal lectures;
- b) innovative teaching is hindered by the need of “passing knowledge”, which is typically done through frontal lectures.

The (almost) obvious consequence of these two assertions is therefore:

- c) innovative teaching can be unleashed by delegating the “knowledge passing” function to video-lectures that students must view before coming to class.

This is the essence of the VOLARE methodology. The methodology assumes that the students’ activity can be divided into three phases:

- KA - Knowledge acquisition
- DU - Deeper understanding
- KC - Knowledge consolidation.

During the first phase, the student is exposed to the theory and ideas. The student grasps concepts and models, and reaches s first level of understanding. This is what usually happens during a frontal lecture in class, or though a first reading of a book. Later (DU) the learner “studies”, that is s/he reviews the concepts, deepens her/his understanding, memorizes facts and formulas and applies the new knowledge by solving exercises. Finally, the acquired knowledge is consolidated by relating the new knowledge and models with that already possessed by the learner (KC). Only after this phase the learning process can be considered complete.

Obviously this is an approximation, as multiple cycles may take place. For instance, during the KC phase the student may discover discrepancies (e.g. caused by misunderstandings and misconceptions) that trigger another pass through the second phase or even elicit the need for a review (or additional acquisition) of material for another iteration of the KA phase. Moreover, often the true consolidation of knowledge is a long process that continues throughout life (reaching levels of deeper and deeper understanding), but this goes beyond the process that happens in the finite time of a course, which is the process that we are trying to enhance.

The main point is that if the KA phase is delegated to the videos, all the available teacher’s time can be dedicated to other aspects: i.e. the teacher can intervene in the following phases of the learning process, supporting and stimulating the DU phase, and engaging in discussions that can also help the KC phase. In other words, all the available time in class can be devoted to activities such as collective discussions, group work and even short individual discussion with some students while the others work in groups.

Suddenly the teacher is free from the duty of delivering content, and can abandon the frontal lecture in favour of other activities.

In introducing the methodology, we also took into account the global workload that students have during an academic course. In the European Community, the so-called Bologna Process aims at making academic degree standards and quality assurance standards more comparable and compatible throughout Europe, in particular under the Lisbon Recognition Convention. As part of this process, the learning activities that take place in an academic courses have been quantified under the notion of a “credit”: a sort of exchange currency that eases comparing courses offered by different universities and facilitates students mobility throughout the continent. A credit is defined to be equivalent to 25 hours of work – usually divided in 6 to 9 hours in class and 19 to 16 hours of individual study. In general for every hour spent in class there are roughly 2 hours of individual study. In the traditional approach, the first of these hours is in class, and the other two correspond to study done after the class hour. In the VOLARE methodology, the first hour is used to individually watch the video. Then the student goes to class for one hour, and finally spends an additional hour on her/his own. The partition is not mandatory, as the time spent watching the video could be somehow shorter (half an hour or three quarters of an hour) and correspondingly the last portion of time dedicated to individual study could be extended. Also time slots can have different aggregations (like 2 hours video, 2 hours class, 2 hours study) but as a rule of thumb for every slot spent watching the video, an approximately equivalent slot is later spent in class, and a third roughly equal slot is dedicated to individual study.

A part of the methodology is the fact that the video should be recorded during a real lecture given in class with real students attending (and not in a TV studio!). This point derives from the evidence provided by Fritze and Nordkvelle [FRI 2003] who showed that recording of real lectures are more effective than lectures recorded in a “sterile” environment. The main reason comes from the fact that in class the teacher has a constant feedback by the listeners, and can adjust the pace, repeat concepts when necessary, use a mot of spirit for lightening the lecture when needed etc. Moreover recording of real lectures cost much less than recording of ad-hoc material (if for no other reason because the lectures happen anyway!).

Although it would be possible to implement the VOLARE methodology by using recordings of another teacher, we believe it is best if the teacher of the course is the same person who was recorded in the video. In fact, this guarantees to the teacher a sense of ownership of the course, gives to the students a more direct sense of interaction and guarantees a better coherence of the presentation. The teacher does not have to interpret what someone else meant, and can discuss in class after the students have been exposed to her/his views, and with exactly that same emphasis on concepts and idea that s/he would use in traditional teaching.

Of course there is a bootstrap problem: in order to use this methodology one needs to have recorded lectures. The solution is simple: during a propedeutic year the usual, frontal methodology is used, and the lectures are recorded. The next year, the videos are available. Moreover, after the first recording one can use this methodology only for a portion of the course (say e.g. three fourth), with the remaining portion (one fourth) being based on traditional lectures that can be recorded and used the next year. In this way it is possible to gradually update the courses, by constantly changing a portion of the lectures.

3. Assessment

We employed the methodology to a first year course of the Computer Science Bachelor. Argument of the course was an introduction to Object Oriented Programming. During the academic year 2008-09 the methodology was experimented on a single lecture that had been recorded in 2006/07. The encouraging results, reported elsewhere [RON09], stimulated us to repeat the experiment on a larger scale. During the academic year 2009- 10 the methodology was applied to the whole course. In the period February- March 2010 students were required to watch videos before coming to class, and all the lectures were replaced by discussions, with the exception of the first, introductory lecture. The videos were live recording of real lectures, delivered by the same teacher during the academic year 2008-09. Every recorded lecture lasted approximately 1.5 hours, and the time spent in class after students watched a lecture was roughly the same. The recorded lectures were primarily based on PowerPoint slides, but the blackboard was relatively often used, mostly for drawing diagrams when the teacher felt that some additional explanation was needed, or to respond to students' questions. Lectures had been recorded with the LODE system¹ [DOL05].

Date		Lecturer	Contents	Slides on line	Downloadable slides	Video on line	Zipped video	Notes
Lenght		Title	(Tag Cloud)	(Click to browse)	(Click to download)	(Click to view)	(Click to download)	
2009-02-17	1h 27m 39s	Marco Ronchetti	lezione 1		1-Javalntro.ppt		01_Lezione_1_2009-02-17.zip	CAMERA IN DEMO MODE - NO SOUND PER I PRIMI 45 SEC
2009-02-19	1h 31m 11s	Marco Ronchetti	-		RichiamiCcpp.ppt		02_2009-02-19.zip	
2009-02-26	1h 29m 2s	Marco Ronchetti	-		RichiamiCcpp.ppt		03_2009-02-26.zip	
2009-03-03	0h 54m 45s	Marco Ronchetti	-		RichiamiCcpp.ppt		04_2009-03-03.zip	

Figure 1 – The LODE web site

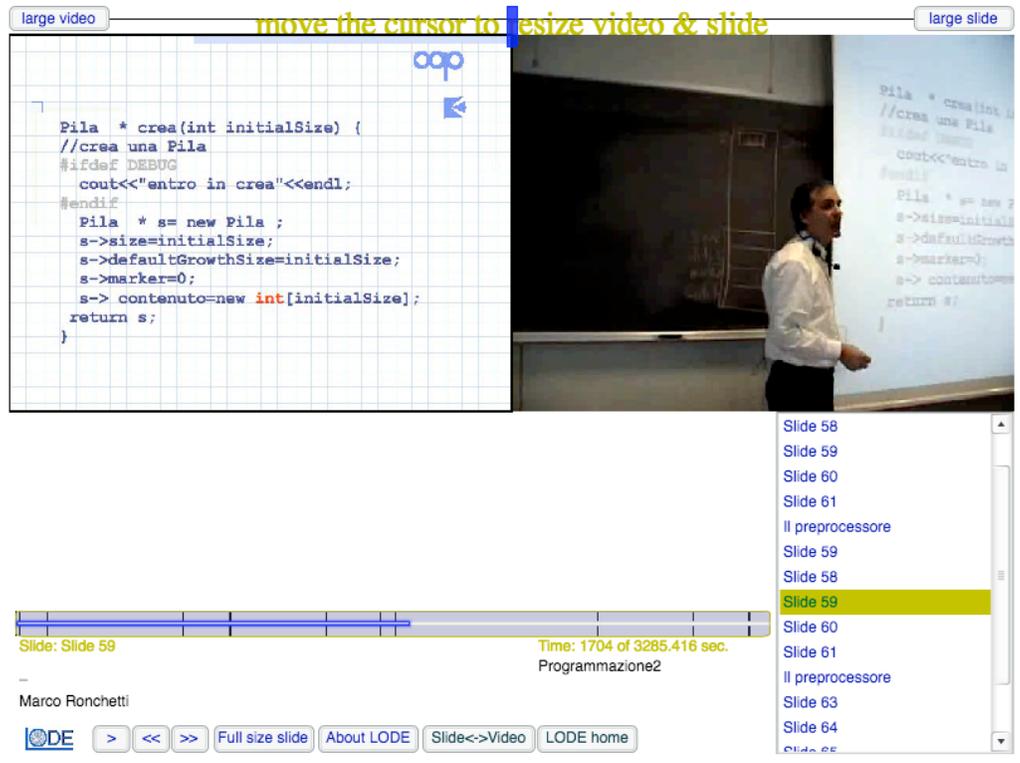
LODE (Lectures On Demand) is a system developed in-house and made available for free to third parties. It produces an video recording with synchronized slides, and automatically generates a web site for the course For every lecture, the video with synchronized slides is available in two formats: viewable on line and downloadable for batch use. The web site also allows getting hints about the

¹ <http://www.latemar.science.unitn.it/LODE>

content of the lecture through a tag cloud, a preview of the slides (so that it is possible to have an idea about the content of a lecture before watching the video, downloadable slides, thumbnails of the video and optional notes.

The videos are embedded in a Flash wrapper contained in web page. Flash allows viewing the video on all major platforms (Linux, Macintosh and Windows). Slides and video are resizable in a continuous manner, so that the student can enlarge the section where his cognitive focus is. Enlarging the video allows reading what the teacher writes on the blackboard. The student can pause the movie, jump to a different section either by section title (section titles are extracted from the slides) or by using a sliding time bar.

For the recording it is necessary a Macintosh (a laptop is an excellent choice) and a digital camera. Radio microphones were used to guarantee an excellent quality of sound.



This video was produced with [Lode4Mac](#)

Figure 2 – The LODE interface

In the classe where our experiment was performed, the number of enrolled students was about 100, but a portion of them have a job so they do not come to class and usually study on books, material given by the teachers (e.g. slides) and on notes taken by their peers (and for them the availability of videos is a blessing). A few students usually drop out after the first semester for a variety of reasons, the most common one being that they understand that their study choice was wrong. The course had an average class attendance of approximately 70 students, which is consistent with the previous years. After the first half of the course, during the Easter break, an anonymous survey was run on the web. 66 students responded to 28 questions (including the possibility of giving a free comment). The questions aimed at investigating:

- how the students used the system,
- How well the videos support the learning experience and how students rated the system quality,
- how they evaluated the VOLARE methodology,
- what use of the video they could envision if they were used as a complement of a traditional teaching style (as opposed to VOLARE).

3.1 How the students used the system

A first (a bit surprising) result was that in a time where video lectures are available on iTunesU and YouTube (also for self study) 82% of the students never used videos for didactical reasons before being involved in our class.

An important element to be able to evaluate the methodology was to assess if the students actually followed the indications, i.e. if they actually regularly watched the videos before coming to class.

It turned out that 86% of them did (39% skipped some lecture).

Also, we were interested in understanding if they watched the videos sequentially from beginning to the end. 50% of the students did so, while the rest of them skip some portions, when they thought they were already familiar with the topic (12% skipped sections often, 38% rarely). An interesting comment by a student was that he watched the lecture at double speed – since speech was understandable also this way – slowing down only in the conceptually new or more dense sections. These behaviours are surprisingly similar to the way we use educational, technical books – skipping parts and skimming through text.

Unlike what happens in class, recordings allow taking breaks and organizing one's own time according to various needs. We investigated this aspect, finding that 72% of the students break the lecture into chunks, and watch the pieces at different times (21% of them rather often and 51% rarely). The remaining 28% of students always watched lectures without a break.

Another freedom allowed by the videos is the possibility of re-watching segments that are more difficult to understand. 72% of the students did so often, and 21% rarely while only 7% never used this opportunity.

Students preferred to download the videos on their machine before watching them, as the following statistics show:

- 6% watched videos on line from University
- 23% watched videos on line from home
- 75% downloaded the video from home
- 44% downloaded the video at the University

(The sum is larger than 100% because multiple choice was allowed).

3.2 How well the videos support the learning experience?

In first place we gathered opinions about the quality of the experience provided by the LODE system, as it is well known that technical problems, bad audio and insufficient video quality are a bad premise, as demonstrated by some early assessment on video lectures run at the end of the nineties (see e.g. [HIL99] [LAU04]). Students evaluated the quality of the LODE system by stating that:

- The video allows reading well the blackboard (yes 60%, no 34%)
- Slides visualization is good (yes 86%, no 14%)
- Audio is good (100%)
- Video quality is fully satisfactory (yes 94%, no 3%)
- Video navigation allows easily finding the searched portions of the lectures (yes 75%, no 16%)

Next we tried to get the opportunity to contribute to the discussion that has been carried on in literature over the last few years, concerning the relative validity of lectures based on video+slides as opposed to audio+slides. Berner & Adams [BER04] conducted a randomized controlled trial on this issue, concluding that adding video to an audio presentation does not lead to greater satisfaction or greater learning. The German instruction psychologist Glowalla [GLO04] expressed a different opinion: according to him, learners show a better concentration in front of a video than in a classroom, while the audio + slide version favours less the concentration, and is perceived as more boring. Data obtained by Reisslein et al. (2004) confirm that students felt that the web-carried video helped them to stay focused during the instruction. McCrohon et al. [MCC01] report that 83% of the students preferred video streaming to audio streaming. Fey [FEY02] argued that video does not increase understanding or retention, but is favoured by most people due to emotional reasons. Moreno & Mayer [MOR00] state a general principle that would bring to the opposite conclusion: "Students learn better when the instructional material does not require them to split their attention between multiple sources of mutually referring information". Their work is sometime used as an argument against the standard video-lecture + slide format, as reported e.g. by Krüger & Plaza [KRU05]. Hermann et al. [HER07] attempted to extract information on users' preferences among the two formats (audio+slide vs.

video+slide) from the access log files of a system for delivering audio- and video-lectures, but their evidence is not conclusive.

Our findings are that 95% of the students believe that a version based only on slides + audio would not be able to substitute the classroom experience in the way video lectures do. For 74% of the students the video helps concentrating, and exactly the same share thinks that the video helps simulating the classroom experience.

The possibility of navigating the lecture was considered useful by the large majority of students (94%, and for 59% it was very important).

3.3 How the students evaluated the VOLARE methodology

When we started the experiment, we feared a few risks:

- Students could consider video lectures boring, and skip them
- Students could feel that the methodology increases their workload (after all in this way the effectively double the time they spend with the teacher, half of the time in virtual space and the other half in the real one).

Our finding was that 14% of the students find watching videos very boring, and 32% rather boring while for the remaining 54% of the students this is not the case.

39% of the students believes that this methodology increases their workload (slightly for 30%, much for 9%) , while for 61% of the students this is not true. In the free comments, several students stated that they would like to have more homework based on the topics of the video lectures, to be then discussed in class – which is an additional indication that the extra workload caused by the methodology is not too much.

For 79% of the students the discussion in classroom has an added value, while the remaining 21% finds it of little (20%) or no utility (1%). Among the reasons to dislike the class discussion is the fear of being personally involved in the discussion in front of the others (35%), although we believe that there is an educational value also in having to express and defend one own's ideas in front of a relatively large number of pairs.

Some students expressed the opinion that this methodology is good if it is limited to some courses, but that extending it to all the courses would be too much. Others think that this methodology is useful for certain disciplines, but not for all. A very small minority of students express preference for traditional lectures.

A student found it possible to watch the video while doing some exercises in parallel: for example trying on the flight some of the examples discussed by the teacher in the video. This is made possible by the fact of being able to pause the video to be able to complete the exercise: a fact that in class would be impossible. In this way one of the worst features of the frontal lectures (the passivity of the student) is overcome, and the quality of learning improves.

3.4 Other observations

Having the opportunity to run the survey, we tried also to gather information about the usefulness of video lecture –also without connection with the VOLARE methodology. In literature there is some anecdotic evidence of the usefulness of video lectures, such as e.g.:

- [MCC01] “92% of students who access the video-streamed lectures (...) agreed that this was a useful learning resource”.
- [RON03b] “students find an added value in having a multimedia version of the traditional lecture, especially if provided through a tool that has a well-thought user interface”
- [REI05] video-lectures-based “distance education was at least as good as traditional classroom instruction”
- [CHU05] for a good majority of students, “a distance learning course without on-line lecture would compromise learning” Chung (2005)
- [MAN06] video-lectures “are indeed adequate alternatives to live lectures for engineering students” Maness (2006)

Our survey indicates a strong interest of students in the support of videos, also without relation with the VOLARE methodology. Only 1% of the students would in fact NOT be interested in using videos for other courses, while 75% would like to have them for ALL courses. The main advantages they see in the video lecture technology are:

- The possibility of checking the notes taken in class (100%)
- The possibility of reviewing portions of lectures that are difficult to understand (97%)
- The possibility to recover portion of lectures in which they were distracted and lost concentration (94%)
- The possibility to recover entire lectures lost due to forced absence (e.g. illness) (98%)

These results echo the ones we had in an early investigation about video usage we carried in 2003 [RON03a], and confirm a very high perceived utility of video lectures.

A minority of the students (6%) declare they would sometimes elect not to go to class if they knew that recordings are available, and another 23% would be tempted to do so. Our experience, based on regular use of videos for seven years, shows that the number of students actually choosing not to go to lecture is much lower than these declaration state.

Finally, prompted by the emergence of mobile versions of video lectures (such as those available via Apple iTunesU) we asked students if they thought that a mobile version of the videos could be useful. Only 44% think so, with 17% very positive about the idea and 34% very negative.

4. Discussion and conclusions

We presented the results of a survey aimed at validating the VOLARE methodology and at gathering some info about the utility of video lectures. Over the last ten years video lectures have expanded and become more popular and widely accepted. In spite of this, still today a tiny percentage of the lectures worldwide are being recorded and made available to the students.

Our results confirm that video lectures are a viable surrogate and/or integration for frontal lectures. Students like very much the possibility of having such resource at their disposal, and find it very useful. Our results reinforce the anecdotic evidence available in literature and discusses above.

Videos with synchronized slides are considered much superior to a version based only on slides plus audio, and result effective in replacing the traditional classroom experience based on frontal lectures. Videos helps concentrating and simulating the classroom experience. Moreover, they allow innovative forms of fruition, like double-speed listening or parallel working on the content that is being presented, also thanks to the possibility of pausing and resuming when needed. The possibility of skipping easy parts and repeating multiple times the difficult ones is also appreciated. The possibility of easily navigating the lecture allows reviewing segments for improving the understanding and for checking notes.

As far as the VOLARE methodology is concerned, students were fairly diligent in respecting the assignment of viewing the videos before coming to class: the large majority regularly complied with the request, even though approximately 40% occasionally skipped a video lecture. Most students reviewed multiple times the more difficult part of the lecture, and a small percentage skipped portions of lectures regularly. We must observe that the background of the students is highly inhomogeneous, with some having had no exposure to programming in high school, while others were trained as programmers – even though using languages different from the one (Java) used in the course. Also the observation that a large minority of students found watching videos rather boring might be cause by this reason. Only a couple of students stated that they prefer traditional lecturing: for the vast majority the discussions in class were valuable and helped them reaching a better understanding. The general opinion was that the methodology has clear advantages even though it requires a little more work. However, applying the methodology to all courses would not be considered desirable.

These results are in line with the small -scale experiment we run in the previous academic year [RON09], when the methodology was applied to just one lecture of the same course with approximately the same number of students. A difference is that some students were sceptical about the possibility to apply the methodology to an entire course, which in this year experiment instead os not creating any major problem.

Our other results essentially confirm the good quality of the tool we used to record and play the videos, and student wish all course would use the system for reviewing purposes.

A limit of our assessment was the impossibility of having a test group and a control group, as to do so we would need to run two classes in parallel: one using the VOLARE methodology and the other one using traditional lecture. Another limit is that we had to run the survey at mid course – but we plan to repeat the survey by the end of the course and to compare the students results at the exam with last year's results.

In summary, our (yet preliminary) evaluation shows a good success of the methodology we proposed for replacing frontal lectures with video recording of the traditional lectures themselves and for making a better use of the time available in class by proposing group exercises, having discussions and conversations.

References

- [BER04] Berner E.S. & Adams B. (2004) Added value of video compared to audio lectures for distance learning. *International Journal of Medical Informatics* (73), pp.189-193
- [CHU05] Chung Q. B. (2005) Sage on the Stage in the Digital Age: The Role of Online Lecture in Distance Learning, *The Electronic Journal of e-Learning* Volume 3 Issue 1, pp 1-14
- [DOL05] Dolzani M., Ronchetti M., (2005) "Video Streaming over the Internet to support learning: the LODE system". *WIT Transactions on Informatics and Communication Technologies*, 2005, v. 34, p. 61-65.
- [GLO04] Glowalla U. (2004) Utility and Usability von E-Learning am Beispiel von Lecture-on-demand Anwendungen. In *Entwerfen und Gestalten*, 2004 (in German)
- [LAU04] Lauer T., Müller R. & Trahasch S. (2004) Learning with lecture recordings: key issues for end-users. *Proc. of the IEEE Int. Conf. on Advanced Learning Technologies 2004*. pp. 741 – 743
- [HIL99] Hilt, V. & Kuhmünch, C. (1999). New Tools for Synchronous and Asynchronous Teaching and Learning in the Internet. In B. Collis & R. Oliver (Eds.), *Proc. of World Conf. on Educational Multimedia, Hypermedia and Telecommunications ED-MEDIA 1999* pp. 975-980
- [FEY02] Fey A. (2002) Audio vs. Video: Hilft Sehen beim Lernen? Vergleich zwischen einer audio-visuellen und auditiven virtuellen Vorlesungen. *Lernforschung*, 30. Jhg (4):331–338 (in German)
- [FRI03] Fritze Y. and Nordkvelle Y.T., (2003) Comparing Lectures: Effects of the Technological Context of the Studio Education and Information Technologies 8:4, 327–343, 2003. Kluwer Academic Publishers.
- [HER07] Hermann, C. Welte, M., Latocha, J., Wolk, C. & Huerst W. (2007) Eine logfilebasierte Evaluation des Einsatzes von Vorlesungsaufzeichnungen, *GI-Edition Lecture Notes in Informatics, DeLFI*, pp. 141-150 (in German)
- [KRU05] Krüger & Plaza (2005). Vortragsaufzeichnungen—Ein Querschnitt über die pädagogischen Forschungsergebnisse. *Workshop Proceedings DeLFI* (in German)
- [MAN06] Maness J.M. (2006) An evaluation of library instruction delivered to engineering students using streaming video. *Issues in Science and Technology Librarianship*
- [MCC01] McCrohon, M., Lo, K. Dang & J., Johnston, C. (2001) Video Streaming of Lectures Via the Internet An Experience. *ASCILITE 2001 - The 18th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education*, Melbourne pp. 397-405
- [MOR00] Moreno, R. & Mayer, R.-E. (2000) A Learner-Centred Approach to Multimedia Explanations: Deriving Instructional Design Principles from Cognitive Theory, *Interactive Multimedia Electronic Journal of Computer-Enhanced Learning* (2)
- [REI05] Reisslein J. Seeling P. & Reisslein M. (2005) Video in distance education: ITFS vs. web-streaming: Evaluation of student attitudes. *The Internet and Higher Education* (8) pp.25-44
- [RON03a] Ronchetti M., (2003a) Has the time come for using video-based lectures over the Internet? A Test-case report CATE - Web Based Education Conference 2003, Rhodes (Greece)

[RON03b] Ronchetti, M. (2003). Using the Web for diffusing multimedia lectures: a case study. *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2003*

[RON09] Ronchetti M. (2009) Using video lectures to make teaching more interactive, Proc. of the Int. Conf. on Interactive Computer Aided Learning ICL-2009

[RON10a] Ronchetti, M. (2010). A different perspective on lecture videostreaming: how to use technology to help changing the traditional lecture model. Accepted for publication on International Journal of Knowledge Society Research

[RON10b] Ronchetti, M. (2010). The Impact Of Internet Carried Video Technology On Education. Accepted for publication in E-Infrastructures and Technologies for Lifelong Learning: Next Generation Environments, G, Magoulas ed., IGI Global