Proceedings of the

Workshop on Analytics on Video-Based Learning (WAVe 2013)

Organized jointly by the 3rd Conference on Learning Analytics and Knowledge (LAK 2013)

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Leuven, Belgium, 8 April 2013

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ISSN: 1613-0073

Published by CEUR Workshop Proceedings at CEUR-WS.org/Vol-983

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Table of Contents

Expanding Horizons and Envisioning the Future of Analytics on Video-Based Learning

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WAVe 2013 workshop at LAK'13, April 8, 2013, Leuven, Belgium.

Abstract
This paper describes the potential and promising value of analytics on the emerging area of video-based learning. In particular, we describe the contributions presented at the International Workshop on Analytics on Video-based Learning (WAVe 2013) and envision the future of this research area. WAVe presents the current state-of-the-art in the design, development and evaluation of video-based learning systems. WAVe 2013 emphasized the importance and benefits of analytics for video-based learning to support learners and instructors with the appropriate resources for improving the use of video-based learning systems. The long term goal of WAVe is to develop a critical discussion about the next generation of analytics employed in video learning tools, the form of these analytics and the way they can be analyzed in order to help us to better understand and improve the value of video-based learning. In this volume, we have included the 6 submissions and the 2 keynote presentations that were featured at the workshop.

Author Keywords
Analytics, Video-based Learning, Video-lectures, Interaction Design, MOOCs

ACM Classification Keywords

K.3.1 [**Computers and Education**]: Computer Uses in Education - Computer-Managed instruction (CMI).

Introduction

With the widespread adoption of video-based learning systems such as Khan Academy and edX, new research in the area of Learning Analytics has emerged. Even new for-profit companies, such as Coursera and Udacity, have started offering forms of instruction that are primarily video-based. To date, universities across the globe (Stanford, Oxford, MIT and some 800 other schools) offer video lectures on topics from Algebra to Zoology.

The use of video for learning has become widely employed in the past years [5]. Many universities and digital libraries have incorporated video into their instructional materials. Massive Online Open Courses (MOOCs) are becoming an increasingly important part of education. For instance, students can access academic content via digital libraries, discuss with tutors by email and attend courses from their home. In order to support video learning, various technological tools have been developed, such as Matterhorn and Centra. These tools and others like them provide an easy way for a learner who has missed a lecture to catch up, but also enable other, especially slow learners, to review difficult concepts.

Many instructors in higher education are implementing video lectures in a variety of ways, such as broadcasting lectures in real time, augmenting recordings of in-class lectures with face-to-face meetings for review purposes, and delivering lecture recordings before class to “flip the classroom” and provide hands-on activities during class time. Other uses include showing videos that demonstrate course topics and providing supplementary video learning materials for self-study.

Millions of learners enjoy video streaming from different platforms (e.g., YouTube) on a diverse number of devices (TV, desktop, smart phone, tablets) and thus create records of billions of simple interactions. This amount of learning activity might be converted via analytics into useful information [4] for the benefit of all video learners. As the number of learners watching videos on Web-based systems increases, more and more interactions have the potential to be gathered. Capturing, sharing and analyzing these interactions (datasets) can clearly provide scholars and educators with valuable information [11]. In addition, the combination of learner profiles with content metadata provide opportunities for adding value to learning analytics conducted on data from video based learning activities.

To explore the future of video-based technologies for teaching and learning, we aim to build a research community around this topical area, to brainstorm about what the next generation of video-based learning tools might look like, what kind of data can be collected, and how these data can help us to better understand and improve the value of video-based learning.

Existing empirical research (e.g. [5, 7, 9]) has begun to identify the educational advantages and disadvantages of video-based learning. However, there still remain many essential unexplored aspects of video-based learning and the related challenges and opportunities;

such as, how to use all the data obtained from the learner, how to combine data from different sources, and so on. WAVe aims to support this research endeavor through an analytics approach to video-based learning. In particular, the objective of this workshop was to bring together researchers, designers, teachers, practitioners and policy makers who are interested in how to do research on the use of any form of video technology for supporting learning. This workshop provided an opportunity for these individuals to come together, discuss current and future research directions, and build a community of people interested in this area.

By taking into account learners' interactions and many other data—such as students' demographic characteristics of gender, ethnicity, English-language skills, prior background knowledge, their success rate in each section, their emotional states, the speed at which they submit their answers, which video lectures seemed to help which students best in which sections, etc. — new avenues for research in the intersection of video-based learning and analytics are now possible.

Objectives

The workshop was structured be an interactive, engaging experience that motivated participants to get involved and engage in fruitful discussions on the topic of Video-Based Learning and the potential benefits of Analytics. To do so, it combined several activities. First, highly recognized keynote speakers opened the workshop. Then the workshop organizers gave the participants the opportunity to be engaged into creative and motivating discussions about the key issues related to analytics on video-based learning.

One of our main objectives was to bring together researchers who are interested on Learning Analytics and their application on video-based learning. Specifically, WAVe aimed to provide an environment where participants had opportunities to: develop their research skills; increase their knowledge base; collaborate with others in their own and complementary research areas; and discuss their own work. In particular, guiding questions and themes included:

- What might next generation of analytics enhanced video learning tools look like?
- What kind of data can be collected from video-based learning tools?
- How these data can help us to better understand and improve the value of video-based learning?

Contributions

The contributions of WAVe covered several topics, such as visualization techniques, video learning tools description, empirical examinations and best practices descriptions. In addition to the workshop proceedings (which are freely accessible from CEUR-WS), the presentations of WAVe are available via videolectures.net[1].

In particular, Brooks et al., [1] present information visualization techniques for video-lectures capture systems. With the principal goal to better understand how students use these systems, and what visualizations make for useful learning analytics. Brooks et al., applied three different methods to viewership

[1] http://videolectures.net/wave2013_leuven/

data aimed at understanding student re-watching behavior, temporal patterns for a single course, and how usage can be compared between groups of students.

Ronchetti [8] describes the current state of MOOCs and indicates that some already available tools can be better used for the extraction of semantic information from the videos. To this end, he proposes that we can improve the sensemaking of the information extracted from videos.

Ilioudi et al., [6] empirically examine the effects of video presentation styles in supporting the teaching of mathematics in secondary education. Using three different groups of students (2 with videos and one with traditional book reading), they indicate a significant difference on students attitude and that learning effects show up only after the second week. The difference on learning effect demonstrates that Talking Head video-style was more effective than the traditional book reading for complex topics.

Canessa et al., [2] introduce new prototype applications for automated recording of lectures using mobile devices. These applications were developed based on the experiences gained by the ICTP Science Dissemination Unit (SDU) in Trieste, Italy with its open source “Enhance your Audience” (EyA) recording system[2]. ICTP has more than 10 thousands hours of automated educational recordings in the fields of physics and mathematics.

[2] wwww.openeya.org

Viel et al., [12] give an overview of a system which allows capturing a lecture to generate multi-video learning object composed of synchronized videos, audio, images and context information. In addition, they present how a group of students interacted with a learning object captured from a problem solving lecture and give ideas of how navigation facilities and visualization tools can assist us to include more contextual information during the presentation.

Chorianopoulos and Giannakos [4] present an open-source video learning analytics system. The system captures learners’ interactions with the video player (e.g, pause, replay, forward) and at the same time it collects information about their performance (e.g., cognitive tests) and/or attitudes (e.g., surveys). The tool is a freely available open source project[3] for anyone to use and improve it.

Conclusions and the Way Ahead

The role of analytics on helping individuals to make sense of the learning procedures has drawn the interest of many scholars and practitioners in the last years. Analytics have proven their ability to help us to understand (make sense) many complex learning phenomena in the past [11].

However, comparing with research on text and discourse analytics, the research on video analytics is still on embryotic stage. Video analytics have an enormous potential, especially given what is currently happening around the explosion of MOOCs. As most of the MOOCs are using videos as their primary content delivery mechanism, research on MOOCs will heavily

[3] https://code.google.com/p/socialskip/

influence video-based learning research. So we believe that the topic of WAVe is very timely with great potential. This potential will grow as MOOC platforms, like Coursera and Edx make their data publicly available to the research community.

Although research on video based learning has been increased in the last years [5, 10], a number of questions remain regarding the use and design of videos for learning [3]. In particular, little research has been conducted on the functionalities and the characteristics of learning videos. Characteristics like quality of visuals used, cognitive load, engagement and tone of voice, pace, length, and segmentation need to be examined in more detail in order to improve the effectiveness of video as learning medium [7].

With respect to the viewing patterns of learners, some interesting preliminary work was noted [7] including when and where students watch learning videos as well as how they view materials (e.g., in small chunks). Future research can focus on a more detailed analysis of viewing patterns and its impact on learning outcomes. For example, students who skip or re-watch segment may integrate less knowledge than students who view videos more systematically. To this end, sophisticated video analytic systems (e.g., [4]) can be used and help us to make sense and improve how students learn with the assistance of videos.

Acknowledgements

We would like to thank Dr. George Siemens and Dr. David Geerts for accepting our invitation to give keynote presentations, the workshop Program Committee members for contributing to the success of WAVe and the workshop chairs for their constructive comments and their helpful assistance throughout the workshop. Finally, we would like to thank http://videolectures.net/ for recording and editing the presentations of WAVe and the ERCIM "Alain Bensoussan" Fellowship programme for the financial support.

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Learning Analytics: Sensemaking as a foundation for the field

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Abstract

This presentation explored learning analytics from the perspective of sensemaking - social cognitive processes people use to understand the world and the data they encounter. Emphasis will be on how researchers/educators/administrators can used technical (or big data) analysis to interpret patterns and plan for change strategies that incorporate social aspects of sensemaking. The intent of learning analytics is not only to evaluate what learners have done or what they might do; analytics should help educators make sense of the meaning of the technical analysis of learner activity so they [the institution or educator] can respond and act with consideration of the social dimensions of learning.

The full presentation is available at:
http://videolectures.net/wave2013_siemens_sensemaking/

Author Keywords

Learning analytics, Sensemaking

ACM Classification Keywords

K.3.1 [**Computers and Education**]: Computer Uses in Education - Computer-managed instruction (CMI);
H.5.1 [**Multimedia Information Systems**]: Video (e.g., tape, disk, DVI)

Bio

George Siemens is an educator and researcher on learning, technology, networks, analytics, and openness in education. He is the author of Knowing Knowledge, an exploration of how the context and characteristics of knowledge have changed and what it means to organizations today, and the Handbook of Emerging Technologies for Learning . Knowing Knowledge has been translated into Mandarin, Spanish, Italian, Persian, and Hungarian. Dr. Siemens is the Associate Director of the Technology Enhanced Knowledge Research Institute at Athabasca University, leading the learning analytics research team. He has delivered keynote addresses in more than 30 countries on the influence of technology and media on education, organizations, and society. His work has been profiled in provincial, national, and international newspapers (including NY Times), radio, and television. His research has received numerous national and international awards, including an honorary doctorate from Universidad de San Martin de Porres for his pioneering work in learning, technology, and networks. Dr. Siemens is a founding member of the Society for Learning Analytics Research (http://www.solaresearch.org/). He has served as a member of the Steering Committee for AACE's ED-MEDIA conference since 2008. He is on the editorial board of numerous journals, including MERLOT's JOLT and JIME. He pioneered massive open online courses (sometimes referred to as MOOCs) that have included almost 20,000 participants

Visualizing Lecture Capture Usage: A Learning Analytics Case Study

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Abstract
This paper outlines our initial investigations of applying information visualization techniques to lecture capture video systems. Our principal goal is to better understand how students use these systems, and what visualizations make for useful learning analytics. We apply three different methods to viewership data aimed at understanding student rewatching behaviour, temporal patterns for a single course, and how usage can be compared between groups of students.

Author Keywords
Lecture Capture; Information Visualization; Usage Data; E-Learning

ACM Classification Keywords
K.3.1 [Computers and Education]: Computer Uses in Education.; H.5.1 [Multimedia Information Systems]: Video (e.g., tape, disk, DVI).

Introduction
The activities described in this paper fall into a larger program of research focused on determining the efficacy of lecture capture on student learning. We are interested in using both statistical techniques (e.g. machine learning) and visual techniques (e.g. information visualization) to understand the patterns of interaction

learners have with lecture video. This paper introduces three activities we have undertaken to visualize learner data. The data for this paper comes from Recollect, a lecture capture environment we developed for research use in 2010 and 2011. Described more fully in [2], the data we use is generated by the Recollect *heartbeat*, a client-side event that occurs every 30 seconds and records (among other things) which video a user is playing, the location of the playhead within the video, and whether the video is paused or not. This structure has been ported to the freely available Opencast Matterhorn project[1], which is the focus of new research on lecture capture analytics at our institution.

Case Study: Chemistry 200

One course we examine in this work is a second year undergraduate Chemistry course. This course was taught using traditional lectures to 546 students in multiple sections. One instructor elected to have his lectures recorded and provided to all of the students as a study aid. Examinations and assignments between sections were the same.

Only 333 watched video content for at least five minutes, a participation rate of 61%. In total, learners watched over 77 days worth of lecture video, a remarkable number given that only 38 lectures of 50 minutes each were recorded.

Case 1: Visualizing Rewatching Behaviour

Motivated by the correlative link between re-reading discussion forum messages and academic performance in undergraduate students [1], we were in better understanding whether learners re-watch lecture capture content. Summary statistical usage of our lecture capture facilities shows that some students playback significantly more video than others (see sidebar). Our question is whether there are any meaningful patterns in how learners view lecture videos.

To visualize lecture watching activity, we plotted all of the sessions for an individual user/video pair using a scatter plot, with the x axis representing time within a video playback session in minutes, and the y axis representing the time within the lecture that was being watched. A $45°$ diagonal line represents viewing the video without pausing, while horizontal lines indicate the video was paused. By colour coding sessions and overlaying their plots on top of one another, we can identify how many times a student has watched a particular portion of video by summing the number of diagonal lines over a region of the y dimension. If learners spend a session watching some video and "pick up" from where they left off, there will be no gap in the y dimension. If they re-watch from content they have previously seen there will be some overlap of the diagonal lines, and if they skip ahead there will be space in between each diagonal in the y dimension.

Figure 1 shows graphs of student interaction data using three different students and three different videos. The first image, Figure 1a, shows many long diagonal lines indicting the learner tends to navigate to the position of interest and watch for an extended period of time. These lines overlap heavily along the y dimension, indicating the student has rewatched significant portions of the video, some up to four times. There are also long horizontal lines indicating the student has paused the video for extended periods of time. Due to the strong diagonals, we have labelled this activity as *regular rewatcher*.

Figure 1b show a different kind of student, who has viewing sessions with a low slope, indicating they watch the video in less than real time. Our system didn't allow for variable speed playback, and deeper investigation shows that the learner both pauses the video frequently and slowly seeks through the video, perhaps spending time on particular segments to transcribe content or apply it to a problem they may be working on. Despite this, the learner has both rewatched one section of the video completely (given by the two overlapping lines), and ended up playing back all of the video content. Due to the perceived activity of the learner, we refer to this student as a *engaged rewatcher*.

[1] http://www.opencastproject.org

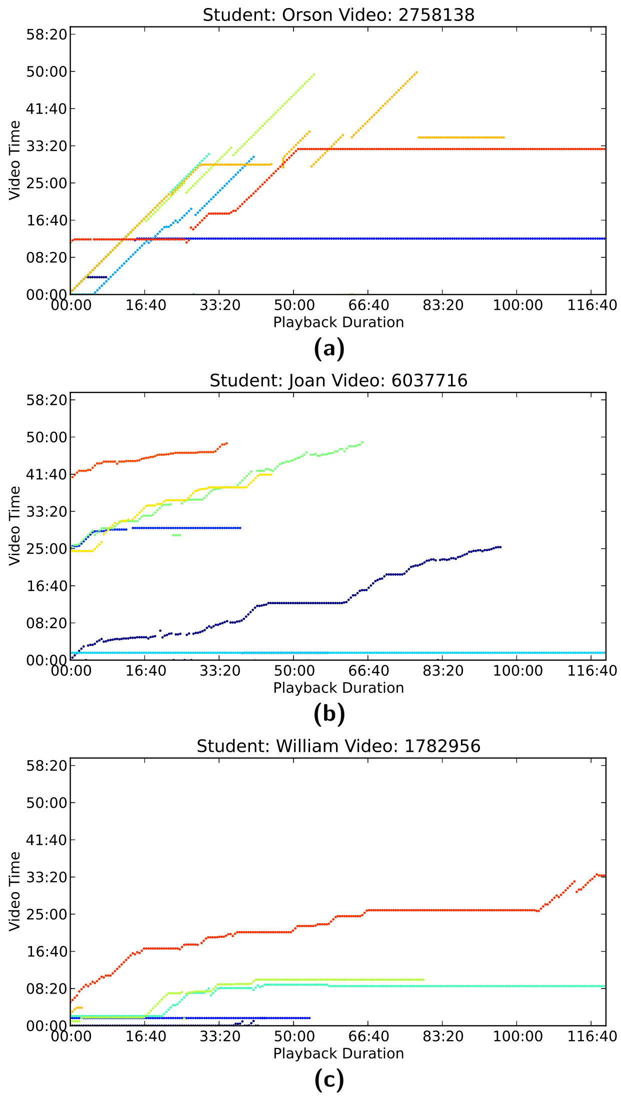

Figure 1: Rewatching graphs for three different learners.

Finally, figure 1c shows a learner who makes strong use of the pause feature of the player. While it was surprising to us, it is not uncommon to find learners who open multiple videos at once and then pause video for hours, even days, and come back to continue playing the video. This learner exemplifies this behaviour, with many sessions containing long horizontal lines, some turning into diagonals after extended periods. While our visualizations are truncated to 120 minutes in order to maintain a 1:1 ratio between axes, there are many learners who tend to follow this *pauser rewatcher*.

Case 2: Temporal Patterns of Viewership

In addition to understanding how learners watch individual videos, we are interested in understanding how learners watch videos over the span of the course. Previous work has been done by others on visualizing intravideo navigation [4], but we're interested in intervideo usage patterns, such as periods of high activity prior to examinations and assignments. We are motivated in part by our previous work, which has demonstrated that there is a statistically significant positive correlation between academic achievement and habitual weekly viewing of lecture videos [3].

To visualize temporal intervideo usage, we created three dimensional heatmaps for each course. These maps plot the time a video was made available to students (y axis), the time at which students watched that video (x axis), and the the total time that video was watched (colour axis). Data was binned to one day intervals and, while we did not hold the axes equivalent as we did in the previous example, a strong diagonal line represents learners watching lectures as soon as they become available, and the more filled in the lower right triangle of usage is, the more lectures were revisited.

While a number of different patterns were observed, here we present three distinct patterns. The first kind of course shown in Figures 2a and 2c demonstrate the most typical pattern of interaction. Here, learners rewatch lectures from earlier in the term as evaluations (midterm and final exams) approach. While there is some watching of early lecture content throughout the term, we notice large patches of blue (cool, or minimal) usage of content that was recorded before the midterm evaluation once the midterm has been delivered. While there is some viewership of this content right before the final exam, this activity is minimal.

The second kind of course is shown in Figure 2b, that has particularly strong viewership of only the most recent video right before the final examination. This suggests a very important lecture at the end of course was given (perhaps a comprehensive review of topics), or that topics from early on in the course will not be tested. As this course was an introductory programming course in Computer Science, it is quite likely that the early portion of the course focused on fundamental skills, while the latter half of the course required execution of these skills in programming assignments (leading to a reduction in watching of video content).

The last kind of course, an introductory Calculus class for non-majors, involved regular forms of evaluation spaced roughly every two weeks. Here, viewership patterns follow a diagonal band, where early content is rarely watched later on in this course. This suggests to us that the content either comes in distinct "chunks" which are unrelated, or that early content is fundamental to the later content and doesn't need to be revisited as the course progresses. This pattern is most interesting to us given our previous studies indicating regular viewership of captured lectures is correlated with academic achievement. In this course we don't observe the same amount of "cramming" when regular evaluation is applied, and we are interested in determining if it is the domain that causes this change, or the pedagogical approach.

Throughout most of these visualizations, we see a trend of high viewership (high temperature colour) early on in the course, at evaluation points, and at the end of the course.

Case 3: Comparing Usage Between Groups of Students

Our final visualization aims to shed light on how students in different identifiable groups use lecture capture facilities differently. We are particularly interested in comparing high achieving learners (those who achieved an exceptional pass of the course with a 87.5% or higher grade) to low achieving learners (those who achieved are marginal pass of the course with a 50% – 62.5% grade).

We plotted a histogram of viewership activity for each group. We concatenated the lengths of each lecture together[2], to form a continuous x axis of 28.5 hours of video. Each 15 minutes along the axis denotes a single histogram bin, viewership for that bin is equal to the number of heartbeats we would expect if every student in that group watched the whole 15 minutes (e.g., 30 heartbeats per student). This captures both initial watching and rewatching behaviour, but not behaviour where the video is paused. The two histograms were then plotted simultaneously with alpha channelling to see commonalities – in Figure 3 the red plots indicate viewership by high achieving students, the blue plots indicate viewership by low achieving students, and the shared viewership patterns are shown in purple.

[2]For data cleaning we limited the length of a lecture to 45 minutes.

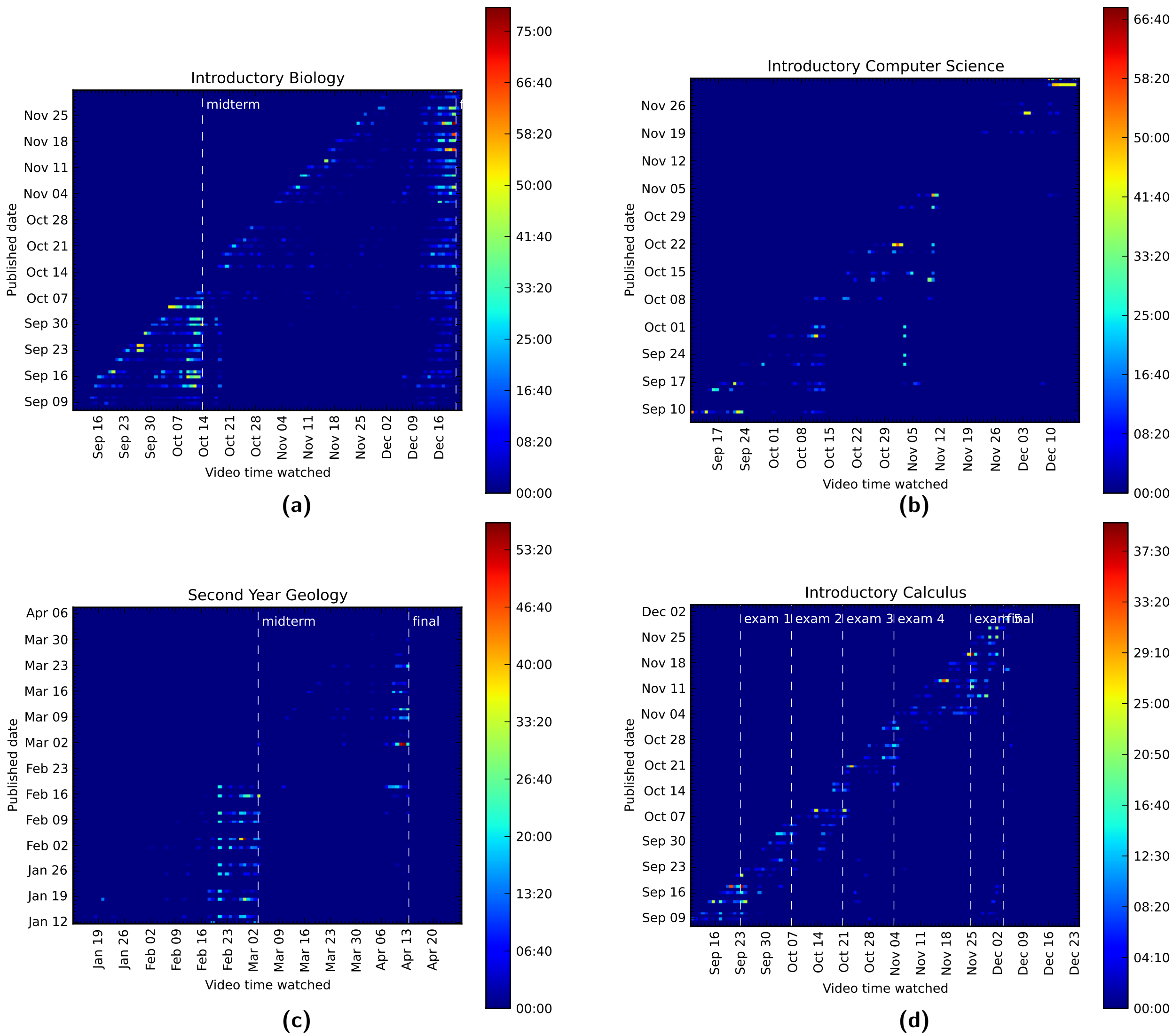

Figure 2: Heatmaps for four cohorts demonstrating the relationship between publication date of video and viewing date by students.

Conclusions

Through these visualizations, we have been able to gain insight into how learners used lecture capture, how this aligns with activities over an academic term, and how student populations differ in their use of lecture capture systems. Applying visual analytics to "big data" problems is not without caveats – the effects of parameters for charts including time offsets, resolution on heartbeat data, aggregation into bins for heatmaps and histograms, and determining the right data to process make discussion and prototyping essential steps in the process.

How to provide visual learning analytics to different stakeholders is also an issue we are carefully considering. Currently, our work is aimed at instructional designers and instructors who are deeply interested in their courses. We are interested in also showing visualizations to students and instructors to help them gain insight into their learning and teaching and how that relates to usage of technology like lecture capture.

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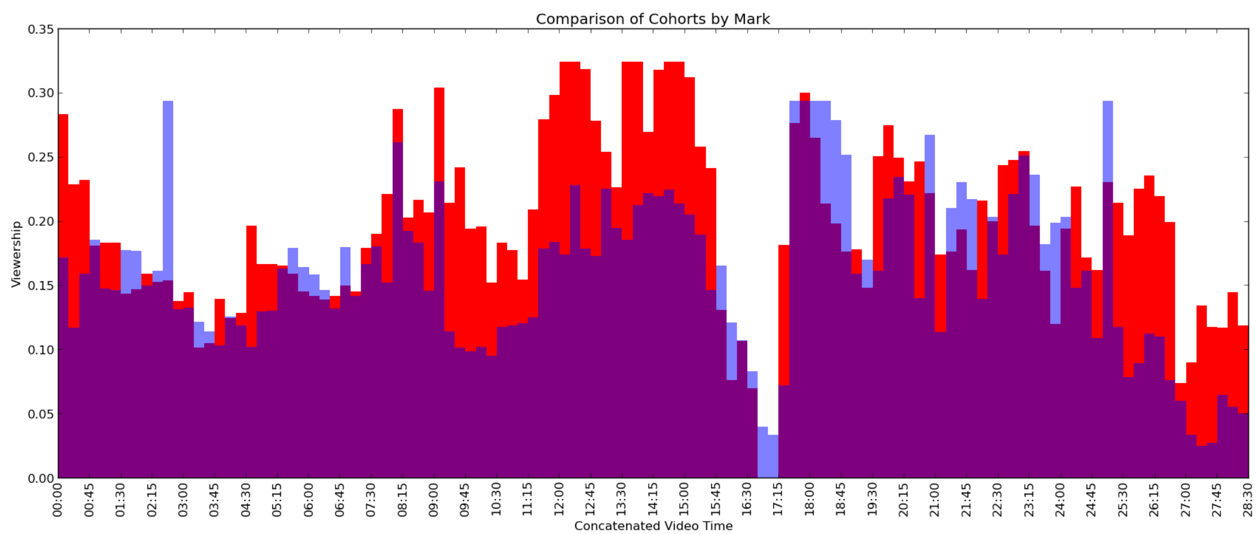

Figure 3: Overlapping histograms showing the viewership of high achieving students (red), low achieving students (blue) and that viewership common to both groups (purple). Videos of the *Chemistry 200* course were used for this plot.

Videolectures Ingredients that can make Analytics Effective

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Abstract

Videolectures over the Internet started at the turn of the century and became more and more popular, until they recently obtained a wide echo in the form of Massive Open On-Line Courses (MOOCs). Although videolecture usage data have always been important, in the case of MOOCs they are vital for the success of the initiative. In the present paper, we suggest that some (already available) tools for the extraction of semantic information from the video should be used, as they may vastly improve the meaningfulness of the information extracted from videolecture analytics.

Author Keywords

Videolectures, effective analytics, semantics, MOOCs

ACM Classification Keywords

K.3.1 [**Computers and Education**]: Computer Uses in Education - Computer-managed instruction (CMI).

Introduction

The idea of massively using videos of recorded lectures for teaching goes back to the attempts to use TV as an educational medium. The TV introduced some educational programs (and later channels), but only in rare occasions they were a success. A such case was the Italian TV show "Non è mai troppo tardi" (It's never too late) which from 1960 to 1968 brought more than a million of illiterates to achieve a primary school degree (probably one of the most successful examples of TV-based distance education ever, and a sort of early MOOC –Massive Open On-line Course, even though the "line" was not the Internet). Even before that there were instructional movies – used for instance to demonstrate scientific experiments that were too complex or too lengthy to be performed in a school laboratory. Also today there are educational TV channels, like Teachers TV : 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 (more recently also via Internet).

In the seventies, the use of VHS cassettes allowed for the first time to attempt transforming videos into an "on demand" resource for satisfying educational needs, but again the effort had only a marginal impact on the education mainstream.

At the end of the 80's, a system that implemented a rather mechanical process of individualized instruction was patented [1]. Part of the system consisted in the ability to use some ad-hoc hardware to play movies.

Only in the nineties PCs had sufficient power and memory space to consider them as tools that can be used for reproducing videos and multimedia in general. With the millennium turn the increased network bandwidth and the power of mobile devices (laptops first, and then pads and smartphones) allowed distributing videos over the Internet, which ultimately delivered today's capability to use video instruction anywhere and at any time. Since the early experiments [3, 13] a lot of research has been done on the Internet carried videolectures field (for a review see [9, 10]).

It took then about 15 years for these videolectures to pass from the work of the pioneers to the pages of the New York Times [8]. They went progressively though a larger and larger diffusion, with a first boost given (around 2005) by the Apple iTunes-U initiative, which also allowed extracting some usage data from the logs, see e.g. [2]. Along the path, for a few years (starting again from 2005) the podcasting variant has been a fashionable approach. Only recently MOOCs finally made it into the official dictionaries: the MOOC entry in the English Wikipedia dates July 2011. A history of MOOCs in 2012, the year of the boom, is reported in a post by Audrey Watters.

MOOC Numbers

Figures such as "1.7 million students for Coursera" or "ratio students to professor 150.000:1 in Udacity" [8] are certainly impressive: however, in spite of their popularity, there is little data on MOOCs. Stories of success and failure are often anecdotal. Some statistics is available coming from MOOC platforms like Coursera, Udacity and MITx, and they are puzzling.

The first MIT MOOC (MITx - 6.002x: Circuits and Electronics.), boomed with 154,763 registrants. Only 45% however (69,221 people) looked at the first problem set, and out of them only 26,349 earned at least one point (17% of the enrolled): we can consider these as the ones who manifested a real interest, rather than just a curiosity.

The number halved by the midterm assignment (13,569 people looked at it while it was still open and 9,318 people got a passing score on the midterm - 6% of the enrolled).

In the end, after completing 14 weeks of study, 7,157 people earned the first certificate (4,6% of the enrolled, i.e. 27% of those who really manifested interest). In spite of the gigantic drop, having more than seven thousand students passing a course is a massive achievement indeed.

The numbers for Coursera's Social Network Analysis class are less encouraging. Out of the 61,285 students registered, 1303 (2%) earned a certificate, and only 107 earned "the programming (i.e. with distinction) version of the certificate" (0.17%).

MOOC questions and challenges

The statistics raise several questions. The most compelling one is probably "why aren't a large number of students finishing the course?". This question may be difficult to find a response to, but responses to other inquiries can be obtained by monitoring the users' behaviour, and gathering statistics and analytics. Examples of such queries are e.g. the following ones:

- Where do the students come from?
- Which videos are most popular, and which ones attract little interest?
- Are students actually watching the videos on the assigned dates?
- Are viewers watching all the way through?
- At what point in the lecture, if any, do viewers stop watching?
- Are there any portions of the videos that are being watched repeatedly?
- Are the students watching the videos by the assigned deadlines?
- Do the videos generating active user engagement?
- Do students edit, share, download the material?

The interpretation of the statistics may however be not easy. Knowing that the sequence on lecture N at time between t1 and t2 is often reviewed is not by itself a meaningful cue. What is there? To know, we need to view ourselves the fragment. When the potentially interesting sections or points are many, this may be a very time-consuming task. The problem arises by the lack of semantic information.

Some help may come from a low-granularity structure of the material. For instance, if "lectures" are broken into small pieces (20 minutes) as in the case of Kahn Academy, or even less (10 minutes fragments, like in certain Coursera cases), it is likely that each unit has a well-defined semantics. Instead, if a lecture is recorded in class, and hence follows time constraints which are dictated by logistics rather than by content, things are much more difficult.

In these cases, substantial help may come from certain ingredients that we claim to be important ingredients of the videolectures:

- multiple (parallel) cognitive channels,
- semantic marking,
- transcripts,
- annotations

Videolecture enhancements that may (also) help analytics

The ingredients we mentioned are not really new, as some people have been using them for years in the context of videolectures as tools for improving the user experience. For instance, semantic annotation has been used for facilitating lecture navigation (see e.g. [11]), and transcripts have helped searching a videolecture (see later). However, in the light of analytics they assume a new dimension. Let us briefly examine them.

The first component we mentioned is multiple cognitive channels. Typically on-line lectures in MOOCs focus on at exactly two channels: they are either video + audio, slides + audio (the so called webcasts), or computer screen + audio (as e.g. in the case of the Kahn Academy). There are even lectures bases on audio alone (podcast), even though they were mostly used before the success of the MOOC term.

In contrast, even the snubbed frontal lectures in class are based on a richer paradigm. The teacher uses the blackboard, PowerPoint slides, may project his/her computer screen, and at the same time students see gestures and facial expressions. It is quite possible to reproduce such environment even in on-line lectures. A variety of authoring systems allow using in parallel (at least) two visual channels (e.g. slides + video), making the on-line lecture richer. While Moreno and Mayer [7] suggested that the presence of multiple cognitive channel brings a negative "split attention" effect, Glowalla [6], a German instruction psychologist, reported that lectures showing a video and slides favour learners show better concentration, while the audio + slide version is perceived as more boring. Data obtained by other investigators [4] confirm the better efficacy brought by the presence of video as an additional cognitive channels. We believe MOOCS should adopt such a rich communication paradigm, and not rely on the poorer paradigm based on a single video channel (+ audio).

This choice would help introducing the second ingredient: semantic marking. Having e.g. slides transitions makes it very easy to associate metadata to specific portions of a video. When a teacher presents a slide, what is s/he talking about? Most likely, we find the answer in the slide title. If slide transition timing, and slide content, are captured while recording the video, it becomes extremely easy to tag the video with semantic annotation. Questions like the ones we have mentioned, e.g. "Are there any portions of the videos that are being watched repeatedly?" may have now a significantly more interesting answer than "at time nn:nn": the answer might rather be something like "the fragment discussing third Kepler law". The power of analytics suddenly is vastly increased, exactly because of the availability of semantic metadata. And the important point is that such metadata – which are a resource which is notoriously difficult and costly to obtain, are automatically generated!

On the same line, availability of (synchronized) audio transcripts allows associating meaningful information to the timeline. A few years ago, we [5] successfully experimented using Automatic Speech Recognition tools to enrich videos with synchronized transcripts that allowed students to perform searches into on-line videolectures. This technique would of course also allow mapping any data coming from analytics on the content without the need of visual inspection of video fragments. Natural language processing (NLP) tools could be used to extract additional semantic information from a specific video fragment.

Finally, we mention in passing that the possibility for students to annotate video lectures would be a yet additional, precious source of information. Again, this would be a case of a feature that was originally designed to achieve a particular goal (such as e.g. to grow a community sense around a set of videolectures), and that would acquire an additional value in the context of usage analysis that is typical for analytics tools. This would be true for the extra information that NLP tools could mine from the notes, but in addition to that, data regarding annotation would per se be an extra source that could be mined (e.g. to find correlations with the difficulty or interest of a particular video portion).

Conclusion

MOOCs may be just an ephemeral fashion, or might revolutionize the future landscape of higher education: only time will tell. In this short paper we advocated the need for them to embrace a richer cognitive paradigm, and to be enriched by metadata associated with video fragments. The availability of such metadata, which should be automatically extracted, provides important hints that they make the information extracted by videolecture analytics much more significant.

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Investigating Differences among the Commonly Used Video Lecture Styles

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Abstract
Many educational organizations are motivated to create and share instructional videos, but there are no guidelines about the presentation styles. In practice, the presentation style of video lectures ranges from simple video capturing of classroom teaching, up to highly elaborate authoring of video presentations that include close-ups and video-cuts of instructors, slides, animations, and interactive drawing boards. In particular, there is limited research about the effects of each presentation style on student learning performance and attitudes. In this work, we examine the effects of video presentation styles in supporting the teaching of mathematics in the secondary education. In addition to a control group that studied through a paper-book, two groups of students attended two distinct styles of video lectures: 1) video capture of class teaching (Talking head style), and 2) close-up video capture of an interactive drawing board with voice-over (Khan style). The participants of our study consisted of 36 students (15 boys and 21 girls, 16 years old), who received the respective three treatments (paper book, talking head, khan style), over the course of three math modules in three weeks' time. We found that learning effects show up only after the second week and that the Talking Head style was more effective than the book for complex topics.

Figure 1. There are many styles of presenting a video lecture. In this work, we focus on the talking head and the interactive drawing board ones which are popular with iTunes University and the Khan Academy respectively

Author Keywords

Video, talking head lectures, khan style, satisfaction, playfulness, enjoyment, e-learning, performance

ACM Classification Keywords

K.3.1 [**Computers and Education**]: Computer Uses in Education - Computer-managed instruction (CMI).

Introduction

Video lectures have been growing in popularity and many organizations, universities and open learning systems are employing them as a main- or self-study medium, such as Coursera, Udacity, EdX, Khan Academy, TED, and Video Lectures. Although there is a growing interest and use, the benefits and the drawbacks of each different lecture type have not studied yet. The main goal of our research is to explore the effectiveness of different video lectures in teaching mathematics. For this purpose, we produced two different kinds of video lectures: 1) Video capturing of a typical class course and 2) video capturing of an interactive drawing board with voice over. Next, we employed three groups of students, namely two groups for the two kinds of video lecture, as well as one control group. In addition to learning performance measurement, we also employed the enjoyment construct, which students reported at the end of their participation.

Research has shown that students benefit from video based or assisted learning [1], [5], [6]. Specifically nowadays with the growth of many and diverse learning systems like Centra and Matherhorn; the use of video to enhance the learning process attracts much attention. Many educational systems have been developed to use video as the main or secondary tool to enhance the learning process. For example, Carnegie Melon University has created a low cost system called "Just-In-Time Lecture". This system has shown that the use of video in the educational process has analogous results with the traditional classes [9]. In the year 2012, there has been a proliferation of Massive Open Online Courses (MOOC), from companies such as Coursera, Udacity, and EdX. Since there is no single standard way or right way of doing a video lecture (Figure 1), it is worth exploring the effects of different styles of video lectures.

Indeed, videos lectures can take diverse forms and the video lecture style might have effects on important educational parameters such as learning performance and enjoyment. One of the most commonly used is the talking-head lecture, which is the type used by most of the universities (e.g., Stanford, MIT courseware). Another style of video lecture that is growing in popularity is the Khan academy style (hereinafter Khan style). Therefore, the main research goals of our study is to explore the differences among talking head and khan video lectures style, and to compare the differences to the traditional paper book that has been used for centuries during the self-study of the student. The motivation for study is based on the importance of enjoyment derived from a teaching method and is in alignment with previous research [4], who performed a comparison between two teaching methods.

Methodology

We produced two styles of videos, one with teacher's participation (Talking Head) using the traditional green chalkboard (Figure 2) and the other one with the teacher's voice over the interactive drawing board (Figure 3). In our study, the duration of each video was

Figure 2. Example of Talking Head Video

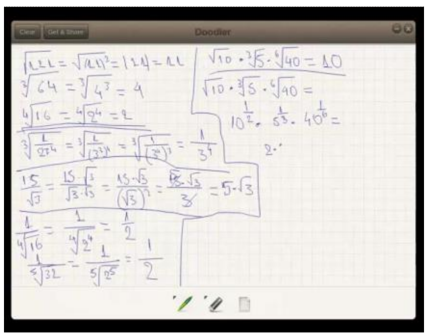

Figure 3. Example of Khan Style Video

Table 2. The Factors and their definitions

Factor	Definition
Enjoyment	The degree to which the teaching type is perceived to be personally enjoyable
Learning Performance	The knowledge acquired during the treatment.

10 minutes. For the talking head style of video lectures, the content looks like the traditional lecture and it has been a popular video lecture format for many online videos because it is easy to capture and share without going through a resource intensive video editing post-production. In these videos the teacher was presenting a summary of the unit he had taught. For the Khan Style lecture, the viewer concentrates upon the boards' content. Only the teachers' voice and the exercises are participated in this kind of video. The video content focuses on what is being written on the board. The bamboo pen was used for the creation of these videos. This kind of video is very popular in the Khan Academy and Udacity, which was the motivation for this study. In both video lecture styles, the teacher was presenting the exact same summary of the module he had taught during the normal course hours.

Thirty-six experimental subjects, 15 boys and 21 girls (16 years old) participated in this study. The students wrote a pre-test on mathematics before the separation into groups, so that the groups are equivalents in terms of previous math performance. After the test we had three groups with 12 students each with a grade average in the pre-test of 16.5 out of 20 points. The presentation of the video took place in the computer laboratory. Every student was watching the 10 minutes video on the computer. One group watched the video with the teacher making a presentation (Talking Head lecture); another group watched the video with a close-up of an interactive board (Khan Style) and the control group browsed through a paper book for the same amount of time.

The study consisted of two parts. In the first part, each one of the groups studied for their module by employing the respective treatments (two styles of video and the paper book). This part of the study was held three times for each group for three different modules of mathematics. Students had ten minutes to watch each style of video and the control group to read the respective module from the book. At the end of each time students solved a test according to the unit they had taught, which lasted twenty minutes. In all cases, the experimental procedure was very strict with regard to the time that the students had. For the implementation of the second part we employed a standard questionnaire which consisted of three questions. The purpose of the questions was to examine the Enjoyment factor (Table 1). Finally, we analysed the data with the use of SPSS program. We used the Mann-Whitney U Test for the processing because of the small sample.

Results

In the following table we summarize the results of our study.

Table 3. Mean values & standard deviations of the 3 types

	Mean (S.D.)		
	Talking Head	Khan Style	Paper book
Enjoyment	2.03 (0.96)	1.97 (0.82)	2.89 (1.15)
Learning Performance 1	6.38 (1.52)	6.31 (1.54)	6.26 (1.12)
Learning Performance 2	6.37 (2.95)	5.89 (2.40)	5.24 (3.04)
Learning Performance 3	7.62 (2.70)	6.51 (2.05)	4.66 (3.50)

To examine potential differences among the three groups we performed Mann-Whitney U test. As it can be seen from the outcome data in Table 3, students' studied at the 'Paper Book' group enjoyed the procedure more than the 'Talking Head' and the 'Khan Style' groups ($p<0,05$). In addition, we used Mann-Whitney U to test the difference on learning performance. During the first two modules the learning performance of the three groups has no significant difference. However, at the third module the learning performance of the Talking Head group was significantly better than the Khan Style group ($p<0.05$).

Table 4. Testing the differences among Talking Head, Khan Style and Paper book using Mann-Whitney U test

Factor	Type A	Type B	Z	U	P	Result
Enjoyment	Talking Head	Khan Style	-0.058	71	0.95	i.d.
	Talking Head	Paper book	-2.07	36.5	0.04*	**s.d.**
	Khan Style	Paper book	-2.01	37.5	0.04*	**s.d.**
Learning Performance 1	Talking Head	Khan Style	-0.38	65.5	0.71	i.d.
	Talking Head	Paper book	-0.17	69	0.86	i.d.
	Khan Style	Paper book	0.00	72	1.00	i.d.
Learning Performance 2	Talking Head	Khan Style	-0.99	55	0.32	i.d.
	Talking Head	Paper book	-1.16	52	0.25	i.d.
	Khan Style	Paper book	-0.52	63	0.60	i.d.
Learning Performance 3	Talking Head	Khan Style	-1.78	41.5	0.08	i.d.
	Talking Head	Paper book	-2.39	31	0.02*	**s.d.**
	Khan Style	Paper book	-1.48	46.5	0.14	i.d.

i.d. Insignificant Difference; s.d. Significant Difference

Conclusion and Further Research

We found significant statistical differences between the tested video styles and there are also some interesting explanations and useful conclusions. Most notably, the enjoyment measure was reported higher in the control group, who employed a paper-book to study the three modules in mathematics. The familiarity of the students with paper books might be one explanation of enjoying this medium in comparison to the video medium. Another explanation is that students of the Talking Head group and Khan Style group had not employed any video before for their self-study. The preference of video styles might depend on previous exposure to them and there might be cultural and personal parameters, which have to be controlled in further research. In conclusion, further research should pre-test students according to their previous exposure to video lectures and to group them accordingly.

Actual learning performance was slightly improved when the students employed the videos in comparison to the paper book, but this is only after the second week, which indicates that the students need to become familiar with new teaching styles. In particular, there was higher performance in the case of the Talking Head over the Khan Style video lecture. Although we hypothetized that the Khan Style might be result in better performance this was not true. One explanation is that the students felt more familiar with the Talking Head video lecture. Notably, the improvement in learning performance was higher for the last mathematics module, which was the most complicated module of the three. Therefore, there might be an influence of the type of course on the learning performance across the self-study mediums and video lectures seem to be superior for complex learning.

Moreover, further research should measure the learning performance over more teaching modules than three and over more courses than mathematics.

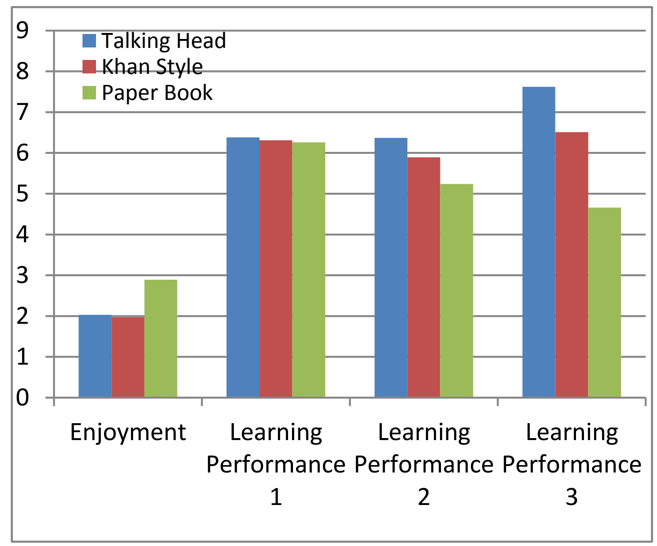

Figure 4. Students enjoyed the book because they had control of browsing, but their performance was higher with the Talking Head video lecture for complicated mathematic module

It is important to note that students watched the videos linearly and did not have the time to watch the video again or reply it. In particular, the use of video did not give the opportunity to students to have any interaction with it when they were watching the video, in contrast to the paper book treatment group, who was observed to browse through the pages. Therefore, in further research, we must allow the students to interact with the videos [2], but this treatment might need more time than the video length. In practice, allowing students to skip through a video should improve their learning performance, but might come at the cost of additional time. Despite all these limitations all students were positive to employ this way of learning and during the interviews at the end of the research we found that the use of video in self-study motivates the weak students.

Acknowledgements

The authors would like to express their gratitude to all of the students for volunteering their time. Our very special thanks go to the math teacher, of the, for his assistance in our study. We would like also to thank EC project for providing the equipment.

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Social Interaction Design for Online Video

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Abstract

The social nature of watching audio-visual content drives developers of online video to explore the integration of social media with streaming video. This leads to new kinds of services such as twitter updates that enhance live video streaming, or Facebook apps that allow chatting while watching video content. Moreover, several apps are being created for smartphones and tablets, which act as secondary devices or 'second screens' that allow remotely communicating with friends while watching video. This presentation will give an overview of current developments on social video applications as well as an insight into incorporating social features to enhance the video viewing experience through social interaction design. David Geerts highlight and summarize the most important social features present in these applications and present them in a coherent framework that helps in understanding the relevance of these emergent applications. The following key principles in designing such applications will be discussed in detail: activity, awareness, synchronization, social interaction, device, and social reach. Each of the principles will be illustrated by using existing applications, including secondary screens, rich social experiences with other viewers and social sharing of video content with close relationships.

The full presentation is available at:
http://videolectures.net/wave2013_geerts_television/

Author Keywords

Online Video, Interaction Design, Sociability

ACM Classification Keywords

H.5.1 [**Multimedia Information Systems**]: Video (e.g., tape, disk, DVI); K.3.1 [**Computers and Education**]: Computer Uses in Education - Computer-managed instruction (CMI).

Bio

David Geerts has a master in Communication Science at the KU Leuven, a master in Culture and Communication at the KU Brussel and a PhD in Social Sciences at the KU Leuven. David is Research Manager of the Centre for User Experience Research (CUO) at the faculty of Social Sciences and is specialized in user-centered design and evaluation of future ICT applications, such as social interactive television, serious games and social media, working on several local and EU projects. He organized many workshops, special interest groups, and tutorials at international conferences, and for some years has taught a course on Human-Computer Interaction for master students of the faculties of Social Sciences and Economy. David Geerts is member of the IFIP TC14 WG6 on Entertainment Computing, is co-founder of the Belgian ACM SIGCHI.be chapter (now CHI Belgium), is part of the EuroITV steering committee and was program chair of the EuroITV2009 conference on interactive television.

Apps for Synchronized Photo-Audio Recordings to Support Students

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Abstract

We introduce new prototype Apps for the automated recording of complete lessons, seminars, talks, *etc* using mobile devices running Android OS and iOS, which aim at supporting the recoding of academic lectures by students themselves. These Apps are free for use and are based on the experiences gained by the ICTP Science Dissemination Unit (SDU) in Trieste, Italy with its open source *"Enhance your Audience"* (EyA) recording system: wwww.openeya.org --with more than 10 thousands hours of automated educational recordings in the fields of physics and mathematics.

Author Keywords

Automated recording, Photo-Audio Recordings, physics and mathematics

ACM Classification Keywords

H.4.3 Communications Applications, H.5.1 Multimedia Information Systems, H.5.2 User Interfaces, K.6 Management of Computing and Information Systems

Motivation

Rich-media video recordings of lectures, seminars, conferences, *etc* are now being produced world-wide by prestigious institutions, research centers, schools and others since the technology to implement video streaming and recordings is getting robust and cost effective. Another reason for this growth lies in the fact that access to the Internet is now available to all at affordable costs and at faster speeds throughout different means, including the new mobile devices. It is forecasted that in only few years ahead, on-line videos traffic will consume most of the bandwidth available for academia and entertainment [1].

Pioneering educational video archives such as the MIT OpenCourseWare [2], and the ICTP pre-PhD Diploma Courses On-line for Physics and Mathematics [3] are increasing their popularity with scholars around continents. New open educational programs for blended learning, mobile learning and others in different fields are being developed and made available at reasonable prices, giving the opportunity scholars to advance in their careers. Most recently, the implementation of Massive Open On-line Courses (MOOC) [4, 5] by EdX.org of MIT and Harvard are opening also new ways to offer excellence and free education for all. The technology needed to optimize these educational programs such as Coursera and Audacity are still under developments [6]. In this regard, the recent Pinvox algorithm [7] can be used to certificate self-study by the attentive vision by students of their assigned educational on-line videos by their Tutors.

There is little work for supporting and facilitating the easy recordings by the students themselves, specially now that they have easier access to computers, and a large variety of mobile devices to communicate with their peers and to participate in social networks activities or to use them during their academic activities. From the technological point of view, many efforts have been principally devoted to support the recordings by Institutions, and little support has been given to the possibly of developing tools for allowing students to carry out their own recordings, which should be optimized for long traditional classroom lectures of 45min or so.

In this work we introduce our new prototype Apps for the automated recording of complete lessons, seminars, talks, *etc* using mobile devices running Android OS, and iOS (displayed in Fig.1). Our aim is to support the recoding of academic lectures by the students themselves.

Figure 1. EyApp icon on a iPhone.

EyApp & AndrEyA Apps

The releases of the applications for AndrEyA on Android OS and EyApp that can be used also on iPads and iPod touch, have been deployed to allows scholars to make their own recordings or Postcasts with just the press of a button, and to allow them to share their recorded courses immediately on the Internet soon after the lectures ends or save it for future reference and study.

These Apps are free for download and use, and are based on the experiences gained by the ICTP Science Dissemination Unit (SDU) in Trieste, Italy with its open source *"Enhance your Audience"* (EyA) recording system: www.openeya.org --with more than ten thousands hours of automated educational recordings in the fields of physics and mathematics (see: ICTP.tv).

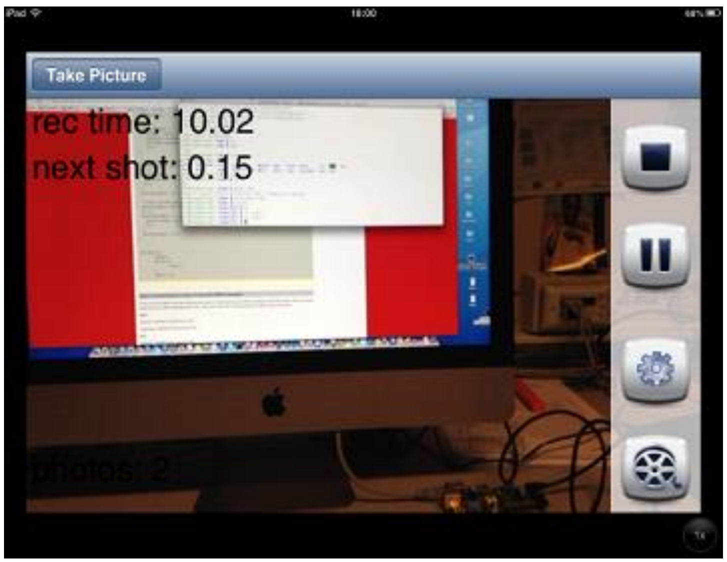

Figure 2. EyApp Control Panel with buttons for Manual Photo Shooting, Recording/Stop, Pause, Preferences and View.

EyApp is available on the iPhone App Store: https://itunes.apple.com/, and the AndrEyA App through the website http://www.andreya.org.

Like a small video camera, EyApp (shown in Fig. 2) and AndrEyA can simultaneously record the voice of the speaker and take pictures of the screen, which projects digital presentations, or from a podium holding a traditional blackboard. As a main difference though, these Apps on an iDevice (iPhone, iPad or even an iPod touch) save students from the frustration of learning the art and science of video recording and the many options of conversion to multiple video formats.

Figure 3. EyApp Frame Control from 5 to 20 seconds.

With EyApp and AndrEyA Apps it is possible to create one's own photo-audio movies that are composed by still frames (*i.e.,* screenshots of what is projected or written by the speaker or lecturer) synchronized with a continuous audio signal. The result is a file of smaller size compared with a traditional video (HD or standard resolution) because the still frames can greatly benefit of the highly-efficient compression algorithms used by the H264 video format used by modern mobile iDevices.

Figure 4. AndrEyA App icon for Android: www.andreya.org

Within EyApp and AndrEyA one can shot automatically, every 5, 10, 15 or 20 seconds, or the shootings can be controlled manually by the user as shown in Fig. 3, allowing for many different situations of usage. There is also the possibility to pause the recording by pressing a button and to re-start the recording again from the point at which was paused, saving in this way periods of silence or any breaks done throughout during the lectures.

To make the application even more engaging, EyApp outputs (and also next versions of AndrEyA --whose icon is shown in Fig. 4) can be saved on the device's photo/movie gallery, and from there it can be further edited with other Apps, shared by e-mail and rich-media messaging systems, or via social networking Apps, or transferred to a computer (*c.f.,* Fig. 5). In particular, our EyApp allows to create personal recording archives as well as to share them via popular self-video archives such as YouTube.

Figure 5. EyApp Output files containing synchronized audio-photo recordings. These can be easily erased or transferred.

Our final goal is to facilitate the recording of seminars with Apps like EyApp and AndrEyA, either at an School, University, Conference or anywhere a student could be present. Most importantly for the project ay hand is to allow students to record an event of their interest at any time and for their own purposes, and/or for sharing their recordings with colleagues and friends.

Mobile Internet in Developing Countries

For developing countries experiencing the so-called Digital Divide, there are now new opportunities to leapfrog "old" technologies such as wired phones and desktop computers. This is increasingly the case in Africa, as the costs of intelligent mobile devices continue to fall and the prices and availability for WiFi and cell phone coverage improve [8].

According to a recent report [9], Africa is the most dynamic e/m-Learning market on the planet. In the last two years, many African countries have embarked on new government backed initiatives to integrate learning technologies into education and training. The growth rate for self-paced e-Learning is above 15%. Senegal has the highest growth rate in Africa at 30.4%, followed by Zambia (27.9%), Zimbabwe (25.1%) and Kenya at 24.9%.

Many countries are adopting e/m-Learning programs as a way to meet the strong demand for higher education. For example, the pan-regional virtual University of South Africa (UNISA) has over 310,000 students (of which 3,500 come from outside Africa). A year ago, the African Development Bank Group (AfDB) approved a $15.6 million grant, "to help strengthen the capacity of the African Virtual University (AVU)", with the goal to use these funds to build out 12 e-Learning Centers.

On the other hand, the growth of mobile phone subscriptions world-wide in the last few years has been also tremendous. With 5.9 billion mobile-cellular subscriptions, today's global penetration reaches 87% and 79% in the developing world. Mobile phones have changed the way people access the Internet to study, work and search for information and knowledge.

Mobile-broadband subscriptions have grown 45% annually over the last four years, and today there are twice as many mobile-broadband as fixed subscriptions. This means that people, especially scholars at a young age, use the Internet via mobiles devices more than they do at home. Hence, it is foreseen that educational Apps, like EyApp and AndrEyA --that aim to support students' work, will became more and more useful and popular.

Acknowledgements

We would like to thank Prof. Fernando Quevedo, ICTP Director, for supporting our SDU projects, and Pankaj Nathani for help with the technicalities.

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Presentations Preserved as Interactive Multi-video Objects

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Abstract
We first give an overview of a system which allows capturing a lecture to generate, as a result, a multi-video multimedia learning object composed of synchronized videos, audio, images and context information. We then discuss how a group of students interacted with a learning object captured from a problem solving lecture: a similar approach can be used by instructors to reflect about their performance during their lectures.

Author Keywords
Student-multimedia interaction. Interactive Multimedia. E-learning. Ubiquitous Capture and Access. NCL.

ACM Classification Keywords
H.2.3 [Communications Applications]: Information browsers.

General Terms
Documentation, Measurement, Verification.

Introduction
Increasingly universities record lectures and make them available on the web, exploiting the fact that the classroom can be viewed as a rich multimedia environment where audiovisual information is combined with annotating activities to produce complex multimedia

objects [1]. Although in some cases the web lecture may be a single video stream (e.g. Kan Academy and TED talks), more elaborate viewing alternatives are available (e.g. *opencast* [2] and *openEya* [3]).

Once captured lectures have been made available, being able to analyse how the users watch them – and learn from them – is a challenging task, as illustrated by Brooks and colleagues [2]. In such a scenario, extracting semantics from the captured information is a must [7].

We built a system prototype that allows recording a lecture: audio and video streams from the instructor, slides, writings on whiteboards, as well as contextual information – the aim is to automatically generate an interactive multimedia object [5, 6]. Given the several sources of information, students must be given a broad range of interaction alternatives when reviewing the lecture: our system generates multi-video objects in a standard for interactive multimedia, so that students have several interaction alternatives at the same time that can use a standard HTML5 browser. The actual student interactions are also captured so they can be analysed.

Next, we briefly introduce our system, and outline results from analysing the student interactions with the resulting interactive multi-video object.

From capture to interactive multi-video

We have instrumented a classroom with cameras (Figure 1(a)), and built a prototype system whose modules (Figure 1(b)) capture several information streams from a lecture and generate an interactive multimedia object (NCL[1]), which can then be played-back in a player which runs on standard HTML5 browsers (Figure 1(c)).

[1]Nested Context Language - http://ncl.org.br/en

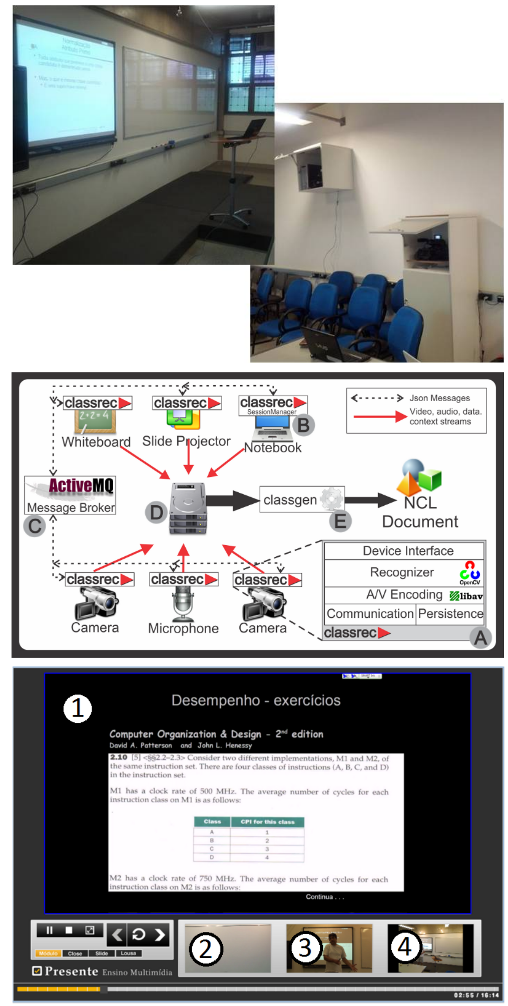


Figure 1: (a) Classroom. (b) Prototype overview. (c) Player

The player (Figure 1(c)) is designed so that the multi-video object corresponding to the lecture may be reconstituted and explored in dimensions not achievable in the classroom. The student may be able, for example, to obtain multiple synchronized audiovisual content that includes the slide presentation (1), the whiteboard content (2), video streams with focus on the slide (3) or the lecturer's full body (4), or the lecturer's web browsing, among others. Moreover, the student may choose at any time what content is more appropriated to be exhibited in full screen. The student may also be able to perform semantic browsing using points of interest like slides transitions and the position of lecturer in the classroom. Moreover, facilities can be provided for users to annotate the captured lecture while watching it, as advocated by the Watch-and-Comment paradigm [4].

One lecture, 12 modules

Using the capture-tool prototype, one instructor captured one lecture without students in the classroom: students had access to the multi-video object to prepare to their final exam.

The lecture was a problem solving session for a Computer Organization course in which an instructor solved a total of 15 exercises. These exercises were related to each other and usually a subsequent exercise used some results from the previous one. The exercises also become more difficult as the presentation progressed.

The lecture was divided into 12 modules, totalling 1 hour and 18 minutes. Module 1 presented 3 exercises, module 5 contained 2 exercises, and all the other modules presented one exercise each.

Eighteen students watched the lecture for at least 4 minutes: the average playback time was 59 minutes, with standard deviation of 39 min. The average number of interactions was 118.6, also with a large deviation (99.6).

Checking out student interactions

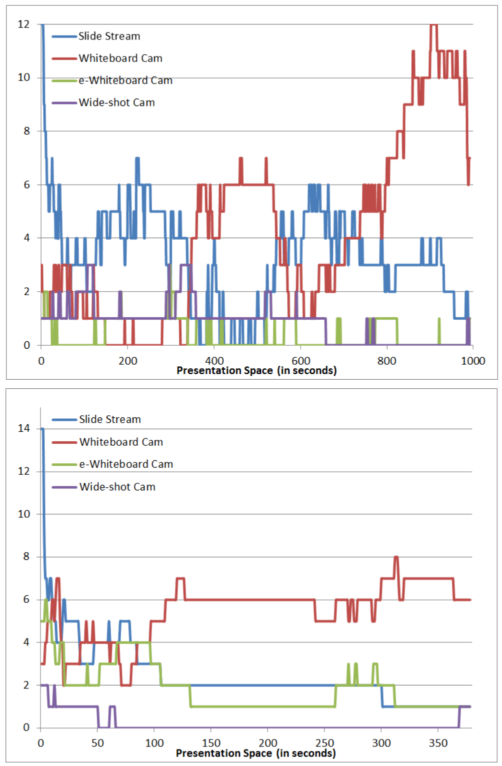
Given that the multimedia object has more than one video stream and that students can choose which stream they want as the main stream (presented in the large window in the player), the information of which stream is the most selected as the main stream at each moment can be useful for the instructors to reflect about their performance during the lecture.

We present next how students interacted with the several video components that make up the multi-video object of modules 1 and 4. A detailed discussion of the students interaction with all modules is available elsewhere [8].

Figure 2(a) and Figure 2(b) summarize which streams were most selected as the main stream, respectively, for module 1 and module 4. Each line represents how many times a stream was watched in a specific moment:

- the blue line corresponds to the slides as presented in the instructors notebook (Figure 1(c-1));
- the red line corresponds to the conventional whiteboard (Figure 1(c-2));
- the green line corresponds to the electronic whiteboard which presented slides which could be annotated by the instructor (Figure 1(c-3));
- and the purple corresponds to the camera giving an overview of the classroom (Figure 1(c-4)).

As shown in Figure 2(a), students watched more, as the main stream, the slides and the whiteboard. The three regions with higher values for the red line correspond to the moments in which the instructor solved the three exercises writing on the conventional whiteboard. Accordingly, the higher values for the blue line correspond to the slides with the specification of the exercises, and precede properly the higher values of the red line. A similar behavior is shown in Figure 2(b): the difference is that this module discussed a single exercise.



(a)

(b)

Figure 2: Studen interactions with modules 1 and 4

Final Remarks

Our plans for future work include capturing more contextual information during the presentation toward providing novel navigation facilities, and the development of visualization tools for the instructors to analyse the students multi-video object interaction.

Acknowledgements

We thank the courses instructor and the students, the WAVe13 organizers for the opportunity to present our work, and the workshop participants for their inspiring presentations.[2]

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Merging learner performance with browsing behavior in video lectures

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Abstract
Video lectures are nowadays widely used by growing numbers of learners all over the world. Nevertheless, learners' interactions with the videos are not readily available, because online video platforms do not share them. In this paper, we present an open-source video learning analytics system. The system captures learners' interactions with the video player (e.g, pause, replay, forward) and at the same time it collects information about their performance (e.g., cognitive tests) and/or attitudes (e.g., surveys). We have already validated the system and we are working on learner modeling and personalization through large scale data analysis. The tool is a freely available open source project for anyone to try and to improve.

Author Keywords
User Interactions, Video Based Learning, Education, Learning Analytics

ACM Classification Keywords
H.5.2 [**Information Interfaces and Presentation**]: User Interfaces, user-centered design; K.3.1 [**Computers and Education**]: Computer Uses in Education - Computer-managed instruction (CMI).

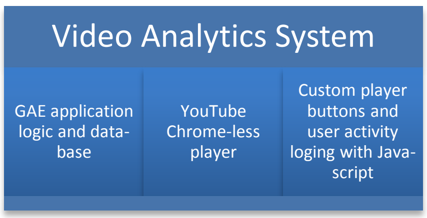

Figure 3. Video analytics system architecture is modular and cloud-based. Web-based video systems might employ the open-source application logic, in order to dynamically identify rich information segments

Introduction

The use of videos for learning has become widely employed in the past years [3]. Most of the universities and digital libraries have incorporated video into their instructional materials. Currently, Massive Online Open Courses (MOOCs) are becoming an increasingly important part of education. In order to support video learning, various technological tools have been developed. For example, Matterhorn and Centra are just few of them. However, information from the video-based learners' behavior and navigation is not yet freely available to the educational technology community.

Figure 1 Matterhorn provides an annotated seek-bar in order to improve navigation within a video lecture, but there is no support for collecting and analyzing learners navigation

Capturing and sharing analytics in emerged learning technologies can clearly provide scholars and educators with valuable information. Specifically for the case of video based learning, information obtained from learner (hereinafter Learning Analytics-LA) have recently started to be used in order to provide educators with valuable information about students (Figure 2). However, the usage of LA on video based learning it is still on embryotic research stage.

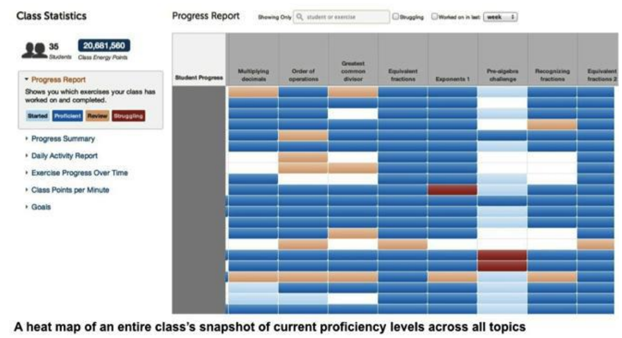

Figure 2. Khan academy provides the teacher with a dashboard that depicts the performance of students across topics, but it does not link the performance within the respective video sections.

The purpose of this paper is to present an open-source video learning analytics system. The system facilitates the analysis of video learning behavior by capturing learners' interactions with the video player (e.g, seek/scrub, play, pause) and collecting information for their performance (e.g., cognitive tests) and attitudes (e.g., surveys).

Open-Source Video Learning Analytics System

Learners' interactions with the videos are not readily available, because online video platforms do not share or they are not interest on them. In order to be able to capture and store these interactions, we developed an open-source video learning analytics system. Our system facilitates the analysis of video learning behavior by capturing learners' interactions with the video player (e.g, play, pause).

For developing the Open-Source Video Learning Analytics[1] System (Figure 3), we used the Google App Engine (GAE) cloud platform and the YouTube Player API [4]. There are several benefits of the selected tools (GAE, YouTube, Google accounts). GAE enables the development of web-based applications, as well as maintenance and administration of the traffic and the data storage. YouTube allows developers to use its infrastructures (e.g., YouTube videos) and provides chrome-less user interface, which is a YouTube video player without any controls. This facilitates customization within Flash or HTML 5. As such, we used JavaScript to create custom buttons and to implement their functions. Additionally, learners' used Google account in order to sign in and watch the uploaded videos. In this way, we accomplished user authentication and we avoid the effort of implementing a user account system just for the application. Thus, users' interactions are recorded and stored in Google's database alongside with their Gmail addresses. The Google App Engine database (Data store) is used to store the interactions. Each time someone signs in the web video player application, a new log is created. Whenever a button is pressed, an abbreviation of the button's name and the time it occurred are stored.

The video player (Figure 4) employs custom buttons, in order to be simple to associate user actions with video semantics. We have modified the classic forward and backward buttons to "Skip30" and "Replay30". The first one jumps backwards 30 seconds and its main purpose is to replay the last 30 seconds of the video, while the Skip30 button jumps forward 30 seconds and its main purpose is to skip insignificant video segments. The main reason for developing these functions is to identify the video segments which learners' consider as important (repeated views). We decided to use buttons that are similar to the main controls of VCR remote controls because they are familiar to users. In addition, questionnaires and performance tests can be employed next to the main interface of the player (Figure 4) and the respective data will be integrated in the Data Store.

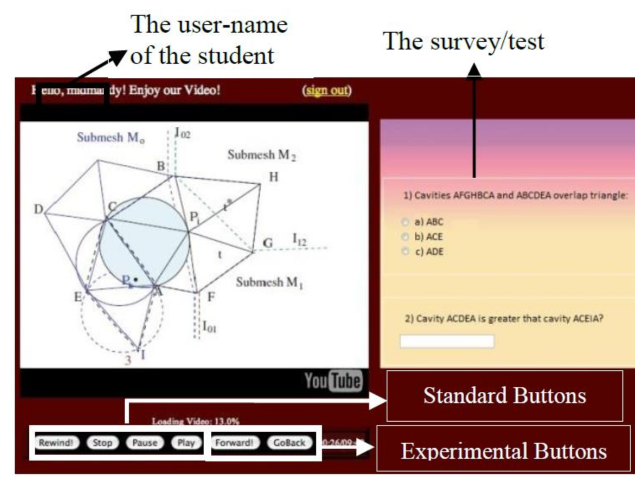

Figure 4. The interface of the system has familiar buttons, as well as questionnaire functionality

[1] Open source project: https://code.google.com/p/socialskip/

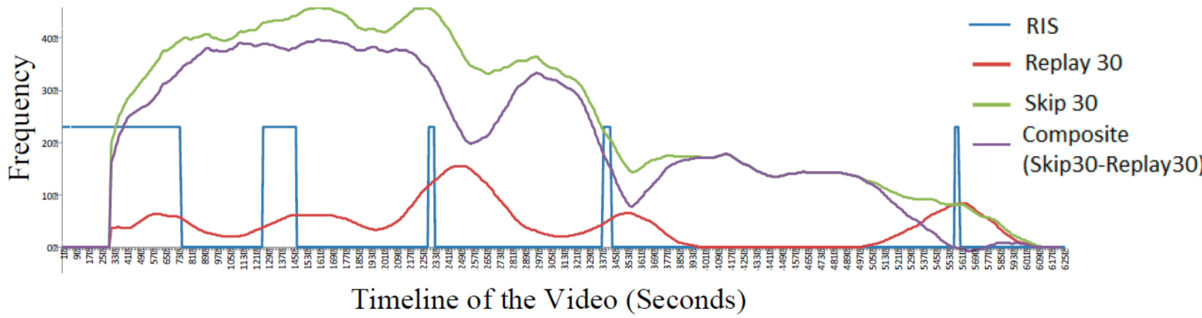

Figure 4. An Example of Learner Activity Visualization

The system is also providing all these interactions in an form which can be easily visualized, using for example times series (Figure 5). To this end, researchers and scholars are being able to extract all the rich information and understand better the learner behavior. In addition, the results from the questionnaires and performance tests can be used to triangulate the results. By taking into account learners' interactions and many other data—such as their demographic characteristics, prior background knowledge, their success rate in each section, their emotional states, the speed at which they submit their answers, which video lectures seemed to help which students best in which sections, etc.— we will be able to understand how this medium is being used by the students and proceed to the appropriate amendments to the current video based learning systems and practices.

Benefits and Perspectives

Many corporations and academic institutions are making lecture videos and seminars available online, there have been few and scattered research efforts (i.e., [5]) to understand and leverage actual learner experience. In addition, to the best of our knowledge there are no efforts using LA from diverse sources in order to triangulate them and derive valuable information about students.

In that paper we present an open-source video learning analytics system. Although we designed the system as a web-based one, the concept of mapping implicit learner interactions to a time-series for further analysis has a much broader application.

This large amount of LA produced during the interaction of the learner with video-based learning system can be converted into useful information for the benefit of all video learners. As long as learners' watching videos on Web-based systems [1], more and more interactions are going to be gathered and therefore, dynamic analysis would represent in a timely fashion the most important (rich-information) segments of a video according to evolving learner interests. We also expect that the combination of richer user profiles and content metadata provide opportunities for adding value to LA obtained from video based learning.

By taking into account learners' interactions and many other data—such as students' demographic characteristics of gender, ethnicity, English-language skills, prior background knowledge, their success rate in each section, their emotional states, the speed at which they submit their answers, which video lectures seemed to help which students best in which sections, etc.— new avenues for research are opening. As Butin [2] clearly articulated in ACM eLearn, using students' data, we can feed powerful algorithms and create seemingly personalized feedback [6]. Future work will help to collect diverse LA (i.e., success rate, emotional states), which will allow the community to consider the challenges for developing a "recommender system", which we have all encountered on Amazon. Such a system would have allowed video lectures to discover that perhaps certain lecture characteristics and practices, help some students more effectively at different points in a course.

The intellectual merit of this proposal is the development of a novel experimental video analytics system. The presented tool aims to contribute to the area, by providing an open source solution for video analytics capturing (the first of its kind to the best of our knowledge) for further improvement and experimentation.

Acknowledgements
The authors would like to express their gratitude to Ioannis Leftheriotis and Chrysa Gkonela for their contribution on that research.

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