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Effectiveness of Video Lecturing Technology in ICT Learning

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Abstract

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This thesis studies large-scale initiatives that support the use of video lecturing in teaching and presents a system for using video lectures and for integrating them to courses in a Moodle learning management system.

The main emphasis of the thesis is in the implementation of video lectures and the analysis of the learning results through video lectures. Also, the influence of using video lectures in teaching is evaluated by comparing the learning of student groups with and without the possibility of using video lectures. Effectiveness of video lecturing has been studied by comparing the average exam points acquired by different student groups.

First an introduction to video lectures and typical ways of using them in large-scale initiatives is presented. Also the challenges and possible ways to optimize the use of video lecturing are examined. Then the thesis describes possible ways to produce screencast to be used as video lectures and presents the method used to create these video lectures for an experimental course dealing with information technology systems and devices. The distribution of the video lectures to the students and the implementation to the Moodle learning management system are also described.

The last part of the thesis focuses on analysing the use of video lectures and the exam results with three different student groups that used video lecturing material and one group without such possibility. Each group of students that used video lectures used them in different way.

The result was that the benefits of using video lectures alone were not found to result in better exams results in the experimental course between groups with or without video lectures. However, at the same time the student inquiry clearly showed that video lecturing made studying more convenient for the students. Also the influence of time and place independent learning enabled by video lectures for youth students shows positively in the exam results.

Key words	Video Lecture, Streaming Video, Moodle LMS, Screencast

1 Introduction

Video lectures and distance learning in real-time are like video meetings when parts of the audience are connected to the virtual classroom in different physical locations. This is often used when students from different physical locations take part for education that is centralized as one virtual class. Motivation to this can be that one school alone does not have enough students to arrange rational education for some course topics and schools arrange these courses together.

Recorded lectures and demonstrations can also be used as a video lecture; in this way it is possible to support an asynchronous learning method in education. An asynchronous learning method gives students a better ability to learn independently of time and place when necessary, and gives them more control for their own time scheduling.

The experimental part this thesis focuses on a computer operating system course to first year students. Teaching a first year student to use and effectively administer a computer operating systems is challenging, one of the major reasons being that the level of the students' basic information of the subject at hand varies substantially. As a result, competent students easily get frustrated while the teacher is undergoing knowledge on how to do the administrative tasks when competent students are able to do this on their own. On the other hand the teacher's ambition to rush by the basic knowledge grows when the subject is familiar to most of the students and in this case some students can be left behind. The situation is even more complicated when number of the students increases. Previous efforts of reducing these problems in the case course of this present study resulted in no remarkable achievements.

The previous experiments to solve the problem involved written guides to typical administrative tasks and putting a lot of screenshot pictures to help the student carry out the assignments. That method was not satisfactory enough to teach the students administering operating systems. Also writing guides was very time consuming for the teacher and students were not able to keep up their interest while following these written guidelines. In addition, the Windows operating system has been renewing its user interface rapidly and that cuts down the time span of the written guides for the assignments.

The idea of using video lectures as course material seems to be the most effective change to the case course, but previous efforts have always ended to the same problem, which is that there were no applicable video lectures available, and the problems were even greater with the Finnish-speaking students. Several years of experience in teaching administering operating systems, and detecting that the problem getting worse every year encouraged to make more drastic structural changes to the course.

The above mentioned problems encouraged to seek new techniques and methods to ease the teacher's course material creation process as well as to be able to better support the students' interest to the subject through the course.

Rising use of video lectures in education and its impact on the learning process seemed to be the most promising candidate to try. It also seemed to be the most sensible and practical choice for the case course of the present study. The learning material should be easy to create, update, and the created video lecturing material should be accurate and easy for the students to use. On the basis of previous video lecture experiments, it was understood that it is relatively easy to use in the Moodle learning management system which is essential for this course.

The aim of this study was to evaluate the effectiveness of video lectures in ICT learning, and the research questions were how an opportunity to use video lectures affects the students' learning results and how mandatory video lectures of the course affect the students' learning results.

The present study also aims to describe how video lectures are used in a number of large universities and to specify an example solution on how to implement video lectures to be part of Moodle learning management system. Also the challenges that the teacher has to face to develop and implement video lectures are evaluated and described.

The study consists of three main parts. In the first part the ways of using and creating video lectures in education and in large-scale initiatives are studied. The second part describes the comparison and selection of the available tools and network services that can be used to create and distribute the video tutorials as course material. Also the ways video lectures were implemented to the learning environment used are documented in the second part. The third part described the findings when video lectures were used during the experimental course and focuses on analysing the effect of video lectures to the learning process and results.

For the first part, the method of the study was mostly desktop research. The initial step was to raise awareness of video lecture opportunities and to collect knowledge of ways on how large universities use them. By studying the use of video lectures in large universities it was hoped to find out the challenges that video lecturing will face when it is used in education.

As for the second part, the methods were experiments, tests, calculations and measurements. The goal was to find the most appropriate environment to create and publish video tutorials as course material for the administrative assignments on the case course. Also the usability of the video lectures is given special attention, while trying to maximise the benefits of using video lectures.

The third part focuses on analysing the learning results of different student groups whose usage of video lectures differed during the course. Also experiences of using video lectures as course material from a teacher and student perspective are analysed in the part. Furthermore, a student inquiry was created, and the answers are analysed in third part.

2 Video Lecturing and Supporting Systems

Teaching and learning with widely published video lectures is a new phenomenon in universities. Large universities have already created working procedures to get lectures published to the students and in many cases for the open public. They have their own channels in mostly used public video streaming services such as YouTube EDU, iTunes U, Academic Earth and most of them are also running their own video streaming services. Comprehensive comparison of different universities and their usage of video lectures could not be found. Also research of the actual benefits of using and publishing video lectures to students has not been widely published to the public.

The most significant findings while exploring use of video lectures by many universities was that in many cases their use is routine activity. Because research documents of the actual benefits of using video lectures were almost impossible to find, the present study focuses more on the different ways to use video lectures in education. In the following the most widely recognized and large-scale initiatives using video lectures are introduced.

Massachusetts Institute of Technology (MIT) and Open Course Ware

The MIT faculty instructs undergraduate and graduate students, and engages in research. There are 1,017 faculty members (professors of all ranks). MIT employs about 10,485 individuals on the campus. In addition to faculty, there are research, library, and administrative staff, as well as many others who directly or indirectly support the teaching and research goals of the Institute. [4].

Massachusetts Institute of Technology and its Open Course Ware (OCW) history start from 2001 when it was announced in The New York Times. After that OCW has grown substantially to a milestone of 2000 courses published in year 2010. MIT is publishing streamed video lectures also in YouTube and iTunes U, and it has its own video streaming servers and file servers for video lectures. [2.]

Hewlett Foundation has encouraged its grantees to adopt Google Analytics to provide comparable data between universities online courseware projects. As Figure 1 shows, the MIT OCW traffic outpaces other initiatives such as Open Yale Courses (OYC), webcast.berkeley and Carnegie Mellon Open Learning Initiative.

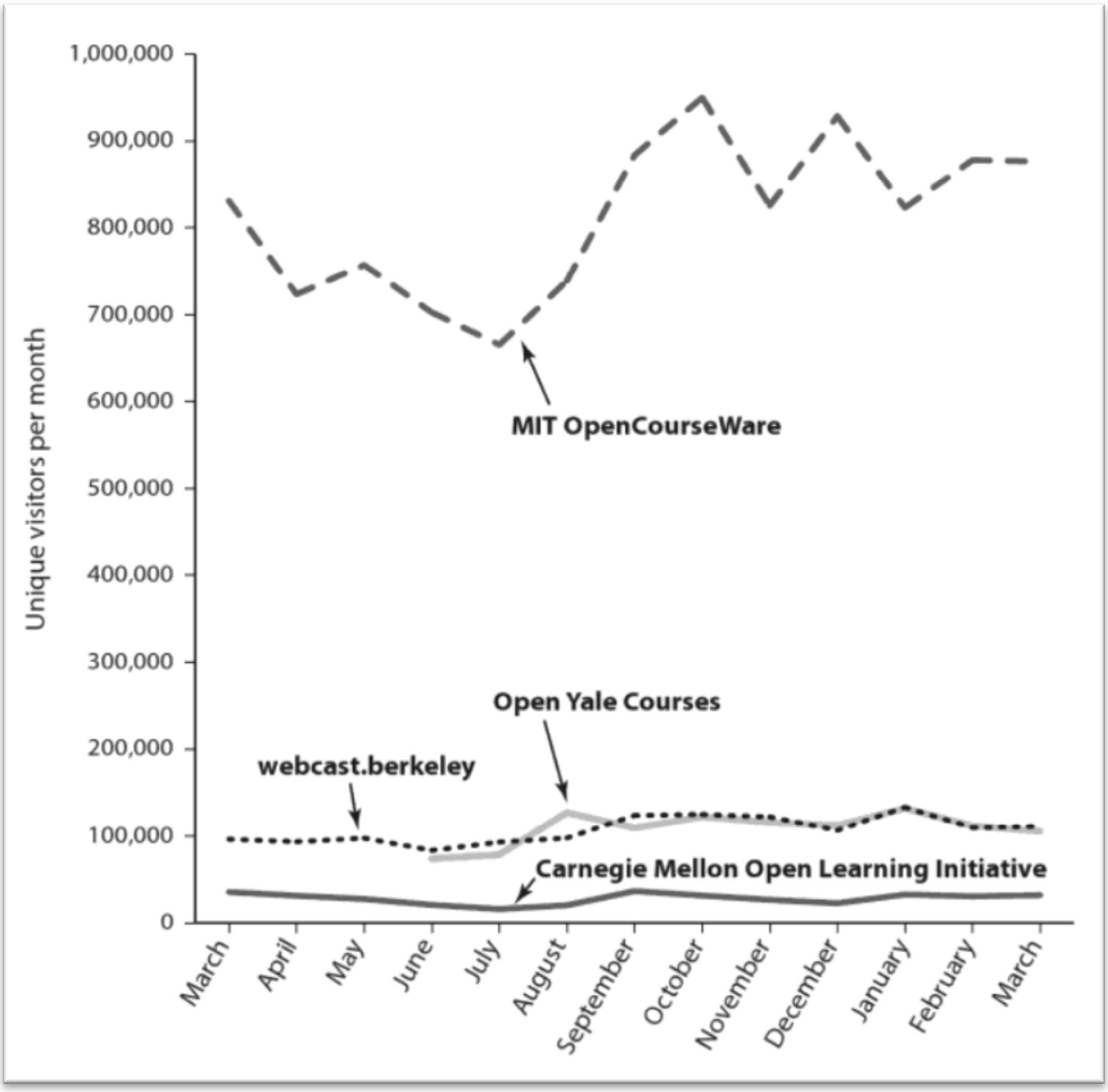

Figure 1. Usage data by initiative of universities' online courseware, 2009-2010.

The analytic data used by Hewlett Foundation in Figure 1 applies only for the visits into these projects primary sites: MIT OCW, OYC and webcast.berkeley. It also uses secondary distribution sites such as YouTube EDU and iTunes U, so their content is viewed more frequently than these numbers reflect [19].

Ithaka conducted a survey to the faculty of the U.S. four-year colleges and universities and they found that 18 percent of respondents consider "free web-based education resources such as iTunes U, YouTube EDU and OpenCourseWare" as very important to their research and teaching [19].

MIT has published some facts of its video lecture production for the public at open course ware. Average effort to produce published course on their site requires 100 work hours, while MIT faculty devote 5-10 hours of their own time for each course. They have a publication group of twelve people working directly with the MIT faculty. MIT faculty average time needed for publishing a course is 5-10 hours. MIT publishes 200 courses each year, and they use their own OCW publication staff to minimize MIT faculty time used to publish course materials. OCW publication staff work directly with the faculty to ensure proper licensing for open sharing. They also have two intellectual property staff and four production staff to support the publication team [10].

Videolectures.net

Videolectures.net portal is a free and open educational video lecture repository that is becoming a reference repository of video training material and dissemination channel for academic researchers. The idea is to network similar initiatives, new frameworks and plans to boost up e-science video reference network [14].

Videolectures.net is combining universities and research institutes to provide a qualitative stream of scientific and training programs. They are going to film and provide services for major worldwide scientific conferences and extending to cover also non- technical and natural sciences. The portal is aimed to promote science, and support exchanging ideas by providing didactic content to a scientific community and to a general public. Videolectures.net also has over 10000 lectures published containing over 12900 recorded videos [14].

All published lectures are given by distinguished scientists at prominent events like conferences, summer schools, workshops and science promotional events from many fields of science. All lectures and related documents, information and links are systematically selected and classified through the editorial process respecting also users' comments. The training material are being developed within several European Framework Programs, where VideoLectures.NET web portal is being used as an educational platform for several EU funded research projects and different organizations among others. MIT OpenCourseWare and CERN European Organization for Nuclear Research are also using Videolectures.net services [14].

iTunes U

iTunes U has topped 300 million downloads on just over three years of presence at August 24, 2010. It is becoming one of the most popular online educational catalogs, covering over 800 universities with over 350000 audio and video files from educational institutions around the world. Content is created in collaboration with colleges and universities offering users public access to the content of lab demonstrations and special lectures from world class institutions such as Harvard, MIT, Cambridge, Oxford and many others [16].

YouTube EDU

YouTube EDU is one of the largest online video repositories of higher education content in the world with partners from over 300 universities and colleges. There is over 350 full courses and sixty five thousand videos available that have been viewed tens of millions of times. YouTube EDU was launched with a mission to deliver some of the world greatest university courses to anyone with an Internet connection and a screen. Now they also have products to generate added value for the content for example English spoken videos can have automated captions and auto-translation into 50 different languages [18].

Academic Earth

Academic Earth is centralising and collecting learning content from many subjects and distributes it in an engaging way. There are already over 1500 videos from MIT, Stanford, Harvard, Princeton and Yale. Some of the videos are grouped into courses that typically have videos from 4 to 50 lectures. Richard Ludlow is founder of Academic Earth and he has used MIT open course ware materials to supplement his own studies at Yale University. He founded Academic Earth with the idea of centralizing online education resources to this educational ecosystem that provides teaching from some of the world's greatest scholars to everyone with an access to the internet. Academic Earth is focusing on video content that is packaged with additional educational materials (activities, exercises, readings and assignments) [17].

The most common way to create the video lectures on the introduced initiatives is that the lectures are captured in a real classroom situation. That makes it possible to minimize the lecturer's extra work for the creation process of the video lecture. The above mentioned initiatives to support educational video lecturing were chosen because of their volume and level of recognition.

2.1 Innovations to Exploit Video Lecturing

University usage of recorded lectures and demonstrations has strongly risen during the last ten years. Simultaneously students have accustomed to finding information accurately and quickly in the web. However, trying to find that same specific piece of information from a video lecture can be problematic and frustrating for the students [1]. In the following, attempts to solve this specific problem are introduced as new innovations to exploit video lecturing.

MIT Lecture Browser

MIT researchers have released a video and audio search tool that is trying to solve one of the most challenging problems in the field: how to break up a lengthy academic lecture into manageable chunks, pinpoint the location of keywords, and direct the user to them. The idea is to convert the audio of the lecture to a searchable text [1].

Figure 2 shows the MIT researcher's attempt to solve this problem. It shows as an example the results for search of words "video lecture" from the MIT Lecture Browser database.

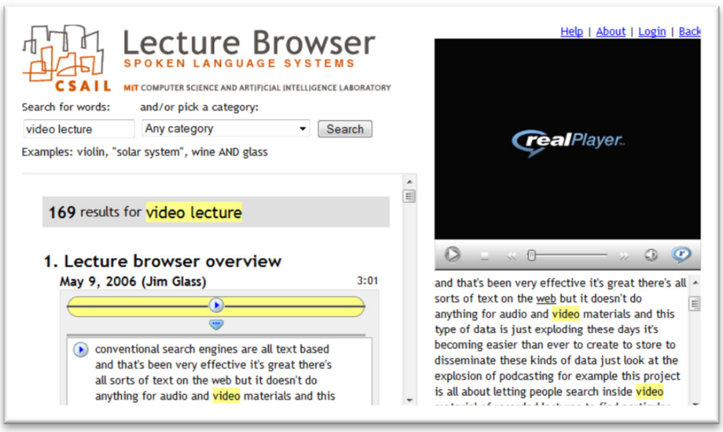

Figure 2. Picture of Lecture Browser at MIT. (from http://web.sls.csail.mit.edu/lectures/)

MIT researchers faced particular challenges when using audio search tool with academic lectures. Many lecturers are not native English speakers, which can cause automatic transcription that is trained to American English accents to drop its accuracy to as low as 50 percent. Such a low accuracy would not produce usable transcript of the lecture, but it can still be useful for keyword searches [5].

The special words favoured in science lectures can be rather obscure. Also lectures have very little discernable structure, making them difficult to break up and organize for easy searching. To organize the transcribed text, MIT researchers created software that breaks the text into chunks that often have correspondence with individual sentences. The software places these chunks in a network structure; chunks that have similar words or were spoken closely together in time are placed closer together in the network. The relative distance of the chunks in the network lets the software decide which sentences belong with each topic or subtopic in the lecture [5].

YouTube automatic captioning

One of the goals through the years of YouTube is accessibility and auto-captions are meant to be giving users more ways to access its content. Speech recognition is used to automatically transcribe what is said in a video spoken in English. This makes the videos accessible not just for hearing-impaired people, but also for viewers around the world, who can translate any video that is spoken in English to 50 different languages.

Lectures that are not signed for the deaf people and hence difficult to understand are now more usable and accessible with auto-captions on the streaming video. Captioning is not perfect just like any speech recognition application; auto-captions require a clearly spoken track. Background noise or a muffled voice can’t be auto-captioned [20].

Google’s Speech Technology and its auto-captions are available to everyone who’s interested in using them. The owner of the video needs to check to make sure that they are accurate enough to be used with the uploaded video. Mike Cohen as Google’s researcher says that the ultimate vision is to provide accurate captions for all videos in all languages. But that comes with many problems like massive vocabulary issues with poor recordings, background noise, and accents. Also every language comes with its own unique challenges [20].

It is somewhat surprising that YouTube does not support a search feature for the auto-captioned content of the video because it would be useful for learners to be able to search inside of the video lectures as it is possible to do in the MIT Lecture Browser.

Figure 3 shows the YouTube closed captioning options that the user has while watching YouTube video with auto-captions and translate captions features available.

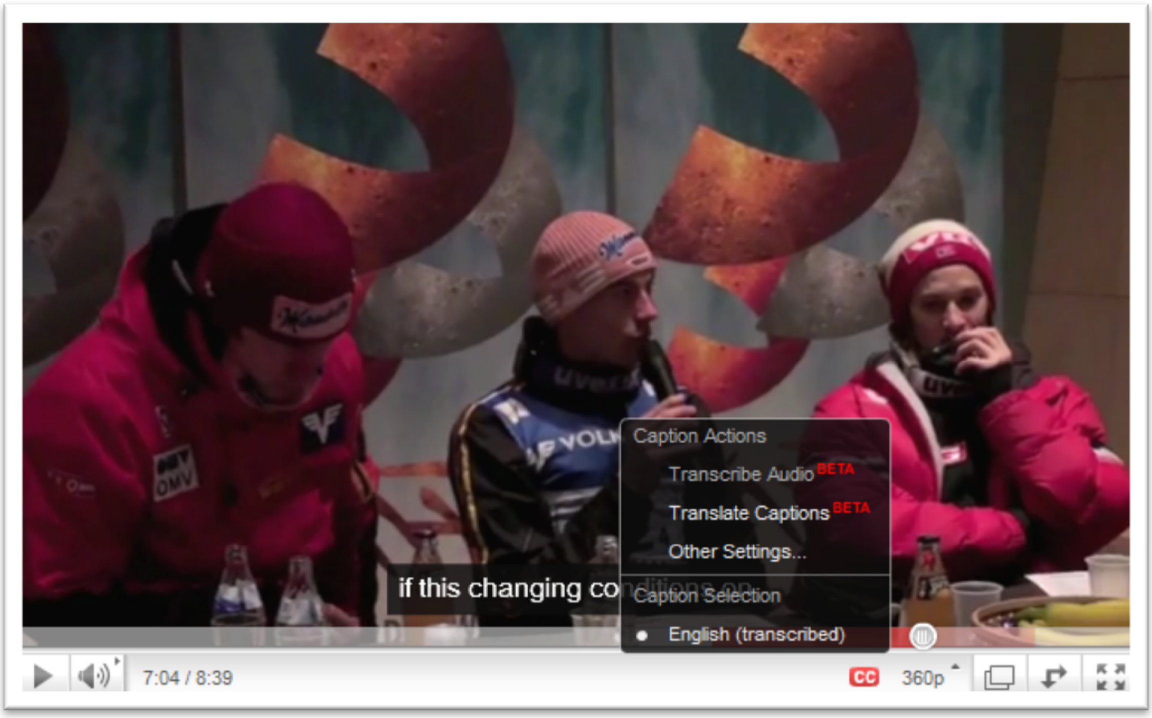

Figure 3. YouTube example of auto-captioning.

The possibility to have Finnish subtitles on any video spoken in English is an attractive opportunity. This is possible when the video has auto-captioning and translate captions features available. YouTube already has a large number of English spoken video lectures available and Finnish subtitles increase their usefulness for the case course of the present study.

The researcher’s own perceptions of the YouTube auto-captioning are also presented here to justify the choice of video publishing service.

YouTube’s speech recognition and translation was evaluated with the Winners Interview recorded at Lahti Ski Games. This video was published years ago and the purpose was to create auto-captions to the video and then translate these captions to Finnish subtitles. Test result was that these features are available, but the quality of Finnish translation of the closed captions was more humorous than beneficial.

Enhanced video player by Microsoft Research Project Tuva

Figure 4 shows Microsoft Research Project Tuva as an example that has created an enhanced video player that can support learning more interactively than most of the traditional video players.

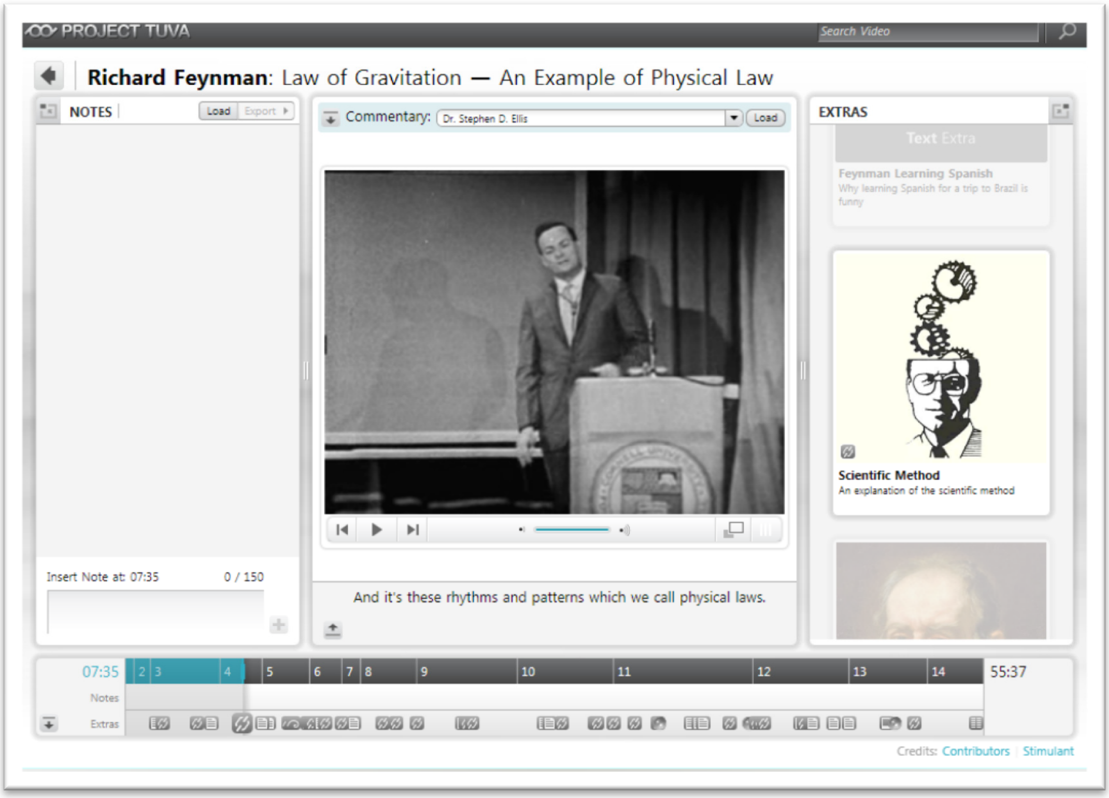

Figure 4. Microsoft Research Project Tuva. (from http://research.microsoft.com/apps/tools/tuva)

Figure 4 shows a Project Tuva user interface that is enhanced with several different layers of contextual information to the video lecture: full transcripts and captions of the spoken content of the video, fully searchable transcripts, time-synchronized contextual extras that link to web resources to learn more about a spoken topic, the ability to take notes while watching and integration with Microsoft Research's own material [24].

Project Tuva was the most complete and clean package found during the study of different implementations of video lectures and estimating their usefulness for the video lectures and their integration to other learning tools. However, there was no information found if it would be available for wider use in educational utilization or how much effort it takes to create that kind of a user experience to share knowledge presented on the video lectures.

Project Tuva is an independent environment and it is impossible to embed that kind of video player and its learning tools to Moodle learning management system that is used in the experimental part of this thesis. However, Project Tuva is a useful as a reference point for making of an own implementation of video lectures and its supporting tools.

2.2 Video Lecturing Systems

Publishing classroom lectures as videos or creating video lectures as study material for a course have different workflows, but certain parts of the workflow are always required in both cases. Relevant parts of the workflow are: planning, capturing, editing, converting, publishing and delivering of the video lectures. That process consumes a teacher's time and resources from lecturing, but with suitable video lecturing systems significant percentage of that process can be automated to minimize the teacher's time used to publish video lectures.

Process of creating video lectures

Planning the lecture involves typical lecture planning added with the needed knowledge of what and how can be captured and published as video lecture. Everything that is possible in typical classroom lecturing is not always possible in a video lecturing situation. Figure 5 shows a typical workflow of publishing of a video lecture.

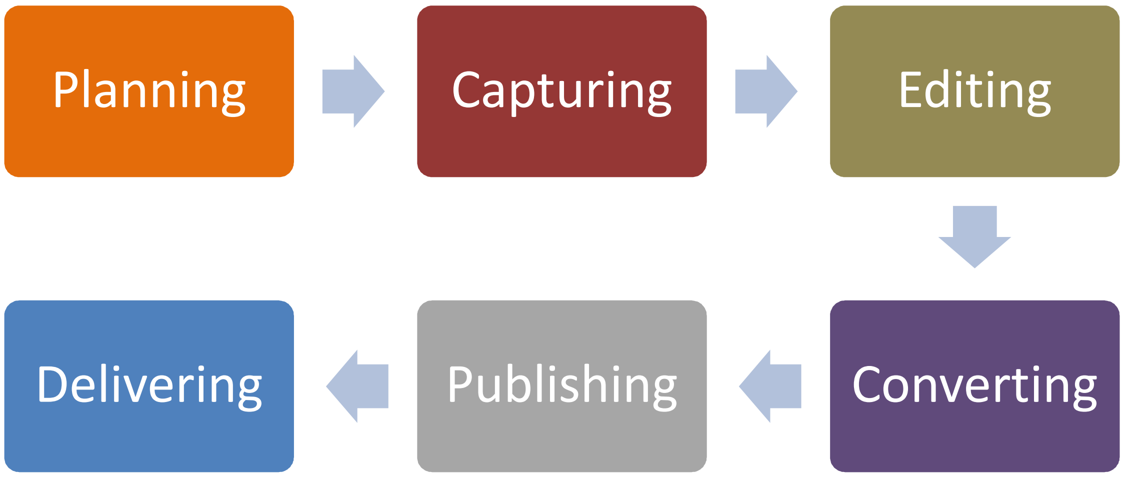

Figure 5. Workflow of publishing video lectures.

Taking time to plan will lead to a more polished screencast. The topic, if possible, should be divided into small distinct modules because people have short attention spans. Before starting to capture the lecture there should be a step-by-step instructions outlining exactly what you want to show the viewer and in what order. If the plan is to record simultaneous narration to the captured screencast it is beneficial to create a script so everything that should be said in that lecture will be said during the capture. Planning ahead can save a lot of time. After all, one mistake can force to start that recording of the screencast all over again [23].

Capturing a lecture from the computer screen or with the camera from live classroom situations is definitive to the video picture and audio quality. If possible, the video should always be recorded in the maximum fidelity available. Improving video quality afterwards is nearly impossible.

Editing video lecture has become easier to everyone. These days a typical captured video can be edited with the built-in software in modern operating systems. Usually basic video editing is mostly cutting out irrelevant parts of the video or subtitling some parts of the video. With video editing tools it is also possible to highlight some important parts of the video. In any case training and practising is necessary for the teachers.

Converting the video files to all suitable formats for different type of terminals is tricky because devices students may use to watch video lectures vary. Modern video streaming services are capable of supporting most of the main types of devices that students use and they are also able to convert different captured video formats to their own video streaming format. These attractive features that video streaming servers for the most part have substantially simplified the conversion process of the video files.

Publishing video lectures to the students, teachers or to the entire Internet user space can be done in many ways. Proprietary video-server gives the best control of the videos, but it is costly and needs continual administration. Publishing video lectures in public video streaming services such as YouTube.com is free of charge, but it does not give the owner of the video the same privacy control to the published video as the proprietary video-server.

Delivering videos to the students in the way the students want is important and often determined by the content of the lecture. Video lectures can be delivered to the students as files or streamed over the Internet. Delivering video lectures as files is an old method and not very successful anymore. If video lectures are handled as files there is no effective way of searching the content of the lectures. All universities whose use of video lectures were studied favour the use of streaming video. Streamed video has remarkable benefits without any major drawbacks.

2.3 Synchronous versus Asynchronous Learning with Video Lectures

If the educator chooses to use video lectures with streaming video services the learning is no longer confined by the walls of a classroom or to specific hours in a day. Video meetings either live or recorded are usually a collaborative part of the studies, where the lecturer has more of a peer role than in a classroom education. In video lectures that are recorded in a classroom, the lecturer has typically a more noticeable role than if he or she is a part of video conferencing type of a lecture.

Video lectures can carry out video and audio from different sources. With video lectures the educator can have a wide range of possible expert introductions and presentations available to use in a lecture. Different types of video lecturing systems give different opportunities to the lecturer.

Video lectures can be roughly classified as synchronous or asynchronous education and they can be part of distance learning or classroom education. In the following the main differences of the two are studied in more detail.

2.3.1 Synchronous Learning with Video Lectures

Video lectures and distance learning in real-time are like video meetings when parts of the audience are connected to the virtual classroom from different physical locations. This is often used when students from different physical locations take part in education that is centralized as one virtual class and the instructor and students are interacting at the same time. Synchronous video lecturing education can provide immediate feedback, however, it also requires that the lecturing time is scheduled. The synchronous learning described above is an example of location independent together with time dependent use of video lectures.

Video meetings are not necessarily recorded. If video meetings are a new learning environment for the student, there might be some difficulties to follow the education. However, if recording is possible, it should be done. Then it is possible for the students to review parts that they have not had enough time to understand during the session. Recording of the lectures was the first step to make the synchronous learning process more asynchronous for the students as it makes it possible to allow the participation in lectures independently on time and place.

2.3.2 Asynchronous Learning with Recorded Lectures

Asynchronous approach for video lecturing supports education that occurs independently of time. Asynchronous instruction is easier for students and instructor to fit in their schedules but often involves delayed feedback or no interaction at all.

Video lectures can be recorded as a classroom education situation, demonstration in factory or modelled virtual reality situation. Anything that is possible to see or be heard can be part of the lecture. Often it is difficult and non-effective to establish complicated demonstration situations inside a classroom. However, with video lectures it might be possible to record a demonstration setup and effectively show it in a classroom environment as a part of a video lecture.

One of the greatest benefits of using recorded video lectures of any kind is that the students can review the videos when necessary. With recorded lectures the students can review difficult parts of the lecture to help them learn and keep up with the lecturer.

It is also possible to suspend the lecture and seek some background information to understand specific topics of the lecture if necessary. Recorded lectures and demonstrations can also support students learning independently on time and place. Usually this is called as asynchronous learning. In that way recorded lectures can give students more control of their own time and it is also possible to give better support for different types of learners.

2.3.3 Screencast Lectures

With screencast it is possible to support both synchronous and asynchronous learning. Screencast is a recording of three basic sources: record what you see on your computer screen, record any sounds on your computer and record lecturer's own voice as narration to the video [6]. Screencast is capturing visual material generated by a computer. Students usually need to access and view screencasts with a computer [7].

Screencast is a promising technology to enhance traditional instructor led training which deals with the use of computer applications and their properties. When the lecturer is recording a screencast tutorial, the educator can show the learner what he will actually see while he is going through the exercises. The lecturer is also able to give audio narration and thus guide a learner to deeper understanding of the demonstrated topic. Screencast is also easy to the lecturer because when the teacher is recording a screencast as a study material for the course, the lecturing style is equivalent to the traditional instructor led demonstration situation.

2.4 Automation of Video Lecturing Systems

Some video lecture capture solutions with proper setup can record all what happens in a classroom. The actual classroom is recorded with a camera just as the lecturer's appearance. Also the microphone has to be fine enough to capture all of the sounds inside the classroom and the material that the lecturer is showing is captured as part of the recorded lecture. In the following, a few examples of video lecturing automation systems having their functional description available are introduced.

The University of Geneva automated recording and publishing of lectures

As of the year 2007 the University of Geneva had a group of 25 lecturers using its own video capturing and publishing system that was producing 40 online lectures every week. Setting up audiovisual showrooms, while increasingly common, remains a sensitive topic in most universities unless the technical infrastructures underlying lecture capture require minimal human intervention. Otherwise, the workload on technical staff can rapidly become unmanageable and cause too much extra costs [15].

The Geneva University's IT department aided upgrading lecture halls with modern-day automatic lecture recording systems. User-Centric Approach is used in automatic lecture capture, with different degrees of sophistication, and has received increased attention. Most advanced systems have cameras with tracking techniques to keep it focused on the lecturer and to display audience members when they talk. Also automatic synchronization of slides and lectures are used more widely [15].

The University of Geneva automated lecture capture and publishing workflow is illustrated in Figure 6 and they use three different staff groups during the process; Teachers, Faculty librarians and Audio-visual technicians [15].

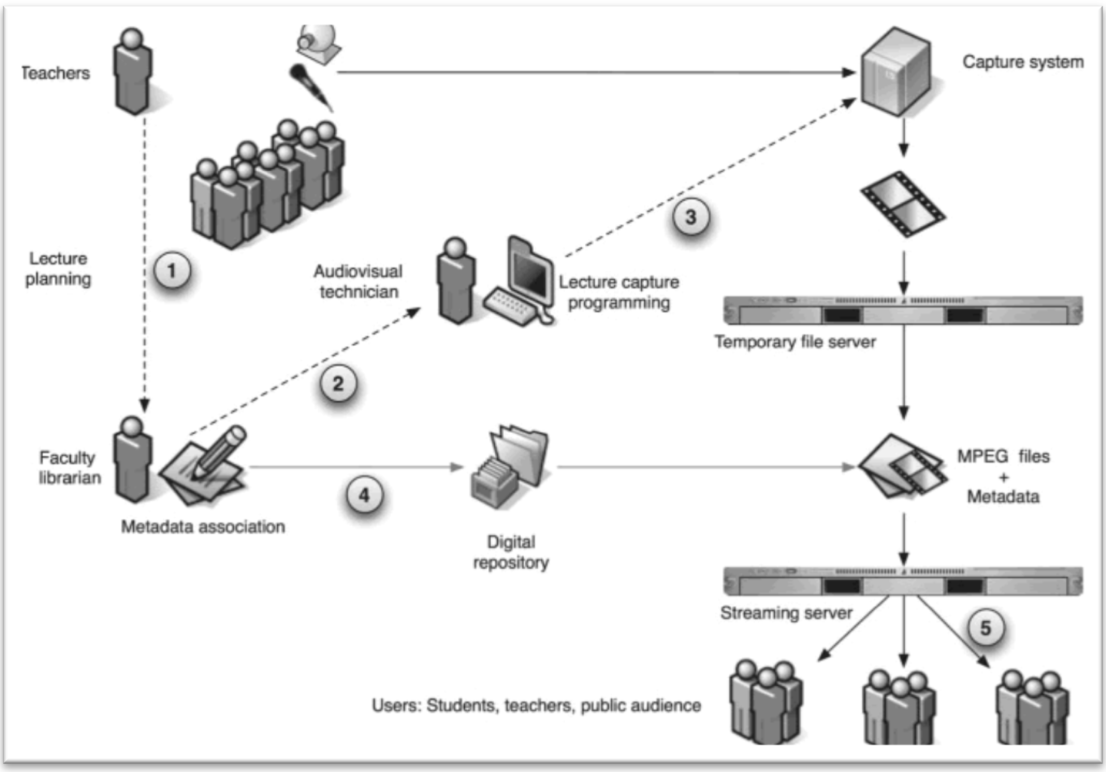

Figure 6. Lecture-Capture Workflow [15].

As can be seen in Figure 6, the lecture capture and publishing system workflow is presented in activity steps during the process, every necessary step is a circled number in the figure.

The process is initiated by the teacher, who communicates typically before the beginning of a semester or while planning of their lectures using ad hoc forms transmitted to faculty librarians (step 1). In the lecture hall teachers can concentrate exclusively on teaching without a regard of the technical aspects pertaining to the lecture-capture system. There are only few auditoriums where teachers must ensure proper set-up of the microphone [15].

Faculty librarians relay the lecturers' planning to the audiovisual technician who is in charge of lecture halls and also creates metadata associations to the captured video lectures (step 2 and 4) [15].

The audiovisual technicians schedule the capture system for the required periods by specifying the date, starting time, duration and the hall number of each lecture (step 3). Their duty is also to regularly check the cameras and wireless microphones in the lecture halls to guarantee optimal recordings [15].

Captured lectures are recorded and stored on a temporary file server as scheduled and further processed by faculty librarians. They perform daily checks of new recordings on the file server and to each new file they can associate up to 16 metadata tags (step 4) which include; lecture title, lecturer's name, faculty, expiration date (if specified by lecturers), academic year, and so forth. Also information related to the access policy, such as whether the captured lectures should be open to the public or limited to specific end users. They have librarians in charge of the metadata to guarantee the quality of information in the long term, a necessary condition for proper indexing and successful retrieval of the recorded lectures by students [15].

Panopto Focus

Professors at Carnegie Mellon University have founded Panopto, Inc. in 2007. Panopto Focus is a presentation capture platform that let users capture, edit, stream, archive and share recordings that preserve critical knowledge. Panopto Focus is the result of years of research in scalable media systems to harness the advantages of modern video capturing, video streaming, content searching and archival technologies [21].

Panopto Focus key features are that it supports capturing a combination of video, audio, PowerPoint and screen components instantly using the recording equipment you choose from simple webcams to traditional recording equipment. Visual recordings can include high definition cameras, electronic white boards, document cameras and more.

Links to completed recordings are available immediately after the presentation and it is possible to start sharing content instantly. Recordings can also be edited through Panopto Focus' Web editing interface. With no file downloads or additional formatting, the editor can cut unwanted presentation segments or create entirely new versions of recordings. Recordings can be stored in one central location or managed using content managements systems such as Blackboard or Moodle [22].

Recording can be started automatically as scheduled or manually, depending on the nature of the situation. Recording content is possible even if the network is not available with Panopto Focus's offline recording functionality. Recordings are then uploaded automatically once the network is available [22].

Panopto Focus recordings can be watched in any Internet browser, including Firefox, Safari and Internet Explorer. Video podcasts are also available for devices without Adobe Flash support such as iPhones, video iPods and iPads. Recordings can be shared for public or restricted access to specific viewers to ensure the content reaches the right audience. Viewers' access levels can be controlled with Panopto Focus' integrated AD/LDAP security and entitlement system. Personal and public notes are available during live presentation and playback situations. All notes are searchable as well as PowerPoint text and optional closed captioning and transcriptions. Viewing statistics of the recordings are available for defined user groups, employee level, constituent type and more [22].

Figure 7 shows a typical PowerPoint lecture viewed through the Panopto Focus video lecturing system.

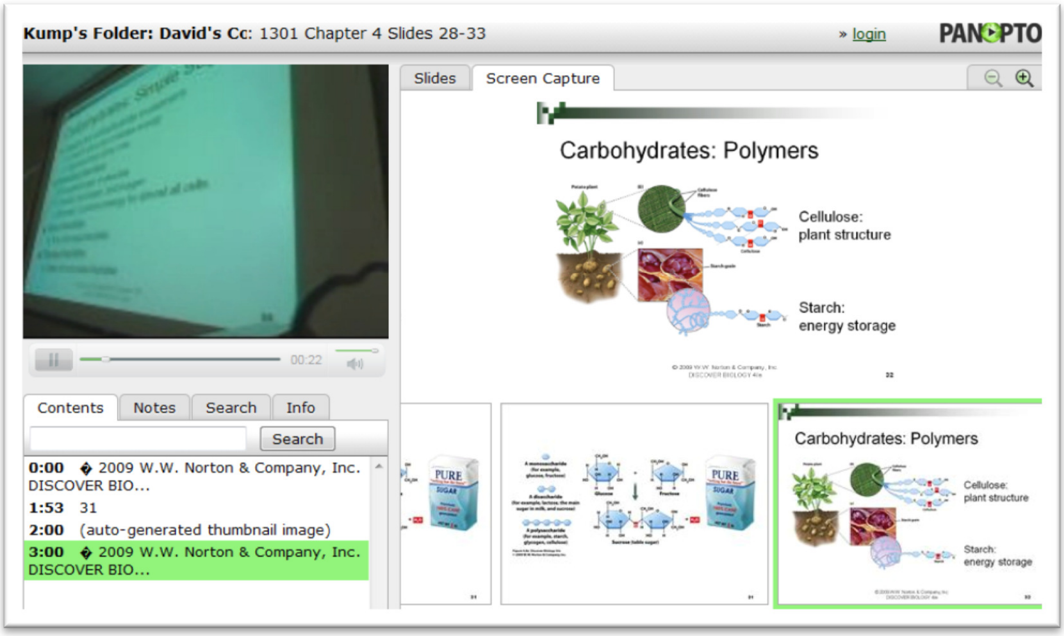

Figure 7. Panopto Focus computer presentation.

Viewer interface for the recordings is presented in Figure 7. The user interface is divided into sections, where the first section is webcam captured video of the presenters' gestures and the atmosphere of the presentation. Below there are buttons for browsing the lecture titles, notes about the lecture, possibility to search the recorded material and information about the recording. On the right side of the user interface there are presentation graphics, in this case a PowerPoint generated presentation. The titles of the PowerPoint slides are automatically shown in the content browsing area with the time-stamps by which they are selected to display.

Figure 8 shows the same user interface while the presentation graphics are drawn on the blackboard.

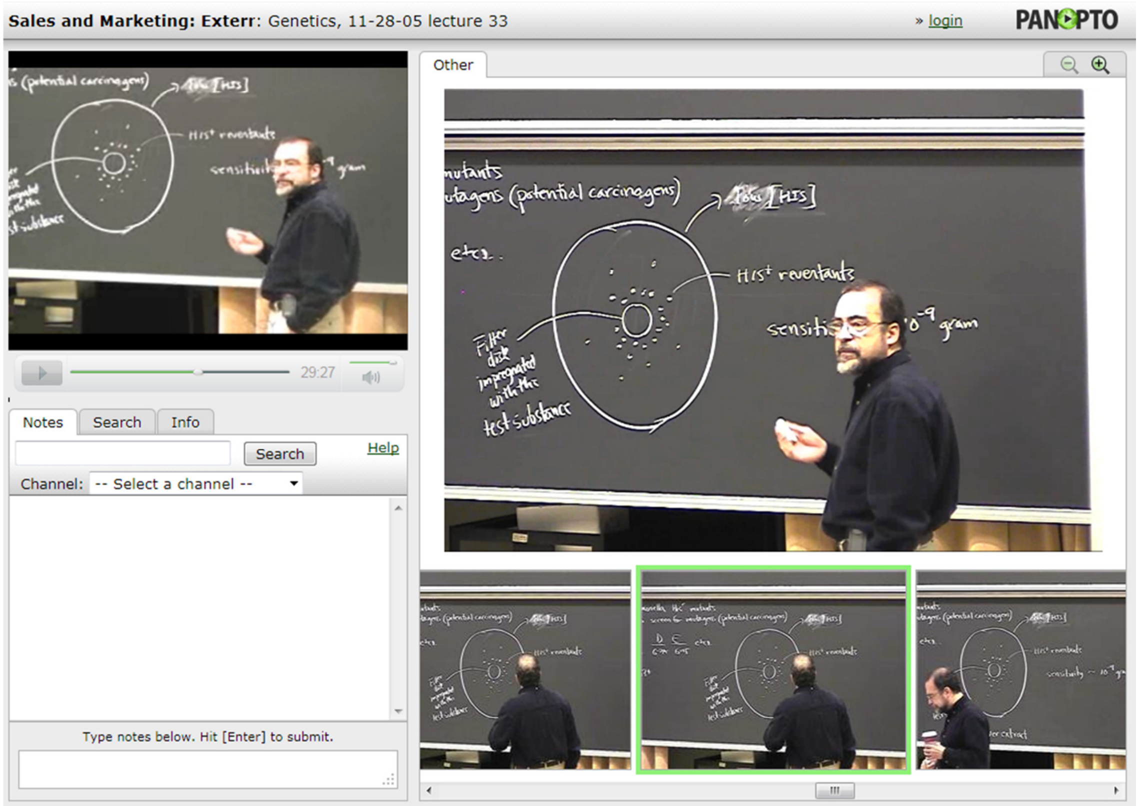

Figure 8. Panopto Focus blackboard lecture.

If the presentation is given on the blackboard the time-stamps and titles are not automatically generated, so if the titles have to be available the presenter has to create them after the presentation manually. The right side large picture of captured presentation is recorded with a very low frame-rate, because its purpose is to be accurate enough to show all the details that are drawn on the blackboard. Recording in a low frame-rate helps to keep the bandwidth needs and file-size of the recordings at a reasonable level.

Panopto has guidelines for storing recorded lectures in different qualities. These guidelines inform that the storage capacity on the web server is the same, whatever quality is used. It is always 390GB for every 1000 hours of web stream video that is want to make available (390MB/hour) corresponding to 870 kbps.

There are three different quality-levels available to use in the system; WR (Web Ready) quality, High Quality Compressed (HQC) and Digital Video (DV) quality.

The amount of storage that is needed on the data storage server varies. After the recording has been deleted from data storage server, it is no longer possible to re-edit or re-encode the recording. Web Ready (WR) Quality needs 265GB for every 1000 hours of WR recordings (265MB/hour). High Quality Compressed (HQC) needs 660GB for every 1000 hours of HQC recordings (660MB/hour). Digital Video (DV) Quality needs 13TB for every 1000 hours of DV recordings (13GB/hour).

Adobe Connect - Web Conferencing

Adobe Connect is a web conferencing solution for online meetings, eLearning, and webinars. It is based on Adobe Flash technology and it supports rapid creation of online training and delivery of virtual classes in real time, on demand of offline [25].

Adobe Connect is widely used in Finnish Applied Sciences Universities and in this study it was used as a backup tool to support students if they had problems with the virtualization environment or with the assignments of the video lectures outside the school campus. The key features for the use of Adobe Connect in the present study are the support of different client operating systems. Students may use Linux, Windows or Mac OS X host operating system in their home computer and supporting channels have to be available to support them if they are member of the asynchronous group of students in the experimental course.

Adobe Connect user interface is divided into manageable elements called pods, Figure 9 shows a typical scene of a web conference.

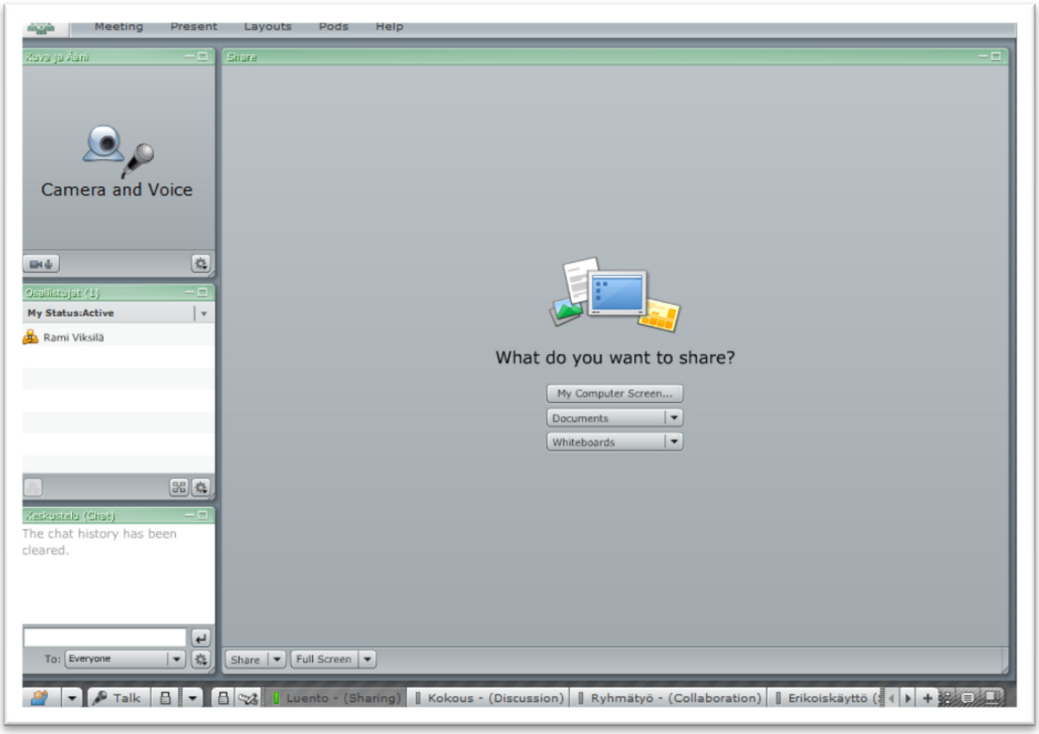

Figure 9. Adobe Connect Web conferencing.

The first pod in that view is the Camera and Voice pod, which shows a shared picture of each participant transmitting a live or still picture. If the participant is transmitting video feed from his location it will automatically start transmitting audio, too.

The second pod is a participant list which shows a list of online participants and their latest active gesture, gestures can show to the presenter if some participants are asking him to talk slower, talk faster or they can just raise a hand to get attention when needed. The same list shows who is talking at the moment or what the status of each participant is.

The third pod is a chat-pod that permits participant to write text messages to all participants or select one participant to communicate. This is handy when giving feedback to the presenter during his speech. The biggest pod in Figure 9 is the sharing pod, it allows hosts and presenters to share the view of documents, applications, desktops or whiteboard activities with other participants.

3 Materials and Methods

The idea of strengthening the learning by utilizing video lecturing was the result of previous experiences on the target course. The impression was that part of the students felt that they had an inadequate opportunity to take advantage of their individual prior knowledge on the course topics and in the same time some students felt that the basics of the course topic were not covered in sufficient depth. This conflicting fundamental problem was the one that was tried to be reduced and video lecturing seemed to be the most promising technique for reducing that problem.

The video lecture opportunity to allow students to proceed with their own pace based on their skills seemed to be able to support both the most competent students and the less experienced students simultaneously. Motivation for this thesis was to study whether it was possible to verify the benefits of video lecturing in practise and what would be the possible downsides of the new lecturing method.

3.1 Process Description for Creating Video Lecturing Material

Creating video lectures as course source material might be challenging and time consuming for many courses. If the purpose of the lecture is to learn something that can be shown or used on the computer screen, it is relatively easy to convert this type of instructor led training to the screencasting type of video lectures.

There are different types of learners; usually learners are divided to visual, auditory and kinaesthetic learners. The individual style of learning is defined by the strongest way of adoption of new information [13]. The main intention for the use of video lectures in the experimental course is to activate all the three different types of learners; video demonstrations to the administrative assignments activate visual learners, lecturer's narration to the theory background and for the assignments activates auditory learners and the assignment that learners carry out with the help of the video lecture activates kinaesthetic learners.

Practical considerations before creating a screencast are shown in Figure 10.

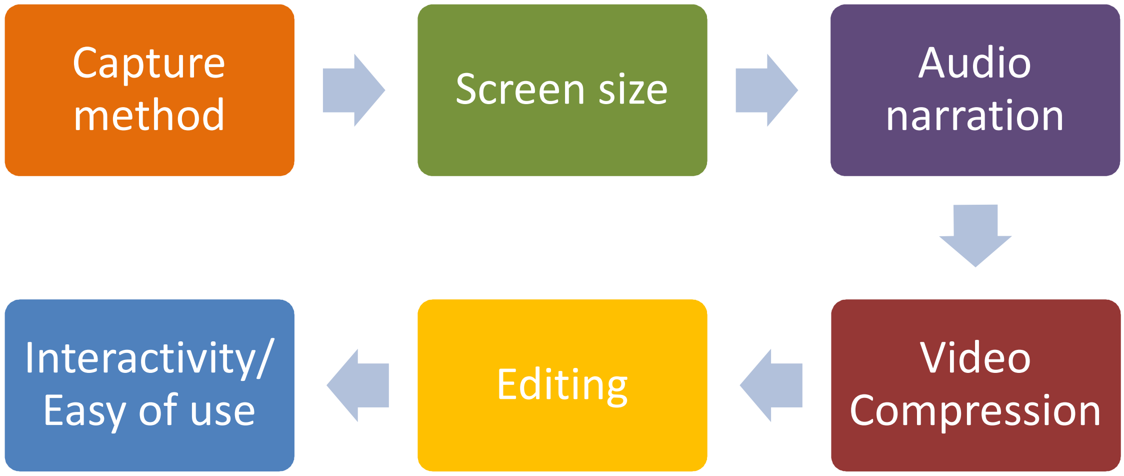

Figure 10. Considerations before creating a screencast.

The capturing method for some of the screencast applications is that they only take screen captures based on triggered events on the capturing computer without support for the video capturing method. This can lead to unwanted miss of important actions on the screen and force one to record the entire screencast again [23].

The screen size and colour depth while capturing screencast affect significantly the file sizes and bandwidth needs of the recordings. These settings were determined by the requirements of the demonstrated operating system Windows Server 2008 Enterprise. Minimum requirements Microsoft has described to the Windows 2008 Server operating system and for its display are Super VGA 800 x 600 or higher resolution [27].

The quality of captured audio is essential for the usefulness of the video lecture. Students can watch poor quality video if the audio quality is good, but high-quality video with poor-quality audio is not acceptable. This is especially true for the talking head recordings [28]. For the screencast it is appropriate to aim to a simple, clear and intelligible audio throughout the presentation. Microphone type, quality and placement are critical for obtaining the optimum captured audio. The target is to achieve the highest possible ratio of the volume of speech to the ambient sound (background noise). The

background noises just give the encoder more data to compress and that means higher bandwidth need and lower quality without any benefits.
Recorded video is a sequence of pictures called video frames, and each picture can be processed by video compression algorithms as isolated pictures, much like the widely used JPEG standard for digital pictures does. The JPEG standard is widely used to compress continuous-tone greyscale and colour images. The JPEG compression is based on a technique called discrete cosine transform and the compression method selectively discards some picture information. It is called lossy compression. After decompression the final picture is a representation of the original [28].

The JPEG lossy compression can achieve ratios of 20:1 or greater of data reduction, but the original picture can never be fully restored from a lossy compressed JPEG file. The JPEG standard also supports a lossless compression with about 3:1 reduction in data. Video compression can be lossless or lossy. If all captured information is preserved the codec is called lossless [28].

To achieve the high level of compression demanded by the streaming codecs, the lossless codecs are not a feasible choice. When the compression is increased it usually means that more picture data is being discarded and more compression noise like artifacts becomes apparent. The acceptable levels of compression noise depend upon the content of the picture [28].

Video editing can improve the usability of the captured video by, for example removing unwanted or highlight important parts of the lecture, but at the same time one easily loses some of the lecturing feeling of the presentation. Also, editing is very time-consuming and it encourages creating all too flawless recordings of video lectures used for small audience. Therefore teachers should be conservative in doing excessively time consuming video editing.

There is a variety of ways on how to increase the usability of the video lectures, such as creating needed information to facilitate more effective ways of browsing and searching information within the recorded lectures. Advanced systems such as MIT Lecture Browser and YouTube.com auto-captioning make it possible to automatically interpret the spoken English content of the video lectures as a searchable transcript.

These tools were not available to use in the present study, but some benefits of these advanced systems can be achieved with much less effort as is explained in Chapter 3.5.

3.2 Comparison and Selection of Tools to Capture Screencast Video

It is important to have software that is able to satisfy the versatile needs of the content. At the same time the captured video quality has to be met both in terms of picture quality and low bandwidth need. It was also decided that the application must be free of charge. Therefore these compared applications support video capture instead of individual screenshots as their recording mode and they are all free of charge for academic use.

Surprisingly, the finding was that only a couple of the studied software actually support the video recording method, while the most commonly supported method is to take action based screenshots of the individual actions such as mouse clicks and keyboard presses. Action based screenshots help to reduce the file size of the screencast recording, but at the same time it is possible to lose some important events on the screen. The compared products for creating screencast in this thesis were RenderSoft CamStudio, BB FlashBack Express and Windows Media Encoder x64 Edition.

All of these products met the minimum requirements necessary to capture the screencast to be used in this thesis. The selection of the product was made based on the personal assessment of the usability of the product and with the quality and usefulness of the recorded audio and video files. In the following the essential features of the available products are presented.

BB FlashBack Express 2

BB FlashBack Express is a Blueberry software product that supports recording computer screen, sound and webcam [29].

It is possible to record narration or computer sound while capturing the screencast. Also the user can record a single window, region of the screen or full screen captures.

With the webcam recording feature it is possible to record picture-in-picture talking head video simultaneously with creating screencast recordings [29].

After the recording is finished it is possible to place a webcam video in a desired size and place on the video picture area of the screencast, or after the recording is captured it is even possible to remove the webcam captured talking head from the recorded video without re-recording the entire screencast session.

Figure 11 shows the user interface of the FlashBack Express video player where the user can easily follow different streams recorded during the screencast capturing.

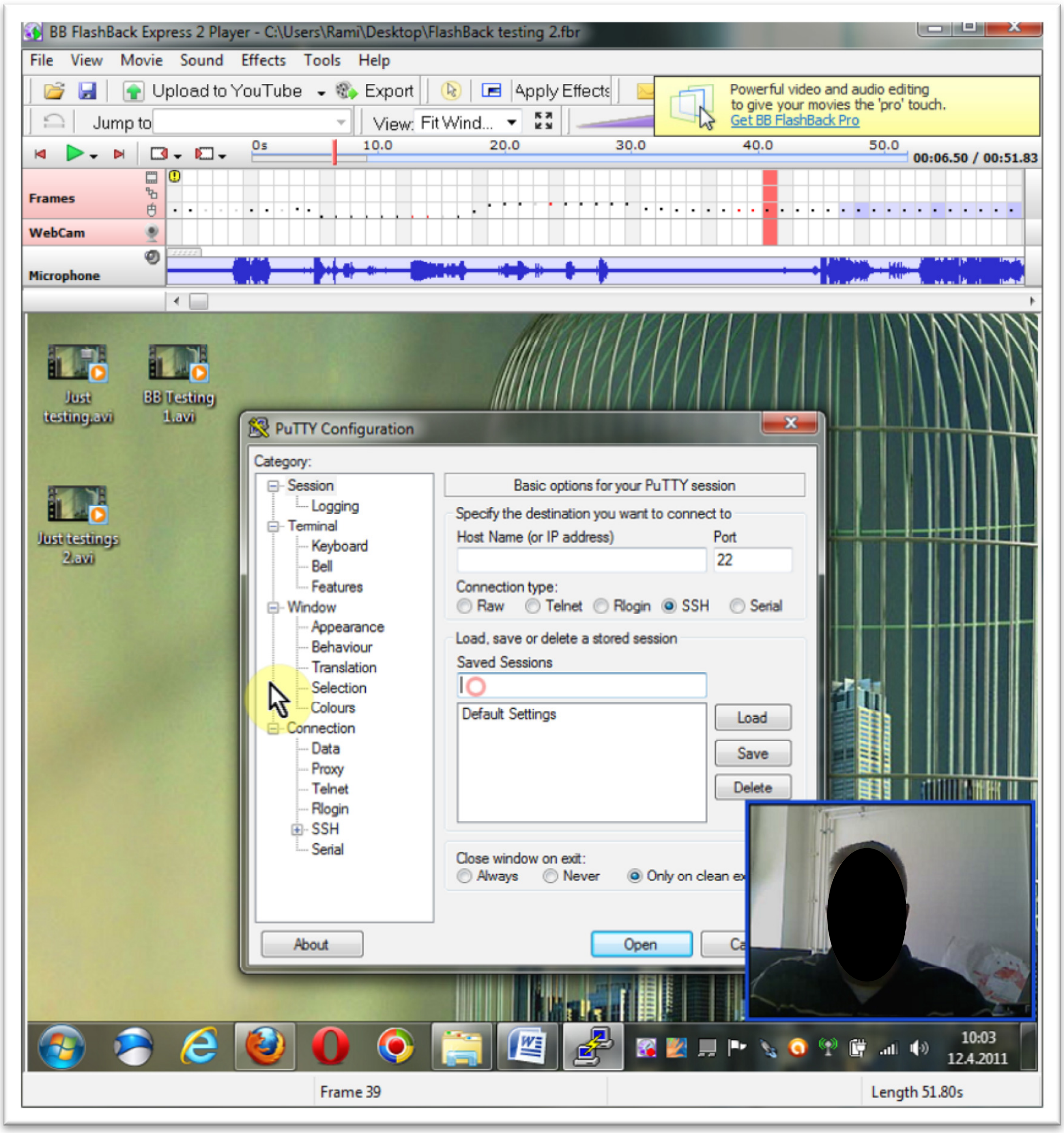

Figure 11. BB FlashBack Express player view.

The noticed strengths while testing BB FlashBack Express 2 were the easy use of capturing functions, support for multiple simultaneous captured information sources and possibility to place and resize captured element before converting captured content to the single video file. The noticed weaknesses of the BB FlashBack Express 2 were that its demand on computer resources while capturing simultaneous video sources such as webcam for talking-head video and screen recording for the video lecture. Also support for different video file formats was limited in The Express 2 free version. Most of the attractive software features are available only in commercial versions which were not tested within the present study.

Prices of the commercial products start at 65€ for BB FlashBack Standard Edition and BB FlashBack Professional Edition with 147€ for single license through their online store. They also have volume licenses and bulk discounts available.

RenderSoft CamStudio

CamStudio is an open-source project that supports creating industry-standard AVI video files and compressing them to desired bandwidth-friendly streaming flash videos. Software is visually plain, but includes all the essential functionality such as full-screen capturing, adjustable video compression and annotations [26].

Figure 12 shows the user interface of the RenderSoft CamStudio where it is possible to control the screencast capturing and the settings for the software.

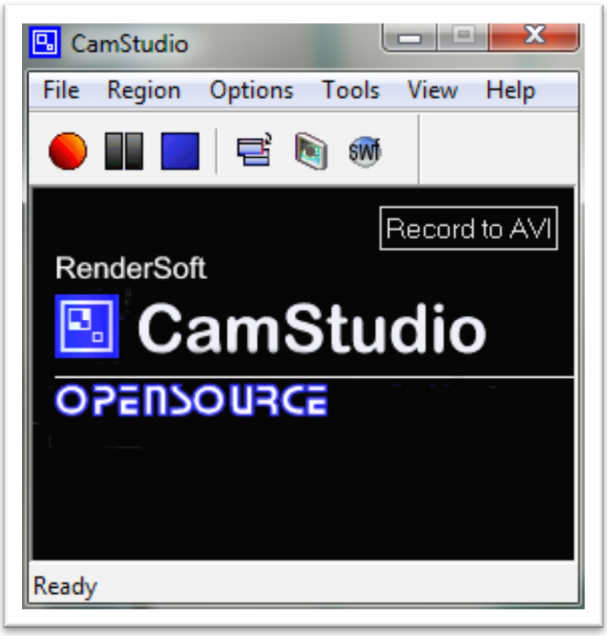

Figure 12. RenderSoft CamStudio streaming video software.

The noticed strengths while testing CamStudio were its clean and simply user interface, easy to use capturing functions, and support for multiple simultaneous captured information sources. The noticed weakness of the CamStudio was its demand of computer resources while capturing simultaneous video sources such as webcam video and screen recording for the video lecture. Also the support for different video file formats was limited in CamStudio.

Windows Media Encoder x64 Edition

Microsoft Windows Media Encoder x64 Edition is a production tool for converting both live and pre-recorded audio and video into Windows Media files or streams. Creating screencast video files in Windows workstation with Windows Media Encoder x64 Edition software is relatively easy, free of charge to use and compatible with Windows 7 Professional 64-bit version. Microsoft has renewed their software range and Windows Media Encoder has been retired as of 2010, and users are encouraged to transition to Expression Encoder software [11].

Figure 13 illustrates the user interface of the Windows Media Encoder x64 Edition.

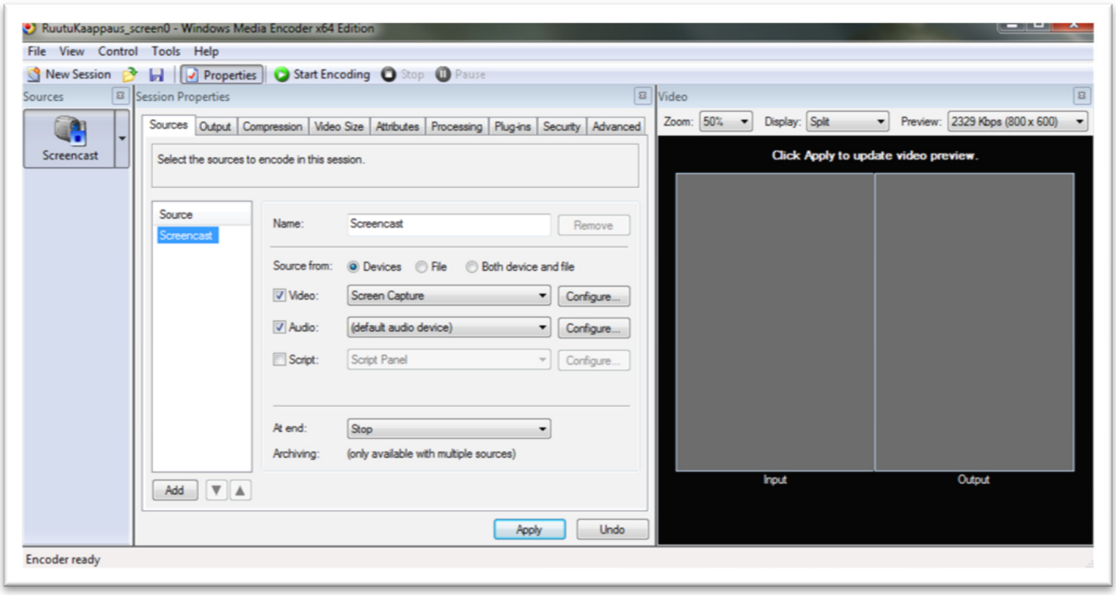

Figure 13. Windows Media Encoder x64 Edition.

The noticed strengths while testing Windows Media Encoder were its feasibility to different screencast scenarios such as live broadcasting while recording screencast to the file at the same time. Also the capturing functions were easy to use and the possibility to monitor the audio narration level while recording screencast was a valuable feature. After the recording is finished the saved file is immediately ready to be published. The noticed weaknesses of the Windows Media Encoder were its demand of capturing computer processor resources while capturing screencast and its complex settings to capture and compress. The capturing settings demand a careful planning and setup of session settings before starting the capturing session. Also the actual bitrate calculated from compressed video file is significantly less (typically 67%) than expected by the configured session settings.

Comparison and Selection of the Screencasting Software

Different screencasting software implementations were experimented in difficult operating conditions. In the experiments just one laptop computer HP EliteBook 8530p (Intel Core 2 Duo T9400 processor and 4GB of memory) had to run two virtual machines (Windows 7 Professional and Windows 2008 Enterprise Server) simultaneously on top of Windows 7 Professional 64-bit operating systems. These virtual machines have to be able to run smoothly without any annoying delays, while all that appears on the screen has to be saved without any interference in the screencast recording.

Findings during the experiments were that in these working conditions the screencast capturing software can easily end up with problems if there is not enough resources for the screencast software to do the capturing of different sources, compressing and to save the captured and compressed content to the hard disk.

Figure 14 shows the amount of increased average processor load from the total capacity of the processor (Intel Core 2 Duo T9400) during the first 60 seconds when screencast capturing is started. The estimation of the increased use of processor resources is observed with the Resource Monitoring tool that is included in the Windows 7 operating system.

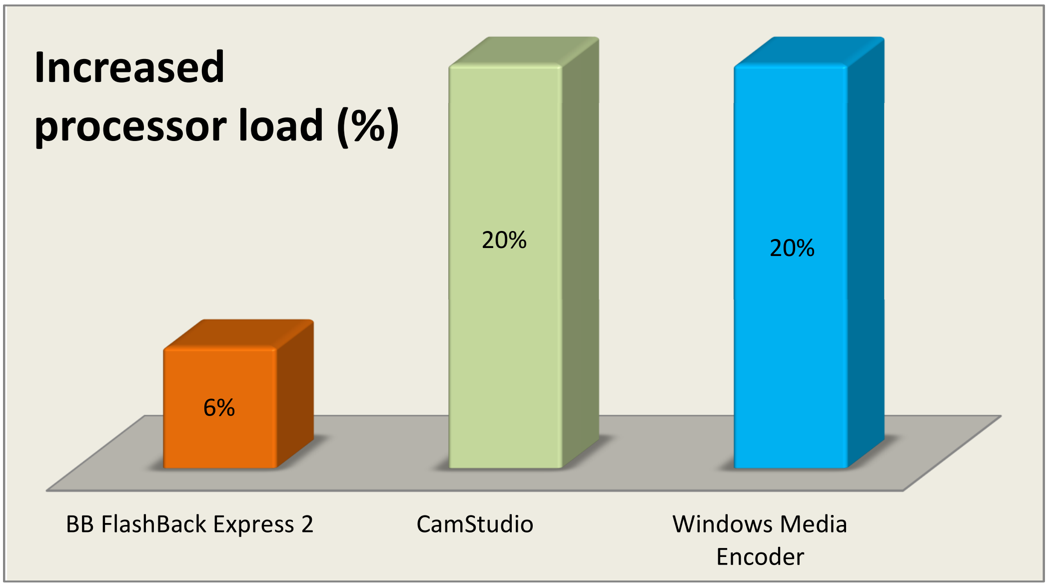

Figure 14. Average processor load increase when capturing screencast for 60 seconds.

After the capturing of the screencast is ended the BB FlashBack Express 2 and CamStudio require post-processing for the captured content to be able to produce a screencast video file. Because of that required post-processing the processor load increase for BB FlashBack Express 2 and CamStudio is actually more than what shows in Figure 14. Windows Media Encoder was the only compared application that did not have to do post-processing for the captured content and it also supports live broadcasting to the Internet.

Figure 15 illustrates file sizes of compressed screencast video files with different applications. The measurements were carried out creating 60 seconds of captured and compressed full screen sessions where the content came from a remote server with occasional screen events. The captured amount of content and the used screen resolution between applications were fixed.

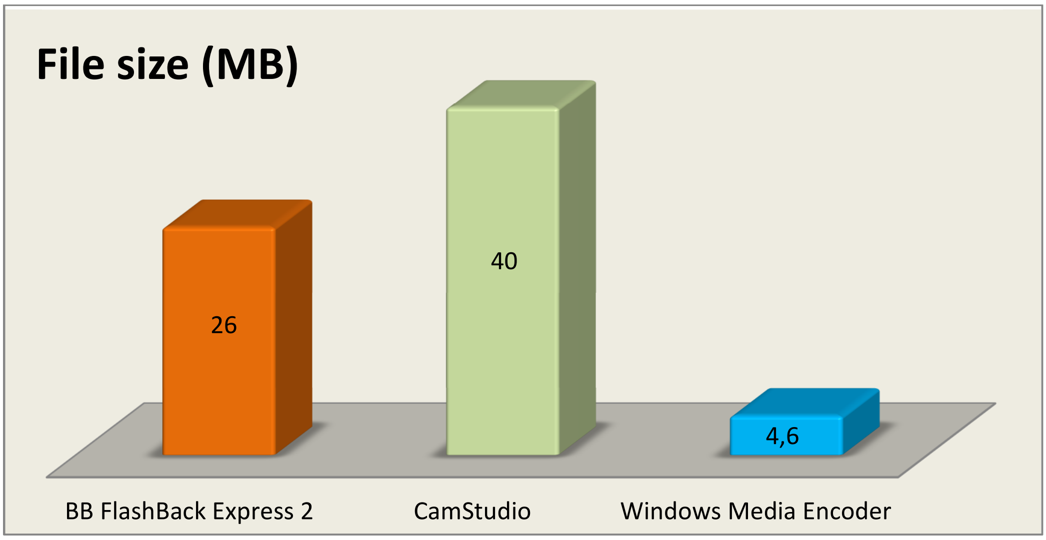

Figure 15. Comparison of the 60 second compressed screencast recording file sizes.

The selection of screencasting software was unclear until the limitations of different public video streaming services were studied. Most of the public video streaming services were useless for the experimental video lecturing purposes either because they have narrowed down the maximum playtime of a single published video to an impractical length or due to the search of key sections of the video lecture being too difficult.

The only video streaming service found to meet both of the features mentioned above was the Viddler.com video streaming service. Viddler.com service has only file size limitations for the published content and the Viddler.com video player supports timed tags and comments on the embedded video player timeline. This fact significantly affected the choice of screencasting software as it increased the importance of small file size of the recordings and in this regard the Windows Media Encoder x64 Edition was superior. Comparison and selection of video streaming service is explained in more detail in Chapter 3.4.

With Viddler.com public video streaming service the published video is not limited in playing time, only the file-size of the single published video is limited to 500MB. The capturing settings described in this study and used in Microsoft Windows Media Encoder x64 Edition capture audio and video content with an actual approximately 633 kbps bitrate. Calculations constitute that 500 MB file-size limit means that the maximum playing time for one published video lecture can be 1 hour 48 minutes. If lectures are longer than that, they have to be divided into separate sections.

3.3 Properties of Captured Audio and Video

Windows Media Encoder supports only VC-1 as a format of the captured video. VC-1 is a video codec specification that is standardized by the Society of Motion Picture and Television Engineers (SMPTE) and implemented in Windows Media Encoder x64 as Microsoft Windows Media Video 9 (WMV9) [12].

VC-1 formal standardization is a result of over 75 companies' technical scrutiny to ensure video content delivery, transport, interoperability and conformance [12].

The VC-1 codec is designed to handle video with 1920 pixel × 1080 pixel resolution (Full HD) at 6 to 30 megabits per second (Mbps) for high-definition video or even higher resolutions such as 2048 pixels × 1536 pixels for digital cinema, at a maximum bit rate of 135 Mbps. There is also possibility to very low bit rate video with 160 pixel × 120 pixel resolution at 10 kilobits per second (kbps) [12].

Detailed information about VC-1 profiles and levels is shown in Figure 16. VC-1 Advanced Profile is also transport and container independent. This provides even greater flexibility for device manufacturers and content services [12].

Profile	Level	Max Bit Rate	Representative Resolutions by Frame Rate
Simple	Low	96 Kbps	176 × 144 @ 15 Hz (QCIF)
	Medium	384 Kbps	240 × 176 @ 30 Hz 352 × 288 @ 15 Hz (CIF)
Main	Low	2 Mbps	320 × 240 @ 24 Hz (QVGA)
	Medium	10 Mbps	720 × 480 @ 30 Hz (480p) 720 × 576 @ 25 Hz (576p)
	High	20 Mbps	1920 × 1080 @ 30 Hz (1080p)
Advanced	L0	2 Mbps	352 × 288 @ 30 Hz (CIF)
	L1	10 Mbps	720 × 480 @ 30 Hz (NTSC-SD) 720 × 576 @ 25 Hz (PAL-SD)
	L2	20 Mbps	720 × 480 @ 60 Hz (480p) 1280 × 720 @ 30 Hz (720p)
	L3	45 Mbps	1920 × 1080 @ 24 Hz (1080p) 1920 × 1080 @ 30 Hz (1080i) 1280 × 720 @ 60 Hz (720p)
	L4	135 Mbps	1920 × 1080 @ 60 Hz (1080p) 2048 × 1536 @ 24 Hz

Figure 16. Microsoft Windows Media Encoder video format VC1 profiles and levels.

The basic functionality of VC-1 involves a block-based motion compensation and spatial transform scheme similar to MPEG-1 and H.261. In addition VC-1 includes innovations and optimizations that make it more advanced than the basic compression scheme, resulting in excellent quality and efficiency. The more sophisticated codecs like VC-1 and H.264 are both more complex in video coding and decoding than MPEG-2. A study by 3rd Generation Partnership Project (3GPP) has found out that VC-1 is more than twice as efficient in terms of processor load in decoding as compared to H.264. 3GPP also found that VC-1 Main Profile requires 25 percent fewer processing cycles than H.264 Baseline profile, which leads to lower power consumption and reduces the time lag while decompressing the compressed video. However H.264 Main Profile requires even more processing cycles than Baseline, because it uses highly complex arithmetic CABAC coding [12].

Windows Media Encoder x64 settings used for screencast capturing

The settings were optimized for generation of a small file size as possible without loosing too much information or the real look and feel of a video when using Windows operating system. Especially the frame rate and modest screen resolution are the key settings to keep the information rate at minimum. Numerous possible options for capturing and compressing the screencast were tested and with visual evaluation led to the conclusion that Windows 7 Professional animations and most of the interaction are fluent with as low as five screen updates per second. Lower screen updates start causing irritating effects for the lectured operating system animations and watching these videos becomes more exhausting.

For the usability of the video lecture the audio track quality is essential. Experiments using analogue microphone generated too much static noise to the recordings, while a laptop integrated microphone was too sensitive and captured all the background noise at the recording vicinity. After some experiments a USB headset microphone (Logitech USB Headset H330) turned out to be a functional solution. Microphone close to the speaker's mouth captures a loud and clear sound narration while at the same time it is not too sensitive in capturing the background noise from the vicinity of the recording room. Final microphone setup captured an audio track where no noticeable background noise or hum was detectable and the audio track with the narration quality fitted well for the purpose of video lecturing experimental.

The used settings for audio and video sources, compression and other configurable settings are shown in Figure 17.

Source settings	**Output settings**
Video: Screen Capture	[v] Encode to file
Audio: USB Audio headset	
Compression settings	
Frame rate: 5 fps	Key frame: 2s
Image quality: 0	Buffer size: Default
Video encoding mode: CBR	Audio encoding mode: CBR
Video codec: Windows Media Video 9	Audience: 1904,05 kbps
Video bit rate: 1863 kbps	Audio codec: Windows Media Audio 9.2

Figure 17. Windows Media Encoder x64 Edition settings for capturing screencast.

With these session settings for the Windows Media Encoder x64 Edition the actual bit rate calculated from the compressed screencast video files differs from 604 kbps to 648 kbps. That is significantly less than expected by the configured session settings.

3.4 Video Lecture Distribution Options

It is possible to distribute video lectures to students in several ways. Each way has its strengths and weaknesses. Selection criteria for the video lecture distribution were that the system had to be robust, affordable, user-friendly and possible to be integrated to the existing Moodle learning management system.

Video lectures as plain video files can be easily published in the Moodle learning management system, but then students must download a large video file before they can start watching the lecture. Creating and sharing removable media copies of the video lectures can accelerate the sharing of the video files, but the limited interaction with the video lectures remains if video lectures are shared as files. All of the large scale initiatives using video lectures used streaming video services combined into efficiency-enhancing web portals. Video streaming is something that today’s students expect. It is easy and fast to use and it is simple to embed in most learning environments. Thus streaming video seemed to be the only appropriate alternative to publish video lectures to the students and therefore it is the only method used in this experiment.

In Lahti University of Applied Sciences there was no own video streaming servers available for use for publishing the video lectures to the students and that forced to seek for a public service suitable for the needs of the present study. Several of the studied public video streaming services were not able to support the needed maximum length of the video lecture. As an example YouTube offers video files with a 15 minutes maximum length limit. Luckily the Viddler.com video streaming service was found as it has no limits for the playing time and also has interesting and relevant features to further improve the user experience of the video lectures. The published video lectures were not limited in playing time. Only the file-size of the single published video is limited to 500MB in the Viddler.com video streaming service.

The total length of the five video lectured topics produced for this thesis was 6 hours and 18 minutes and they cover 20 hours of the classroom exercises. The bit rates calculated from the compressed video files vary from 604 kbps to 648 kbps depending of the content of the compressed video.

The studied network services that support free video streaming and offer a possibility to embed their video player to the Moodle learning management system were: Vimeo.com, Viddler.com and YouTube.com. Figure 18 shows the key features of the video streaming services compared.

	Vimeo.com	**Viddler.com**	**YouTube.com**
Video file-size	500 MB / week	500 MB / video	2000 MB / video
Video playtime	Unlimited	Unlimited	15 minutes
Video timeline tags	no	yes	no

Figure 18. Comparison of the free network video streaming services.

In this thesis it was not possible to use the same methods as the MIT Lecture Browser or YouTube.com auto-captioning have to offer, but some of the same advantages can be achieved with the possibility to manually create labels that Viddler.com enables on their streaming video player timeline.

Figure 19 shows the Viddler.com streaming video player embedded to the Moodle learning management system, the timeline of the video player has white dot indicating the manually created labels for key points of the lecture.

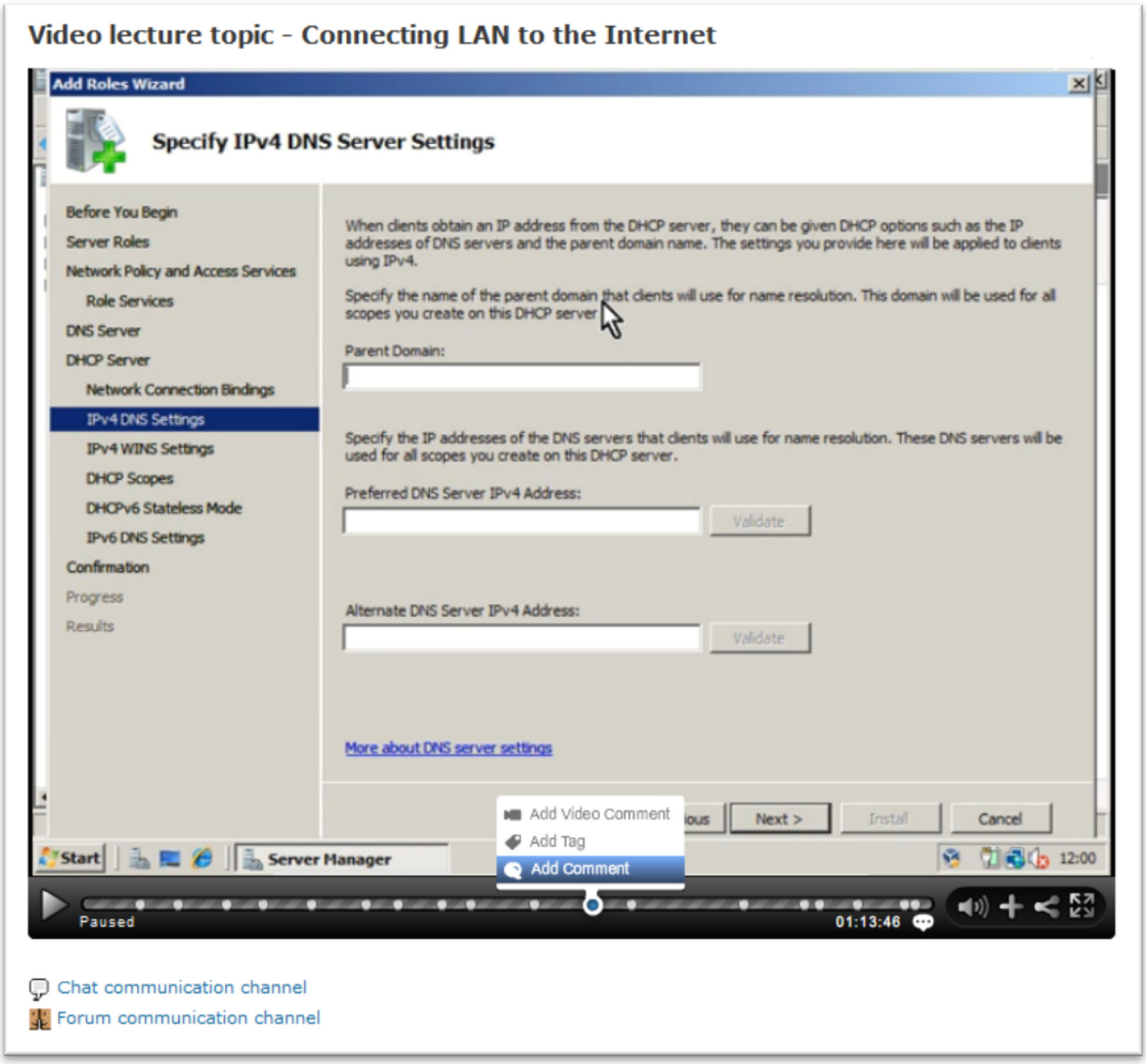

Figure 19. Video lecture with Moodle and Viddler.com communication channels

When the viewer keeps the mouse pointer for a while over some of the dots the player shows a message bubble with the time tagged description or the subtitle of pointed section of the video.

When students watch video streams through the Viddler.com own embedded video player it is possible to allow students to make their own notes, comments and video comments to the video timeline as shown in Figure 19. In this experiment the features where not allowed to ensure that all of the communication of the course topics went through the official Moodle learning management system communication channels.

3.5 Embedding Video Lectures to the Moodle Learning Management System

The Faculty of Technology at Lahti University of Applied Sciences uses mainly Moodle based learning management system on all study courses. Implementing video lectures to the study course was therefore straightforward. Moodle supports linking of external streamed video material to the study course as links to the video streaming service or embed them directly to be shown in the course topics.

Benefits of using the Moodle learning management system in collaboration with embedded video lectures gives a lecturer more tools to communicate with the students. Most of the public video streaming services do not have effective communication channels to be used with the students using video lectures from these services. This present study uses the Viddler.com video streaming service as a publishing system of the video lectures. Viddler.com video streaming service itself supports two-way communication with the audience in written messages or captured audio/video recordings. These Viddler.com communication channels were not used in this study, because Moodle supports linking video lectures to the two-way communication channels of the Moodle environment.

Significant benefits of using Viddler.com video streaming service were that it can support video lectures with a suitable length of the lecture for the course needs and the time tagging option to mark lecture subtitles to the streamed video timeline. With using the time-tagged subtitles it is possible to more efficiently search the content of the video lectures. Viddler.com gives some attractive privacy controls for the publisher and the owner of the video files, e.g. a possibility to make own videos files private and still being able to embed them with little modification of the embedding code to the Moodle learning management system.

The Viddler.com video streaming content can be published using different techniques such as on a Web page, in a blog post, in an instant message, on Twitter and there are several ways to embed a video using Viddler.com video streaming player [30].

Viddler.com supports a couple of distinct player types: Full and Simple. The Full Player features an interactive video viewing experience allowing the viewer to see and possibility to allow viewer to create timed comments and tags directly on the video timeline.

Comments can be in both text and video. In comparison the Simple Player will allow the user to focus more on the video itself, without all the interactivity [30].

In the experimental system, embedding of Viddler.com video streaming player was implemented by using Hyper Text Mark-up Language (HTML) with a small block of code shown in Figure 20. With that small block of code usually called "embed code" it is possible to configure which video is shown on that embedded player and in which dimensions and various other options [30].

Video lectures embedded to the Moodle learning management system look as shown in Figure 19. The used embed code to the Moodle learning management system is shown in Figure 20. The embedding code is used if the used web browser is identified as a Microsoft Internet Explorer. The embedded video player object is defined to use the same resolution as the captured video files are in order to ensure the best possible video quality to the students watching the video lectures.

```
<!--[if IE]>
    <object width="800" height="648" id="viddlerOuter-c2703995"
        classid="clsid:D27CDB6E-AE6D-11cf-96B8-444553540000">
        <param name="movie" value="http://www.viddler.com/player/c2703995/0/74108750">
        <param name="allowScriptAccess" value="always">
        <param name="allowNetworking" value="all">
        <param name="allowFullScreen" value="true">
        <param name="flashVars" value="f=1&autoplay=f&disablebranding=t">
        <object id="viddlerInner-c2703995">
            <video id="viddlerVideo-c2703995"
                src="http://www.viddler.com/file/c2703995/0/74108750/html5mobile/"
                type="video/mp4" width="800" height="648"
                poster="http://www.viddler.com/thumbnail/c2703995/0/74108750"
                controls="controls" x-webkit-airplay="allow">
            </video>
        </object>
    </object>
<![endif]-->
```

Figure 20. Viddler.com streamed video embed code for the Internet Explorer.

As Figure 20 shows, the first setting in embed code is to describe an *object* to show on the browser and to define its dimensions. The defined object *width* is the same as the captured video content but in the *height* there are 48 pixels more than in the captured video. The pixels are added for the interactive timeline of the video player. Also the unique video file *id* for the embedded video player is defined in that same object line.

The *classid* attribute uniquely identifies the embedded video player software to use. It is always set to *classid="clsid:D27CDB6E-AE6D-11cf-96B8-444553540000"* in spite of the selected video player type between Legacy and Flash with HTML5 mobile fallback options.

The only required parameter for the object is the video key which in Figure 20 is *C2703995* [30]. The additional */0/74108750* is added because the embedded video is classified as private and the number 74108750 is the secret key of that private video. The feature to embed private videos is not officially supported, but the guides to add the numbers to the embed code were available at Viddler.com support discussion forum.

When students log to the course web page through the Moodle learning management system the web browser loads the embed code that shows the Viddler.com streaming video player. There are several optional *flashVars* parameters to control the presence of the video player and the most practical to use in this experiment is the possibility to show a single picture of the video lecture as a thumbnail picture. With the parameter value *"autoplay=f"* or *"autoplay=t"* it is possible to have control for the video streaming player that is or is it not allowed to start video streaming process immediately when loaded to the web browser.

To prevent the autoplay feature of the embedded video streaming player the following line was added to the embed code: *<param name="flashVars" value="f=1&autoplay=f">*

Each video lecture started with a short introduction to the subject matter of the problem while showing a table of the contents on the screen. It was possible to configure inactive Viddler.com video player to show that table of contents picture on the Moodle learning management system before starting to play it.

The inactive video player helps students to easily find the appropriate video lecture and the desired section of the video when needed. Students just come to the course page on the Moodle LMS and they see a table of contents of each embedded video lecture and the proper communication channels of each video lecture.

If all of the embedded streaming video players start playing the video streams immediately when the user logs into the course web page it generates a lot of network traffic every time a student comes to the course web page on the Moodle learning management system, even if he or she is not going to watch any of the video lectures.

Viddler.com also supports an opportunity to html5mobile fallback if the used web browser lacks the possibility to use flash video streaming. Devices such as Apple iPhone and iPad do not support flash video and that is one of the major reasons to use this html5mobile fallback. That makes watching the video lectures with iPad and iPhone possible.

Figure 21 shows the added code to be used with non Internet Explorer recognized browsers.

```
<!--[if !IE]><!-->
    <object width="800" height="648" id="viddlerOuter-c2703995"
        type="application/x-shockwave-flash"
        data="http://www.viddler.com/player/c2703995/0/74108750">
        <param name="movie" value="http://www.viddler.com/player/c2703995/0/74108750">
        <param name="allowScriptAccess" value="always">
        <param name="allowNetworking" value="all">
        <param name="allowFullScreen" value="true">
        <param name="flashVars" value="f=1&autoplay=f&disablebranding=t">
        <object id="viddlerInner-c2703995">
            <video id="viddlerVideo-c2703995"
                src="http://www.viddler.com/file/c2703995/0/74108750/html5mobile/"
                type="video/mp4" width="800" height="648"
                poster="http://www.viddler.com/thumbnail/c2703995/0/74108750"
                controls="controls" x-webkit-airplay="allow">
            </video>
        </object>
    </object>
<!--<![endif]-->
```

Figure 21. Viddler.com streamed video embed code for the non Internet Explorer browsers.

An annoying but tolerable finding was that if the web browser uses html5mobile video streaming player it is not able to show the labels or subtitles of the video on the video player timeline. While trying to find out the reason for this not working timeline tags problem it was discovered that html5mobile is now available only for the Viddler.com commercial business clients and partners.

Figure 22 shows an example video lecture in the Moodle experimental course context.

Figure 22. Inactive screencast video lecture that is embedded to Moodle from Viddler.com.

Figure 22 shows the Moodle features that are used to support embedded video lecture, these features are: Moodle topic to describe the content of the video lecture, inactive video player with time tagged key sections of the video and Moodle communication channels.

Figure 23 shows the active and embedded Viddler.com video player view for the students where the student can see all the learning tools for the video lecture at once.

The view shows the total playing time of the video lecture, current section time and place on the video timeline and Moodle communication channels.

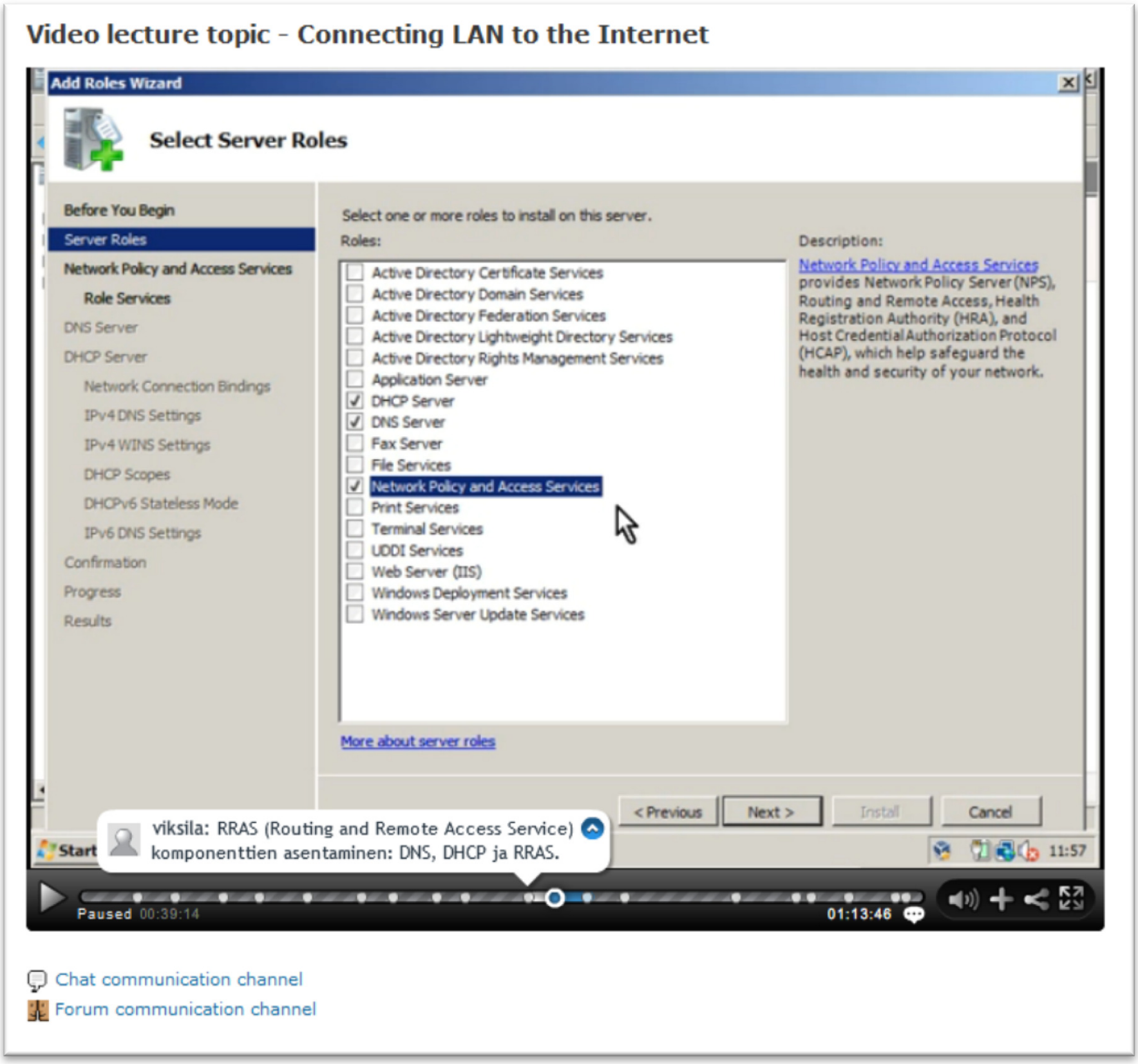

Figure 23. Active screencast video lecture that is embedded to Moodle from Viddler.com.

Messages in forum communication channels are saved to the Moodle learning management server and the students and the lecturer can answer each new topic on the forum. All the questions on the forum are answered and the communication channel has a more official status on the learning process, while the chat communication channel is more informal.

The chat communication channel is planned to be used for communication while students are executing the exercise. If they have problems or thought-provoking experiences they want to share immediately with others doing the same exercise the chat communication channel works as a common to all instant messaging tool. Messages are not saved for longer than 2 days on the Moodle learning management systems to give the communication channel a more informal status in the learning process.

3.6 Description and Background for Video Lecturing Experimental System

Video lectures were accomplished at Lahti University of Applied Sciences (LUAS) and its Faculty of Technology. LUAS is owned by the municipalities of the Lahti region through the Lahti Region Educational Consortium. LUAS is an independent commercial undertaking within the Consortium, and it is governed by the Board of LUAS, which is nominated by the Consortium except for the representatives of the personnel and the students. LUAS has about 400 full-time staff and over five thousand enrolled students [8].

The instruction is given at the Faculties. Within the Faculties there are in many cases Departments, which are responsible for individual degree programmes and main subjects. Faculty of technology offers fields of study for the undergraduate programmes that are material and production engineering, information technology and environmental technology. Information technology is divided into five major study areas; software engineering, computer electronics, telecommunications technology, mechanical and production engineering (mechatronics) and media technology (visualisation engineering) [9].

Case course "Operating system and device management, 5 ECTS"

The case course for the implementation of video lectures where the impacts of using video lectures are examined is competency-based and the student learning targets for the course were:

- understand the basics of the computer operating system and identify good practices for computer management
- know-how to use the administrator's management tools
- know-how to create and manage computer domains and its users and computers rationally
- to be able to design and implement network services

- understand the importance of information security in systems operation and maintenance

The Finnish name of the course is ”Järjestelmät ja laitteistot” and almost all study material and spoken lectures are in the Finnish language. Also the screencast narrations on video lectures used in this course are spoken in the Finnish language.

The assignments in this experiment course were the same as in previous year, with the difference that the virtual workstation operating system Windows XP and Windows 2003 Server was now upgraded to the Windows 7 Professional at workstation and Windows 2008 Server editions.

Description of the groups of students and their role in the experiment

This study involved four groups of students and each group used video lectures in a different way. The total number of students participating in the study was 86 and the number of students in each examined group is presented in Figure 24.

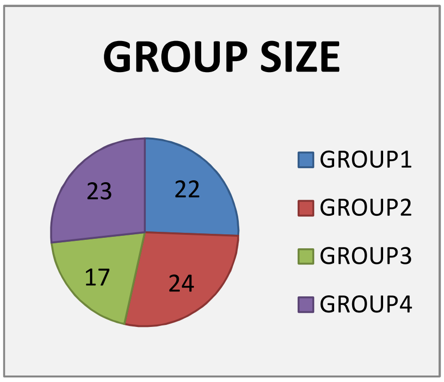

Figure 24. Number of students in different groups.

Each of the four groups had different function in the study. Group 1 had no video lectures available for the students, Group 2 did have video lectures available for the students, Group 3 was an adult group utilizing video lectures as part of the studies and Group 4 only applied distance learning with video lectures.

Group 1: 47MON10D (no video lectures available for the students)

The first part of the study course dealt with the basics of a UNIX- and Linux operating systems. That part of the course consisted of 23 hours of classroom training by using UNIX server available to all University students. The first part of the study course was carried out by performing predetermined plain assignments for typical administrative situations. If the student was able to solve the assignments by following the in advance published guidelines with the shared tutorials and guides, it was possible to accomplish this part of the course without participating in the classroom exercises at all. None of the students in this group used this option, at least not in such a way that they would not have participated in the classroom exercises. This part of the course was evaluated with an exam lasting for 2 hours and an exam feedback that lasted for 1 hour.

The second part of the study covered Windows workstation and server management. The second part of the course consisted of 24 hours of classroom training. That part of the study course was performed on the school's workstations with Oracle VirtualBox virtualization environment on each workstation. The descriptions of this topic exercises were available online for the students, but comprehensive carry out of the exercises remotely was not possible. This part of the course was evaluated with an exam lasting for 2 hours and an exam feedback that lasted for 1 hour.

The third part of the study course was the task to establish a network service in a small group, that part of course consisted of 9 hours of classroom working. The students formed small groups (four people or less) and they were to develop a network service together. The service could be a content management system, communication forum type of service or the same level of challenging installation of software to the server. The installation was documented and presented to the other groups. The third part of the course was only approved or rejected based of the presentation. After the presentation was approved it did not affect the student's grade.

Group 2: 47MON10B (video lectures available for the students)

The first part of the study course dealt with the basics of a UNIX- and Linux operating systems. That part of the course consisted of 23 hours of classroom training by using a UNIX server available to all University students. This first part of the study course was carried out by performing predetermined plain assignments for typical administrative situations. If the student was able to solve the assignments by following the in advance published assignments with the shared tutorials and guides, it was possible to accomplish this part of the course without participating in the classroom exercises. None of the students in this group used this option, at least not in such a way that they would not have participated in the classroom exercises. This part of the course was evaluated with an exam lasting for 2 hours and an exam feedback that lasted for 1 hour.

The second part of the study covered Windows workstation and server management. The second part of the course consisted of 17 hours of classroom training. That part of the study course was performed on the school's workstations with Oracle VirtualBox virtualization environment on each workstation. The descriptions of this topic exercises were available online for the students, as well as screencast video lectures to demonstrate how to accomplish the assignments of this part. It was possible for the students to carry out the exercises in advance by remotely using the laboratory workstations over the Internet. None of the students in this group used this option, at least not in such a way that they would not have participated in the classroom exercises. A few students did use the video lectures to go through classroom exercises on the period they were sick or otherwise not able to be present in scheduled classroom exercises. This part of the course was evaluated with an exam lasting for 2 hours and an exam feedback that lasted for 1 hour.

The third part of the study course was the task to establish a network service in a small group, that part of course consisted of 6 hours of classroom working. Students formed small groups (four people or less) and they were to develop a network service together. The service could be a content management system, communication forum type of service or the same level of challenging installation of software to the server. The installation was documented and presented to the other groups. This third part of the course was only approved or rejected based of the presentation. After the presentation was approved it did not affect the student's grade.

Group 3: 07TIEIA10 (video lectures used as a mandatory part of the course)

The first part of the study course dealt with the basics of a UNIX- and Linux operating systems. That part of the course consisted of 18 hours of classroom training by using a UNIX server available for all university students. This first part of the study course was carried out by performing predetermined plain assignments for typical administrative situations. If the student was able to solve the assignments by following the in advance published assignments with the shared tutorials and guides, it was possible to accomplish this part of the course without participating in the classroom exercises. Some of the assignments were to be made independently as a pre-task for the classroom exercises. This part of the course was evaluated with an exam lasting for 2 hours and an exam feedback that lasted for 1 hour.

The second part of the study covered Windows workstation and server management. The second part of the course consisted of 12 hours of classroom training. That part of the study course was performed on the school's workstations with Oracle VirtualBox virtualization environment on each workstation. The descriptions of this topic exercises were available online for the students, as well as screencast video lectures to demonstrate how to accomplish the assignments of this part. A substantial part of the assignments had to be done independently as a pre-task for the classroom exercises following a video lecture demonstration of the assignments. It was also possible to do this part of the course remotely using the laboratory workstations over the Internet or visiting the classroom when it was free from other lectures. This part of the course was evaluated with an exam lasting for 2 hours and an exam feedback that lasted for 1 hour.

The third part of the study course was the task to establish a network service in a small group. Group 3 did not establish any network services, but they got extra assignments to study how to setup virtualization and use it effectively to do the Windows workstation and server management part of the course. The students were encouraged to use their own computers to setup desktop virtualization or remotely using classroom workstations; this is giving them the flexibility to use virtualization effectively in their own needs and eases the use of video lectures. That part did not directly affect the students' grades.

Group 4: 47MON10NET (distance learning with video lectures)

The first part of the study course dealt with the basics of a UNIX- and Linux operating systems. That part of the course had no classroom training at all. It was carried out using a UNIX server available for all university students by performing predetermined plain assignments for typical administrative situations with mostly written assignments and work instructions for doing it. The parts that include working in a graphical user interface were covered with pre-recorded video lectures. If the student was not able to solve the assignments by following the in advance published assignments with the shared working instructions and guides, it was possible to organize online tutoring with the lecturer using Adobe connect network meeting software. This part of the course was evaluated with a classroom exam lasting for 2 hours and an exam feedback that lasted for 1 hour.

The second part of the study covered Windows workstation and server management. The second part of the course consisted of no classroom training at all. That part of the study course was performed on own home computers or using remotely or locally the schools' workstations with Oracle VirtualBox virtualization environment on each workstation. The use of the laboratory workstations over the Internet or visiting the classroom was possible only when it was free from other lectures. Descriptions of this topic exercises was available online for the students, as well as screencast video lectures to demonstrate how to accomplish the assignments of this part. This part of the course was evaluated with a classroom exam lasting for 2 hours and an exam feedback that lasted for 1 hour.

The third part of the study course was the task to establish a network service in a small group. That group 4 did not establish any network services, but they got extra assignments to study how to setup virtualization and use it effectively to do the Windows workstation and server managements part of the course. The students were encouraged to use their own computers to setup desktop virtualization or remotely using classroom workstations; this gives them the flexibility to use virtualization effectively in their own needs and eases the use of video lectures. That part did not directly affect the student's grades.

This group 4 implementation of the course is addition to the original course implementation plan. The reason for creating that additional group was that there were too many students on every parallel study group when this course started and there were not enough computers for each student in the classroom to do the assignments.

This problem described above and the possibility to support online learning and an asynchronous learning method with the material created to the video lectures experimental course together encouraged to try how well this course server as an asynchronous online course.

The idea of the possibility to carry out this course as an asynchronous online course was presented for the students and it was hoped that enough interested students to this extra implementation of the course could be found. The students were so enthusiastic about the online possibility of the course that the number of participants had to be restricted. As a result of the voluntary transition to the second group there were enough interested students in each group so there was a sufficient number of computers for all the remaining students in each parallel group after the transition to the new study group.

3.7 Experiences on how Video Lecturing Influences Teaching

The creation of screencasting lecture recordings process did not differ much from the classroom teaching presentation. The most significant difference was that the coverage of the intended subject was most probably treated without any interruptions. A typical classroom presentation can be interrupted for several of reasons such as students enter or leave the classroom in the middle of the lecture.

There is a greater change in the teacher's role, when students follow the video lectures and most of the information is given as video lectures and a significant part of the instructor's work is done in advance when recording the video lectures. That gives the teacher an opportunity to give more individual support to the students when they need it during the assignments.

One of the most significant problems of the previous implementations of this course has been that if some of the students were not able to participate in a classroom training session. Then it is possible that they fall behind the other students.

The nature of the lectured topics and exercises was that the students can only proceed on the exercises when completed the previous tasks successfully. Now students had a better opportunity to compensate their possible absence from a classroom training session and they could do the missed exercises independently by following the video lecture demonstration without the lecturer. Obviously this is not desirable, but a much better option than totally missing the information given.

3.8 Experiences and Ambience of Using Video Lectures

The previous implementations of the experimented course have been lectured in three sections and the teaching method has been mostly carried out as traditional classroom training. Also in this experiment the first section of the course for the groups 2 and 3 was lectured as traditional classroom training and the lectured topic was how to administer the Linux operating system. For the second section of the course the lectured topic was how to administer Windows operating system and the teaching method introduced the video lecturing method to the students.

The first impression when the teaching method turned from the traditional classroom training to the video lecturing was noticeable: it was hard to believe that the students were actually the same students as in the first section of the course. Almost all of the hassle in the classroom ended and the concentration to the exercised topic increased significantly. The reason for the students' comprehensive concentration for the video lectured exercises might have been result of the students' increased control of the lectured topics. Also the student role was more active than in traditional classroom training because they had to carry out the exercises while they followed the video lecture.

4 Results and Analysis

All of the examined student groups had the same learning objectives and they all took two exams that were the same between the different student groups. Also, the first part of the study that dealt with administering of UNIX and Linux operating systems were lectured in the same way for groups 1, 2 and 3. The only exception was group 4 which completed the whole course without classroom training.

The amount of video lecturing material that were used to study the effectiveness of video lecturing and produced for the experimental course was 6 hours and 18 minutes. At the same time that video lecturing material covered 20 hours of classroom training exercises on the experimental course. Each of the five video lectures has been viewed at an average of 118 times, which means 1.85 times per student for whom it has been available.

The effect of the video lectures on the students' learning outcomes is examined through the average points that each control group acquired in the second part exam of the course. That part of the course dealt with administering the Windows operating systems and in that part of the course the video lectures were used differently in each group.

4.1 Effect of Video Lectures on Students' Exam Points

The video lectures were only used in the Windows part of the course assignments. That gave the opportunity to evaluate the effect of video lectures on the learning outcomes by comparing the exam points of the groups.

Figure 25 shows the average exam points of each group in both exams (Linux and Windows part of the course).

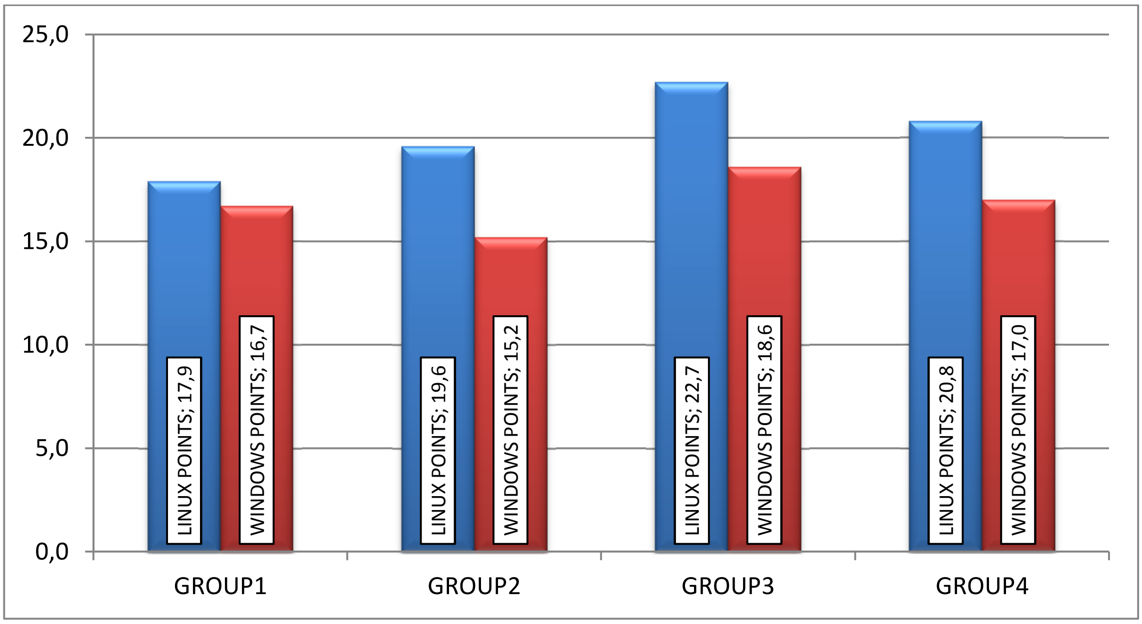

Figure 25. Exam points of study groups in Linux and Windows exams.

As can be seen in Figure 25, the Windows exam was more difficult for all the groups, with or without the use of video lectures.

For group 1 there was no difference in the use of video lecturing, because they did not use the video lectures at all. Group 1 had 23 hours of classroom teaching for the content of the Linux exam and for the Windows part of the study they had 24 hours of classroom training.

For group 2 the video lectures were available and used as course material during the Windows part of the course. Group 2 had 23 hours of classroom teaching for the content of the Linux exam. For the Windows part of the study they had 17 hours of classroom training.

By comparing the development of the exam points of the two groups it is possible to detect unfavourable change in the exam results for group 2 in the Windows exam. Group 2 got more average points in the Linux exam than group 1, but in the Windows exam the average exam points of group 2 were lower by 9% as compared to those of group 1. From this it is possible to conclude that for group 2 the use of video lectures was not helpful from the perspective of exam results.

For group 3 the video lectures were a mandatory part of the course and they were used as course material during the Windows part of the course. Also, a substantial part of the video lectures were used as obligatory distance learning tasks to compensate for the small number of the classroom training hours. Group 3 had 18 hours of classroom teaching for the content of the Linux exam. For the Windows part of the study they had 12 hours of classroom training.

Group 3 got more average exam points in the Linux exam than group 1, and also in the Windows exam the average exam points of group 3 were higher than those of group 1. However, the number of the average exam points of group 3 from the Linux exam to the Windows exam decreased more than between the two exams in group 1.

For group 4 the video lectures were obligatory course material during the Windows part of the course. Group 4 did not have any classroom training for the content of the Linux and Windows exams.

By comparing group 4 to group 1 it is possible to detect that in both of the exams the average exam points of group 4 are higher. However, the number of the average exam points of group 4 from the Linux exam to the Windows exam decreased more than between the two exams in group 1. The relatively high exam points in both of the exams for group 4 is possibly a result of the fact that this group of students was selected based on their own interest to carry out this experimental course as an asynchronous online course and possibly reached higher motivation.

Figure 26 shows the difference of the average exam points of each group compared to the weighted average of all groups.

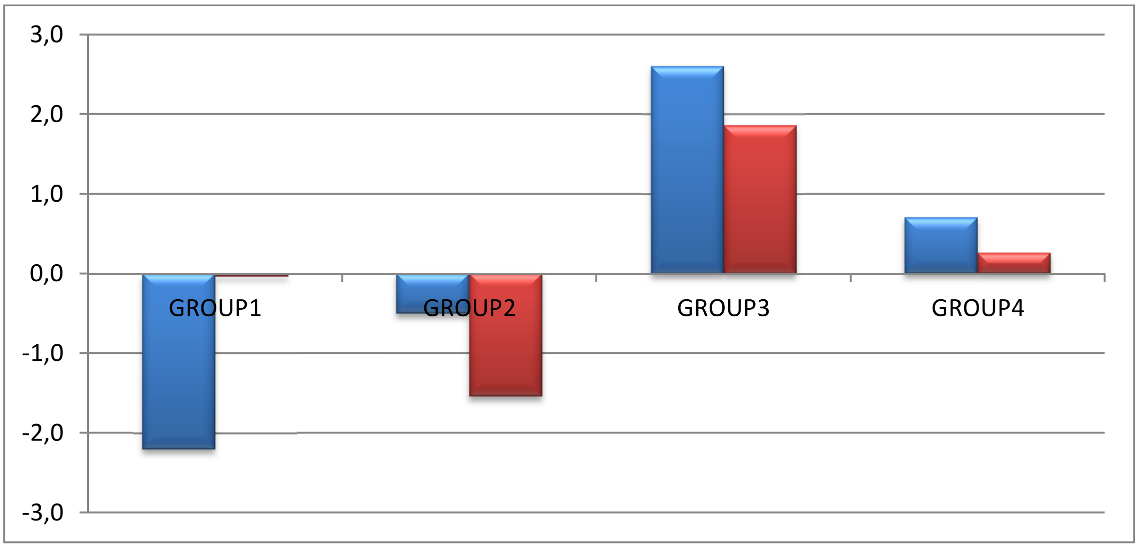

Figure 26. Study group exam points comparison to the weighted average.

The comparison of the exam points of group 1 and group 2 cannot confirm the usefulness of the video lectures as course material on the experimental course, although the classroom situation seemed to be very promising and also the feedback from the student inquiry gave a similar impression.

The good results of group 3 in both exams stand out in Figure 26. They got the highest average exam points in both exams even though they had less classroom teaching than groups 1 and 2. This may be result of the special feature of group 3 that they were all adults and all of the students in that group had already worked in the information technology sector.

With group 4 average exam points it is possible to detect that online learning with the video lectures is a viable solution for the experimental course, although the online learning method is not appropriate for all students. When students had selected the online course option themselves they acquired equal exam results on the course.

4.2 Student Evaluation on Using Video Lectures

Obviously the obtained exam result alone do not give an adequate general view of the suitability of the video lectures for the experimental course; therefore it was decided to organize a student inquiry to determine how the students experienced the use of video lecturing material during the course.

Figure 27 shows the numeric results of the inquiry conducted with group 3 students. From the 17 members of the group, 10 gave their response; the response rate of the control group 3 to the student inquiry was 59 percent.

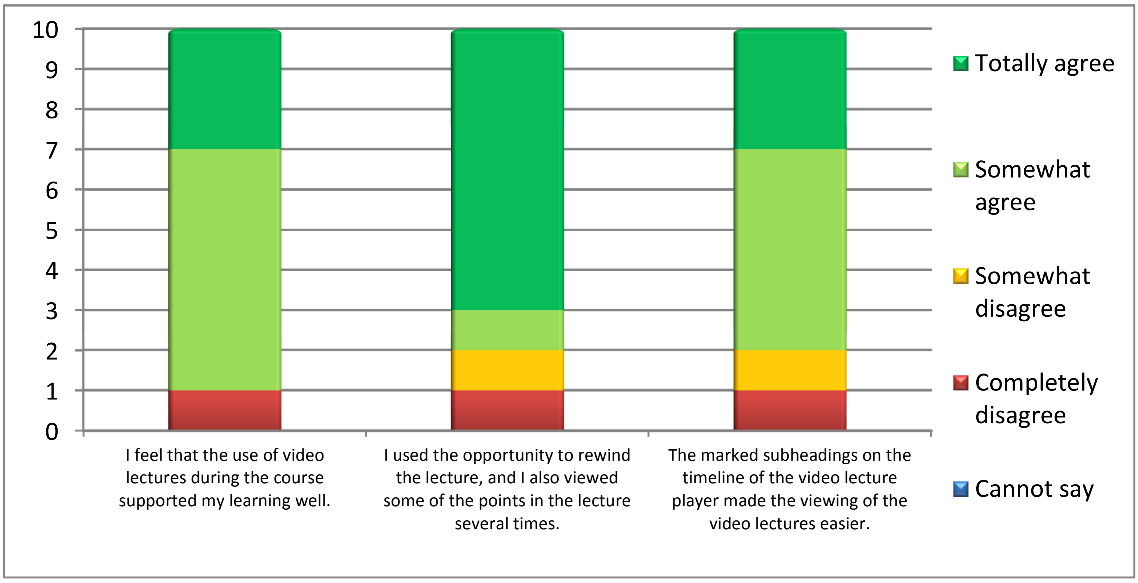

Figure 27. Results of the inquiry with group 3.

The claims were; 1. I feel that the use of video lectures during the course supported my learning well. 2. I used the opportunity to rewind the lecture, and I also viewed some of the point in the lecture several times. 3. The marked subheadings on the timeline of the video lecture player made the viewing of the video lectures easier.

The student inquiry results are in line with the observation made in the classroom training session with the video lectures. Video lectures seem to be a pleasant way to learn the subjects of the experimental course, although its benefits are difficult to validate prove with the exam points of the course.

Students also had a possibility to give some free written answers to question "Was there anything special you want to share about the way of video lecturing was used on the course, about usability or about learning with the help of video lectures in general?"

The free feedback from the students to the inquiry was solely positive and the general spirit of the messages was that they hoped to have an increased number of video lectures available in the future. Below there are some of the free feedback comments that the students mentioned in the students inquiry: "It was possible to go thru the exercises at your own speed, as well as the opportunity to return to the point that remains unclear."; "Video lectures supports well distance and adult learning."; "Video lectures gave an opportunity to focus on learning at your own peace, outside of the distractions."

Figure 28 shows the numeric results of the inquiry conducted with group 4. From the 23 members of the group, 8 gave their response; the response rate of group 4 to the student inquiry was 35 percent.

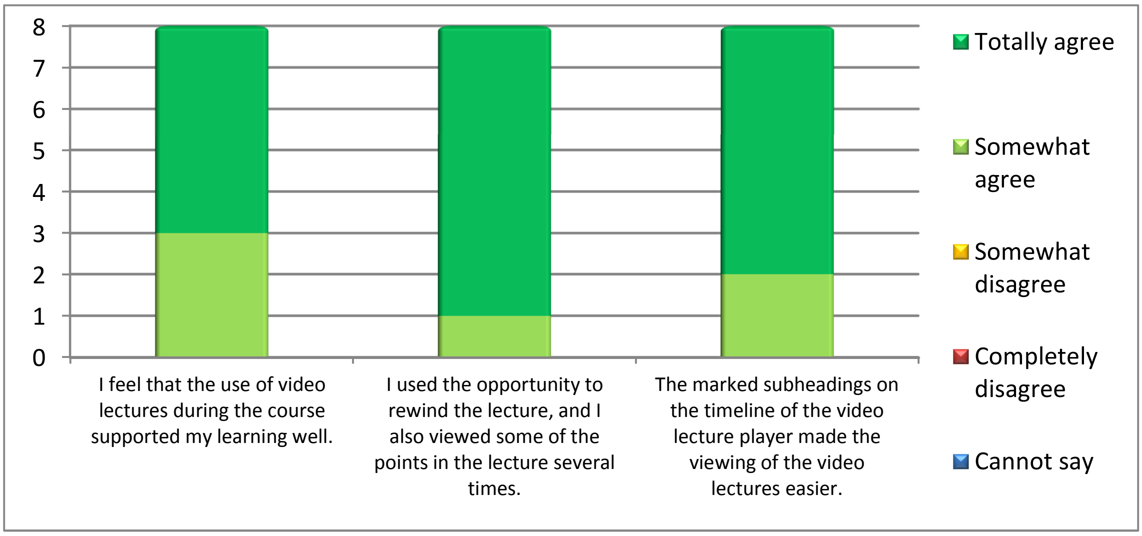

Figure 28. Results of the inquiry with group 4.

The most significant feature of group 4 was that they did not have any classroom training during the experimental course. For that reason the observation of how the students use the video lectures was considerably more challenging, and it was also more challenging for the teacher to have a perception of the students' progress during the course.

Considering that the video lectures were planned and created as a supporting material for the classroom training assignments, it was surprising how excellent the acquired exam points and the feedback from the student inquiry were in group 4.

This suggests that when the lectures are recorded and the lectured content and its presentation are planned as video lectures, the recorded lecture material may be suitable to be used for both synchronous and asynchronous learning methods. At least if the students themselves can choose which kind of implementation they are willing to go through.

Figure 29 shows the numeric results of the inquiry conducted with group 2 students. From the 24 members of the group, 3 give their response; the response rate of group 2 to the student inquiry was only 13 percent.

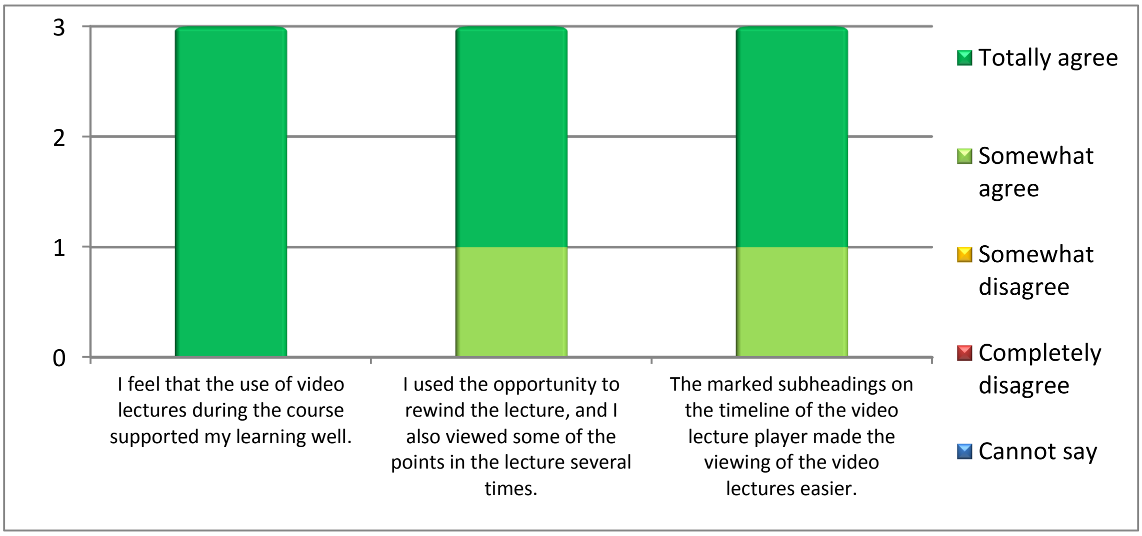

Figure 29. Results of the inquiry with group 2.

Because of the low number of respondents in this group, it is impossible to create an overall understanding of the experiences of this group. However, their feedback is consistent with the results of the other groups.

5 Discussion and Conclusions

After a careful planning and preparation of the video lectures, the recording of the video lectures was unexpectedly smooth. To the teacher the recording of the video lecture is nearly the same as giving a typical classroom training type of a lecture. The amount of work to be done by the teacher for each video lecture increases significantly if the video lectures are created as described in this thesis. However, there are video lecturing automation systems available and some of them are presented in the study. They can substantially decrease the teacher's workload in the creation process of the video lectures.

The video streaming service Viddler.com which was used to publish the experimental video lectures to the Moodle learning management system operated throughout the course without any detected or reported problems. Also, the feature of displaying manually created labels on the embedded video player timeline and that way supporting the enhanced video browsing capabilities for the students was an advantageous feature that was valued in the responses of the student inquiry. Some teachers may appreciate the possibility to use private video files as video lectures and still being able to embed that private content to Moodle learning management system.

Video lectures also have a great potential in the student's personal learning environment, and the student can utilize many simultaneous information sources to gather the information required to accomplish course assignments. With the possibility to use video lectures the students can have more control of their own time and place of studying. The benefit of using video lectures does not necessarily influence the course grades directly but they may still be beneficial to the studies and the student's career development.

The experience collected through the experimental course, the feedback from the students during the classroom training and in the student inquiry brings out numerous advantages that are possible to achieve when video lectures are used. However, video lectures in all cases increase the teacher's workload and also the benefits of using video lectures were not detected as better results in the exams in the experimental course between the different groups with or without video lectures. At the same time it is obvious that video lectures make studying more convenient for the students.

In general it can be said that video lectures are a good way to show what universities are really doing. However, many lecturers have to update and rearrange the content of their course when converting it to support the video lecturing environment. This converting process of the course material takes a considerable amount of the teachers' time and the results of this effort are not necessarily shown in the students' exam results.

Video lecturing systems are able to ease and sometimes even automate the process of creating video lecturing material for the teachers. With the use of free open-source platforms such as Opencast project Matterhorn it is possible to the universities to lower the technical and financial barriers to start using a video lecturing system.

In the future it appears that learning will become increasingly fragmented and to succeed in the education, universities have to better adapt to students' life in different situations. Video lecturing and especially the possibility to time and place independent learning seem to be a valuable opportunity to enable efficient distance learning.

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