



## EXPANDING THE USABILITY OF RECORDED LECTURES IN WATER MANAGEMENT

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**Abstract:** Recorded lectures are playing an increasingly pronounced role in modern academic education. This was demonstrated in a course at TU Delft with 550 students. Only around 15% opted to follow the lectures live in the lecture room, with its options for interactions with the lecturer. Another 15% preferred to follow the lectures either live via an internet connection or on demand later that day. Both of these groups followed the weekly scheduling of this course. The majority used the recorded lecture as an exam preparation aid. All lectures were viewed on demand some 300-400 times. A large part of these views occurred during the days preceding the exam.

Recorded lectures can be distributed via popular platforms such as iTunesU and YouTube EDU. The latter allows for online translated subtitles, which is considered a very useful tool for the international students at TU Delft. Future developments for recorded lectures were investigated in an MSc research project in Computer Science at University of Twente. It was shown that the word correctness of modern speech recognition is around 50%, which is insufficient for direct use as subtitling, but rather appropriate for search engines. A prototype for such a search engine over a full course has been developed based on lecture titles, chapter titles, slide data, transcripts, subtitles and speech recognition output. An online time framed discussion board was reviewed, showing that in these discussion boards' student-to-student interactions might be more intensive than student-lecturer interaction.

Introduction of recorded lectures allow for a much more flexible scheduling of courses, either multiple times a year, as well as in intensive short courses.

**Keywords:** Recorded lectures, OpenCourseWare, water management, drinking water engineering.

### 1. Introduction

During the last 10 years most universities in the western world have started to record some of their lectures. The recent developments in ICT on streaming video, as is shown in the amazing 5 year history of YouTube, have largely boosted the recording of lectures. An overview of these developments can be seen in YouTube EDU (since March 2009), iTunesU, videoLectures.net and Academic Earth. Around 200,000



video recorded lectures are available on these platforms. Recorded lectures might be regarded as “the ultimate form of lecture notes”.

In 2007 Delft University of Technology (TUDelft) started a free service for their lecturers to record their lectures.. This paper gives an overview of some experiences of this recording program within the courses for Water management. Recorded lectures are part of the TU Delft OpenCourseWare program [1].

During 2009 Delft University of Technology has done a MSc research project in Computer Science in cooperation with University of Twente in order to look for “expanding the usability of recorded lectures”. The results of this research project are included in this paper.

## 2. Recorded lectures for lecture room extension

In the year 2009-2010 the BSc course Water management (CT2011/CT3011) was shifted in the curriculum from a third year course to a second year course. This means that for this year only, two student cohorts were to be expected. This was reflected by the 550 students enrolled in Blackboard.

This number largely outranged the maximum seating capacity of 350 students in the largest lecture room at the faculty of Civil Engineering, home of the department of Water management.

By scheduling the lecturers at the most inconvenient students hours (Mondays and Fridays, the first 2 lecture hours) it was expected that not all students would follow the actual course, but such a scheduling is more based on practical limitations than on educational motivations.

These constraints were used to experiment with a new approach on using recorded lectures. The lecture was made available to the students at four alternative ways:

- live in the largest lecture room, with the lecturer in front
- live in a “movie theatre lecture room”, with lecturer and slides projected on a large screen
- live on the viewers PC, via a live internet connection to the lecture room
- on-demand, showing the recorded lecture afterwards.

The last three viewing options are all based on the Collegerama recording. The live viewing in the theatre lecture room and the live viewing on PC's are actually using the recorded lecture at a time delay of some 5-8 seconds. The on-demand viewing also plays this recording.

In view of the early lecture hours and the live lecture recording this course was advertised as “attending lectures in your bed”. Figure 1 gives an impression of the 4 viewing options.

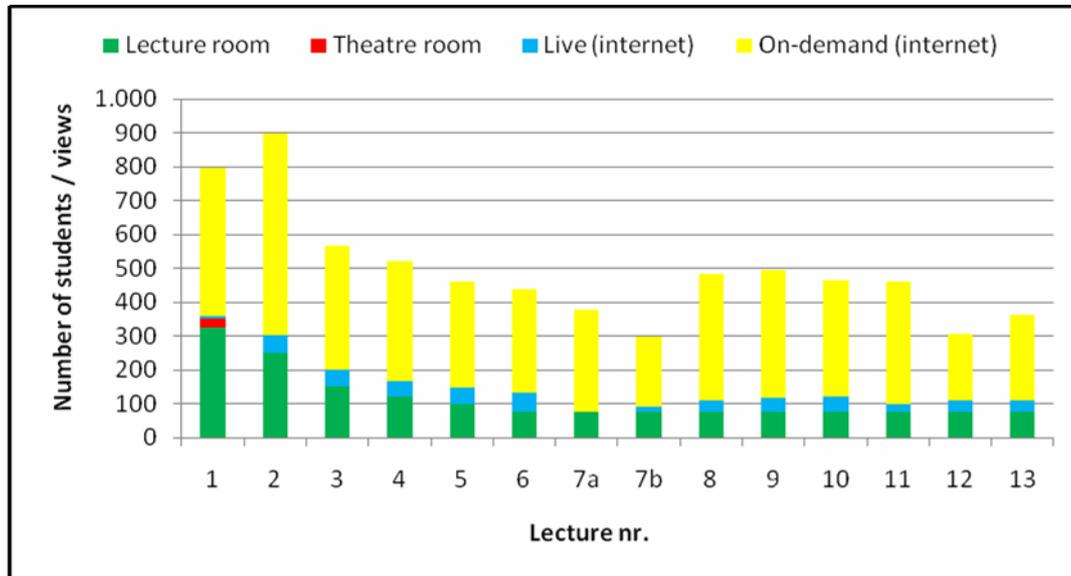


**Figure 1** : The lectures could be followed live, whether in the lecture room, in the theatre room or at any place, but also afterwards on-demand (at any place)



## Lecture attendance

The experimental setup with these Collegerama recordings was monitored extensively on attendance and viewers. Figure 2 gives the number of students for the 4 viewing options for each of the 13 lecture sessions.



**Figure 2 :** Number of students in the lecture room, the theatre room or live viewing, and the total number of on-demand view for each lecture.

The first lecture was attended by 350 students. All seats were taken, so some students had to sit on the lecture room steps or had to stand behind the upper seats. Some 20 students decided to follow the lecture in the theatre room. Hardly any student watched the live stream because they were unaware of this possibility or they did not believe that this was actually possible. However since the lecturer made a short demo of this feature after the break every student was notified that this option was actually functioning.

For the second lecture the number of students was decreased to such a number that the theatre room stayed empty, and was removed from the schedule for the following lectures.

The total number of students attending the lecture room decreased to a steady number of roughly 75 students, while about 20-50 students viewed the recording live. Another 20-50 students viewed the lecture at the same day but at a later (more convenient?) time.

The majority of the views were on-demand. Each lecture was viewed on-demand around 200-400 times.

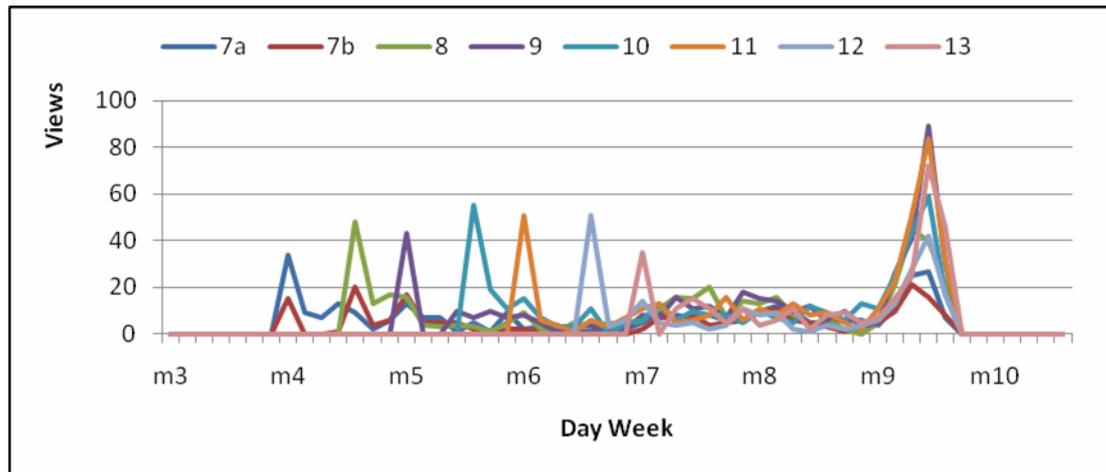
This means that on average every student has followed the lecture. However several students did not follow the lectures but instead relied on book and lecture notes in addition to the sample exams.

Lecture 7a was not streamed live, because of technical problems. As a result the second part of the lecture (7b) was viewed live by a smaller viewing audience.



## Viewing moment

The viewing days for each lecture are shown in Figure 3. The views per day of each recorded lecture show that the most popular viewing days are just before the examination, and on the lecture day itself. Next to that it should be noted that preceding lectures are also viewed on following lecture days, possibly by students who have missed the live lecture.



**Figure 3 :** The views per day of each recorded lecture shows that the most popular viewing days are just before the examination, and on the lecture day itself (m4=Monday week 4).

## Lessons learned

From the figures above it can be concluded that only 15% of the students actually followed the lecture in the lecture room which enables them to communicate with the lecturer by asking questions and/or responding on his question. The majority of the students just followed the lectures on-demand at a more convenient moment and at a more convenient place.

This shows that with recorded lectures the seating capacity of lecture rooms can be dramatically decreased [2]. The total number of attending students was large enough for the lecturer to receive feedback and response from the students.

The viewing moments also show that a more compact scheduling of this course might be possible. Since a lot of students view the lectures just prior to the examination it seems that they might opt for a more intensive full day course, with an immediate examination afterwards.

The results of the examinations were in accordance with the results of previous years. The recorded lectures seem to overcome the large student cohort and inconvenient lecture scheduling.

Moreover the viewing moments show the large potential for recorded lectures as an “examination aid”. This was also observed at the re-examination 10 weeks later, at the end of the next educational quarter. Papers accepted are published in the symposium proceedings. We ask all authors to follow these guidelines in order to maintain a high standard of consistency.



### 3. Recorded lectures for iTunesU and YouTube EDU

The Collegerama recordings can only be viewed online from the TU Delft website, because of their multi-file structure. Creating a single film movie from these recordings enables distribution of the lectures on the most popular platforms for movies (YouTube and iTunes) as well as downloading these videos.

Since early 2010 TU Delft publishes the recorded lectures within their OpenCourseWare program on iTunesU and YouTube Edu.

The recorded lectures on iTunesU can be downloaded to iPods, iPhones and iPads, but also to standard PC's and laptop computers.

In view of the limited screen resolution of an iPod, TU Delft developed a small size movie (video 320x240, MP4) for the conversion of its high quality Collegerama recordings. In this movie the presentation slides or tablet PC screenshots are dominant in order to keep the maximum readability at this small resolution. The movie part of Collegerama is placed in the left bottom corner as a small transparent thumbnail-movie. This setup still gives an adequate viewing because of the dominant role of the audio recording (see Figure 4).



**Figure 4** : Screenshot of a recorded lecture at the iPod platform (320x240, MP4)

The YouTube EDU special platform allows universities and colleges to upload movies of (nearly) unlimited length for streaming at the very popular YouTube platform, with additional options for downloading by the viewers (in beta).

Initially TU Delft has published its low resolution iTunesU movies at this platform. However YouTube allows for streaming movies at a much higher resolution (HD movies, 1280x720 or 1920x1080). This is more convenient for the viewer especially at full screen viewing. The larger resolution can be used for creating movies with a resolution equivalent to the original Collegerama recordings.

The YouTube EDU platforms gives all the normal options of YouTube, like full screen viewing, the use of subtitles, as well as the options for annotation. Moreover this platform allows for viewers feedback, and viewers statistics (number and residence of viewers, etc.).

For international education the subtitle option is very convenient. In the case that a subtitle file is uploaded for the lecture, it can be viewed with these subtitles at the viewer's selection. Not only the original subtitles, but also in one of the 53 available foreign languages.

This latter feature is based on Google's online translation engine.



#### 4. Future developments for reusing recorded lectures in study programs

From the previously presented developments in recorded lectures it might be evident that more options for 'expanding the usability of recorded lectures' will be available in the near future. For investigating and evaluating the options an MSc research project in Computer Science was started in corporation with University of Twente [3].

Special subjects within this research were

- evaluating and designing single file vodcasts from the multi-file Collegerama recordings
- using speech recognition for creating subtitles
- searching in recorded lectures, using all available text sources
- evaluating different sources for creating tag clouds
- evaluating future developments in online communication.

Some of the results will be presented here.

#### Subtitling with speech recognition

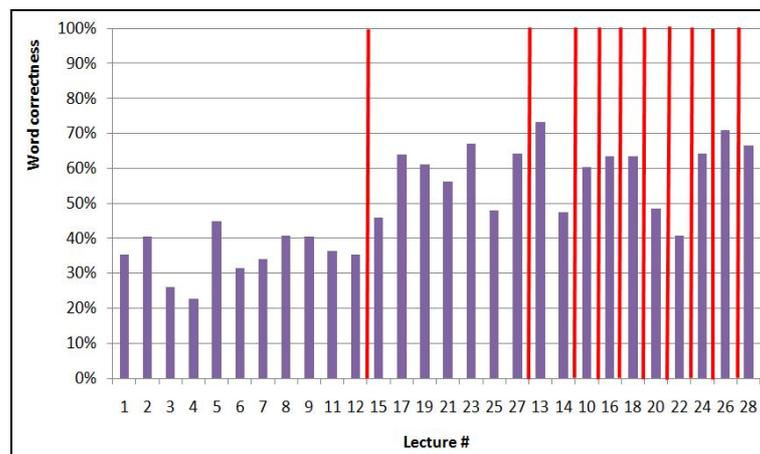
Subtitling is considered a very useful supplement for recorded lectures. It allows for teaching students with a hearing problem, for online translation (see Chapter 3) and for the application of search engines.

The creation of subtitles is a time and money consuming process. It was assumed that speech recognition might be beneficial for creating subtitles.

All 28 recorded lectures (45 minutes each) of the course CT3011 Water management (given in the Dutch language) were submitted to the SHoUT speech recognition engine [4].

The results of this engine were measured by 'word correctness' giving the ratio of the proper words over the total number of output words. The latter was established to be around 5% more than the real number of spoken words because the speech recognition engine breaks up long combination words.

The results in word correctness are shown in Figure 5, in which the lectures are clustered by lecturer (2 principal lecturers, with 9 guest lecturers giving 1 (or 2) lectures).



**Figure 5** : Word correctness of SHoUT speech recognition for all course lectures, clustered by speaker/lecturer

The mean word correctness was 50%, with a variation between 23 and 73%.



The word correctness differs significantly for different lecturers. For this word correctness, no correlation was found with either the gender of the lecturer (male or female voice) or the age (lowered voice).

Putting the individual words into subtitles sentences gives an even worse result. Only 7 out of 48 test sentences were perfectly recognized. Speech recognition at the present state of development was found unsuitable for the creation of subtitles. Correction of the produced text is more time consuming than creating a human-made full transcript.

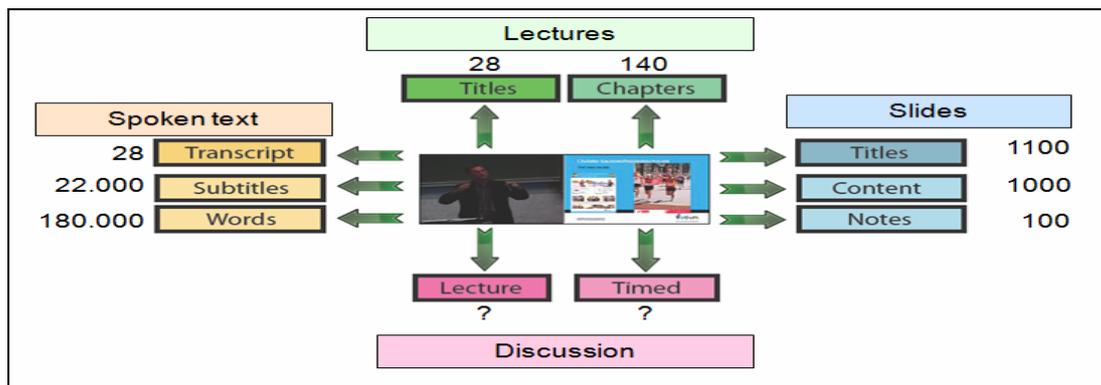
The used speech engine might be useful for time tagging of such a human-made transcript.

### Searching in recorded lectures

The accessibility of a recorded lecture is better than a plain video recording due to the described 'chapter' approach and the slide navigation of Collegerama.

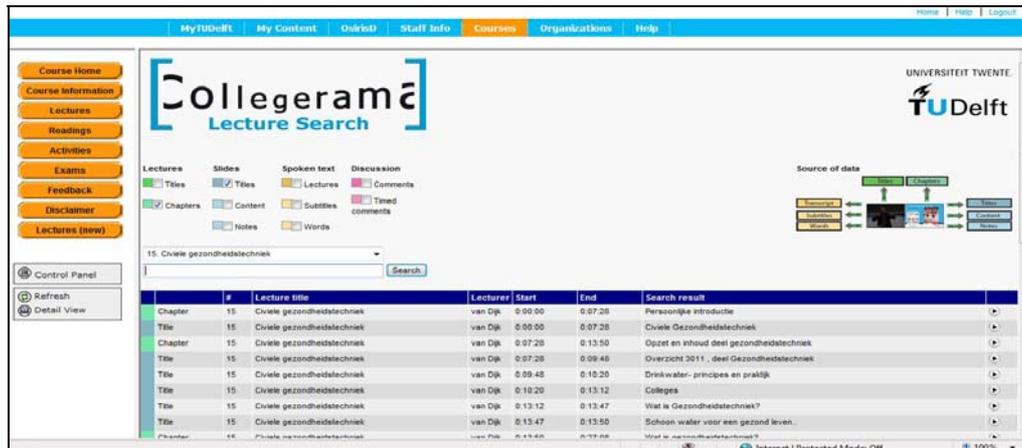
The accessibility can further be improved by collecting all meta data of all the lectures in a course (lecture titles, slide titles, slide content, transcript, subtitles etc.) into a multimedia database in which each record has a start and end time within the related movie files.

The input for such a system is shown in Figure 6.



**Figure 6** : Input of a multimedia database from lectures of one course (numbers indicating records in the database)

The input was used to develop the Collegerama lecture search. This search engine allows for searching by all input types or combinations, over all lectures in the course, as well as in a specific lecture. Multi-keyword searching was facilitated by clustering the subtitles and words to slide level. This dramatically reduced the viewing time in the results of such multi-keyword search. Figure 7 gives an impression of this Collegerama lecture search. The result set of the search is related to starting times in the lecture movies.



**Figure 7 :** The Collegerama lecture search allows for flexible searching as well as multi-keyword search

### Online discussion board

The main reported drawback on recorded lectures is the absence of lecturer-student interaction. The limited live attendance of the previous reported lectures (see Chapter 2) shows that only some 15% of the students are willing to overcome the logistical drawbacks to get this interaction, and/or appreciate the time discipline of actually being there. In general students hardly asked questions during and around the lectures. Student interaction can also be obtained by a time framed discussion board. This is demonstrated in educational environments where live attendance never exists, like online poker classes. Figure 8 gives an example of such class. The lectures are scheduled on a weekly basis and students might put questions at a certain time frame. Most of these questions are actually answered by fellow students. The threshold for putting up questions seems to be lower in online classes than in full lecture rooms where students seem to be embarrassed to ask questions...



**Figure 8 :** In this online class communication is entirely done by a time framed discussion board

### Reusing recorded lectures

Recorded lectures allow for multiple use of the lecture, as is shown in Figure 9. In the present situation at TU Delft, a course is given in the lecture room in only one quarter per (academic) year, with an examination at the end of this quarter. Re-examination is scheduled at the end of the following quarter. Recorded lectures can be used as an examination aid (see Chapter 2) for the re-examination. The recorded lectures might be made available in the e-learning environment on a weekly base, allowing for online discussions between students, and eventually the lecturer. This kind of programming can be used in quarters as required. Such a more flexible scheduling might be beneficial for students who are in Delft only during a certain semester, like many European exchange students.

**Present situation**

Course schedule	P1	P2	P3	P4	P5
Education	■				
Exam	●	●			

**Extra recorded course before second exam**

Course schedule	P1	P2	P3	P4	P5
Education	■	■			
Exam	●	●			

**Extra recorded course in other semester**

Course schedule	P1	P2	P3	P4	P5
Education	■		■		
Exam	●		●		

**Full year course**

Course schedule	P1	P2	P3	P4	P5
Education	■	■	■	■	■
Exam	●	●	●	●	●

**Figure 9** : Recorded lectures allow for a more flexible course scheduling

The setup of course scheduling in Figure 9 assumes a yearly update of a recorded lecture. For some courses such a frequent updating is needed, but other courses might have a longer sustainability.

## 5. Conclusions

Recorded lectures are playing an increasingly pronounced role in modern academic education. This was demonstrated in a course at TU Delft with 550 students. Only around 15% opted to follow the lectures live in the lecture room, with its option for interactions with the lecturer. Another 15% preferred to follow the lectures either live via an internet connection or on demand later that day. Both of these groups followed the weekly scheduling of this course. The majority used the recorded lecture as an exam preparation aid. All lectures were viewed on demand some 300-400 times. A large part of these views occurred during the days preceding the exam.

Recorded lectures have a large potential for extending its usability as was demonstrated in an MSc research project in Computer Science at University of Twente. Subtitling, translation of subtitles, search engines, speech recognition and tag clouds can be applied for recorded lectures.

Introduction of recorded lectures allow for a much more flexible scheduling of courses, either multiple times a year, as well as in intensive short courses.

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