Methodological triangulation of the students’ use of recorded lectures

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Abstract: A lot of research into the use of recorded lectures has been done by using surveys or interviews. We will show that triangulation of multiple data sources is needed. We will discuss how students use recorded lectures according to their self-report and what actual usage of the recorded lectures can be derived from the data on the system. We will present the data collections and cover areas where the data can be triangulated to increase the credibility of the results or to question the students’ responses. The triangulation shows that we lack data for a number of areas. We will need high-quality surveys and interviews combined with the log data to get a complete picture. We need to be able to link data sets together based on the identification of the individual students, which might raise privacy issues.

Keywords: recorded lectures; web lectures; learning analytics; data mining; data triangulation; learning technology.

1 Introduction

The lecture method has been around since before the time of the printed book, when monks would read a book aloud, at a lectern, and scholars would copy down what was said word for word (Exley and Dennick, 2004). Its effectiveness as an instructional method has been questioned (Phillips, 2005; Jones, 2007) but a recent survey amongst more than 23,000 lectures at the University of California (Hurtado et al., 2012) showed that although the lectures had increased their use of other instructional methods, the use of extensive lecturing had remained fairly stable during the last decade. In some areas, 69.7% of all lecturers reported to use extensive lecturing in all or most of the courses they teach.

The availability of more advanced lecture capture systems (LCSs) has allowed a growing number of universities to create recordings of these lectures (Leoni and Lichti, 2009), allowing students to review lectures at their own pace and at a time and place of their choosing. A LCS handles the simultaneous capture of both the audio and video of the lecturer and everything that is being projected during the lecture, usually a PowerPoint presentation. It handles the automatic synchronisation of all the captured media, uploads the recorded lecture to a server and can post a link to the recording in the virtual learning environment (VLE), notifying students the recording is available. The students can then view the recording in a web browser. Figure 1 shows an example of a recorded lecture with both the video of the presenter and a view of the projected PowerPoint slide side by side.
1.1 Existing research

Much of the existing research into recorded lectures has been focused on improvements of the technology used to record the lectures. Researchers tried to improve the quality of the recordings by adding more advanced interaction options (Arons, 1997; Baecker et al., 2003), automated capturing (Brotherton and Abowd, 2004; Abowd et al., 1998; Zhang et al., 2005) and camera control (Lampi et al., 2007), search options (Hürst, 2003) and mobile solutions (Read, 2005). More recently there also has been more focus on the use of the recorded lectures by students (Veeramani and Bradly, 2008; Filius, 2008; Traphagan, 2006; Preston et al., 2010; Gosper et al., 2008), their use in university settings (Zupancic, 2006; Russell et al., 2008), its use for students with a handicap (Russell et al., 2007) and possible impact of recorded lectures on the attendance of students (Williams and Fardon, 2007b; Traphagan et al., 2010). One interesting area of research that has grown in popularity in recent years is the use of automatically captured data about the use of recorded lectures to analyse student behaviour, called learning analytics (Siemens, 2010) or academic analytics (Campbell and Oblinger, 2007). Phillips et al. (2010) used log data collected by the LCS to profile students study behaviour.

1.2 Triangulation

Often, research in this area is only based on surveys and verbal reports by students of their use of recorded lectures. The data of these surveys are in general accepted at face value, even though they often correlate poorly with observational data (Smith, 1975). More than 60 years ago, Deming (1944) identified 13 possible factors that can account for errors in surveys. They range from variability in response to bias arising from non-response or the selection of the respondents or errors in the interpretation of the questions by respondents or changes in the attitudes of respondents. Exclusive reliance on one method may bias or distort the researcher’s picture of the reality being investigated. Confidence that the results are not merely artefacts of the data collection method used can be increased by comparing the results of multiple collection methods (Cohen et al.,
Thus, the integration of multiple techniques not only improves the results in a quantitative way by increasing the amount of data available, but also in a qualitative way (Sieber, 1973).

The use of two or more methods of data collection in the study of some aspect of human behaviour is called triangulation (Cohen et al., 2007). This multi-method view on triangulation has a precursor in the multi-trait multi-method approach to concurrent validity brought forward by Campbell and Fiske (1959). There are a number of different types of triangulation (Denzin, 1970; Smith, 1975):

1. Data triangulation
2. Investigator triangulation
3. Theory triangulation

Data triangulation employs data sources that differ in time, space and/or the persons involved. The event under analysis stays constant, but is collected from dissimilar groups or at different times, like consecutive years or semesters. An example would be to analyse different groups of students or different courses at a single university individually, to select students from different universities, or to repeat a survey multiple semesters or years in a row. Investigator triangulation simply means that multiple observers collect the data; this removes the potential bias that comes from the observations of a single person. An example would be to have researchers code the transcripts of an interview with students instead of one, and then compare and combine their results. Theory triangulation tests alternative theories against the same body of data. For example, one study might find that students that view a lot of recorded lectures tend to skip the live lectures (Williams and Fardon, 2007b), while another study links study styles and approaches in problem solving (Laurillard, 2005) and a third study describes the purpose and functions of live lectures (Bligh, 1998). All three studies together can help to better explain the observations. Methodological triangulation can be categorised as within-method triangulation and between-method (or across-method) triangulation. The within-method triangulation takes one method (for example a survey) and uses multiple strategies within that method to examine the data. This however comes with the inherent flaw that it only uses one method of data collection. The between-method triangulation employs different methods on different sets of data concerning the same object of study.

1.3 Research questions

Little is known, still, about the way in which students navigate within the recordings or how they find (the parts of) the recordings they want to watch. The goal of our research is to get a better understanding of how students use recorded lectures and how we can help them to navigate more efficiently to the parts of the recordings they want to view. This paper is part of a larger research project into the use of recorded lectures by students. The main research questions for that project are:

- How do students use recorded lectures?
- How do students use recorded lectures according to their self-report?
• What actual usage of the recorded lectures can we derive from the data on the system and does that match with what students report?

• What usage patterns can we identify in both the reported and actual usage of recorded lectures by students?

• How can we facilitate the usage of recorded lectures by students?

The main focus of this paper is the first research question and its two sub questions: How do students use recorded lectures? How do students use recorded lectures according to their self-report? And what actual usage of the recorded lectures can we derive from the data on the system and does that match with what students report?

We used both data triangulation and methodological triangulation to increase the validity of the results obtained. In this paper, we will present the three data collection methods used and look at the areas where we can triangulate the collected data. What data can be provided by the LCS log data and do we still need surveys to ask students about their use of recorded lectures? We will first describe the method of data collection and then focus on the use of methodological triangulation to determine convergence and divergence between the results of the analysis of the two datasets.

2 Method

For our research we used three methods of data collection: first we conducted an online survey that was followed up by semi-structured interviews to collect verbal reports by students (Gorissen et al., 2012a). A third method was the collection log data generated by the LCS (Gorissen et al., 2012b).

2.1 Online survey

Participants in the survey were students from various faculties of the Eindhoven University of Technology (TU/e) and the School of Nursing at Fontys University of Applied Sciences in the Netherlands. Both the TU/e and Fontys use the Mediasite LCS to create recorded lectures. In the survey we wanted to address the following questions: Where and when do students watch the recorded lectures? With what purpose do they watch? If they did not watch the recorded lectures, for what reason did they not watch? Is there a relationship between the use of recorded lectures and the level of ambition of students, the ease of use of the recorded lectures, or the use of other resources available to the student?

The first part of the survey asked students for their interest in the topic of the course, the perceived importance of the course for their course of study and the grade they wished to achieve for the course. In the second part of the survey, students rated the effectiveness of a number of available activities (e.g., attending face-to-face lectures) and supporting resources (e.g., slides, lecture notes, etc.) in helping them to succeed in the course. It also asked about any previous experience with lecture recordings, and whether they had used the recorded lectures for the course in question. In part three of the survey, those students who had used the lecture recordings were surveyed in more detail about their experiences during that use. Those questions were not displayed to students that indicated they had not used the recorded lectures. The final part of the survey contained
Methodological triangulation of the students' use of recorded lectures

questions for all students, seeking out reasons they did not watch one or more of the recorded lectures (if applicable). We reviewed the survey and tested it online with a number of peers and experts.

Student selection for the survey was based on recent participation in a course that used recorded lectures with recordings being made on a regular basis (weekly or more often). We also wanted to make sure that there was minimal overlap between the courses so that we could question the students about one specific course. For Fontys, these criteria limited the number of available students to 203 students participating in a single course. At the TU/e we selected six courses that matched our criteria.

All of the recordings for the selected courses are of traditional university-style lectures with the teacher standing in front of the class lecturing. Exceptions to this were lectures where assignments and the test were discussed. All recordings are between 40–45 minutes long. In all of the recordings, video of the lecturer is recorded and displayed. Five of the courses used PowerPoint or other computer-based applications recorded alongside the video of the lecturer. Two of the courses contained recordings of the lecturer and the blackboard. All students in the courses had a choice between attending the lecture, viewing it online, or doing both. Table 1 shows the seven selected courses for the survey, the number of students per course, the response rate per course for the survey, what was being recorded and the number of recordings per course.

Table 1 Courses selected for the survey and response rates

<table>
<thead>
<tr>
<th>Course</th>
<th>N</th>
<th>Responses</th>
<th>What is being recorded?</th>
<th>#4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>(%)</td>
<td>PowerPoint</td>
<td>blackboard</td>
</tr>
<tr>
<td>TU/e</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C01 methods and models in behavioural research</td>
<td>307</td>
<td>144</td>
<td>45.6</td>
<td>Yes(1)</td>
</tr>
<tr>
<td>C02 control systems technology</td>
<td>190</td>
<td>72</td>
<td>34.7</td>
<td>Yes(3)</td>
</tr>
<tr>
<td>C03 chemical biology</td>
<td>136</td>
<td>68</td>
<td>49.3</td>
<td>Yes</td>
</tr>
<tr>
<td>C04 facades and roofs</td>
<td>115</td>
<td>40</td>
<td>33.9</td>
<td>Yes</td>
</tr>
<tr>
<td>C05 vector calculus</td>
<td>94</td>
<td>47</td>
<td>48.9</td>
<td>No</td>
</tr>
<tr>
<td>C06 calculus</td>
<td>77</td>
<td>43</td>
<td>55.8</td>
<td>No</td>
</tr>
<tr>
<td>Fontys</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C07 anatomy and physiology</td>
<td>203</td>
<td>103</td>
<td>47.8</td>
<td>Yes</td>
</tr>
<tr>
<td>Total</td>
<td>1,122</td>
<td>517</td>
<td>46.1</td>
<td></td>
</tr>
</tbody>
</table>

Notes: (1) Both PowerPoint and demos of applications
(2) For additional notes, during five recordings
(3) During eight of the 20 recordings
(4) Number of recordings for this course.

We approached the students using a personalised e-mail that contained the link to the web-based survey. In the e-mail and the survey itself, the students were asked to complete the survey based on their experiences and use for the one specific course for which they were selected. The survey was open online for two weeks. An e-mail reminder was sent after one week and again on the final day of the survey to those students who had not completed the survey.
The online survey contained 17 questions using both multiple choice and Likert scale questions. Some of the questions have been used in other surveys on the use of recorded lectures (Hall, 2009; Kishi and Traphagan, 2007; Traphagan, 2006; Veeramani and Bradly, 2008; Wieling, 2008; Williams and Fardon, 2007a; Zupancic, 2006). The first part of the survey asked students for their interest in the topic of the course, the perceived importance of the course for their course of study and the grade they wished to achieve for the course. In the second part of the survey, students rated the effectiveness of a number of available activities (e.g., attending face-to-face lectures) and supporting resources (e.g., slides, lecture notes, etc.) in helping them to succeed in the course. It also asked about any previous experience with lecture recordings, and whether they had used the recorded lectures for the course in question. In part three of the survey, those students who had used the lecture recordings were surveyed in more detail about their experiences during that use (e.g., how much of a recorded lecture did they view, how often did they view recorded lectures, the benefits of viewing recorded lectures). Those questions were not displayed to students that indicated they had not used the recorded lectures. The final part of the survey contained questions for all students, seeking out reasons they did not watch one or more of the recorded lectures (if applicable). Students were able to complete the survey in about 10–15 minutes.

2.2 Semi-structured interviews

As part of the survey, we invited students for follow-up questions. A total of 120 students accepted the invitation initially. Of those students, 14 were interviewed using a semi-structured interview lasting 30 minutes. During the interviews, students were asked to elaborate on their use of the recordings during the course. The interviews were recorded and transcribed. The results were used to provide examples of student’s use of the recorded lectures alongside the survey results (Gorissen et al., 2012a).

The second dataset contains data collected by the LCS. All recordings are available online; students can view them in their browser, both at the university and from home. Students need to logon using their university account to view the recorded lectures. No downloadable versions of the recordings are provided. Whenever someone views a recorded lecture, a log entry is created by the system detailing the time and date of the view, the recorded lecture that was viewed, the user that viewed the recorded lecture and the parts of the recorded lecture that were sent to the user.

2.3 LCS log data

The LCS that was used for this research does have extensive reporting functionality. It offers administrators the option to create reports based on statistics for the LCS as a whole, for (individual) presentations (recorded lectures), (individual) presenters and (individual) users. It lacked, however, the options we needed to create the reports that were needed for this research. The analysis required a more extensive set of filters than could be provided. For example, it was not possible to create a combined report on all recorded lectures viewed by a single student or a group of students for a given time period. The recorded lectures were always treated as separate standalone entities while we wanted to analyse the student’s interactions in the context of a ‘learner session’: an
uninterrupted period of time during which a learner accesses one or more recorded lectures (Advanced Distributed Learning, 2004). Because of that we had to create our own dataset for the analysis.

We performed a process called ‘data pre-processing’ (Sheard, 2011) to prepare the dataset for analysis. Figure 2 shows the steps taken during this process. The data from the Mediasite LCS were available in a Microsoft SQL Server database and text-based log files. The Microsoft SQL Server database contains a total of 92 tables with information about the lectures that have been recorded (title, course, recording date/time), the lecturers/presenters, students’ user ids, staff and others that viewed the recordings, and other data that Mediasite LCS needs. A copy of this database was used in the analyses.

**Figure 2** Data pre-processing steps

The text-based log files were created by the video server (Microsoft Windows Media Service) that streams the video to the viewers. The video server creates a new log file each day. Each log file contains a number of log entries, one per request to the server. A request is an uninterrupted stream of video sent to the viewer. Whenever a viewer skips ahead or back in the video or jumps to a new recording, a new entry (line) in the log file is added. Figure 3 shows an example of such a log file with a single log entry marked. The total set of log files contains more than 1.5 million log entries.
The format of the log file used by Microsoft Windows Media Service (WMS) has been documented by Koyun (2007). The log files were imported into the same SQL Server database as the copy of the Mediasite LCS database. The entries in the log file did not contain user names; those were stored in the Mediasite LCS database. However, the log files contained more details about the jumps through the video than were available in the Mediasite LCS. The data was combined into one table with user names being linked to the detailed log data. In the analysis and reporting, the data was anonymised to ensure the privacy of the users involved.

After combining the datasets, we performed a number of data cleaning steps.

The Mediasite database contains data starting March 29, 2004 (the oldest recording still available live online); the log files available for our analysis range from January 9, 2008 up to and including August 31, 2010. For our analysis, we needed data from both sources, so we limited the set to the range January 9, 2008 up to and including August 31, 2010. Further analysis of the dataset showed the Mediasite database did not contain data for the time period January 19, 2009 to July 27, 2009. This means we were unable to connect the detailed information in the log files to individual users. Therefore, data emerging from this time frame was also excluded from our dataset.

Next we removed all data irrelevant to the analysis. The LCS used at the TU/e system not only records lectures but makes recordings of seminars, public speakers and other events that take place during the year as well. We removed all data that was not related to recorded lectures from the dataset. Because we were able to identify individual users, we could also remove the data for all users other than students. This included other staff, the professors/lecturers, and the researchers conducting this analysis.

The next step of the data cleaning involved the identification of learner sessions. The number of views or hits by students, still is the most used metric when reporting the success of lecture capturing (Gosper et al., 2008; Echo 360, 2012; Janssen and Dekker, 2007; Harley et al., 2003; Collegerama, 2012). This only reports how many students have
started watching the recorded lecture. This metric does not distinguish between students who just watched briefly to check out the topic of the recorded lecture or the ones that actually view a significant part of one or more recorded lectures.

The aim of this study is to analyse the interaction of the student with the recorded lectures. This interaction has a clearly marked beginning: the first request for video from a recorded lecture. However, the interaction does not have an equally clear ending. The student does not press a ‘stop’ button at the end of a session. He or she might just close the browser, or simply stop watching and leave the browser open. The Mediasite system does not receive a notification when a student is finished viewing lecture recordings. This can only be determined by the absence of new requests for video. It is a problem that is directly linked to the semi-stateless nature of the World Wide Web. For web analysis, usually a fixed period of time of inactivity is taken after which a session is considered ended (Burby et al., 2007). For the purpose of our analysis we defined the learner session as: an uninterrupted period of time during which a learner accesses one or more recorded lectures. This definition is based on the definition of the Advanced Distributed Learning (2004) for a session within the context of learning management systems.

The end of a learner session is then defined as:

\[
\text{learner session end } = \text{date of log entry} + \text{time of log entry} + \text{video duration} + \text{time-out period}
\]

In this definition, date of log entry + time of log entry are the start date and time of the last request that a student made for video of a recorded lecture. Video duration is the length (in seconds) of the amount of video that the student received; time-out period is a (chosen) fixed period of time after which the learner session is considered to have ended. As mentioned before, the LCS does not receive a signal indicating this end of a session. For regular websites the chosen time-out period usually is about 20–30 minutes. We, however, assume that students do not simply just watch videos during a learner session. Based on the responses from survey and the interviews with the students, we learned they also read from the books while (re-)watching the recorded lectures, work on their assignments or study and complete their notes. We analysed the log files to find out if there was a logical time-out period, a given period of time which would clearly indicate an end of a learner session. However, there was no such clearly defined period that could be determined based on the log files. Because of that, the time-out chosen for this study, though somewhat arbitrarily, is four hours. This time-out causes the use of the recorded lectures on individual days to be separated into individual learner sessions and groups most of the activities on a single day into one or two learner sessions.

Finally, the data cleaning removed all outliers from the dataset. We were only interested in learner sessions where students actually make use of the recorded lectures. There was no existing research available on how long a minimum session length should be. We choose a length based on the assumption that for a 45 minute recorded lecture; at least some significant amount (multiple minutes) of video should have been received to call it a learner session. Learner sessions shorter than three minutes or learner sessions where a total of less than two minutes of video has been received by the student were not considered to be actual use of the recorded lectures as part of study activities and were removed from the dataset.
2.4 Focus of this paper

For this paper we will focus on one of the courses selected for the original survey and interviews. This course, C01, is a course at the Department of Industrial Engineering & Innovation Sciences at the TU/e. Students that participate in the course come from a number of different departments within the university: 66% of the students are from the Industrial Engineering department; another substantial group of students (23%) is from the Innovation Sciences department. The course consists of an introduction to empirical research. Students learn how to translate real-life questions into research questions, and they learn how to create and evaluate a research design. In the second part of the course, they get hands-on training using SPSS. The course is taught by two lecturers: one for the first part of the course and one for the second part. The first part of the course is taught in Dutch; the second part is taught in English.

The lecture recordings we examined span the period August 2009 through January 2010. During that period, there were a total of 35 recorded lectures captured as 17 2 × 45-minute recordings (the last lecture only consisted of 1 × 45 minutes).

3 Results

In this results section, we will use the data from the filtered dataset that relates to the C01 course (‘dataset course C01’ in Figure 5) and report on the students for the C01 course only.

Figure 5 Selecting dataset for analysis

3.1 Survey and interview results

The surveys and the follow-up interviews provide contextual information about the students using the recorded lectures created for the course C01, not available in the log data collected by the LCS. Students felt that the topic of the course was important and agreed that the course was an important part of their study (see Table 2). On average, students aimed for a 7 (on a ten-point scale) as a grade for this course.

Table 2 Importance of the course for the students

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree (%)</th>
<th>Somewhat disagree (%)</th>
<th>Neutral (%)</th>
<th>Somewhat agree (%)</th>
<th>Strongly agree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I’m interested in the topic of this course</td>
<td>1.4</td>
<td>9.0</td>
<td>22.9</td>
<td>61.8</td>
<td>4.9</td>
</tr>
<tr>
<td>This course is an important part of my study</td>
<td>1.4</td>
<td>2.8</td>
<td>15.3</td>
<td>63.2</td>
<td>17.4</td>
</tr>
</tbody>
</table>

Note: n = 144.
Students for the C01 course rate lecture recordings highest when asked about their effectiveness in helping them to succeed in the course (see Table 3). For this group, it scores considerably higher than attending the face-to-face lectures.

Table 3  Indicated effectiveness in helping to success in the course

<table>
<thead>
<tr>
<th></th>
<th>Somewhat or very effective (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture recordings</td>
<td>83.3</td>
</tr>
<tr>
<td>Other course resources (slides, lecture notes, etc.)</td>
<td>81.9</td>
</tr>
<tr>
<td>Online VLE</td>
<td>70.8</td>
</tr>
<tr>
<td>Attending face-to-face lectures</td>
<td>52.2</td>
</tr>
<tr>
<td>Other Students</td>
<td>47.2</td>
</tr>
<tr>
<td>Going to professor or teachers assistant office hours</td>
<td>20.9</td>
</tr>
</tbody>
</table>

Note: n = 144.

A more extensive analysis of the survey and interview results can be found in Gorissen et al. (2012a)

3.2 Analysis of the log data

The filtered total dataset contained data on 4,192 lecture recordings, for a total of 263 different courses. It contained 48,539 learner sessions, viewed by 4,927 unique students. The average number of lecture recordings per course is 16, with a maximum of 54 lecture recordings per course. Students watched an average of three different recorded lectures per learner session ($Mdn = 2, SD = 2.6$). The course C01 had 35 recorded lectures for 17 lectures of $2 \times 45$ minutes each and a final lecture of $1 \times 45$ minutes. During our study period, August 2009 through August 2010, the recorded lectures for the course C01 were viewed by 291 unique students in a total of 2,650 learner sessions.

Figure 6  Heatmap of video viewed per student
Figure 6 shows a greyscale of the heat maps that were created during the analysis of the LCS logs. It shows a heat map for a single recorded lecture. From left to right it represents sections of 20 seconds each for the recording ranging from 0 seconds (the start of the recorded lecture) to 44 minutes and 49 seconds (the end of the recorded lecture). The rows represent each individual student, a total of 175 unique students have viewed this particular recorded lecture once or more. For each student and for each 20 second section, we counted how many times the student received the video for that section. This count was then converted into a colour code with red (the darkest areas in the greyscale) representing a large number of views. A white area has a view count of 0, meaning that the student has never received that part of the video of the recorded lecture.

Although the greyscale lacks much of the detail of the original full colour heat map, it still shows that there are some students that viewed all or most of the recorded lecture while others skipped through parts of it and some only viewed the beginning or the recorded lecture.

A more extensive analysis of the LCS logs can be found in Gorissen et al. (2012b).

3.3 Triangulation of the data sources

As part of the triangulation of our data sources we examined which questions in the survey could be linked to LCS log data, either directly or indirectly.

When asked about technical difficulties while watching the recorded lectures, 47.2% of the students reported that there were no technical difficulties. Problems mentioned were: slides and video not always playing synchronously (20.8%), bad video quality (14.6%) or bad audio quality (13.2%). Network related problems mentioned were: “the playback of the presentation stops to buffer/load” (11.8%) and “loading the presentation takes a long time” (4.2%) The log data from the LCS does contain some information about the bandwidth used during the playback of the recorded lecture and possible lost packets of data sent to the student, but that cannot be translated into real technical difficulties like those surveyed.

We also asked students to indicate the importance of a number of features available in the player for the recorded lectures. Table 4 shows their responses to that question.

<table>
<thead>
<tr>
<th>Feature</th>
<th>n</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Playing at higher or lower speed</td>
<td>110</td>
<td>85.2</td>
</tr>
<tr>
<td>Navigating using the slide list</td>
<td>98</td>
<td>76.0</td>
</tr>
<tr>
<td>Scanning through video using play head</td>
<td>80</td>
<td>62.0</td>
</tr>
<tr>
<td>Muting sound/controlling sound level</td>
<td>78</td>
<td>60.4</td>
</tr>
<tr>
<td>Skipping back</td>
<td>75</td>
<td>58.1</td>
</tr>
<tr>
<td>Viewing the lecture recording offline</td>
<td>48</td>
<td>37.2</td>
</tr>
<tr>
<td>Downloading additional resources via presentation links</td>
<td>39</td>
<td>30.3</td>
</tr>
<tr>
<td>Saving links to specific locations in the lecture recording</td>
<td>34</td>
<td>26.4</td>
</tr>
<tr>
<td>Mailing questions to lecturer from within viewer</td>
<td>9</td>
<td>7.0</td>
</tr>
<tr>
<td>Sharing lecture recording via mail with other students</td>
<td>9</td>
<td>7.0</td>
</tr>
</tbody>
</table>

Note: *Students could select multiple options.
Table 4 shows that replaying the recorded lecture at higher or lower speed, navigating through the recorded lecture using the slide list and using the play head are features found to be important by a majority of the students. Although it would be possible to track the use of the above-mentioned features, there is currently no data about actual use in the LCS log data to substantiate or correct these reports. The player used to display the recorded lectures does not send any information related to the method of navigating or the speed at which the video is displayed back to the server.

The survey also asked students how important different purposes of recorded lectures were to them. Table 5 shows that making up for a missed lecture and preparing for the exam score highest for course C01, as well as improving test scores, which can be seen as an indication that preparing for the exam is an important use of the recorded lectures for students.

Table 5  Somewhat or very important purposes of using recorded lectures

<table>
<thead>
<tr>
<th>Purpose of use of recorded lectures</th>
<th>n*</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Making up for a missed lecture</td>
<td>124</td>
<td>96.2</td>
</tr>
<tr>
<td>#2 Preparing for the exam</td>
<td>120</td>
<td>93.0</td>
</tr>
<tr>
<td>#3 Improving test scores</td>
<td>112</td>
<td>86.8</td>
</tr>
<tr>
<td>#4 Improving retention of lecture materials</td>
<td>102</td>
<td>79.1</td>
</tr>
<tr>
<td>#5 Clarifying the material</td>
<td>99</td>
<td>76.8</td>
</tr>
<tr>
<td>#6 Replacing live attendance</td>
<td>96</td>
<td>74.4</td>
</tr>
<tr>
<td>#7 Assisting with an assignment</td>
<td>88</td>
<td>68.2</td>
</tr>
<tr>
<td>#8 Reviewing material after a lecture</td>
<td>70</td>
<td>54.3</td>
</tr>
<tr>
<td>#9 Managing distractions during lectures</td>
<td>64</td>
<td>49.6</td>
</tr>
<tr>
<td>#10 Reinforcing the experience at the live lecture</td>
<td>46</td>
<td>35.6</td>
</tr>
<tr>
<td>#11 Reviewing material before a lecture</td>
<td>43</td>
<td>33.4</td>
</tr>
<tr>
<td>#12 Checking own notes</td>
<td>33</td>
<td>25.6</td>
</tr>
<tr>
<td>#13 Overcoming language barriers</td>
<td>16</td>
<td>12.4</td>
</tr>
</tbody>
</table>

Note: * Students could select multiple options

To triangulate these results with the data in the LCS logs, we defined a number of possible indicators that would support the existence of the different purposes (see Table 6).

Table 6  Possible indicators in LCS logs for purpose of use

<table>
<thead>
<tr>
<th>Purpose of use of recorded lectures</th>
<th>Possible indicators in LCS logs</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1, #6</td>
<td>Recorded lectures are (re-)viewed in full</td>
</tr>
<tr>
<td>#2</td>
<td>Recorded lectures are viewed in week before the exam</td>
</tr>
<tr>
<td>#3</td>
<td>Recorded lectures are viewed in week before the retest</td>
</tr>
<tr>
<td>#7</td>
<td>Recorded lectures are viewed in week for which assignment is due</td>
</tr>
<tr>
<td>#8, #9, #10, #11, #12</td>
<td>Recorded lectures are viewed in week after lecture takes place (before the next lecture)</td>
</tr>
<tr>
<td>#13</td>
<td>No possible indicators in LCS logs</td>
</tr>
</tbody>
</table>
There was no direct method available in the data to analyse whether students actually missed a lecture before viewing the recorded lecture. Lecture attendance was not mandatory and no attendance register was created during the C01 course for 2009–2010. Instead, we used the dataset to analyse the students’ viewing behaviour. If students used recorded lectures to make up for a missed lecture (purpose #1) or to replace a live lecture (purpose #6), they are more likely to view the full length of a recorded lecture. It is not possible to determine with absolute certainty whether a student has viewed a part of a recorded lecture or not. The system only logs whether the student has received a part of the video. For the purpose of the analysis we assume that receiving the video equals viewed the video. We assume that they have viewed the full length of a recorded lecture if they received at least 80% of the video for the recorded lecture.

Based on the LCS logs and the heat maps (see Figure 6), we could calculate that during the one-year period covered by the dataset, on average each recorded lecture for the C01 course is viewed in full a total of 11 times. Only 27% of all the students received 80% or more of the video of one or more of the recorded lectures. The maximum number of recorded lectures viewed in full, for a single student for the C01 course, is 20 recorded lectures out of a total of 34 successfully recorded lectures. There were 13 students who viewed 10 or more recorded lectures in full. So the LCS log data does not support the responses by the students with regard to purposes #1 and #6.

Figure 7  Number of learner sessions per week (see online version for colours)

To triangulate the other purposes, we analysed the number of learner sessions for the course C01 based on the LCS log data. Figure 7 shows the number of learner sessions for course C01 per week. It shows that there are four weeks in which there is an above-average use of the recorded lectures, indicated as [1] to [4] in Figure 7. These are the weeks in which the assignment for the course is due, a written test is planned, the
laptop test is scheduled and the week before the retest takes place. The analysis shows that the LCS log data supports the response by students for purpose #2 and #3; the recorded lectures are viewed a lot in the week before an exam or retest. The figure also supports the response with regard to purpose #7, the use of the recorded lectures to assist with an assignment.

Although Figure 7 also shows use of the recorded lectures in the other weeks of the semester, use is much lower than for the four weeks with about-average use. The figure does not refute the response by the students, but the log analysis reported in Gorissen et al. (2012b) shows that usage patterns of the recordings are more influenced by the schedule of the exam than the lecture schedule. Less than 10% of all learner sessions take place within the first seven days after the recorded lecture has been made available. These findings do not correspond with purposes like #8, #9, #10, #11, and #12.

Our dataset did not contain information about the origin and language of students, so we were not able to determine whether non-Dutch students used the recorded lectures more often than Dutch students.

Another triangulation we performed was between the number of times students reported they had used the recorded lectures for the C01 course. Table 7 shows that the reported number of learner sessions for this course is approximately equal to the actual measured numbers of learner sessions.

<table>
<thead>
<tr>
<th>Table 7</th>
<th>Number of times respondents used recorded lectures for the C01 course</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reported</td>
</tr>
<tr>
<td></td>
<td>n (%)</td>
</tr>
<tr>
<td>Never</td>
<td>13 9.1</td>
</tr>
<tr>
<td>&lt; 5 times</td>
<td>22 15.4</td>
</tr>
<tr>
<td>5–10 times</td>
<td>51 35.7</td>
</tr>
<tr>
<td>&gt; 10 times</td>
<td>57 39.9</td>
</tr>
</tbody>
</table>

This cannot be said about the reported and actual percentage of a recorded lecture that students view on average. Table 6 shows that the majority of students say that on average they watch three quarters or more of a recorded lecture. As in the previous analysis, we assume that the amount of video received by a student is equal to the amount of video watched by the student. We accumulated all the video received by each student for each recorded lecture for all the learner sessions during the researched period. Sections of a recorded lecture that were viewed multiple times were only counted once. Based on the total length of each recorded lecture, a percentage viewed of each video per student was then calculated. These percentages were then averaged per student.

<table>
<thead>
<tr>
<th>Table 8</th>
<th>Average percentage of a recording viewed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reported</td>
</tr>
<tr>
<td></td>
<td>n (%)</td>
</tr>
<tr>
<td>0%–10%</td>
<td>2 1.5</td>
</tr>
<tr>
<td>10%–25%</td>
<td>4 3.1</td>
</tr>
<tr>
<td>25%–50%</td>
<td>7 5.4</td>
</tr>
<tr>
<td>50%–75%</td>
<td>26 20.0</td>
</tr>
<tr>
<td>75%–100%</td>
<td>91 70.0</td>
</tr>
</tbody>
</table>
Table 8 shows that although 70% of all students indicate that they usually watch 75%–100% of a recorded lecture, this is actually only the case for 2.7% of the students based on the LCS log data. The vast majority of all students (69.8%), on average, only received between 10%–25% of the video of each recorded lecture.

4 Conclusions

The analysis shows that the survey still is an important method to collect information from students about their use of recorded lectures. The survey provides data about the attitude, motivation and behaviour of the students. Their assessment of the importance of a course for their study, their perception of the difficulty of the course can influence their viewing behaviour (Gorissen et al., 2012a). The data logged by the LCS does not provide all the information that we want and need to get a complete picture. But, methodological triangulation is a valuable step to confirm or to question at least some of the students’ responses. It is not sufficient to rely on just the self-reported data by students. The triangulation showed a convergence of results found for the number of learner sessions for this course but also showed a divergence for the reported percentage of the recording that is being viewed by the students. This is also the case for the purpose with which students watch the recorded lectures.

Care should be taken when designing surveys aimed at collecting data about the use of recorded lectures by students. Respondent’s bias can greatly influence the results. For example, a positive attitude towards the use of recorded lectures could lead to over reporting of a student’s use of the recorded lecture or could lead to an over representation of possible use purposes to emphasise the importance of recorded lectures (Arnold and Feldman, 1981; Kopcha and Sullivan, 2007). Also, students’ accounts of their use of the recorded lectures can be fallible (Winne and Jamieson-Noel, 2002). This might be an explanation for the difference between the self-report of 70% of all students indicating that they usually watch 75%–100% of a recorded lecture, while this actually was only the case for 2.7% of the students based on the LCS log data. The vast majority of all students (69.8%), on average only received between 10%–25% of the video of each recorded lecture.

In cases where the data logged by the LCS currently is insufficient to perform triangulation, improvements can be made. For example, the methods that a student uses to navigate through the player interface is not yet logged, but could provide valuable information about whether the interface allows them to quickly find the parts of a recorded lecture that they want to view. If the data pre-processing steps described in Gorissen et al. (2012b) are incorporated into the LCS and reported on a regular basis, lecturers could be given access to the reports and use them when evaluating their lecture design. It would also enable time based triangulation where reports for recorded lectures of consecutive years or cohorts of students can be compared easily. More works also needed on further strengthening the definition of a learner session and the selection of outliers, sessions that are too short to be considered actual learner sessions. More works also is needed on the identification of purposes of use based on indicators in the LCS log data. Table 6 shows that a number of different purposes share a single indicator, making it impossible to distinguish between them based on just the LCS log data. Phillips et al. (2010) defined student profiles based on study behaviour combined with use of the
Methodological triangulation of the students’ use of recorded lectures

recorded lectures. Although, their patterns did not yet incorporate the amount of use by a student (learner session length), they offer another possible direction of research.

To be able to rely on this combination of datasets, unique identification of users is very important. We have seen examples where a single recording has been viewed on the same university computer by three different students on a single day. Just counting IP-addresses would provide incorrect information. Downloadable recorded lectures can only be counted but actual use of them cannot be tracked in detail. This also raises issues for universities that (also) provide their recorded lectures as open educational resources (OER); publicly on the internet for anyone to view. Surveys also cannot be anonymous. Although the data in the reports can be anonymised to assure the privacy of students, triangulation can only be performed if the survey data can be linked to the LCS log data of that same user. Universities should be aware of those effects on the completeness of reports they can create.

The selection of students for the survey is an example of the types of trade-offs that have to be considered in data triangulation: further triangulation by sampling students from a broader time and subject spectrum would prevent or at least lessen the power of the detailed analyses that eventually were performed.

A first step towards extending our analysis is to repeat the triangulation for the other six courses that were included in the original survey. Another option is to repeat the analysis for new cohorts of students or to add additional levels of triangulation by including additional data sources, e.g., by including log data from the VLE, containing data about the use of other course materials, assignments and exercises by the student. This allows us to validate the results and to determine the reliability of the observed convergence and divergence.

Another possible extension would be to integrate the survey more closely with the regular use of the recorded lectures. The survey already was conducted electronically and online, but it could be made part of the regular interface for the LCS. Like is done on some websites, students could be asked to complete the survey on a continuing basis. Care needs to be taken to not ask students this too often and it would only collect data for active users of the LCS, while the current survey also reached users that did not use the recorded lectures.

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