Generating OER by Recording Lectures: A Case Study

Martín Llamas Nistal, Senior Member, IEEE, and Fernando A. Mikic Fonte

Abstract—The University of Vigo, Spain has the objective of making all the teaching material generated by its teachers freely available. To attain this objective, it encourages the development of Open Educational Resources, especially videos. This paper presents an experience of recording lectures and generating the corresponding videos as a step towards this objective. The core system used to record lectures is OpenCast Matterhorn (free and open-source customizable software to support the management of educational audio and video content). This paper also focuses on the study and analysis of the students’ experience of using recorded videos as support for their learning process. This case study was carried out in the Fall 2012 offering of the first-year Computer Architecture course in University of Vigo’s Telecommunication Technologies Engineering program. Finally, the paper addresses students’ level of satisfaction with the recorded lectures, and gives students’ opinions on the use of these videos.

Index Terms—Educational resources, learning support, learning videos, open repositories, recorded lectures

I. INTRODUCTION

The term OER (Open Educational Resources), first adopted by UNESCO, is defined as the “technology-enabled, open provision of educational resources for consultation, use and adaptation by a community of users for non-commercial purposes”. Another widely-accepted definition of OER [1] is that: “OER are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge”.

The OER movement had its origins around 2000; it attracted considerable attention when the Massachusetts Institute of Technology (MIT) launched its large-scale OpenCourseWare (OCW) program in 2001. This movement is a technology-empowered effort to create and share educational content on a global level, providing open access to high quality digital educational materials. Technology has the ability to reduce the time and money required to produce and communicate a course, thus making its content available to millions. New distance education technologies, such as OpenCourseWares, act as enablers for the universal right to education [2].

Easy access to learning materials for any individual promotes broader participation in education, as well as open and flexible learning opportunities. Moreover, the use of OER is not restricted to e-learning, or distance learning; it can also be used in traditional learning environments to enrich the learning experience. Learners’ and educators’ participation and collaboration in this, by sharing learning resources and potentially continuously revising them, increases the resources’ efficiency and quality, for example by reducing duplication and increasing cost-efficiency.

Reductions in cost and the growing numbers of participants promote inter-institutional collaboration and sharing, which stimulates continuous improvement and innovation of the learning resources. Using, producing, and sharing OER has benefits for the whole educational community (individual learners, teachers, institutions and countries), and can be seen as a systemic transformation that affects the entire educational system.

One particular form of material that can be used as OER are recorded lectures or video lectures, which are essentially educational videos recorded and published online. Accessible on-demand, they make excellent pedagogical tools, and are increasingly being used to enhance and supplement the classroom [3]-[5].

This paper presents the experience of recording lectures to produce OER, and reports students’ opinions of their use. The next section gives a brief overview of the state of the art of OER and recorded lectures. Section III presents the recording method and tool. Section IV gives a case study. Section V draws conclusions and reflects on the experience.

II. STATE OF THE ART

The increasingly popularity of OER has attracted a lot of universities and private organizations to this movement and its development. As a result, many OER-related projects and resources (courses, videos, repositories, etc.) can be found, such as: the OpenCourseWare Consortium [6], the Saylor Foundation [7], Academic Earth [8], Merlot [9], and OER Commons [10]. The website SCORE (Support Centre for Open Resources in Education) [11] is to be recommended, for its case studies, publications, and various types of OER-related resources.
During the last decade, research and use of applications in the field of lecture recording have grown exponentially worldwide, reaching a level that makes their management a topic of great importance. The literature of lecture capture identifies the many benefits offered by recorded lectures, such as: reviewing material to complement in-class interactions, improving test scores, improving retention of class material, schedule flexibility, catching up missed classes, and the ability to clarify misunderstandings [12]. Recorded lectures thus provide students with more control over their schedules and learning. Despite concerns that recorded lectures reinforce traditional forms of teaching, students are generally very positive about rich media, believing that it helps their learning [13]-[15].

Some examples of experiences, projects, initiatives, and tools strongly related to recorded lectures are presented next, to serve not as an exhaustive review, but as an introduction to the field.

A significant outcome has been the emergence of systems that easily capture and process lecture recordings, such as: i) the E-Chalk project [16], a system that transforms the lecturer’s input on a large touch-sensitive screen into an intelligent electronic chalkboard; ii) the virtPresenter lecture recording framework [17], that automates lecture recording production and presents the content through highly-adaptable Web 2.0 user interfaces (which can also be integrated in social environments); and iii) ETH Zurich’s REPLAY [18], that automates the lecture recording with dedicated hardware, and incorporates content indexing. Other approaches use a lecture recording search engine specifically for academic content, or use podcasting as an easy distribution channel for lecture recordings [19], [20].

Other experiences of the use of recorded lectures can be found in [21]-[23]. The first of these reports the recording and subsequent evaluation of a series of organic chemistry lectures. The second presents the results of a study into the use of recorded lectures at two universities in the Netherlands, to gain a better understanding of how students use recorded lectures. The last is an exhaustive report on the status of recorded lectures at Delft University of Technology, Netherlands.

For analysis of the use of video lectures, a useful source is the proceedings of WAVe 2013 [24], a workshop whose long-term goal is to develop critical discussion on the next generation of analytics employed in video learning tools, to promote understanding and improvement in this area. In a useful workshop paper, [25], the authors seek to improve the understanding of how students use the systems, and what visualizations are used for learning analytics. They applied three different methods to understand students’ re-watching behavior, the temporal patterns for a single course, and how usage can be compared between groups of students. Another interesting paper, [26], presents an open-source video learning analytics system that captures learners’ interactions with the video player while collecting information about their performance and/or attitudes. The WAVe congress is concerned with the extraction of useful information from the analysis of data on students’ use of video lectures systems. The present analyses data about the use of the system to extract conclusions related to both the user’s experience and the students’ participation in exams (and their assessment).

Some examples of projects and initiatives using recorded lectures include:

- The project “OER – resources for learning”, part of the National Library of Sweden Open Access initiative, intended to explore, raise awareness of and disseminate the use of OER and the resulting pedagogical advantages for teaching and learning [27].
- The collection of campus lectures of the Irving K. Barber Learning Centre in British Columbia, Canada consists of digitally-recorded special lecture presentations by guest speakers, or class-lecture presentations that appeal to a non-specialist community audience off campus [28].
- A lecture recording system in the Faculty of Information Science of Kyushu Sangyo University, Japan, which has a video-camera and microphone installed in every lecture room to record all the lectures given in the Faculty of Information Science; these are then distributed via the Web, although restricted to the campus [29].
- Mitx [30], an initiative to make courses available to MIT students, and open to anyone interested in taking a course. These courses will include recorded lectures, course material, and assessments, which can be organized in a student portfolio.

Several tools have been developed to support the use of recorded lectures, such as:

- Lectern II: Touch-sensitive screen technology enables a “digital desk” that effectively supports and transparently captures all the important components of standard classroom lecturing activity (without video). Recorded lectures can be edited and automatically uploaded to a Web server, and then viewed by students via a standard streaming player [31].
- Synote [32]: A web-based application [33] that allows the creation of synchronized bookmarks; these can contain notes and tags synchronized with audio or video recordings, transcripts and slides/images, and can be used to find and replay parts of the recordings.
- MERLINGO (MEDia-rich Repository of LearnING Objects) [34]: A project whose goal is to build a central repository of multimedia learning objects in a distributed environment containing teachers’ presentations.

Finally, the tool used by the University of Vigo (UV) is Opencast Matterhorn [35]. As defined on its own website [36]: “Matterhorn is a free, open-source customizable software to support the management of educational audio and video content.” Higher education institutions use Matterhorn to produce lecture recordings, manage existing video, serve designated distribution channels, and provide user interfaces to engage students with educational video. Matterhorn
features: (i) administrative tools for scheduling automated recordings; (ii) integration with recording devices in the classroom for managing automated capture of audio, VGA, and multiple video sources; (iii) processing and encoding services, including rich media features (slide segmentation/indexation) for in-video search; (iv) distribution to local streaming and capability for distribution to channels such as YouTube, iTunes, or content management systems; and (v) rich media user interface for learners to engage with content, including slide preview, content-based search, heatmaps and additional features.

Open educational resources (particularly recorded lectures), and the number of organizations participating are increasing every year with the adoption of the principle of open access.

III. LECTURE RECORDING

As mentioned, Matterhorn is the core system used to record lectures. UV’s technical staff (TSU) are responsible for the installation of all the material in the school’s single classroom, the connection to the Institutional Learning Management System (ILMS) to upload the recorded lectures, and the proper operation of the tool.

The complete system architecture is shown in Fig. 1. Its main components are MH-Core, Galicaster and PuMuKIT. MH-Core, as its name suggests, is the core of the system providing technologies for recording lectures, managing existing media, serving designated distribution channels, and providing user interfaces to engage students with educational videos. Galicaster [37] is an alternative capture agent, compatible with Matterhorn, used by UV to cover some specific needs not met by the official Matterhorn Capture Agent, such as graphic interfaces (ready to use with touch screens), live visual feedback of what is being recorded, remote monitoring of the recording, enriched management of recorded videos, automatically triggered recording, and on-site basic control of the recording. PuMuKIT [38] is a comprehensive media cataloguing system, providing enhanced capability for adding metadata to videos. TSU manages and controls the whole system, and are responsible for publication in ILMS.

To record a lecture, teachers have only to operate the tool following TSU’s instructions. The classroom computer-based equipment has a screen from which the teacher can monitor and control the recording process. Having loaded their slides onto the computer, the teacher can start recording the lecture. From that moment until the teacher stops the recording, the lecture will be recorded and synchronized with the projected slides. The teacher has a wireless microphone that can be muted as necessary.

The recorded lecture, after processing by TSU, is made available through the ILMS. 

Matterhorn’s interface for the user to see the recorded lecture, Fig. 2, consists of, from top to bottom:

- The slide screen (left), that corresponds to the slides projected in the classroom, and the blackboard screen (right) that simultaneously shows the teacher and the blackboard behind. This allows a user (student or teacher) to see exactly what a student in class would see. Just under these two screens are the standard video controls (forward, play, backward, volume) and a menu on which the user can choose the size of each screen, or even omit one of the screens.

- Below is a timeline divided into one segment per slide, to give directly access to the video corresponding to a particular slide. Just under this timeline, on the right, is the “Viewing Statistics” menu, which when clicked shows statistics for the use of each segment, Fig. 3. This very useful feature enables the teacher to identify the most-visited parts (and slides) of the class.

- At the bottom there is a tabs menu with three options: (i) “Description” shows information on the video (number of views and date of recording); (ii) “Segment”, (shown in Fig. 2) shows each time segment with its corresponding slide; and (iii) “Segment Text” showing this same information, but in text.

For the student, there are basically two modes of viewing: (i) viewing a class for the first time, that is, the student has not seen the lecture before; or (ii) viewing all or part of a previously-seen class, reviewing material that has been forgotten or hasn’t been understood. The slides menu or the timeline make it easy to view in part. Even if a student...
chooses to see the lecture for the first time, it makes it possible to focus only the parts she or he consider more interesting.

A teacher can check all his/her lectures, and know from the slide statistics which slides (video segments) have been watched most often. This information may serve as an indication of the level of difficulty of that material, and can thus serve as feedback as to areas for improvement, perhaps generating a specific learning object (learning pill or other learning object). The teacher can also decide if a lecture can be accessed openly, or only by the enrolled students, or only certain in parts.

IV. A CASE STUDY

A. Hypothesis

This study deals with the satisfaction and experience in using the recorded videos by the students as useful support. It proposed the following hypothesis:

“The final score of students who viewed the recorded videos is higher that of students who did not.”

B. Procedure

This case study was carried out in the Fall 2012 offering of the first-year Computer Architecture course in UV’s Telecommunication Technologies Engineering program. To pass the course, a student must pass both the theory and the laboratory parts of the course, in each case with a minimum mark of 5 out of 10, or with an average grade for both parts of 5 out of 10. (So if in one part a student’s grade is less that 5, she/he can still pass the course if the other grade is high enough to raise the average grade to 5 or above). This case study focuses on the theory part of the course, and for the sake of clarity only students who passed or failed this theory part are considered.

A total of 27 lectures were given; 21 of these were recorded. The first two course lectures were not recorded because the tool was not yet available, three lectures were dedicated to student testing, and 1 lecture was spent watching videos available on YouTube [39]. The course was given in three sections. Only one of these was recorded, given that for all three sections the lectures were given by the same teacher and were essentially the same. Of the 21 lectures recorded, 18 were recorded as real lectures. The other three were recorded without the students being present, since they were intended for use when the teacher was unavailable.

Fig. 4 shows the number of students attending for each recorded lecture, the number of students accessing the class through the ILMS, and the number of videos viewed through the Matterhorn interface. The data for: (i) the lecture “attendance” was obtained from observation by the teacher in each lecture; (ii) the number of “accesses” to recorded lectures through the ILMS was obtained from the ILMS logs; and (iii) the number of “videos viewed” through the Matterhorn interface was obtained from the description menu of each recorded lecture. Note that only in case (ii) it is possible to have the student names associated with the data.

C. Results

The course enrollment was 262 students. The maximum attendance was in the fourth lecture, with 183 students, and 225 students taking the exam. The first lectures had an attendance between 170-180 students, and then the attendance decreased to 80-90 students in the last lectures, where the minimum attendance was 57 students in lecture 20.

This attendance pattern is normal at UV, both in this and previous years, independent of grade and course, and it has not changed even with the implementation of the Bologna process. As the course progresses students need more time to devote to other courses and prepare for exams, and therefore stop going to class.

The lectures can be classified in three groups. The first group consists of lectures 1 to 12, where the number of accesses is quite similar to the number of videos viewed, and clearly less than the attendance. The second group corresponds to lectures 13, 14 and 15, the lectures recorded for viewing in the absence of the teacher, which obviously have no student attendance. These are among the most viewed

---

Fig. 3. “Viewing Statistics activated” (Matterhorn Interface).

Fig. 4. Number of lecture attendees, accesses through the ILMS and viewed videos through Matterhorn interface, for each lecture.
lectures, with lesson 15 being the most viewed, and lesson 13 the third most viewed, very close to the second most viewed.

For the third, final group of lectures, 16-21, the viewed video numbers exceed the accesses and the attendance, which at this point in the semester is under 100 students, on average. The numbers also include many repeat viewings. This high number of accessed videos can be imputed to two causes: first, the increasing absence of students and second, the level of difficulty of these last lectures, that in some cases is increased by the students’ absence from class.

Since the access data is not anonymous, the influence of online access to lectures on students final grade in the theory part of the course can be studied. Fig. 5 shows how many of the 262 students enrolled in the course viewed (accessed) at least one video, and how many viewed no videos. Only 20.6% (54) of enrolled students viewed no videos, showing wide student acceptance of viewing (208 students viewed at least one lecture).

Fig. 6 shows how many lectures students access, giving student numbers per five-lecture band. Nearly half the students (46.2%) accessed less than five lectures.

To pass the course, students undergo an evaluation process that consists of several exams and partial tests. Fig. 7 shows the level of students undergoing this evaluation, according to the number of lectures accessed. Most of the absentee students are in the band of 0 lessons viewed, with 22 out of 54 students (40.7%) versus 15 students in the rest of the bands, that is, out of 208 students who accessed a minimum of one lecture (7.2%). This implies that a clear majority (92.8%) of students who accessed at least one lesson underwent evaluation.

In the 2012-13 academic year, 85.9% of the enrolled students (225 out of 262) underwent evaluation, compared with 67.9% (150 out of 221) in the 2011-12 academic year.

Fig. 8 shows the same parameters, but from a global point of view. That is, the number of lessons accessed according to students evaluated. Of 37 students not undergoing evaluation, more than half (59.5%) had not accessed any lesson. Of 225 students evaluated, 14.2% had accessed no lectures, 36.9% had accessed between one to five lectures, 31.6% between six to ten, 10.7% between 11-15, and 6.7% between 16 to 21. So a clear majority (85.8%) of students evaluated had accessed some lectures.

Fig. 9 and 10 show the number of students who passed the evaluation by band of accessed lectures. Fig. 9 shows the percentage of the total number of students who passed, and Fig. 10 shows the percentage for the students in each band.

In Fig. 9 the 6-10 lecture band represents 45.2% of passed students. A vast majority of passing students accessed (viewed) some videos (92.3%).

Secondly, in Fig. 10 it can be seen that the 66.2% of students in this band (i.e., 66.2 of students who accessed between 6 and 10 lectures) passed the evaluation. It also can be seen that the 6-10 and 11-15 bands had a pass rate greater than 50%.

These figures give an idea of the value and influence of seeing recorded classes, but before concluding if the hypothesis is true or not, a statistical analysis is needed. Therefore, statistical tests, Table I and II, were performed with R statistical software (v. 3.0.2) on two groups: students who did and did not watch the videos (and recorded lectures). For the statistical tests and confidence intervals, a confidence level of 95% (significance level of 5%) was used. Therefore, any p-value lower than .05 leads to a statistically significant result.

However, p-values between .05 and .10 give borderline significance, so the results could change with a greater sample size.

Table I shows several tests to determine if the two groups have statistically significant differences in their academic results. Three statistical tests were used: a t-test for comparisons of means, a nonparametric test for comparison of medians, and a Chi square test for comparison of proportions of passed students.

Statistical significant differences are obtained for means (p=.0004) and medians (p=.0004), showing better results for those students who saw the videos (means: 4.45 vs. 2.71, medians: 4.90 vs. 1.60). The study of passed students also shows statistically significant differences (p=.016), with better results for the same group of students who saw the videos (49.74% vs 25.00%).

The linear association between the final score and the number of videos seen was explored using the Pearson's correlation coefficient (Table II). A significant positive correlation was obtained (0.241076, p=.0003). One can surmise that the more videos seen, the higher resulting score.

The conclusion drawn from the results of tests shown in Table I is that the hypothesis is true: “The final score of students who viewed the recorded videos is higher that that of students who did not”. Moreover, the analysis of the correlation coefficient, Table II, leads to the conclusion that there is a significant positive correlation between the number of videos and recorded lectures seen by students and their final score.
Another interesting issue is if students developed habits in viewing videos. Bearing in mind that only the ILMS access data, and not the Matterhorn data, is identified with the corresponding user, a study was done on the mean time elapsed between the last time a video was seen and the date of the final exam was taken. To normalize these measures, the time considered was \( T_M = (T_E - T)/(T_E - T_A) \), where \( T \) is the time of the last seeing of the video, \( T_E \) is the time of final exam, and \( T_A \) is the time when the video was accessible for students. Therefore, if a student sees all the videos on the same date that they were uploaded in the ILMS, \( T_M \) is -1. And if this student sees all the videos on the same day as the final exam, her \( T_M \) is 0.

To simplify the representation, \( T_M \) was divided in four slots: Q1, Q2, Q3 and Q4, each one representing one quarter between -1 and 0, that is, Q1 when \( T_M \) is in the range -1 and -0.75, Q2 when the range is -0.75 and -0.5, Q3 for -0.5 and -0.25 and Q4 for -0.25 and 0.

Fig. 11 shows the distribution of the mean \( T_M \) for these quarters for all students who saw some videos, and the Fig. 12 shows the ratio of passed students for the total of students in each quarter.

These data were analyzed by looking for correlation between the time \( T_M \) (that is, the time elapsed between the last time videos are seen and the final exam) and the final student score.

### Table I: Statistical Tests

<table>
<thead>
<tr>
<th>Score</th>
<th>Students who have NOT seen the videos</th>
<th>Students who have seen the videos</th>
<th>p-val</th>
<th>95% CI for difference</th>
<th>Test</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± standard deviation</td>
<td>2.71 ± 2.10</td>
<td>4.45 ± 2.63</td>
<td>0.0004</td>
<td>(-2.71, -0.78)</td>
<td>( t ) with equal variances</td>
<td>Statistically significant difference between means</td>
</tr>
<tr>
<td>Median</td>
<td>1.60</td>
<td>4.90</td>
<td>0.0004</td>
<td>(-2.80, -0.70)</td>
<td>Wilcoxon</td>
<td>Difference between medians</td>
</tr>
<tr>
<td>% Not Passed</td>
<td>75.00%</td>
<td>50.26%</td>
<td>0.0160</td>
<td>(-43.14%, -6.34%)</td>
<td>Chi-2 with continuity correction</td>
<td>Significant difference of proportions</td>
</tr>
<tr>
<td>% Passed</td>
<td>25.00%</td>
<td>49.74%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table II: Correlation between the number of videos seen and final score

<table>
<thead>
<tr>
<th>Correlation Coefficient</th>
<th>p-val</th>
<th>95% CI</th>
<th>Test</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.241076</td>
<td>0.0003</td>
<td>(0.113876, 0.360509)</td>
<td>Pearson based in t-distribution</td>
<td>Significant Positive Correlation</td>
</tr>
</tbody>
</table>
scores. A borderline correlation \( (0.1222689, p=0.09461) \) was obtained, as can be seen in Table III, applying similar methods to those used in Table II.

Finally, Table IV reports students’ opinions of several aspects of this case study. A survey was sent to 225 students who underwent the evaluation; 87 responded. They reported a very favorable opinion of the usefulness of this kind of resource to support and review traditional classes, and to see classes they were unable to attend.

The fifth question in Table I shows there is a greater division of opinion as to whether all traditional lectures should be recorded, with in-person classes being kept for debate and problem-solving. This may due to limited awareness of flipped learning, where traditional classes are followed at home, and the usual homework is done in class.

Another aspect of this work concerns possibility of feedback to the teacher about which classes, and which parts of classes are most viewed. For example, in Fig. 3 the teacher could see that the start of the lecture and the beginning of slide 12 were the most viewed. As a result, the teacher could decide to split this lecture into two parts - from the beginning to slide 11, and from slide 12 to the end of the class - to improve access to and use of this material.

V. CONCLUSION AND FUTURE WORK

UV’s goal is to make its teaching material generally available. Initially, this material was accessible through the Web pages of the corresponding teachers, Departments and Centers. The implementation of the Institutional Learning Management System (ILMS) then meant that all this material was accessible only to the students enrolled in each course, thus losing the original “open” characteristic. This, however, was not intentional, nor a university-level decision.

UV now has proactive policies for the development of Open Educational Resources, especially videos. There are two main video repositories, UvigoTV [40], with corresponding channels on Youtube [41] and in iTunes [42]; and “Campus do Mar TV” [43], which contains more than 1642 hours of video, with a corresponding Youtube channel [44].

Although the Open Repositories are considered very useful, they have not been used as widely as expected and desired [45], [46]. UV is planning to join the OCW Consortium and that make all its teaching material available to anyone. The experience presented here of recording lectures and generating the corresponding videos is a step toward this objective.

The main conclusion of this work is that this type of OER is a useful resource for students: the final scores of students who saw the recorded videos are higher than that of those who did not.

![Table III](image)

**Table III**

<table>
<thead>
<tr>
<th>Correlation Coefficient</th>
<th>p-val</th>
<th>95% CI</th>
<th>Test</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1222689</td>
<td>0.09461</td>
<td>(-0.02121251, 0.2608154)</td>
<td>Pearson based in t-distribution</td>
<td>Borderline Correlation</td>
</tr>
</tbody>
</table>

![Table IV](image)

**Table IV**

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Agree</th>
<th>Slightly Agree</th>
<th>Neutral</th>
<th>Slightly Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think that recorded lectures are a good support material</td>
<td>86.2% (75)</td>
<td>9.2% (8)</td>
<td>4.6% (4)</td>
<td>0% (0)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>I think there should be more videos about other concepts and problems of the course</td>
<td>70.1% (61)</td>
<td>9.2% (8)</td>
<td>17.2% (15)</td>
<td>3.4% (3)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>I think the recorded classes are useful to review concepts</td>
<td>88.5% (77)</td>
<td>4.6% (4)</td>
<td>4.6% (4)</td>
<td>2.3% (2)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>I think the recorded classes are useful even for classes that I could not attend</td>
<td>87.4% (76)</td>
<td>4.6% (4)</td>
<td>3.4% (3)</td>
<td>2.3% (2)</td>
<td>2.3% (2)</td>
</tr>
<tr>
<td>I think all lectures should be recorded, and classes should only be for problem solving and exercises</td>
<td>34.5% (30)</td>
<td>17.2% (15)</td>
<td>13.8% (12)</td>
<td>27.6% (24)</td>
<td>6.9% (6)</td>
</tr>
<tr>
<td>The videos and recorded lectures have been of great help to better understand the course</td>
<td>66.7% (58)</td>
<td>12.6% (11)</td>
<td>14.9% (13)</td>
<td>3.4% (3)</td>
<td>2.3% (2)</td>
</tr>
</tbody>
</table>

Bold values represent the highest values for an item.
not. There is a statistically significant positive correlation between the number of videos and recorded lectures seen by students and their final score.

The videos and recorded lectures were widely accepted by the students, encouraging the authors to produce more. From the point of view of the teacher, besides being a helpful resource, the recording of lectures provides useful feedback as to which parts of each class are most viewed by students and thus where additional resources might be needed. From this point of view more personalized statistics about students’ use of each resource would be useful, so the teacher could have more detailed information about the implications of the use of these resources in the testing process. However, this would require a modification of Matterhorn functionalities; even that might not be enough, given that many students download the videos to their own PC, laptop or smartphone to view them as desired without having to connect to the internet again. This practice does allow tracking of student video-watching behavior.

A further advantage of recorded lectures is that students with disabilities can access them from home, without needing to go on campus. This aspect can be studied in more detail by the university. In the short history of the Telecommunications School at UV there have only been a few students with disabilities, but this number could be increased using these kinds of resources.

In this area, the application to deaf students is one of the first actions that will be developed, using tools such as whatscine [47], that easily permits the adding of subtitles (both text and sign language) to videos. Experience and feedback applying OER to this kind of student may be an invaluable step in adapting recorded classes for deaf students.

Finally, and independently of the clear advantages of using recorded lectures, this work can be seen as a first step to a “flipped teaching” or “inverted classroom” [48], and also as the basis for converting this course into a MOOC (Massive Open Online Course). The “inverted classroom” paradigm changes the role of classroom lectures and homework: the transmission of knowledge in the traditional classroom is moved to the home through recorded lectures, and traditional homework is moved to the classroom, taking better advantage of the interactivity of students and teacher in the classroom. The objective is to introduce this “inverted classroom” paradigm in the 2013-14 academic year.

ACKNOWLEDGMENT

This research was supported by the Spanish Ministerio de Ciencia e Innovación under grant “Methodologies, Architectures and Standards for adaptive and accessible e-learning (Adapt2Learn)” (TIN2010-21735-C02-01), and the AECD (Spanish Agency for the International Cooperation to Development) under grant A2/042374/11.

Thanks to Jeffrey Lessoff for proofreading this paper for English, and to José Ramón Fernández Bernárdez for his support to statistical analysis.

REFERENCES

[34] I. Martinik, “Accordent media management system technology and its integration with the MERLINGO portal services,” in IST-Africa, pp. 1-7, Fac. of Econ. VSB, Tech. Univ. of Ostrava, Ostrava, Czech Republic, 19-21 May 2010  