Integration of multimedia contents in the teaching of electronics

A practical test case in the teaching of digital circuits at the University of Seville

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Abstract— **In this paper we present the integration of multimedia contents in the teaching of Digital Electronic Circuits and Computer Structure, of the first course of Computer Engineering at the University of Seville. Different tools for screenshot and video recording have been used for the preparation of audiovisual material, integrated in the learning platform currently used at the University of Seville. Feedback on the prepared material was collected in a survey, showing the interest and utility found by students in the preparation of theoretical and experimental classes with the videos. Successful results have been obtained in the evaluation of students. Suggestions of improvement and further work to be carried out are also described in the paper.**

Multimedia contents; Digital Electronic Circuits; Computer Structure; Virtual Learning Environment.

I. INTRODUCTION

The use of multimedia contents in learning is beginning to experience a significant increase, with many universities and schools currently incorporating the distribution of video lessons via Internet, for a wide variety of subjects [1], [2], [3]. The study of digital electronic circuits can benefit greatly from these techniques, complementing the traditional teaching of electronics, both in the theory and experimentation, with audiovisual support material, useful for students to prepare the lectures and practical classes in laboratory. The available "on demand" content has the additional advantage of allowing adjustment to the learning needs of each particular case, contributing to improve student´s motivation and approach to the world of electronics and microelectronics.

In addition, a number of advantages in the practical case studied at the University of Seville can be found, such as enabling the preparation of material specifically taught at the Department of Electronics Technology and the preparation of accessible, on demand content for students with special limitations.

There are currently a large number of applications for the preparation of audiovisual material [4], [5], [6]. The combined use of these tools integrated into educational web portals [7], [8] allows innovative teaching possibilities. However, there are several factors that delay their use in the physical or virtual classroom, among which it can be underlined the difficulty to find the adequate multimedia content and to integrate in a simple way these resources in teaching [9], [10].

In this paper we use a specific tool for the preparation of audiovisual material, uploading the videos in the learning platform currently used in the University of Seville, for the preparation of audiovisual contents in the subjects of Digital Electronic Circuits and Computer Structure, of the first course of Computer Engineering. The proposed content is specifically designed for these subjects, including CS1, CS2 and CS2010 computers [11], designed at the University, allowing "on demand" multimedia content for students.

In section II the selection of multimedia contents and technical preparation of the material is explained. Section III is devoted to the evaluation results obtained with this work, summarizing the experience in the preparation of teaching materials and students' opinion of the methodology and materials. Finally, in section IV, conclusions are presented, together with the future work to be performed.

II. MATERIALS AND METHODS

A. Selection of multimedia contents

The following contents and objectives were chosen for the preparation of multimedia contents:

- Initial lessons of the subject Digital Electronic Circuits.

This subject is delivered in the first term. The aim of producing these videos is to provide a support material for the students that incorporate late to classes without delaying the planning of the teaching. This is of particular importance for students that change their matriculation during the academic year, which frequently results in high abandonment rates.

- Specific lessons of the subject Computer Structure.

Support material is especially interesting for the teaching of CS1, CS2 and CS2010 computers, designed at the Department of Electronics Technology [11]. It is also interesting for the teaching of microcontrollers where insufficient bibliography is found, apart from datasheet, as it is the case of the microcontroller Atmel ATMEGA328P.

• Initial lessons of the practical classes in laboratory.

The aim is to show the correct operation of digital electronic circuits and the laboratory instrumentation, specially in those practical classes with a higher difficulty.

• Adapted contents for students with special limitations.

Students with special limitations, such as hearing disabilities, could find in the contents prepared a good support for the learning of electronics.

Selected contents must be integrated in the overall planning of the subject and must support the generic competencies to be achieved by the students in the learning of the subject.

B. Technical preparation planning

For the preparation of audiovisual material for theoretical and experimental classes, different tools have been used.

RecordMyDesktop sofwtare has been used for screenshot and audio recording. RecordMyDesktop is a free and open source desktop screencasting software application written for GNU/Linux. The program is separated into two parts; a command line tool that performs the tasks of capturing and encoding, and an interface that exposes the program functionality graphically. There are two front-ends written in python with pyGtk (gtk-recordMyDesktop) and pyQt4 (qt-recordMyDesktop). RecordMyDesktop also offers the ability to record audio through ALSA, OSS or the JACK audio server. RecordMyDesktop outputs to ogv format, using Theora for video and Vorbis for audio [6].
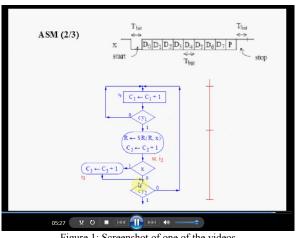

Figure 1: Screenshot of one of the videos

BB FlashBack recorder, another open source software, has also been used, with the aim of exporting the videos to .avi, and facilitate the access to students in Microsoft Windows operating system, as shown in Figure 1.

Theoretical and Laboratory classes are also planned to be recorded with available video cameras at the Department of Electronic Technology, to cover the mentioned contents in section II.A. Initial video prototypes have been recorded, as shown in figure 2.

A subtitle editor, Subtitle Workshop, for creating and editing subtitles to be superimposed over, and synchronized with video is also planned to be used, in order to implement accessibility requirements.

Figure 2: Initial prototypes of videos recorded

III. PRACTICAL TEST CASE

A first practical test case was carried out with audiovisual material covering contents of the subject Digital Electronic Circuits, delivered on the first term of the first course of Computer Engineering. The practical test case took place in one of the groups of the subject, with a total number of 74 matriculated students, who had access to the recorded videos.

The videos were uploaded in the learning platform commonly used for students to access the information needed to prepare theoretical and experimental classes [11].

The audiovisual material consisted of short screenshot videos (around 5 minutes length), covering the following selected topics:

• Theoretical lessons of analysis of combinational and sequential circuits.

• Theoretical lessons of design of combinational and sequential circuits.

• Resolution of problems proposed in the subject.

The format used for this first practical test case was ogv (recorded with RecordMyDesktop). Some links to ogv players were also provided to the students in the web page, in order to facilitate to the students the reproduction of the videos.

The audiovisual material was distributed together with a short survey, aiming to collect students´ feedback on the prepared material and give open suggestions for the improvement of the work. The proposed questions were the following ones:

1. Do you think it is useful to have multimedia content for the preparation of this subject?

2. Which of the theoretical or experimental lessons would you find more interesting to prepare with the support of audiovisual content?

3. What do you think of the first demo video that has been prepared? How do you think it could be improved?

4. How would you like to access to these multimedia content? (website of the subject / other portals?)

5. In what format would you like to have the videos?

Students with special needs were personally interviewed, to have a more detailed information about their evaluations.

IV. RESULTS

A. Results of the Survey

A total number of 11 interviews were collected among the students of the group. Results of the survey are summarized in the following points:

1. Utility of the material

All the surveys indicated the utility found by the students in the audiovisual material to prepare the subject. In one document it was suggested to include different topics to those seen in classes.

2. Contents preferred

Students expressed their preferences between theoretical, problems and laboratory classes as shown in figure 3.
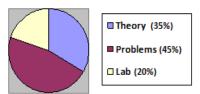

Figure 3: Contents preferred by students

Special emphasis was put on contents they regarded as difficult to understand or important in the overall qualification of the subject, as could be expected.

3. Demonstration video

All the questionnaires expressed a positive evaluation of the audiovisual material. Minor specific problems were found in the quality of the sound or in the low speed of explanations. A clear understanding of the topic was expressed. The utility of the specific material for the preparation of the subject was also commonly commented in this question.

4. Access to multimedia content

A clear preference towards uploading the multimedia content in the web page of the subject was expressed. Students found this way of accessing the information easier and more organized than through the WebCT virtual learning platform [7].
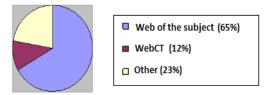

Figure 4: Access to the content expressed

5. Format of the videos

A wide variety of formats were suggested. Special interest was expressed in windows compatible formats. A significant number of questionnaires showed no preferences in the format of the videos.

Students with special needs expressed their interest to have accessible multimedia content, with appropriate subtitles. This reduced group of students found the material of particular importance not only in the preparation of the theory, but also in the preparation of laboratory practices, especially in those where documentation was harder to find, as in the CS1, CS2 and CS2010 computers.

B. Academic results

Of special interest was found to be the results of the final exam, where students had to answer different questions in relation with the concepts seen on the videos, with very good results. In the following table the results of the tests can be observed, in comparison with the results obtained in the previous academic year.

Academic year	% Presented students	% Pass (over presented)
2010 - 2011	38,2%	44,9%
2011 - 2012	49,2%	62,6%

Table 1: Academic results.

The use of the videos and the good acceptance found among students, according to the survey, could be influencing the improvement on the number of approved students. However, it is necessary to keep evaluating the method in other subjects, as in the current tests being carried out in Computer Structure, and also in forthcoming academic years.

V. Conclusions and future work

In this paper we present the integration of multimedia contents in the teaching of Digital Electronic Circuits and Computer Structure, of the first course of Computer Engineering at the University of Seville. RecordMyDesktop was used to prepare the first audiovisual contents, which were uploaded in the web portal used for the teaching of the subject Digital Electronic Circuits.

Students´ feedback on the prepared material was collected in a survey, showing the interest and utility found by students in the preparation of theoretical and experimental classes with the videos. A special emphasis was put on contents they regarded as difficult to understand or important in the overall qualification of the subject, and suggestions were made in relation with technical issues such as the format of the videos. Results of the final exam show very good results on the specific questions where videos were prepared.

Future work will be focused on the preparation of multimedia contents for the teaching of the subject of Computer Structure, delivered on the second term of the first course of Computer Engineering. The architecture and operation of the computers CS1, CS2 and CS2010 will be shown, and specific material will be prepared, covering both theoretical and experimental classes. Accessibility requirements collected in this work will be taken into account, in order to improve the learning of electronics by students with special limitations.

Acknowledgment

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