Abstract—In this paper we present Polimedia as an alternate way of producing video learning objects instead of lecture recording. We are using heavily this technology with a teacher support program involving more than two hundred teachers and in this time we have produced more than two thousand Polimedia learning objects and we have also disseminated this technology with several universities. We present also results of using this technology together the support program.

Keywords: learning objects, lecture recording.

I. INTRODUCTION

Lately there has been much work around lecture recording systems. On those systems a more or less complex set up is prepared to record simultaneously audio, video and teacher computer’s screen in order to get a high fidelity view of a lecture.

The presentation of those recorded lectures and other talks takes various forms: Simple combinations of audio and presentation, combination with presenters’ video (“talking head”), picture-in-picture with optional re-sizing and highlighting of the two elements (video and presentation) or a synchronized side by side – the options are manifold. While they are able to convey the content of the recording, their visual appeal is limited when compared to customized productions or TV-style webcasts.

There are many examples of lecture recording systems. From late 90’s University of California Berkeley [1] has been recording live sessions. Also there are many lecture recordings into the OCW project [2]. A common issue in these projects is the need of making an automated production as a requirement for scaling lecture recording for a massive deployment. There are some works on this field, like in [3] [4]. Also there is a need for indexing that lectures. That can be done through automated speech processing, like in [5]. Lately, ETH Zurich’s Replay [6] and VirtPresenter [7] are good examples of the capabilities of those lecture recording systems, and the recent Matterhorn [8] project from the Opancast consortium [9] is filling the gap for an enterprise-level platform for lecture recording. 

At Universidad Politécnica de Valencia (UPV) we decided in 2003 to take a slightly different route for video content creation. We record small pieces of synchronized screen + audio + video in a specialized production studio and we add a pedagogical content to create a learning object, that will be distributed offline through a Learning Management System, in our case Sakai [10]. The fact that the teacher is not in a lecture hall and that he has no real students in the recording allows some interesting possibilities. The process of creating those video learning objects is what we call Polimedia.

The idea behind Polimedia is that when you record a lecture in a standard hall, you have a content that is not atomic in the sense that is formed of diverse topics, and is not easily reusable because that content refers to other topics, usually from previous lectures. For instance, in Berkeley’s webcasts [11], each year has its own recordings for the same topic. Instead of this approach we decided to create Learning Objects (LO), small atomic pieces of reusable content, and as this creation can’t be done easily on a lecture recording hall we use a recording studio, that allows us to improve the recording quality. Finally a teacher can use any LO in a lecture session, or have it as a learning material.

Also we realized that there is also a need for quality reviewing in the content production scheme. At UPV we designed, and we have used for three years a complete program of content production, beginning with teacher selection, content creation, quality assurance and rights management. That program has allowed us to have currently a portfolio of 4535 Polimedia objects from 734 different teachers, with a total time of 698 hours.

The rest of the paper is organized as follows: in section 2 we will explain the Polimedia approach to video content production. In section 3 we will present the learning objects paradigm. Section 4 will be devoted to the digital production program. Section 5 deals about the results we have obtained from Polimedia and the digital production program. Finally in section 6 we will draw some conclusions and we will talk about our planned future work and interaction with external projects.

II. THE POLIMEDIA PRODUCTION SYSTEM

Any lecture recording system aims to produce a high quality and visually appealing view of the teacher, the computer screen or the blackboard, and the audio recording. That view has to be clear, smooth and must not distract the student from the learning process. With these issues in mind we have stacked horizontally the slide and the presenter, composing a 1088x672 frame, as you can see in figure 1.

If we show only the bust of the presenter we allow a little overlap between the presenter and the slide, maintaining the frame size. It is only noted when the presenter extends his right arm. This is depicted in fig. 2.
We have designed the process carefully to achieve both a high rate of production and to get a final quality comparable to a TV production, but with much lower cost. A key piece in this setup is the production studio.

A Polimedia production studio is a 4x4 meters room in which we deploy a camera, two PCs, a pocket microphone, lights and some A/V equipment, including a video mixer, and an audio noise gate. It is worth noting that the use of lights in such a reduced set allows getting a sharper image easier than in a lecture recording hall. The cost of this studio is around 30,000€.

When a teacher wants to record a Polimedia, he/she arrives to the studio with the slides and shows a presentation directly on the studio. There we record both the screen and the teacher video in two different streams. After that we have a raw preview of the Polimedia content by putting the screen and the teacher video side-by-side, and on that screen the teacher can review the material he has just created. If everything is OK we start a process for cropping, joining with a little overlap and encoding, in order to have an .mp4 file with h.264 encoding, suitable for distributing and archiving.

Then, the cropping, joining and encoding process is fully automated using avisynth[6] and ffmpeg, so the teacher can see a preview of the recording immediately and the resulting file is ready in a few minutes. As stated, the final file is a .mp4 file at 500kbps, that we distribute by streaming through a flash media server. Also we encode an mp4 designed for mobile devices, like IPhones.

From teacher’s point of view, recording a Polimedia object is as easy as arrive with a PowerPoint file, a laptop, or even a URL to our recording studio. There are two screens, on at the front of the teacher, and one at the right. In such position he or she will record the lesson and both streams will be recorded. In figure 3 you can see the set up for the studio and an image of a live recording. Actually we have 8 Polimedia production studios.

Polimedia content is by design asynchronous, so is intended to be distributed through a LMS or a website. We think the best way of knowing what Polimedia can do is by viewing some examples of them. Here are the direct links to some that represent the possibilities of our work. Please remember that you can access more examples at http://polimedia.upv.es/polimedia or at our Library Dspace repository at http://dspace.upv.es:

- http://polimedia.upv.es/visor/?id=32d880f6-709a-d74b-b7ad-b4394d9ccbfda
- http://polimedia.upv.es/visor/?id=cc42af48-5c15-684c-9e31-53eb2b7ec2581
- http://polimedia.upv.es/visor/?id=59436990-49f6-e64d-b2de-1598776a845b
- http://polimedia.upv.es/visor/?id=98cf78f3-aa20-7142-bf3e-e8f9d6b1efb

So, the main characteristics of the Polimedia tool can be summarized as follows:
- Polimedia allows fast and affordable creation of digital contents. The cost of a study of production does not surpass in any case the 30,000 €, and is operated by just one technician.
- Polimedia does not require special knowledge by part of the professors or expert.
- Polimedia produces high audiovisual and didactic quality content, adapted to its distribution through Internet with any format by transcoding.

In year 2008 we began to disseminate Polimedia technology to other Universities and e-learning projects. Currently we have deployed Polimedia at 10 Spanish Universities, and we are focusing on getting 4 more before the end of this year.

Also we have contacted with some European Universities, like Aarhus at Denmark, and we are willing to support deployment on those Universities. Finally we are putting Polimedia on the AVICENA project, funded by the UNESCO, willing to give e-learning through all African countries and we have installed a Polimedia studio in Dakar. Anyway, we are looking for partners willing to work together with us in further improvements of Polimedia technology.
Figure 3. A Polimedia recording session

Also we can give feedback about how Polimedia is used on Latin America. The Universidad Politécnica de Valencia uses Polimedia to provide e-learning to that continent, and we have a strong tie with Mexico, where we are fulfilling successfully some e-learning needs.

III. DIDACTICAL APPROACH. LEARNING OBJECTS AND POLIMEDIA

The Polimedia system belongs to asynchronous training e-learning category using the Learning Objects (LO) paradigm. As defined by Willey[7], a LO is the minimum unit of digital learning content that can be reused and sequenced. So these small components should work like integrated circuits of the teaching-learning process, offering the students the possibility to improve their performance and level of satisfaction.

Then, the determination of the features of the learning objects facilitates the establishment of some appropriate approaches of their validation, and at the same time it will help in assuring the quality in their creation. So a LO should have:

1) Digital format: A LO should be usable from Internet and accessible simultaneously for many people and from different places.

2) Pedagogic purpose: the objective is to assure a process of satisfactory learning. Therefore, LO will not only include contents but rather also guide the own process of the student's learning.

3) Interactive content: A LO should encourage as much as possible the active participation in the information interchange. Then a LO should tend to include activities (exercises, simulations, questionnaires, charts, graphics, slides, tables, exams, experiments, etc.) that allow to facilitate the process of assimilation and the tracking of each student's progress.

4) Indivisible and independent of other learning objects, so we can make different learning sequences for one LO, depending on the student or the objectives.

5) Reusable in educational contexts different to that for the one that was created. This feature is the one that determines that an object has value, being one of the starts that base the concept of learning object. For a LO can be reusable it is necessary that there isn’t any reference to their location in any particular course neither in the subject nor in the course. Also a LO will use metadata to describe its content.

6) Synergy: Learning modules can be created combining different learning objects within a certain context

By using the LO paradigm, we structure the course in modules, and then in lessons, as seen on next figure. Each lesson will address just one concept, so that we can reuse the content. For instance in next figure we have some Polimedia learning objects, that we could arrange in different learning sequences. In a more general case we access learning modules composed of learning objects through or Sakai learning platform.

In general terms, the learning objects paradigm suppose, on one hand, a saving of time for the professor in the preparation of resources of learning of quality, and on the other hand, a constant update of the resources for the student.

When creating a Polimedia, any teacher has to deal with some requirements in order to achieve a successful work. The main ones are:

- Use a clear, simple language, close to the listener.
- Designing learning activities that encourage the active participation of the learner.
- Include multimedia elements that enhance the learning experience.
- Keep the content concise and focused to avoid overwhelming the student.
- Provide feedback to help the learner assess their progress.

In the previous section we defined a Learning Object (LO) as a digital, self-contained, reusable entity with a learning aim that contains the content, the metadata and the information which helps its identification, storage, and recovery.

In the present section we will explore the design and development of such Learning Objects. We will discuss the different types of content that can be included in a LO, as well as the tools and techniques that can be used to create and deliver them.

The main types of content that can be included in a LO are:

- Textual content: This can include text, paragraphs, bullet points, and tables.
- Multimedia content: This can include images, videos, animations, and audio.
- Assessment content: This can include quizzes, tests, and exams.
- Interactive content: This can include simulations, games, and interactive charts.

In order to create a LO, a teacher needs to follow a process that involves:

1. Defining the learning aim of the LO.
2. Selecting the content that will be included in the LO.
3. Organizing the content in a logical and coherent way.
4. Adding metadata to the LO.
5. Delivering the LO to the learners.

By following these steps, teachers can create high-quality Learning Objects that are effective in supporting student learning and that can be easily integrated into the curriculum.
These are the steps that our teachers follow in the creation of LO.

1. Determine the objectives: conceptual, procedural or attitudinal
2. Create the objects
3. Choose format (text, multimedia, interactive)
4. Create the introduction of the content
5. Create the content
6. Fill up the online metadata form. We use the standard LOM tags.
7. Specify access rights
8. The LO Committee evaluate the quality of the learning object. The LO committee is formed by teachers and pedagogy specialists, appointed by the dean and make a review focusing on the formal aspects of the content and the overall result. Its approval is required for a teacher to get the economic incentive assigned to a LO creation.

After the LO creation it time to create Learning Modules. A Learning Module, as shown in figure 4, is created by the contextualization of one or several learning objects within a didactic environment with the addition of coupling objects. The approximate working time of the student in a learning module is one hour, including all the activities proposed in the module.

So, the detailed process of creating learning modules is:

1. Select the competences to develop in the student
2. Select the kind of objects to work in: conceptual, procedural or attitudinal
3. Define the structure of the module
4. Search for already created learning objects which can fit in our structure
5. Create non-existing learning objects
6. Configure the module: create coupling objects
7. Test the module
8. Evaluate the module by a LO Committee

All the objects are stored in a common repository, catalogued by the University Library in a DSpace repository. Currently we have two types of access rights: Any student from the UPV and Free access with a Creative Commons-like license. Even that we prefer the second one, the kind of license is not determined by the plan and each teacher can decide which one to use.

![Figure 4. Process of creation of a learning object](image)

It is worth noting that as we have a LO Committee that evaluates the quality of the objects, not all our content has been approved, mostly because of the requirement for a LO to be self-contained. That content can be useful too, and teachers are allowed to use in their lectures.

V. STUDYING POLIMEDIA AND LO USAGE. COST ANALYSIS

A. Polimedia recordings

Polimedia operative recordings began in UPV at year 2006, and we have tested or setup for all these years. We have recorded 4535 Polimedia objects from 734 different teachers, with a total time of 698 hours. That content has been viewed about 370,000 times, from 95 different countries. This is shown on fig. 5.

We have carried out study in which we analyzed the log from our Polimedia streaming servers to know about the abandon rate, that is how long users see Polimedia LO. This study has been made with all accesses to our servers in the years 2008 and 2009, with more than 150,000 hits.

First we look at the percentage of time users see our videos, that is depicted in figure 6. In this graph we represent on the X-axis the percentage of viewing time, that is if a user sees fully a LO that time is 100% and if he sees half of time it is 50%. It should be noted that we use a streaming server that provides that kind of statistics, because if anybody does that with a progressive download web server (like Youtube) you don’t have such capabilities.

![Figure 5. Polimedia objects viewed by year](image)

![Figure 6. Polimedia viewing time](image)
Figure 7. Learning objects mean viewing time

Viewing figure 6 we can identify three user profiles:

- Those that open the object and abandon immediately, generally because it was not the object that wanted to see. This corresponds to errors, tries and similar elements, and corresponds roughly to a 20% of the cases.
- Those that see entirely the video (x-axis 90-100%). Here we have 48% of the users and a 60% if we deleted the percentage of errors.
- Those that effectively drops, with a time declining profile.

In figure 7 we compare these data with the length of the LO, that is what is the mean abandon rate for videos with length x. As you can see, the longer the LO the higher the abandon rate. So, it is better to design several shorter learning objects than one longer one. This results support our recommendation that a Polimedia object should have a maximum length of around 10 minutes.

B. Learning Objects support program

The “docencia en red” program began supporting teachers to create LOs in 2007, and we added support for learning modules in 2008. Since then the program is now in its fourth year, and we have created 2451 Polimedia learning objects and a total of 4872 LOs, as shown on fig. 8.

C. Cost Analysis

In the introduction we face the LO & Polimedia method of content creation with the lecture recording approach. While the objective of this paper is not to compare both paradigms, it is true that it is necessary to take account on the costs of a Polimedia recording.

When we appoint a Polimedia studio we reserve about 60 minutes for the recording of two Polimedia, or twenty minutes of content, so we take into account that we need three times the teacher’s time for recording.

There is also a need for restructuring the content on the LO paradigm. This depends very much on the subject and teacher, but we usually estimate this time in one time more, so finally we need four units of teacher’s time to produce one unit of Polimedia content.


