Reaching learning objectives of the cognitive domain with a synchronized streaming media environment

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Abstract

The increasing use of streaming technologies for learning purposes and the potential impact it seems to have in the learning process's flexibility, motivated the study of how comfortable students feel with Synchronized Streaming Media and which learning objectives of the cognitive domain can be directly addressed by this technology. This paper presents that study, developed at the School of Engineering in the University of Minho, Portugal, with undergraduate and postgraduate degree programmes. The experiences consisted on total replacement of a lecture about a given subject, traditionally presented at a classroom using an expository instructional approach, by Synchronized Streaming Media content, followed by evaluation questionnaires. The comparison of the evaluation results obtained from this experience, with the ones obtained in previous years, allowed us to conclude that there was no significant difference between the students using both methods. It was also concluded that students are very enthusiast with the content's format and are looking forward for the methodology to be widen to other lectures. The similarity of correct responses to the questions related with different learning objectives, doesn't allowed to discern the cognitive domain's levels not reached by this technology, but the majority of the students express the need to integrate a discussion forum as a tool to consolidate knowledge.

Keywords: streaming, learning objectives, synchronized streaming media

1. INTRODUCTION

The creation of the European Higher Education Area (Bologna declaration) will have a huge impact in the Portuguese undergraduate course organization and in the relationship between lecturers and students throughout the learning process.

The challenge for lecturers is now how to create a learning context in order to maintain or increase the number of students motivated, with effective learning results, in a new scenario where the traditional classroom lectures are substantially reduced. To do this, the approach to lecturer/student's interaction must be reconsidered. It is necessary to change the content's format, the mean to distribute the contents, the learning activities purposed, the communication policy and the assessment criteria. In a student oriented learning process, where the student has the responsibility to plan and manage his own learning path, the lecturer still have the essential role of creating a suitable learning context.

Aware of the obstacles this process could represent, the School of Engineering in the University of Minho is promoting several studies, where this one is included, to soothe the change process.

Streaming technologies are one of the most promising technologies for learning purposes in this changing domain. It seems to be very flexible and capable of keeping students motivated, mainly because students may

listen, view and "use" lectures wherever they want and need them. However, because preparing contents for this technology is not trivial and may require a lot of resources, before going for mass use we need to know how comfortable students deal with Synchronized Streaming Media and which learning objectives of the cognitive domain can be directly addressed by the technology and which ones require additional activities.

The study presented here intends to be a small contribution to answer this question and, doing this, to enhance the motivation and learning effectiveness of students.

The paper is organized as follows. Section two introduces the Synchronized Streaming Media concept adopted in this study. Section three presents some projects and studies based on technologies and methodologies similar to the ones that oriented this work. Section four enumerates the motivations that were in the base of this study. In section five the technologies used are defined, emphasizing its simplicity and low cost. The scope of the study and methodology are explained in the sixth section. Finally, in section seven we present the results and, in section eight, some conclusions are drawn.

2. SYNCHRONIZED STREAMING MEDIA

In the context of this work, by Synchronized Streaming Media (SSM) content we mean a few media elements integrated and synchronized, producing a pedagogically oriented resource, available to students through an ordinary browser over the Internet. The SSM presentation environment, used within this project, integrates elements such as video, slides, HTML (supporting texts, links and exercises) and a table of contents, allowing interactivity actions typically found in this type of resource (e.g. reverse, forward, pause, and jump to chapter).

Why Integration?

Contents developed for this study were based on the recommendations from the "Click and Go Video Decision Tool" [1], from the "Video Streaming: Guide for educational development" [2] and, from the "Three I's Framework" [3]. These works derived from the Joint Information Systems Committee[1] (JISC) Click and Go Video project, and were used as guidance for the planning, design and the development of the contents.

Recognized the value of the image, in learning contexts, and the flexibility and control given to students by interactivity, integration of media elements, synchronized and reinforcing each other with communication and evaluation tools, give to this kind of environment a key factor to shift distance pedagogical activities to a greater favourable learning context. Young [3] argues that although video can be used on its own, when interlinked with other elements (e.g. slides, supporting texts, resource links) brings the possibility of designing novel learning experiences.

It is known and largely studied that students have different preferences when integrated in a learning process. Using a multi-channel resource, where different channels are synchronized to complement and reinforce each other, allowing the knowledge consolidation or acting as redundant information, can reach a wider variety of learning styles. Multi-channel cues, when synchronized with pedagogical orientation, help students to increase attention focus to the message and act like a facilitator learning agent. The use of multi-channel communication increase the quality of communication [3].

SSM also allows the presentation and explanation of some impossible or difficult to reproduce phenomenon, that can work as support content to case studies, such as natural and environment disasters, experiences with dangerous or rare material, or past events analysis. This kind of contents, rich in visual and motion cues, is impossible to be delivered to students in a text format and can easily loose its impact in an isolated video spot.

Video gives students a richer, more meaningful and more vivid learning experience [1] and can potentially get people to learn more effectively because learning can be made thrilling [4]. A wise blend of streaming video with slides, supporting texts, communication and assessment tools can take distance learning towards a pleasurable experience.

[1] http://www.jisc.ac.uk (Visited Oct/2005)

3. RELATED WORK

Joint Information Systems Committee (JISC) has been particularly active supporting works on streaming video usage in learning contexts. Projects under JISC support has been a true stimulus to other projects in Europe with focus on streaming media in e-Learning. The JISC Click and Go Video is a good example of a project working as starting point to research in this field. The work presented here has been inspired in projects and studies derived from Click and Go Video project.

All the projects have different motivations, which can vary from the substitution of high cost of real experiences by some sort of simulation, to "working" with dangerous material or scarce resources, such as human bodies or radioactive material. Other projects are just motivated by pedagogical issues, aiming to increase student motivation and flexibility to access contents and learning activities, or to decrease the abstinence to traditional classroom lectures.

In spite of the several projects focused on streaming video technologies in learning contexts, in the last years, the approach to integrated streaming video with other media sources and with communication and assessment tools has still much to be explored. There are several universities that published experience's results related with lectures based on video streaming, most of them using video streaming as the content but not integrated with other media or communication elements.

But we have found some projects which also adopted a synchronized multimedia approach. Just to mention a few examples, the University of Manchester presented a study [5] based on a similar technology used by our approach, but where the contents were delivered to students on CD's.

The Georgia Institute of Technology in Atlanta has been delivering courses using slides synchronized with streaming, first only with audio streaming and now with video too [6]. In this case, the main purpose to video streaming adoption was to give the students the sense of being in the classroom and to allow them to follow more closely the material presented [7].

The University of Wisconsin-Madison published experiences [8, 9], based on a special purpose self-developed software, the eTeach [10], which is an authoring tool for content development, with similar functionalities to the ones used in this project.

Finally, "eStream - Increasing the use of Streaming technology in school education in Europe", a Minerva project supported by the European Commission, also have some products and events (e.g. workshops) that use and encourage the use of the same technologies adopted in this project context.

In Portugal, as far as we know, beyond University of Minho there aren't any universities or training organizations using Synchronized Streaming Media as a pedagogical content.

4. MOTIVATION FOR THE STUDY

As stated before, the creation of the European Higher Education Area and the challenges that it implicitly offer to Universities, suggest the enhancement of active learning contexts, focusing the learning process to the student. Portuguese universities are now introducing some changes to converge with the orientation guides. From learning contents to technology, from methodologies to evaluation, from lecturer's role to student's attitude, the next years will require a lot of work.

This work was motivated by the stated challenges and intends to be a small contribution to encourage the learning process participants to promote the development of SSM pedagogical contents, in way to create an enriched learning experience.

After a period of experimental projects, e-Learning is now starting to grow and being disseminated throughout universities. But most of the contents are not adjusted to the new methodologies and are still oriented for formal/classroom education. We believe that SSM is a simple to create, easy to use and low cost type of content that addresses new e-Learning strategies and, when correctly used and supported, can be more effective as the traditional classroom lectures, specially when dealing with large heterogeneous student groups. The motivations for this study are exclusively pedagogical, hoping to enhance learning processes, reaching more students with more quality.

5. TECHNOLOGIES

The approach and recommendations for SSM content's development are based on the use of low cost technologies, most of them already present on lecturer's computers, which enable lecturers to create their own learning contents, without the need of professional equipment or advanced technical skills.

The target of the experiences was a group of students (undergraduate and postgraduate courses) which have access to technical equipment and conditions to intervening in the process (Internet connection and adequate bandwidth). The objective was not to find the conditions and technical considerations where this technology can or cannot be used, but when it is used in the appropriate context, what is the student's satisfaction level in face of a new learning paradigm and which learning objectives can be directly addressed by this technology.

The creation and use of digital web-based video was already open to non-specialists educators [3], but now the integration of streaming video with slides, supporting texts, images and links, can also be supported by easy-to-use technology, allowing lecturers to develop effective and value added, synchronized streaming media content.

5.1 Development and Access Technology

Considering that the technology stack adopted in this project was Microsoft® based, to access the synchronized streaming media content, produced in this project, the students need the Microsoft Internet Explorer® Browser and the Windows Media® Player.

Synchronized streaming media contents were created using Microsoft Producer – a free tool for Microsoft PowerPoint® users – to integrate and synchronize media elements. Besides this tool, the content developer only needs the appropriate technology to create the media elements, in this case: video, slides and supporting texts/links. For video and sound, a Digital Video Camera and a portable tie clip microphone are ideal, but a simple webcam and a headset is enough. As stated, a typical multimedia personal computer fits the requisites for SSM development.

The server side technology is also Microsoft® based. We used a Windows Server™ 2003 standard edition, running the standard Web Server - Internet Information Services (IIS), with Windows Media Services 9 series and Streaming Media Server option.

The interactivity which allows content flow control, such as stop, play, rewind, forward and chapter selection, is only available if Real-Time Streaming Protocol (RTSP) is enabled. So, beyond standard ports, the qualified ports for RTSP should be open.

5.2 Technology Limitations

Bandwidth was the most critical resource identified in this content distribution approach. It was expected that students access the content from two main places: their own homes and inside university campus. Broadband Internet access (ADSL and Cable) is the most widely used technology in Portugal and most of the students have one of these technologies available. Despite this scenario, some details were taken in order to assure video/audio quality and an efficient synchronization between media elements.

In compliance with Microsoft Producer, it was used the Windows Media Video (WMV8 codec), a set of proprietary streaming video technologies included in Windows Media Platform. The contents were published in two different bit rates, available to be chosen by the students: 300kbps, recommended for accesses inside the campus or 150kbps, better suited for remote access. The performed tests proved that those two bandwidth options were sufficient to warrant a good quality access level by students with different technologies.

The video element has been formatted for a maximum of 30 frames per second (fps), at 300kbps but, the negotiation capability of the implemented protocols allows the quality to be dynamically adjusted according to the bandwidth available.

Figure 1 shows the layout used. It was chosen a fixed small area for video display, with 240x180, at the upper left side of the window, and a resizable slide view and hyperlink text areas at the right side. Under the video area there is a table of contents to allow students to navigate throughout presentation, based on chapters.

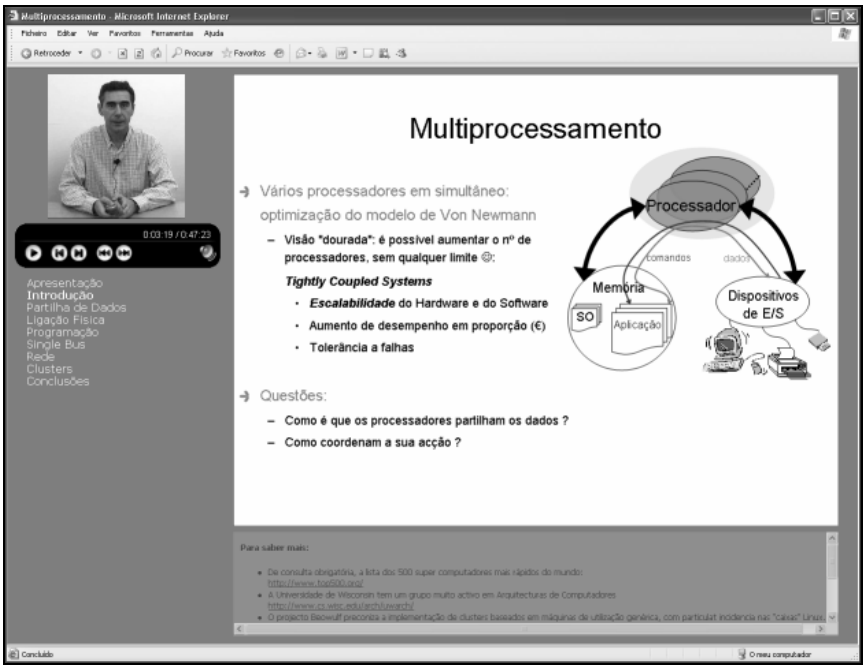

FIGURE 1 - General Media Element's Disposal

The complete lecture was divided into nine chapters, each one associated with a video, a set of slides and supporting texts or exercises, when appropriated. The whole presentation length takes about 47 minutes, requiring about 45MB of data.

6. SCOPE AND METHODOLOGY

Why Bloom's Taxonomy ?

Spite several discussions and revisions [11] Bloom's original taxonomy [12] clearly defines the intellectual skills and is used as a guidance to the learning objectives definition. In fact, it is a well known and understood relevant guide to write learning objectives. It was considered in this study, as the best way to accurately impute each learning objective, in hierarchical levels.

The scope of this study was the cognitive domain. Cognitive domain includes the remembering or reproducing of something that was learned, the application of knowledge in new circumstances and the use of previous knowledge, linked to the recently learned one, in a problem solving approach.

Bloom's taxonomy presents hierarchical levels of the cognitive domain, allowing the definition of learning objectives to address each level, and helps to define how to evaluate student's knowledge about a topic or subject at different levels. The main levels are:

Knowledge – "is remembering or recalling previously learnt material";

Comprehension – "in the lowest level of understanding and interpreting the material so it can be compared and contrasted with similar material";

Application – "is the practical application of knowledge gained by the learner. The learner is informed on a particular subject and application allows them to test this knowledge in a practical situation";

Analysis – "allows the learners to identify the constituent components of the topic they are currently engaged in learning. The learner gains the knowledge on the topic and analysis enables the learner to identify each of the parts that make up the topic";

Synthesis – "involves the learner taking the components or elements of a topic to build some thing new i.e. using old ideas to create new ones";

Evaluation – "engages the learner's own judgement on the material. The learner assesses the value of the material and compares and discriminates between ideas". [13]

The present study intended to measure the student's satisfaction and how comfortable students feel with SSM content, and also to infer which learning objectives of the cognitive domain can be directly addressed by SSM contents. Furthermore, for learning objectives deficiently addressed, we are also looking for additional activities that may be useful (e.g. discussion forums, self evaluation, guided analysis and research, hands-on activities, group techniques). The evaluation results should be compared, whenever possible, with related results from previous years, with special attention to eventual deviations to the typical mean mark obtained with the lecture addressed by this study.

After identification of the problem, and main line definition, planning the project was the next stage of the study. This section describes the methodology followed and the main decisions taken during the planning process.

Initial project meetings were used to determine the scope and objectives, study's target, chronogram and task scheduling, instruments and metrics to measure results. The content development plan included technology definition and implementation scheduling. The chosen subject was Multiprocessing, from IT courses, because it applies to a set of topics common to the undergraduate and postgraduate selected courses.

Another main concern was the assessment instruments. It was decided to get pedagogical expertise support to guide the instruments creation and their validation. Two questionnaires were developed. One for measure the satisfaction level (Satisfaction Questionnaire), the other for evaluation purposes (Evaluation Test). Besides, it was also initially decided that only volunteer students should accomplish both instruments.

Seven (7) specific learning objectives were defined for the subject (Multiprocessing) addressed by the SSM content. Each specific learning objective was associated with a correspondent level of the cognitive domain defined by the Bloom's taxonomy [12]. Since we intend to infer which learning objectives of the cognitive domain can be directly addressed by SSM technology, the SSM contents were presented on their own, without any other supporting learning activity or communication resource. The presentation was preceded only by a brief introduction of the technology and functionalities. Students were given some days to watch presentation and accomplish the satisfaction questionnaire and the evaluation test – time restrictions were considerer irrelevant since one of the SSM's characteristics is exactly to allow students to self-administrate the time they spend with each subject.

The SSM content was composed by: video/audio, with the image of the lecturer explaining the content; slides, synchronized with video to reinforce what was being explained and with soft animations to highlight main concepts; supporting texts and links, when appropriated; and some exercises.

6.1 Instruments

Two main instruments were used in this study: A Satisfaction Questionnaire and an Evaluation Test. The Satisfaction Questionnaire was composed by four areas: Respondent profile area, where questions were made to context the student's answers; the Global Satisfaction area, where respondents gave opinion about the methodology and technology used; the Access area, that allow students to manifest about quality in the access to the content as its interactivity functionalities; Content area, where students could refer about quality of the content and about each elements integrated in the SSM presentation.

The questionnaire includes a mix of answer types (open answers, yes/no, multiple choice), in order to get reliant and complete answers. Both instruments were created under the supervision of experts of the Department of Curriculum and Educational Technology in the Institute of Education and Psychology – University of Minho. Both were also available online, accessed through a Course Management System (CMS) – Moodle[2] – which allow students to accomplish the instruments wherever they wish and automatically register their responses in the project's database.

[2] http://moodle.org (Visited Oct/2005)

6.2 Population

The focus of the study was students from undergraduate degree programmes of Management and Informatics and the postgraduate programme in Information Systems, all from the School of Engineering in the University of Minho.

Fifty seven (57) students have answered to the Satisfaction Questionnaire, forty seven (47) from undergraduate programme and ten (10) from postgraduate programme, but only eighteen (18) have completed the Evaluation Test, sixteen (16) from undergraduate programme and two (2) from postgraduate programme (notice that enrol on both instruments was volunteer).

The main population profile's characteristics are: Fifty seven students from 18 to 36 years old, with a mean age of 22.74 years; thirty eight respondents were male students and nineteen female students; 95% of the students have computers in their homes and, from these students, 85% have access to Internet from the home computers; all students have also free access to computers and Internet in the University.

6.3 Data Collection Process

The Satisfaction Questionnaire and an Evaluation Test were made available to students after a brief presentation of the project, but they were invited to answer only after the time they individually need to watch the SSM content. To accomplish the instruments, students should login in the CMS and only one response per student was accepted. For the evaluation test the overall time of each attempt was registered and uncompleted forms, or forms completed in less than five minutes, were discarded.

7. RESULTS

This section presents the more significant results obtained with the Satisfaction Questionnaire and with the Evaluation Test. To what concerns the evaluation Test, as stated before, we defined specific learning objectives for the subject presented and, for each learning objective, we establish a relation with the five of the six cognitive domain's levels of the Bloom's taxonomy. Naturally, the Evaluation Test included questions to assess how many and to what extend each objective was reached. The sixth level (evaluation) was not considered in this study because the instrument used didn't allow to accurately inferring the cognitive skills necessarily used by students at this level.

The detailed organization of the Evaluation Test was the fallowing: question one was defined at the level one (knowledge) in the cognitive domain of the Bloom's taxonomy; question two and question three should require level two (comprehension); question four should apply to the level three (application); the fourth level (analysis) is assessed by question five; question six is related with the level five of the cognitive skill (synthesis); and finally, the seventh question also apply to levels one and two (knowledge and comprehension).

The table below presents the number of answers considered correct for each question. These numbers evidence almost equity among correct answers, and does not distinguish a particular answer. Therefore, neither a learning objective nor a level of the cognitive domain was emphasized by the instrument results.

Question number	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Number of correct answers	14	10	12	11	14	11	9
Correct answers percentage	78%	56%	67%	61%	78%	61%	50%

TABLE 1. Evaluation Test Results

To what concerns the Satisfaction Questionnaire, a global satisfaction of the content's format was evidenced. From the 57 respondents, 35 (61%) manifest total satisfaction with the SSM content, 19 (33%) manifest some reserves and only 3 (5%) refer displeasure with the SSM content. Most of the respondents, that feel some discomfort, impute this feeling to the absence of way to discuss and post questions.

From the question that addressed the global satisfaction about the content, 52 (91%) of the respondents manifest that the content match their expectations, and only 5 (9%) refer a mismatch between content attended and their expectations.

Through the open answers students referred, as most positive aspects, that SSM content was “less boring than theoretical lectures”, “allows multiple reviews”, was “accessible any time, any where”. On the other hand, as most negative aspects, they were almost unanimous reporting the “impossibility to contact the lecturer”.

Another interesting result derived from the question about which media elements were considered more important to the learning process. By order of importance the answers indicated: slides, audio, video, supporting text / links / exercises. As expected, video is not assumed here as the most important media element since it has been used in a very straightforward way. Despite the tremendous value that can be added by this element, in this study it has not been used in its maximum capacity, and was limited to show the lecturer’s talking head.

The last question of the satisfaction questionnaire asked if students were disposed to totally exchange the time consumed in theoretical lectures by distance learning/self-study activities like this one. 45 (79%) of the respondents agreed with this possibility and 12 (21%) prefer to attend the classroom lectures as they are now.

8. CONCLUSIONS

To what concerns the satisfaction evaluation we clearly registered the enthusiasm and adhesion of the students to SSM contents. They manifest interest in intensifying its use and some expectation to see it extended to other courses.

We also conclude that the SSM contents should be, as expected, integrated in diverse learning activities, that may include small SSM contents with self-evaluation activities, supporting texts, discussion forums, reflection activities, synchronous sessions, guided analysis and research, hands-on activities, group techniques, etc. These activities should support the students, allowing them to control their learning path, to infer their level of knowledge considering the objectives defined for the subject in analysis and to consolidate achieved knowledge. The supporting and communication activities, mentioned by the students, which should complement SSM contents, meet the initial expectations and what is now considered as best practices in e-Learning scope.

A more empirical analysis suggests that engineering students appreciate, as a complement to read material, to see things working, such as experiences, simulations, demonstrations, etc. The integration of video elements in the SSM contents gives that opportunity. Besides, nowadays the student groups are very heterogeneous, being possible to find in the same class students that also work and/or students with different skill levels, possibly from different countries. Obviously exposing them to exactly the same lecture seems to be worst then giving them the opportunity to try different paths with different times, more adequate to personal needs. Once again, SSM contents characteristics fits well in this scenario.

To what concerns the evaluation results obtained and despite we can not state that with SMM activity experience we got better results then we got with traditional classes, we should emphasize that it had not got worst results neither. This way, given the satisfaction level and motivation demonstrated by the students, we are confident to affirm that SMM is a good alternative as a learning tool. The reduced number of students included in the study may also pose some uncertainties concerning results acceptance, specially because this experience run in a voluntary base and there is a possibility of the attendant students being already motivated for this kind of experience. To address this uncertainly we are planning to repeat the experience with different courses, in different faculties, which is simpler now that we have some results and examples to show how to do it.

Finally, to what concern lecturers, we felt some natural resistance to even try such a different approach to their (conventional) activity. Some of them are suspicious about the real value of SMM in learning contexts and think it does not worth the time they would spend. Others do not fell comfortable with what seems to be a very technological demanding approach. They are all right, at least from their point of view. It is impossible to force a lecturer to make a good SMM content if he/she does not believe in it, or has any kind of preconceptions about technology affairs. To make a good SMM content a lecturer need to develop some technical and non-technical skills. It is desirable to understand and know how to use the technology involved and it is necessary some imagination and lecturing experience to put together different media resources towards a common learning objective, just like exploring alternative ways to the same place. All it needs is some training and, of course, the incentive to change.

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Curricula

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