# 'Low-Cost Educational Videos' for Engineering Students: a new Concept based on Video Streaming and YouTube Channels*

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There are many papers that present the problems of educational videos: need of a high number of resources to create them, excess of information in the majority of videos, gaps of information between videos and the rest of materials of the courses, etc. This paper introduces the concept 'low-cost educational video', which attempts to solve to a large extent the problems that have been identified in the educational videos. To this end, an empirical research is conducted with 487 students and various lecturers and professors in three undergraduate degrees: Mechanical Engineering, Industrial Engineering and Management (in face-to-face as well as semi-distance modalities), and Aeronautical Engineering at the Universitat Politècnica de Catalunya (Spain). In order to achieve this goal, we introduce the process and the required resources for the creation and the diffusion of these low-cost educational videos. The results are analysed taking a literature-based questionnaire as a starting point and within the principles of good practice in higher education framework. The main research findings revealed an improved student motivation and an increase of the perceived efficiency in the learning and teaching processes, without substantially raising costs.

Keywords: low-cost videos; video streaming; teaching methodologies; student motivation; perceived efficiency

## 1. Introduction

By the use of new technologies, teaching-learning methodologies at university have been changing progressively. Reduction of attention costs, increase of effectiveness and teaching efficiency are allowed by new virtual tools and resources that Internet provides, such as the Moodle platform -a widely used virtual teaching environment. With the appearance of high-speed connections to the Internet and the Web 2.0, videos open up a new range of possibilities, such as the reduction of teaching and learning costs, while increasing students' satisfaction and motivation. There are many papers that present the advantages and disadvantages of the use of videos in the learning process. However, the majority of these studies present a kind of video that is difficult to create, contains an excess of information, or is independent and not embedded in the rest of materials of the courses. Video streaming -a specific way of distributing videos- allows us to solve some of these problems. Fill and Ottewill [1] suggest that some advantages of the Web 2.0 and, more especially video streaming, are the access speed, the possibility of creating knowledge networks and the active participation of all stakeholders who want to develop them.

In this paper, we introduce the concept of 'low-cost educational video', which allows us to solve some of the main problems or barriers that lecturers and professors identify as the reasons why they do not use videos in their courses. This kind of video is characterized by low production cost in time and resources. In order to assess this new kind of video we conducted a research made up by four phases. The first one was a short course to show the advantages and the process of creating a 'low-cost educational video' using free resources such as 'AutoScreenRecorder 3.0' and YouTube channels. After completing this course, many academics decided to develop and include this kind of videos in their courses. A total of 487 students from three different degrees (Mechanical Engineering, Industrial Engineering and Management—in face-to-face and semi-distance modalities—and Aeronautical Engineering) were involved. In order to assess the results of including this new teaching tool in the courses, the third phase involved the development of an evaluation questionnaire, based on the works of Fernandez et al. [2] and Breen et al. [3], to gather the opinion of students, lecturers and professors. The final phase consisted in analysing the data obtained through the questionnaire and other sources, such as conversations with students, comments through the teaching platform, etc. Finally, we discussed the results within the framework of the principles of good practice in higher education proposed by Angelo [4] and Chickering and Gam-

son [5]. At the end of the paper, some reflections on advantages and disadvantages of the public use of video streaming-based educational channels and on their potential to improve schools and colleges corporative images have been carried out.

## 2. Good practice in undergraduate education

Both Chickering and Gamson [5–6] and Angelo [4] proposed a set of principles for good practice to improve students' learning processes in undergraduate education, which have been widely accepted in the academic environment. These works have many aspects in common, and propose a set of principles for improving learning in higher education: (1) active learning is a key element for improving the learning processes, (2) students need to have high expectations of the course, therefore they need to know the general and the specific goals of the course from the beginning; (3) students need prompt feedback on their learning to achieve the course goals; (4) interaction between lecturers and students is one of the most powerful factors in promoting learning; (5) mastering a skill or body of knowledge takes great amounts of time and effort, therefore working time of students must be considered; (6) lecturers need to increase the motivation of students due to the fact that it is alterable and is one of the main causes of failure; (7) the way in which lecturers evaluate students affects the way in which students study and work during the course; and finally (8) the way how lecturers give the information is an important element for the learning process, due to the fact that students have diverse talents and ways of learning.

In line with the last point, Terenzini [7] suggested that lecturers should respect and consider students' diverse talents and ways of learning. Conner et al. [8] identified different kinds of students according to their learning processes: auditory learners, who prefer to listen to the course in order to learn; visual learners, who assimilate knowledge more efficiently through vision; kinaesthetic learners, who learn better through sensing movements and position, and tactile learners, whose skills allow them to learn better by touching and manipulating objects. However, in most traditional courses the main contents are communicated through the voice of the lecturers in class or thought books or text on the Web.

Although the above principles were developed with independence of the new on-line and virtual tools that Internet provides, Ritter and Lemke [9] suggest that these principles keep being valid in the current situation, and that, according to their research, technological tools improve the learning process in line with some principles such as student-faculty contact, active learning, prompt feedback and a more efficient use of the time. The results of the research of Breen et al. [3] suggest that there is a gap between the theory on learning and teaching practice, especially when conducting research on technologies in a university environment.

## 3. The Video as a teaching-learning tool

During the last decades, the video has been widely known and frequently used as a complement to higher education. Several research studies have recognized its effectiveness as a learning tool (e.g. [10]); however, the existing literature also raised a long list of problems related to the use of educational videos. For instance, the majority of educational videos that we can find required a high number of resources to be created: mainly (digital) cameras, lighting and sound devices, and professional software, which are not always easy to understand and use. As a consequence, upgrading an educational video has a very high cost and, therefore, many of these videos lose value in a short time. From another point of view, the main use of educational videos is to record or capture the live classroom materials. These educational videos are very long and contain extensive quantities of information, which can confuse students because there is no feedback. In the same line, these educational videos are not embedded in the rest of materials of the course and, therefore, these videos do not emphasize working time of students as the principles of good practice propose.

According to Caspi, Gorsky and Privman [11], educational videos can be divided into three categories depending on their use and purposes: demonstration videos, narrative videos and recorded lecture sessions. Demonstration videos are a really good tool to allow and improve autonomous learning, becoming much more effective than other methodologies based on more traditional methods, such as books and written manuals or oral explanations [12]. Demonstration videos allow faculty, especially in technology related areas, to develop new teaching and learning strategies, adding a new dimension in the teaching material. Narrative videos are commonly used in the learning process of a language, offering a unique communicative and cultural context. Finally, video recorded lectures are characterized by the content, which receives full attention. Some researchers argue that this kind of video is not more efficient than audio records or other similar resources [13]. Nevertheless, video recorded lecture sessions have been the most common educational videos during the last decades.

### 3.1 Digital age and low-cost educational video

The use of information technology and communication tools (ICT) is becoming an increasingly common practice within innovative teaching at university. These technologies are new and emerging in education, allowing the incorporation of active methodologies in the teaching-learning paradigm, so tangible and relevant in the European universities due to the European Higher Education Area development and implementation associated with Bologna proposals. Thus, the use of new teaching-learning tools, as chat [14], videoconference [15], podcasting [2] and networked educational videos [16] is in expansion within the academic setting. In the current scenario, where knowledge supply exceeds demand and so many new tools appear, lecturers compete for the so-called 'economy of attention' [17–19]. Motivation and attention of students should increase thanks to the internet audiovisual content, that takes advantage of the possibility of splitting the information into small sections and combining them with other teaching-learning resources such as text, graphics or questionnaires, whether on websites, forums or wikis.

Among these new tools, digital video adds a new dimension to audio-visual teaching materials. Moreover, the fast development of new technologies and the decrease of costs related to video recording, edition and production, make this tool available to faculty, allowing self audiovisual creation, according to the own needs and by means of economic tools with costs similar to the ones required for slide show presentations in any suitable software (e.g. PowerPoint and Impress). A clear example of this is video streaming, which can be defined as a video which can be played by an Internet data stream, directly on a website, in real time, without having to be previously downloaded [10]. In an easier way, it can be described as 'click and get' video, incorporating on-demand strategy for content distribution. Owing to the advantages that are associated with streaming video technology, two very important roles in higher education are identified. On the one hand, video streaming becomes an education tool with many future possibilities and ready to explore; on the other, it has become an outreach and institutional advertising tool for universities [1]. Moreover, stream video technology is widely well known by students, in terms of entertainment, and allows viewing in multiple devices beyond computer such as iPods, mobile phones with Internet connection, etc. (Fig. 1).

Furthermore, students' access to high-quality / low-cost learning materials from anywhere, across multiple platforms, can be guaranteed. From the lecturers' perspective, the Internet itself provides a set of resources that allow viewing audiovisual contents in sessions just with a network connected computer, so there is no need of any software installation or of any specific hardware carrying. In addition, the same material can be easily replayed by students as often as necessary. Even for semi-distance and distance courses, this methodology allows lecturers to devise new communication and students-interaction strategies.

Finally, we define a 'low-cost educational video' as a short demonstration stream video which has a very specific goal and has been created in a very short period of time, with few resources and that can be combined or embedded within other materials of a course. This kind of video allows lecturers to eliminate a great number of the common problems related to the video: the necessary resources (both budget and time) decrease, the process of upgrading the videos is simplified, and it is possible to efficiently fit the video into the course according to the teacher paradigm.

## 4. Methodology

We carried out an empirical research, which consists of a horizontal study over twenty-five courses from three different degrees: Mechanical Engineering, Industrial Engineering and Management, and Aeronautical Engineering, taught in face-to-face and semi-distance modalities, at the School of Industrial and Aeronautic Engineering of Terrassa (ETSEIAT) of the Universitat Politècnica de Catalunya (Spain). The study was conducted during the academic year 2008/2009, introducing low-cost educational videos in different ways, such as classroom sessions, web-integrated using the teaching platform of the University (based on Moodle), or directly through YouTube channels for later reproduction. For the assessment of the efficiency of using low-cost educational videos we gathered information using: (1) a questionnaire based on the works of Fernandez et al. [2] and Breen et al. [3] (with an assessment rubric), which was provided to the stu-



**Fig. 1.** Viewing of a low cost educational video with an iPod.

dents around the middle of each course, and (2) the feedback received from lecturers and students, in conversations, electronic mails and messages in the teaching platform of the University. Finally, we gathered information from 487 students (29.98% woman and 70.02% men), whose average age was 25.68 with a standard deviation of 5.97.

### 4.1 Measurements

Evaluation of emerging educational resources is an activity that requires the execution of judgments on those elements that bring value to the learning process [16, 20]. Thus, we developed a questionnaire and an evaluation table based on the previous works Breen et al. [3] and Fernandez et al. [2] to assess university technology tools from a list of 15 elements including: specificity, efficiency, consolidation handiness, accessibility handiness, interest, accidental discovery, interaction, circulation, overload information, quality of information, failure, preparation, competitiveness for access, availability and attractiveness. Table 1 lists these features and their definitions. At this questionnaire, we included 12 items to evaluate the principles for good practice to improve students' learning processes in undergraduate education.

### 4.2 Elaboration of audiovisual material and formation of lecturers

One of the key specifications of this research was focused on the concept of low-cost educational video, which implied finding ways to produce and distribute audiovisual teaching material minimizing the tangible (in terms of physical and economic resources) and intangible costs. For instance, lecturers would not require advanced levels of knowledge for the creation and edition of videos. Moreover, the necessary software was selected according to two criteria: the cost of the license and the ease of use of the software. Finally, the preparation time of the low-cost educational video should not exceed the necessary time for other conventional teaching materials (e.g. books, manuals, cases, slides) without sacrificing quality. After analyzing the diverse software in the market, we decided to use Open Office as an office computer system, Auto-ScreenRecorder 3.0 (for Windows OS) or Copernicus (for MAC OS X) as screen capture tools and Windows Media Player (for Windows OS) or iMovie (for MAC OS X) for video edition and production. Moreover, lecturers needed to use a microphone or a webcam to record the voice or some images. The following step was to decide the way to distribute this kind of videos. Among the multitude of available platforms for open access videos distribution, including some already existing in the university, YouTube (http://www.youtube.com) was selected, mainly motivated by the following reasons:

- YouTube is, currently, the streaming video platform with the most visits, and provides many videos in all areas of interest.
- Following the Web 2.0 philosophy, YouTube

**Table 1.** Low-cost educational video features and their definitions

| Features | Definitions |
| --- | --- |
| Specificity | Belief or judgment that low-cost educational videos provide results of direct relevance to the learning process accompanied by little irrelevant information |
| Efficiency | Belief or judgment that the low-cost educational videos and their information can be accessed without wasting time or effort |
| Consolidation convenience | Belief or judgment that the low-cost educational videos can be accessed via one single place or device |
| Accessibility convenience | Belief or judgment that the low-cost educational videos can be used at any chosen time |
| Interest | Belief or judgment that intellectual stimulation results from using the low-cost educational videos |
| Serendipity | Belief or judgment that accidental discovery occurs when the low-cost educational videos are used |
| Interactivity | Belief or judgment that the low-cost educational videos respond to characteristics of a user or query |
| Currency | Belief or judgment that the low-cost educational videos produce up-to-date results |
| Information overload | Belief or judgment that learning is impaired by the quantity of irrelevant material |
| Information quality | Belief or judgment that the low-cost educational videos produce results that are valid |
| Failure | Belief or judgment that learning is impaired by malfunction of the low-cost educational videos |
| Preparedness | Belief or judgement that use of the low-cost educational videos is impaired by absent or incomplete learner skills |
| Competition for access | Belief or judgement that the use of the low-cost educational videos disadvantages other learners |
| Real time | Belief or judgement that the information about a learning domain captured by the low-cost educational videos is complete |
| Appeal | Belief or judgement that the use of the low-cost educational videos is intrinsically pleasurable |

allows users to create and keep responsible management of their own channels independently.

- Internationally renowned universities channels, including Universitat Politècnica de Catalunya, are included in this environment.
- Free statistical tools for monitoring and evaluating videos are available.
- The contents are open access, with worldwide diffusion.
- The possibility of easily creating playlists and having permanent links to each channel and video allows combining contents with other platforms, such as Moodle.
- YouTube allows users to upload videos from many different formats, eliminating the problems related to the creation and edition of software.

All these advantages facilitate the lecturers' self-management of the distribution and the maintenance of their own educational videos, with a null economic cost and a minimal time cost, as compared with other video channels. This fact is supported by the comment of one of the members of the project: 'It's as easy to manage my videos through my YouTube channel as to manage the rest of my materials (slides, pack of problems, cases, etc.) in the university open access repository'. Another advantage of the use of YouTube was the chance of creating a network between lecturers, using the option 'Subscribe' of this platform. For making these links or network stronger, the authors created a common YouTube channel where all YouTube lecturers' channels were included. This channel (see http://www.youtube.com/user/upcetseiat) includes the low-cost educational videos of the lecturers and professors of this project and other materials related to the University: conferences, news, educational and cultural activities, etc. Moreover, this YouTube channel allows students to access easily all educational videos and giving, at the same time, a new tool for publicising the quality of the University and distributing corporate information.

After the selection of the required software and hardware, we sent a call for participation in the project to lecturers and professors of the School of Industrial and Aeronautical Engineering of Terrassa. After the first filter, twenty-five subjects were selected for the study. The training of lecturers and professors on the necessary tools for creating and editing low-cost educational videos was developed by means of a semi-distance course during two weeks. Finally, the course showed the ways how lecturers and professors could integrate their educational videos in the teaching platform of the University (named ATENEA after the goddess of wisdom in Greek mythology). The platform ATENEA is a Moodle-based web application that en-

ables integration of high variety of online multimedia resources available through an architecture based on PHP language and MySQL database. Thus, the insertion of YouTube hosted videos was a simple task and allowed different modes, from simple combination of video and text insertion (Fig. 2), to multiple combined video, text, quizzes and other online resources.

## 5.  Results and discussion

After the creation of more than seventy low-cost educational videos and their use in the twenty-five selected courses, we gathered information from students through the previously developed questionnaire, whose items were assessed through a 1-5 Likert scale. We identified six different goals during the development of the low-cost educational videos according to the lecturers who took part in the project: (1) to improve the students' comprehension on the main topics, (2) to increase the students' motivation level; (3) to rise the student's attention level; (4) to stimulate the students' self-learning; (5) to improve the efficiency of the face-to-face sessions; and (6) to generate debate among students. Table 2 shows the obtained results (mean and standard deviation among parenthesis) from the 487 students who completed the questionnaire according to the features presented in the Table 1. The results are shown as a whole and separately according to the six goals. The fifteen features of the questionnaire can be classified into four categories or groups. The first set of features refers to the usefulness of low-cost educational videos. The second group includes the easiness and restrictions of the use of low-cost educational videos according to engineering students. The third category makes reference to students' motivational aspects. Finally, the last set of features concerns the quality of the content of the low-cost educational videos used in this project.

There are various features in the questionnaire, that allow us to assess the usefulness of low-cost educational videos, as for instance, the 'Specificity' and 'Currency' features, which obtained a high (3.79) and medium-high score (3.10) respectively. On one hand, the results of the 'Specificity' feature are similar in all educational videos independently of the six initial goals. Lecturers expect these results due to the fact that the low-cost educational videos are defined as 'short demonstration stream videos, which have a very specific goal [. . .]'. On the other hand, we also obtained similar results in the 'Currency' feature for the majority of education videos except for those whose goal was to improve the face-to-face sessions. The fact that there are only a few videos of this kind could be the reason why the assessment of the 'Currency' feature is not as high as
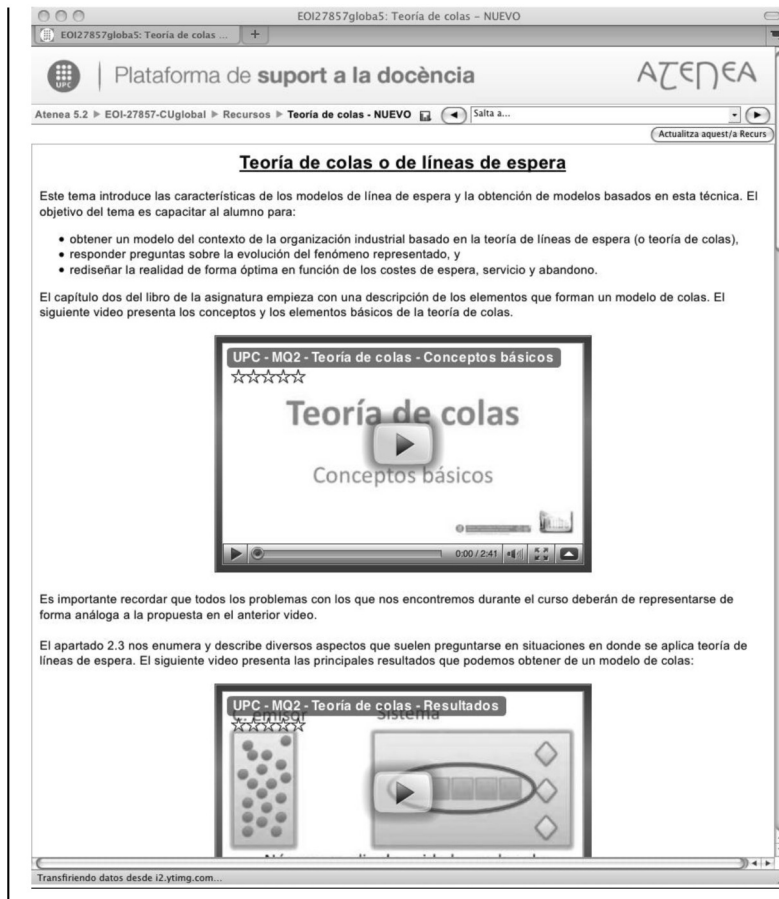
**Fig. 2.** Example of low-cost educational video combined with text in a Moodle platform.

**Table 2.** Results of the questionnaires about the features of the low-cost educational videos

| Features | Global | Goal 1* | Goal 2* | Goal 3* | Goal 4* | Goal 5* | Goal 6* |
|---|---|---|---|---|---|---|---|
| Specificity | 3.78 (0.78) | 3.89 (0.76) | 3.87 (0.76) | 3.96 (0.75) | 3.78 (0.80) | 4.05 (0.74) | 4.04 (0.72) |
| Efficiency | 3.87 (1.01) | 3.96 (1.01) | 3.88 (1.02) | 3.91 (1.01) | 3.73 (1.00) | 4.56 (0.63) | 3.85 (1.01) |
| Consolidation convenience | 3.89 (1.08) | 3.89 (1.15) | 4.12 (0.97) | 4.19 (0.95) | 4.06 (0.91) | 2.07 (0.69) | 3.77 (1.07) |
| Accessibility convenience | 3.86 (0.99) | 3.92 (1.03) | 3.93 (1.06) | 4.03 (1.04) | 3.88 (0.99) | 3.83 (0.83) | 3.77 (1.03) |
| Interest | 3.83 (0.86) | 3.89 (0.86) | 4.01 (0.81) | 4.00 (0.88) | 3.86 (0.84) | 2.95 (0.67) | 4.12 (0.86) |
| Serendipity | 3.78 (0.75) | 3.84 (0.76) | 3.82 (0.77) | 3.78 (0.77) | 3.72 (0.76) | 4.02 (0.66) | 3.85 (0.78) |
| Interactivity | 3.56 (0.94) | 3.69 (0.94) | 3.58 (0.91) | 3.74 (0.93) | 3.56 (0.92) | 4.59 (0.67) | 3.31 (0.84) |
| Currency | 3.10 (1.05) | 3.20 (1.09) | 3.03 (1.01) | 3.00 (1.05) | 2.92 (0.97) | 4.54 (0.67) | 3.31 (0.97) |
| Information overload | 2.39 (1.08) | 2.46 (1.11) | 2.27 (1.00) | 2.40 (0.96) | 2.42 (0.94) | 3.90 (0.86) | 2.23 (1.03) |
| Information quality | 3.49 (1.09) | 3.58 (1.10) | 3.45 (1.08) | 3.38 (1.11) | 3.32 (1.10) | 4.54 (0.64) | 3.23 (1.11) |
| Failure | 2.53 (1.01) | 2.68 (1.08) | 2.43 (0.85) | 2.59 (0.89) | 2.50 (0.84) | 4.63 (0.56) | 2.09 (0.68) |
| Preparedness | 2.10 (1.10) | 2.25 (1.14) | 2.05 (1.02) | 2.25 (1.02) | 2.11 (0.99) | 3.83 (0.70) | 1.88 (1.03) |
| Competition for access | 2.42 (1.06) | 2.43 (1.13) | 2.17 (0.87) | 2.16 (0.88) | 2.20 (0.84) | 4.50 (0.71) | 2.73 (1.04) |
| Real time | 3.72 (0.90) | 3.82 (0.87) | 3.72 (0.84) | 3.68 (0.83) | 3.51 (0.84) | 4.63 (0.70) | 3.85 (0.97) |
| Appeal | 3.65 (0.85) | 3.72 (0.81) | 3.70 (0.84) | 3.65 (0.81) | 3.47 (0.84) | 3.88 (0.60) | 4.15 (0.78) |

* Goals: (1) to improve the students' comprehension on the main topics, (2) to increase the students' motivation level; (3) to rise the student's attention level; (4) to stimulate the students' self-learning; (5) to improve the efficiency of the face-to-face sessions; and (6) to generate debate among students.

in the majority of cases. In the educational videos made to improve the face-to-face sessions the results were better because they were needed to follow and to participate in these sessions.

Two other features related to the usefulness of this kind of videos are 'Failure' and 'Serendipity'. According to the students, the feature 'Failure' obtained a medium-low score (2.53), which is very

worrying because it reflects that the use of low-cost educational videos could cause a damaging effect upon the students' learning process. This feature is very important because a low score is a necessary condition to consider this kind of solution acceptable in education. For this reason, we gathered more information about the causes of this score through conversations with some students and by analyzing some comments that we have received through electronic mail and the teaching platform. We found out that there were two main reasons for this score: students need an online device (computer, laptop, handle . . .) for using this kind of material, and some of them preferred physical materials to study in any place independently of the resources that they had. All the results about this feature are similar except for those related to the improvement of the face-to-face sessions, where the score is very high. Students justified these results because they were not able to easily access the educational videos during the face-to-face sessions. Other kind of physical material (e.g. written documents) would allow a revision during the sessions. Another constructive comment about this kind of videos is that videos do not allow students to obtain a global vision of their content unless they fully view them. These results agree with those obtained with the use of podcasting in higher education [2]. A high score (3.78) was obtained in the 'Serendipity' feature. We received many comments from the students expressing their satisfaction for having understood some specific concepts, which would have been difficult to assimilate otherwise, through the core didactic materials of the course (especially the written documents).

With regard to the easiness and restrictions of the use of low-cost educational videos, there are two more features which are necessary conditions, together with the feature 'Failure', to assess if this kind of videos is useful in Higher Education: 'Competition for access' and 'Information overload'. The score of the first feature is medium-low (2.42). We were very surprised to find these results because we expected lower scores. We looked for the reasons of these results and students explained that it would be more interesting to show the same information in different formats instead of replacing the old materials with these new low-cost educational videos. The result of the 'Information overload' feature (2.39) showed that the use of educational videos does not increase significantly the quantity of learning resources in an unnecessary way. On the contrary, the use of this kind of videos allowed for a significant reduction in the number of questions about the topics covered by the educational video because it was not necessary to clarify details with further comments.

Another considered feature is 'Preparedness', whose score is low (2.10) as we expected. One characteristic of this educational tool is that students do not require specific skills to use them and, therefore, we can eliminate the need for preparing or training students in their use. However, in the cases where educational videos were used in face-to-face sessions, the result was different because students needed to divide the videos into segments for carrying out their activities.

Finally, we observed that the score of the 'Efficiency' feature was medium-high (3.87), which was in line with the results of the previous features. This result is higher in the educational videos to improve the face-to-face sessions, because each video was related to a specific activity or exercise in the session.

The third set of features makes reference to students' motivational aspects. The 'Interest' and the 'Interactivity' features had high scores (3.83 and 3.56 respectively). These results were consistent with many comments that the lecturers received from students, who noted that the use of a new kind of materials was motivating. According to the students, the time that the lecturers spent in creating and editing videos to improve the learning process reflected the lecturers' concern, interest and desire to help them and support their learning. Again, these results are different in the case of educational videos aimed at improving the classroom sessions. In this case, the 'Interactivity' feature has a very high score (4.59) because these educational videos were related to activities in working groups. The last feature of this set is 'Appeal', which scored 3.65. According to the students, the use of the videos was intrinsically very pleasurable, and enhanced their motivation. Fernandez et al. [2] suggested that the use of podcasting also provided an increase in students' motivation because it represents a new technology and students perceive such work as showing a greater involvement of the lecturers towards the students.

Finally, The scores of the two features concerning the quality of the content of the low-cost educational videos: 'Real time' and 'Information quality' were 3.72 and 3.49, respectively. We have to be careful when interpreting these results because they are much related to the personal characteristics of each lecturer and professor.

Table 3 shows the obtained results (mean and standard deviation among parenthesis) from the 487 students according to the principles of the good practices in higher education. (See [5])

The first and the seventh principles (active learning and cooperation among students) obtained medium-high scores (2.62 and 2.84, respectively). Lecturers and professors expected these results because the objectives of the low-cost educational videos were to explain core concepts of the subjects,

**Table 3.** Results of the questionnaires about the good practices in the use of low-cost educational videos

| Principles | Global | Goal 1* | Goal 2* | Goal 3* | Goal 4* | Goal 5* | Goal 6* |
|---|---|---|---|---|---|---|---|
| 1: Active learning | 2.62 (1.20) | 2.65 (1.24) | 2.71 (1.27) | 2.88 (1.32) | 2.86 (1.26) | 2.17 (0.83) | 2.46 (0.95) |
| 2: High expectations | 3.18 (0.89) | 3.23 (0.85) | 3.30 (0.87) | 3.28 (0.90) | 3.20 (0.90) | 2.66 (0.39) | 3.58 (0.84) |
| 3: Prompt feedback | 3.40 (0.93) | 3.47 (0.94) | 3.34 (0.87) | 3.28 (0.92) | 3.20 (0.92) | 4.52 (0.79) | 3.50 (0.91) |
| 4: Interaction—lecturers and students | 3.00 (1.07) | 3.10 (1.07) | 2.98 (1.05) | 2.92 (1.08) | 2.77 (1.00) | 4.02 (0.72) | 3.31 (1.23) |
| 5: Time on task | 3.51 (1.15) | 3.49 (1.23) | 3.77 (0.98) | 3.72 (0.98) | 3.64 (0.96) | 1.29 (0.56) | 3.69 (0.84) |
| 6: Motivation of students | 3.31 (0.68) | 3.35 (0.67) | 3.41 (0.69) | 3.38 (0.71) | 3.26 (0.70) | 2.90 (0.25) | 3.66 (0.74) |
| 7: Cooperation among students | 2.84 (1.09) | 2.87 (1.13) | 2.64 (0.95) | 2.55 (0.96) | 2.51 (0.92) | 4.63 (0.77) | 3.38 (1.17) |
| 8: Students have diverse talents | 3.97 (0.82) | 3.98 (0.86) | 4.03 (0.85) | 3.98 (0.88) | 3.92 (0.82) | 3.61 (0.86) | 4.04 (0.93) |

* Goals: (1) to improve the students' comprehension on the main topics, (2) to increase the students' motivation level; (3) to rise the student's attention level; (4) to stimulate the students' self-learning; (5) to improve the efficiency of the face-to-face sessions; and (6) to generate debate among students.

except when the educational videos were to improve the face-to-face sessions. In these cases the feature 'Cooperation among students' was very high (4.63). The principles about expectations (2nd principle) and motivation (6th principle) have been discussed previously through the features of Table 1, and they are consistent with the conclusions of Charman and Elmes [21], who stated that multimedia and technological course materials help to enhance satisfaction, stimulation and student interest. Feedback (3rd principle), Interaction between lecturers and students (4th principle), and Time on task (5th principle) also scored medium-high values (3.40, 3.00 and 3.51, respectively). Although these results are secondary to the goals of this research, we observed that the lecturer's voice gives students an increased feeling of proximity than other materials. These facts enhanced the feeling of a permanent contact between students and lecturers, as well as of lecturer's concern regarding students' needs. According to Chickering and Gamson [6] and Terenzini [7], lecturers should respect and consider students' diverse talents and ways of learning. Connected with this, the obtained results for this principle (8th) are very high (3.97). We have to remember that this kind of videos can improve the learning process of the auditory learners more than that of the visual learners.

For all the above reasons, we believe that the use of low-cost educational videos is a good choice for improving learning in Higher Education without forgetting or replacing the existing educational materials in other formats.

## 6. Conclusions and future developments

Low-cost educational videos are an invaluable aid in teaching and enable students to visualize examples and processes related to subjects, much better than other kind of teaching materials that require a longer assimilation time. This study reveals that low-cost educational videos reduce significantly face-to-face students' tutoring. One of the main effects of the use of low-cost educational videos was the increase of students' motivation and, consequently, the improvement in the teaching-learning processes. Moreover, this kind of videos improves students' ability to learn in an autonomous way. Discussion and cooperative learning have been encouraged, because dynamic teaching materials can promote searching for new audiovisual materials by students, and therefore, the impact on quality of teaching-learning process is highly positive.

Audiovisual contents promote dynamism in classes, helping subjects' comprehension, making contents more attractive and reducing absenteeism in classrooms, because many students prefer short videos rather than long paragraphs written in response to particular questions. This substitution is considered adequate only if it is associated with a complementary process, because videos do not offer a global vision of a topic. The number of questions is greatly reduced, because students can improve their ability to learn independently. Moreover, it must be noticed that videos allow quick and easy viewing, but they only provide very specific contents and therefore they must not be considered themselves the main element of training. So, written explanations associated with audiovisual content are excellent teaching material, as they can provide a clear and complete idea of a particular event or process.

For all these reasons, authors recommend and encourage such initiatives in different universities, given the very positive results obtained in this research. The creation of YouTube channels and their self-management can help lecturers distributing knowledge more easily in their own university and among other colleagues. This helps knowledge interchange creating synergies beyond departments and universities.

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