Chapter

An Educational Project Based on a Digital Library of Filmed Courses

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Abstract

In this chapter we describe the experience developed around OpenFING, a project based on a digital library of filmed courses. We highlight OpenFING as an initiative of students for students that has obtained the support of the Engineering School of *Universidad de la República* (Uruguay). Currently, OpenFING seeks its consolidation along with an undergraduate course of initiation to audiovisual and multimedia production. The project aims to be an engine to develop educational innovations and different computer tools to support teaching and learning. The objective is to transform OpenFING into an effective collaborative and interactive open learning platform. From the evidence collected by this work, we can conclude that OpenFING is perceived by students and some teachers as an appropriate resource complementary to learning.

Keywords: lecture videos, flipped learning, digital skills, open educational resources, digital libraries

1. Introduction

Many universities disseminate their courses openly on the Internet as part of a policy that encompasses the publication of the knowledge imparted. For instance, the Massachusetts Institute of Technology's OpenCourseWare [1] and the Open University's initiative OpenLearn [2]. Likewise, private organizations also publish courses: Khan [3], Udemy [4], etc. Open policies can change from site to site, and resources can be video-based, as well as text-based, but most of the resources use video. This variety of available resources promotes the implementation of new teaching and learning methodologies, such as blended learning [5–7] and flipped learning [8, 9]. Blended learning is a combination of online and traditional learning (face-to-face learning). Both learning methods are complementary. The online learning includes, for instance, the use of videos, online reading material and online assignments. In flipped learning (flipped classroom) the delivery method in traditional learning is reversed. For example, a student is asked to watch a learning video, read certain material, or participate in an online learning exercise before class. Class time is used to work on the concepts involved, with the guidance of a teacher. In all these methodologies there is generally an online platform where students and teachers can interact.

This work presents OpenFING, an educational initiative based on a digital library of filmed courses, that has the support of students, teachers and learning technologists who collaborate in the development of the OpenFING Project at *Facultad de Ingeniería* (FING), which is the Engineering School of the *Universidad*

de la República (UdelaR), the major university in Uruguay (with approximately 145.000 students). FING is a large faculty, with approximately 10.000 enrolled students and more than 900 teachers to cover 20 programmes in Engineering. Student participation is expected and appreciated at any stage. A lot of students also work full time. The lecture halls for the initial years of most programmes are overcrowded. Most FING courses have two mid-term exams with a pass mark of 60%. A lower score prevents the student from taking the final exam.

As many Latin America schools, FING is experiencing an increase in matriculation rates and scarce resources, observing low graduation and high drop-out rates. New strategies have become necessary to adapt the scholar system to this reality. The video-recording of traditional lectures is a low-cost activity for teachers and it can be seen as a supplement for a traditional course. According to some studies, recorded lectures can become a helpful tutoring resource, mainly because videos have a slower, more step-by-step lecture style than the classroom lectures; student use of videos is voluntary and can be tailored by students to meet their learning and topic-review needs, and can occur when and where students learn most effectively.

OpenFING is essentially a digital video library of standard lectures or masterclasses. The project emerged from a student's initiative: recording courses and publishing the videos openly on the internet. Originally, the use of videos was regarded as a support for the personal study of the student, not as a substitute for the classes. However, the digital resource also addresses issues such as overcrowded lecture halls and the attendance of students who also work full time. Also, the project is a means of introducing innovation in educational strategies, such as the flipped learning model, used in various parts of the world with good results from a learning point of view [8, 9].

In order to sustainably support the OpenFING project and the continuous participation of students, in mid-2016 the course Introduction to Audiovisual and Multimedia Production (IPAM) was created, awarding credits for FING's degree programmes. This allows students who participate in OpenFING to learn digital skills related to the use of cameras and non-linear video editing, as well as the development of other digital educational resources.

The main objective of this chapter is to share OpenFING's experience and tasks planned for the project's evolution. The aim is to improve academic level and enhance the learning experience, taking advantage of the participants' efforts. This chapter is essentially an extended and updated version of [10].

The rest of the chapter is organized as follows. Section 2 discusses the concept of openness in general and its implementation in access to teaching material. Section 3 presents how OpenFING operates and Section 4 describes the OpenFing platform. Then Section 5 introduces the IPAM course and Section 6 analyzes educational experiences that are being developed by considering the integration of OpenFING in teaching and learning processes. Section 7 considers related work and finally Section 8 presents learned lessons and final remarks.

2. Open science, open access and open educational resources

Open science and open access to information sources is still not universally accepted; one part of the world has access to the great variety of paid information resources while the other part depends, at least partially, on free of charge information resources available on Internet. In both cases, members of educational institutions are interested in materials that already incorporate content with a specific didactic or pedagogical approach. These materials are often referred to as digital learning materials [11]. Digital learning materials are available from

multiple personal, corporate and institutional web pages on the Internet, as well as in digital repositories [12].

Open access means that information resources are digital, Internet, free of charge, and free of most copyright and licensing restrictions [13]. In the last two decades, open access initiative has played a prominent role in the dissemination of educational material that is normally found in the libraries of academic institutions [14]. This initiative supports the idea of open science which is gaining on popularity as open access information resources increase.

2.1 Open science

Open science is the idea that scientific knowledge of all kinds should be shared openly as early as is practical in the discovery process [15]. The benefits of open science include sharing of knowledge, especially the knowledge that is publicly funded and the ability to use and reuse the results in particular of teaching where quality information resources are needed. Open science depends on open science information resources that provide opportunities to facilitate access to knowledge.

The idea of open science began to spread and generalize globally. In particular, the proliferation of open access information resources is a prominent manifestation of this process.

2.2 Open access

Paid information resources have become one of the major obstacles in work of the higher education institutions, mainly due to the high cost of subscription to scientific publications that many university libraries have to cover [16]. In particular, students and teaching staff need ubiquitous daily access to information resources which must satisfy the following characteristics: they must be free of charge, they must have validated content and be easily accessible, they must use common formats, etc. The open access initiative became increasingly attractive to facilitate access to scientific information resources used for teaching and research.

The greatest benefits of open access can be observed in research and teaching at academic institutions. However, open access is not understood and presented equally everywhere. There are differences in openness and rights of users in accessing and using scientific and educational materials in open access digital repositories.

2.3 Open educational resources

Open educational resources began to develop a decade after the open access initiative emerged. In 2001, MIT started OpenCourseWare, an initiative that was followed by several universities around the world that contributed to the advancement of open educational resources. Additionally, organizations such as UNESCO, the OECD, the Commonwealth of Learning, and the European Union have supported the development of open educational resources [17].

Open educational resources (OER) are essentially educational materials that are available on the Internet with a low level of restriction. According to UNESCO, *open educational resources are technology-enabled, open provision of educational resources, for consultation, use and adaptation by a community of users for non-commercial purposes*. These resources are generally freely available on the Web or the Internet, and are primarily used by teachers and educational institutions to support course development. Additionally, they can be used directly by students in their usual academic activities. Open educational resources include, for example, learning objects such as videos, lecture material, experiments, references and readings, simulations, and demonstrations.

3. OpenFING

OpenFING was created in 2012 as part of an undergraduate thesis in Computer Science [18], with the intention of providing support in teaching and learning activities using a Semantic Web Technologies platform based on videos. The initiative attempted to solve the problem that a large percentage of students have: most cannot attend classes regularly or must do so in overcrowded lecture halls. Having the complete classes recorded on video and available on the web allows students to follow the course Internet at their own convenience. The initiative also sought to provide an additional tool for students to prepare for their tests, particularly during exam periods.

Nowadays, the OpenFING platform [19] has more than 70 filmed courses (mainly at undergraduate level), making a total of more than 1400 individual lectures. What differentiates this initiative from others is the number of volunteers that have participated: over 200 people including IPAM students.

Between 2013 and 2015, a camera and video editing workshop was held each semester. These workshops were attended by some students enrolled in the Computer Science degree, which prompted the degree directors to assign academic credits to those students who had recorded or edited a course. This was a way to encourage student participation in the OpenFING project. Approximately 40% of the regular courses of Computer Science degree were recorded and published by OpenFING in that period. Also, the option of recording new optional courses was added every semester. It must be understood that nearly 50% of all FING students are enrolled in a Computer Science programme; accordingly, recording those courses turned out to be a high-impact action. From 2016 until now, academic credits are obtained through the IPAM course (see Section 5), and the contents cover further academic programmes from FING.

Accomplishing the organization of such a complex schedule has certain logistical challenges; thus every semester important decisions have to be taken by the coordinating group:

- Which courses to be recorded needs to be agreed, involving authorization from the corresponding teachers and planning for the use of equipment (cameras, microphones, memory cards, tripods). If the teachers refuse their permission to have lectures recorded, then the course goes back to a queue of courses that may be recorded the following period.

- Agreement must be reached on how the course should be published. It is either published on the public OpenFING site or in the Virtual Learning Environment (VLE) where only teachers and students can access it.

- The coordinating group needs to recruit FING students who are interested in participating in OpenFING, and establish who records and edits each course. The recruitment campaign is run using OpenFING's Facebook page and the official FING website.

- During the semester, coordinators need to keep in touch with those students who are filming and editing the lectures, making sure they are performing their tasks in a right and committed way. The editing process is carried out by groups of four students. The task list is defined and distributed among the group members.

- All equipment needs to be checked to ensure good performance. Before each lecture scheduled to be recorded, students check every camera, microphone, battery pack and memory card and their availability.

The members of this team are mostly committed students who remain working on the project for some years, and pass on their knowledge to new members. Recently, FING started to pay a small stipend to two of them, and also had a staff member from *Unidad de Enseñanza* (UEFI) – a center for teaching and learning development at FING – join the team. The recording and editing tasks are carried out by students of the IPAM course. Also, volunteer students participate of their own accord, receiving no academic recognition or payment.

The strength of OpenFING's working model is the students' involvement in the recording and editing of lectures. For example, during the recording they must decide if the teacher or the blackboard must be on frame at a particular time. It is mandatory for the student to have certain knowledge of the lecture topic to do this. The cameraman's knowledge of the topic is essential. For this reason, it is necessary that students in a recording team have previously taken the course. This form of organization is considered an added value when compared to a lecture recorded by a standalone, fixed, big long shot. This fixed model is for example used by *Facultad de Psicología* (Psychology School of UdelaR), or when the recording is done by people who have no knowledge of the course to be filmed.

The OpenFING streaming model is based on an Open Education workflow and on the collaboration between professors and students. The courses are available in digital format, under a Creative Commons open license (BY-NC-ND 4.0). This increases the opportunities for studying and learning, and also the visibility of the University's production. Since 2013, following international trends, UdelaR's governing body is internally promoting the adoption of policies intended to implement more use of open virtual resources. The use of Free and Open Source Software (FOSS) and the creation of an Open Access repository, plus a series of policies aimed at opening up education, allow the material to be used by anyone, democratizing access to knowledge. With more than 110,000 undergraduate students [20] and close to 11.000 teachers [21], the University accounts for the vast majority of the country's total student enrollment, and is considered the main site for the promotion of Open Access and the development of Open Educational Resources (OER). Compared to other South American countries, Uruguay seems to present an enabling environment for Open Education [22].

OpenFING has been adopted by students as an additional study tool. The average number of weekly accesses to OpenFING went from 5.000 in 2014 to 25.000 in 2019. In 2020 this number doubled, due to the COVID-19 pandemic and the need to develop the courses (essentially) virtually, with higher measurements in periods close to the evaluations of the courses.

4. The OpenFING platform

The OpenFING platform was intended to be a collaborative tool based on a variety of materials, but focused on the videos of lectures. The project has a platform with a server which is integrated into the server pool of FING. In this pool, three services are executed: a video server, a production web server and a development web server. These servers are managed and maintained by the *Unidad de Recursos Informáticos* (Information and Communication Technologies Unit) of FING, in coordination with a Computer Science professor and a volunteer student. There is

also another dedicated computer used for exchanging footage between cameramen and editors, as well as for other tasks (post-editing, viewing, graphics).

A new version of the platform is being developed, which includes mechanisms of comment's moderation, together with an easier way to publish videos and an independent chat room. Also, some additional tools might be added, like a Cornell Notes editor [23] and some data analysis process in order to monitor learning and teaching activities. We expect to have an updated platform soon with a collaborative mechanism and facility to relate topics in different videos. Moreover, functionality to add notes to a video will be developed in order to manage teaching in a better way.

Our main goal is to convert OpenFING into a Semantic Web based collaborative platform to publish and annotate videos. With this platform, teachers and students can annotate videos with topics, comments, web resources, and other kind of metadata to improve their teaching and learning activities. One of our main concerns from the technical point of view was to develop an architecture in which new features could be easily introduced to the platform. This leads us to the use of Semantic Web (SW) technologies [24] to develop the platform, in particular Linked Data paradigm [25].

Some functionalities, via a set of use cases, are:

- *Search and find*: a user starts the session selecting a course in the Course Menu. Also, the Search Box can be used to perform queries. Queries input may be plain text (e.x. "induction") or contain tags to refer to specific objects in the platform (e.x. course:, lecture:). Then, the search is performed using a combination of SPARQL queries and text search on the labels and titles values. In our example, the search for "induction" returns a video lecture where the title "Inductive Set Definitions" matches the search criteria. This video contains the complete lecture about the concept he is looking for, but also other related concepts.

- *Fragmentation and annotation*: while the user is watching the video, he decides to mark the video fragment where the teacher defines the "Declarative View of Inductive Sets", and annotate it with the topic "Declarative view". To do this, he uses the Annotation Type Selector to declare the type of the annotation as a "Topic", and then he writes the topic in the Fragment Creator text area. At this time, the fragment start time is recorded. When the user pushes the blue button, the end time is recorded and the video fragment and its annotations are saved. Both objects are associated with the user. In the system, video fragments are identified by URLs which follow the Media Fragment URI 1.0 recommendation of W3C.

- *See annotations of other users*: while the user watches videos, he can also see annotations created by other users in the Annotation Viewer. These annotations appear dynamically as the start time of related fragments is reached. When the user clicks in an annotation, the related video fragment starts in the player.

- *Using external resources*: OpenFING may coexist with learning platforms, such as Moodle. Users may then also annotate video fragments using URLs that refer to lecture slides, or questions in a forum. This mechanism also allows to add reference to any URL on the internet, in particular to add references to other video fragments in OpenFING, and was developed at zero cost because the use of standard dereferenceable URIs.

- *Recommended videos and resources*: while users watch videos, related videos and resources are shown in the recommendations panel, which is accessible from the View Selector. The contents of this panel change dynamically according to the annotations found in the video. The recommendation criteria implemented so far is very simple, and retrieves video-fragments that refer to the same topic, but other criteria can be easily added to the platform.

- *Teachers Activities*: students may use OpenFING without involving the teachers, but their participation may improve the experience. For example, teachers can curate users annotations assessing its correctness, or help in the organization of topics according to some taxonomy. Also, teachers can evaluate the comprehension of a certain topic by checking the annotations created by students. Finally, teachers can also propose the creation of annotations as a learning activity, as suggested in [26].

It is expected that the previously mentioned strategies will have an impact on student learning, by providing a space for reflection and exchange of different points of view on the content of the courses. The objective is to transform the project into an effective collaborative and interactive learning platform.

5. The IPAM course

In 2016 the deanery of FING, learning technologists from the UEFI, the responsible professor for the project at the *Instituto de Computación* (InCo) – the Computer Science department at FING – and staff from the *Facultad de Información y Comunicación* (FIC) – the School of Information and Communication of the UdelaR – started to work together around OpenFING to generate an optional undergraduate course in response to three observed problems:

- the sustainability of OpenFING over time;

- the lack of basic audiovisual knowledge and production skills among engineering students; and

- the differences in quality of OpenFING outputs.

The aim of the course is to develop the ability to create learning resources in various formats, developing skills of content hierarchy, design, production of original materials and therefore communication and digital literacy skills [27]. The theoretical–practical course is offered to students in different FING programmes, as well as those from other schools. Students enrolled in IPAM work in teams. In summary:

- they engage in the recording and editing of a regular undergraduate or graduate course of FING, to be published in the OpenFING digital library;

- they produce an audiovisual or multimedia resource related to the courses, programmes, research, or develop topics of interest for FING, intended to be used both by students and staff.

These types of resources are aligned with the future plans for the OpenFING platform. IPAM encourages the development of OpenFING, as well as the

production of other open educational resources. FIC professors teach general knowledge about communications and audiovisual production that allow students to use the camera, choose shots and follow the scene and take good sound shots. Regarding post-production, they teach about montage and edition through the free program *Kdenlive*. Multimedia resources, based on hypertext and non-linear products with an interactive structure [27, 28], set a strong frame for the development of personal learning strategies. Detailed information about the course, including its programme, is available Internet at the VLE site of the course IPAM-EVA [29]. Some of the audiovisual and multimedia products developed are available on the OpenFING platform.

In recent years more than 200 students have participated in IPAM, helping to film and edit courses for OpenFING, and producing unpublished audiovisual and multimedia resources. The project is kept alive thanks to the contribution of the students.

6. Methodologies to support teaching and learning

Higher education remains generally focused on the transmission of information by the professor to the students, although in recent decades emphasis has been placed on changing this situation and thinking of strategies that situate the learner at the center of the educational process [30, 31]. In particular, FING teachers usually have three types of interaction with students:

- A theoretical class. The classic lecture with a teacher explaining mainly theoretical concepts.
- A practical class. A teacher or a teaching assistant explains the solution of exercises on the blackboard.
- A query class. One or more teaching assistants check with a small group of students (may vary from 15 to 50) the exercise resolutions that students present. This strategy is not developed on all courses.

Staff spend most of the contact time with content explanations; thus the interactions between teachers and students are limited. Also, in this context the role of students tends to be very passive. The conditions of massive attendance in which the courses are developed, in particular from first semester to sixth, seem to be an obstacle to implementing innovations in teaching. At an international level, the need to transform the relationship between teaching and learning of engineering is shared, emphasizing the active role of the student [30, 32]. At our university, in line with the proposals of international literature, the topic of active learning methodologies is becoming more relevant. Since 2011 specific orientations have been included in the ordinance of undergraduate studies that indicate teachers that the central pedagogical strategy will be to promote active teaching, where experiences in which the student, individually or in groups, is confronted to solve problems, exercise their initiative and creativity, acquire the habit of thinking with originality, the ability and pleasure to permanently study and the ability to mobilize specific knowledge to solve new and complex problems will be privileged [33]. It is also indicated that it is relevant to make an adequate integration of theoretical and practical teaching, allowing a permanent articulation between the two and enabling the development of the skills and abilities that correspond to the graduate's profile. In the case of FING, it also seeks to encourage the development of active learning

methodologies by affirming from the FING's governing bodies that it is necessary to support and promote this experiences in the School's courses, specially, in the early stages of the degrees [34].

In the new paradigm of teaching the focus is on producing learning. In this context the development of the strategies promoting active learning in university becomes relevant. Teachers need to create instructional activities involving students in doing things and thinking about what they are doing [35]. In this way: the students are involved in more than listening; less emphasis is placed on transmitting information and more on developing students' skills; students are involved in higher-order thinking; students are engaged in activities; and greater emphasis is placed on students' exploration of their own attitudes and values.

In order to integrate technology and resources to achieve more active teaching and learning practice, professors need to redesign their course methodologies. The following paragraphs describe experiences that represent successful cases in FING.

In 2015, the Discrete Mathematics course was offered in a blended learning format, using the classes that were recorded previously in 2014. The new version of the course presents changes that modify two aspects of the traditional course: the way in which the teacher leads the class and the way a participant studies. Each week, the learners had Internet sessions to prepare for class, with topics, notes, books and recorded lectures on the VLE platform. In addition, practical exercises and periodical consultation classes were offered. The experience was positively evaluated [36]. In particular, although the approval scores did not vary, similar results were obtained with fewer teaching hours, allowing the course to be taught twice a year and therefore providing the opportunity for students to return to study so as not to fall behind on their journey.

In 2017, an alternative modality was developed for the Logical Mathematics course (required for Computer Science students in the third semester). In parallel with the traditional and massive course, the alternative was offered to a subgroup of students. The new modality focused on promoting students' active work using a flipped learning approach. Tasks that students usually performed at home were performed in class and vice versa. The teacher's theoretical lecture was replaced by the availability of other resources, such as lecture videos, class notes and books. Class time was then dedicated entirely to interaction activities, such as discussing the issues students found difficult and working on practical exercises. This strategy transforms the class into an exchange, contact and engagement space. In this experience, the following resources were integrated: VLE, recorded lectures of the theoretical content available on OpenFING, and the use of specific software. These resources facilitated the student–teacher exchange of information prior to the face-to-face classes. The software used was a prototype developed by the students of a programming course and complemented by functionality added by the teaching team. The software consists of a tool based on the Cornell Notes model; it provides students with a space to record relevant ideas, summaries and questions about the videos, the bibliographic material and the exercises to solve in each class [8]. The teacher received the digital Cornell Notes generated by each student weekly, and prepared the classes accordingly, based on the issues or difficulties they had raised and their summaries.

The academic results of the new modality of the Logical Mathematics course show an increase in the percentage of students who obtain the needed credits without the final exam. From the student opinions gathered in surveys, the vast majority positively valued the modality. They highlight aspects of its design: first, the theoretical content was sufficient from the available materials; second, difficulties could be reviewed in class; third, compulsory attendance and scheduled deliverables favored continuous work as well as group dynamics. From the teaching point of view, the experience was ranked as very positive. The increase in contact

time with students allows the design of lectures to be adapted to the specific needs of the group and generates a positive learning environment for the presentation and analysis. The modality was taken by 50 students, so the challenge is to scale to 350 students, which is the estimated average number of students enrolled in the course each year for the last five years.

Another experience that we point out refers to the Computer Programming II course, which takes place in a blended format. As of 2016, the theoretical classes recorded by OpenFING were included in the VLE of the institution. In the last four years the rate of approval without final exam increased from 29% in 2016 to 43% in 2020. Student surveys show the importance of the videos in their learning process, mainly due to the impossibility of attending the face-to-face course. As mentioned earlier, approximately half of the students are in work and participate in the course in a virtual modality. These students also describe the usefulness of the recordings for the preparation of the course assessments and, predominantly, the final exam.

Faced with the suspension of classes due to the COVID-19 pandemic, the teachers asked their students to continue the rhythms of work from the visualization of the filmed classes. Subsequently, based on the needs of the students, synchronous classes were incorporated via conference. The filming made it possible to continue advancing at an adequate pace as well as providing access to the content to those students who cannot connect to video-conferences due to connection problems or schedules. Some teachers of initial and mass courses began to make new uses of the filmed classes and to incorporate them into their planning as a central resource. These practices have not yet been evaluated but show progress in the use of filmed classes for pedagogical purposes. For example, teachers took an excerpt from the class footage where a concept, problem or exercise was explained and during the synchronous conference they showed it to reflect and discuss with the students. In this way they achieved greater interaction and commitment of the student in the class. Other teachers began to use the H5P tool [37] that allows adding interactive elements to the videos. They took a filmed class and added questions, study extensions text, etc. Thus, the teachers were able to enrich the class filming, favor the student's interaction whit the resource and design the student's work outside the classroom. These two experiences focus on reusing the filmed class as well as helping the student to actively visualize and develop study strategies from the videos.

The professors who implemented these new teaching experiences believe that OpenFING has great potential as a tool to improve the development of courses, allowing them to focus their time on the direct exchange with students, promoting the understanding of issues and strengthening the student–teacher relationship. In institutional terms, it is considered important to consolidate these strategies, which include changes in teaching methodologies. The flipped learning model constitutes a change in teaching tasks, as teachers prepare the lectures based on the learning experience of the students and their progress. There is also a concomitant change in the role of students, mostly for the ones who are used to being passive participants in the traditional educational model. The changes and new educational processes are monitored at the pedagogical level by UEFI, which provides a space for support, exchange and development of educational practices.

7. Related work

The use of lecture hall videos as an educational resource is not new. Chtouki et al. [38] highlight the commitment of the students in an experience that studied the impact of the integration of YouTube technology in the teaching of English as a foreign language, making use of educational videos. Following a controlled

academic experiment, they conclude that the experience was successful. In [39] the use of video recordings of live lectures is regularly perceived by students as supporting their learning when preparing for assessments. Furthermore, [40] argue that regular use of video-based resources may enhance learning if the student has appropriate learning skills and strategies. In this vein, [41] developed a guidance framework in order to develop students' effective and efficient use of lecture captures. He found that students use recorded lectures in their own ways depending on private study practice as well as the intended learning from the specific course.

New learning models have been created, such as the flipped learning model, which focus on the development of active teaching and learning methodologies through the use, although not exclusively, of videos for educational purposes [8]. In [42] the authors describe an experience using a system for Internet lecture videos and, although a good level of acceptance by students is highlighted, they mention aspects that can operate negatively if the use of these resources is not related to the educational methodologies and practices followed by the teachers. As highlighted in the experience of the three FING courses, the integration of digital technology (the recorded lectures and the VLE in this case) can function as a window of opportunity to change the traditional pedagogical paradigm towards new ways of teaching and learning. In each case, the use of the video resources needs to be pedagogically aligned [43], and the reasons for its inclusion and how its integration will benefit teaching and learning need to be defined [44].

Some works deal with the use of annotations in e-Learning. In [28] the authors review a set of learning experiences that use annotations, and extract some recommendations about the use of annotations as a learning activity. In [45], an experiment about social annotation in an educational environment is presented which concludes that is a good way to promote the student engagement in the educative process. None of these works deal with video annotations. Several works treat video annotations, but only a few focus on educational videos. The work presented in [46] is close to OpenFING, but they do not use Semantic Web Technologies. About the use of Semantic Web technologies in e-Learning, some works should be taken into account. OpenCourseWare (OCW) Universia Team experience about producing and consuming Linked Data is presented in [47]. The paper introduces LOCWD, a vocabulary to describe OCW resources. In [48] a platform with some similarities to OpenFING is described where the search mechanism exploits LOD.

8. Learned lessons and final remarks

OpenFING started as a project of students wishing to record, edit and publish lectures in order to make them available to other students as learning and study resources. The good experience of the teachers who participated initially facilitated the growth of the project within FING. From 2016 onwards, the OpenFING project began to be articulated by different actors from the institution: the group of students who coordinate the project, learning technologists from UEFI, professors from FING and FIC as lecturers of the IPAM course, with the explicit support of the deanery of FING. This initiative has the potential to be a multidisciplinary educational development, involving staff from different faculties and university students in a common educational project. The current version of the OpenFING platform allows students to watch videos from more than 1400 filmed lectures.

OpenFING has been adopted by students as an additional study tool. The average number of weekly accesses to OpenFING went from 5.000 in 2014 to 25.000 in 2019. In 2020 this number doubled, due to the COVID-19 pandemic and the need to develop the courses virtually, with higher measurements in periods close to the evaluations

of the courses. Actually, more than 80% of users surveyed, think that OpenFING enables them to follow a course appropriately and even more users (88%) think their learning is improved by the project. Additionally, 84% of users agree on a high level of satisfaction with the learning experience using OpenFING. OpenFING is considered a flexible resource by 86% of all users because it allows studying at any time [10].

On the other hand, most of the teachers surveyed (see [10]) have a positive opinion about OpenFING (63%), and 70% also highlight the project as a useful tool for study habits and course follow-up. A negative aspect of the survey carried out among teachers shows that only 26% of those surveyed state that they have changed their teaching practice due to the existence of recorded courses. Regarding the impact of using OpenFING in their classes, 77% of teachers indicate a lower rate of attendance at their lectures. Several teachers are concerned: 35% consider that the situation may be risky, since the replacement of class attendance by video increases the lack of interaction between students and between students and teachers. A change in teaching strategies, and the development of new pedagogical resources mentioned above such as audiovisuals on specific topics, could modify the statistics of preference for online classes (44%). In relation to improvements for the project, 27% of the teachers surveyed propose the creation of short audiovisual content about specific topics in a more detailed way, and also video creation for Internet courses like MOOCs [10].

Many platforms that offer virtual courses and educational resources are well known: Coursera [49], Khan Academy [3], FutureLearn [50], Merlot [51], among others. OpenFING stands out as an educational project made by students for students. Students manage and coordinate their peers for the recording and editing of videos, and perform tasks ranging from the identification of courses to record and contacting the appropriate teachers to the final publication of the videos on the web. This not only makes it possible to keep the project alive each semester, with the support of teachers and the institution, but also generates a remuneration for students who actively participate. This collaborative participation in the production of resources that contribute to the students' learning occurs either through the IPAM course (which supports OpenFING) or voluntarily. Those following the IPAM course will benefit from acquiring knowledge of digital and communication skills, and audiovisual and multimedia resource production, as well as obtaining credits.

A prototype platform was created which enables comments, questions, the addition of related links and course topics that might be associated with video fragments by the users and teachers. The prototype allows suggestions to be presented to the users. However, the development carried out must still be adapted for mass use. At a technical level, it will be necessary to investigate the application of other techniques to select and/or filter interesting materials associated with the videos, using, for example, natural language processing, data mining and machine learning mechanisms, as well as exploring possibilities of processing audio and video to retrieve information.

An updated platform with a collaborative and thematic relationship mechanism is expected soon [52]. Annotation strategies of video fragments will be designed, focused on the development of software for the management of teaching. This software will add each student annotation about a video fragment into a graph database. The database may enable the analysis of each student graph and detect "wrong links" exposing any wrong understanding about some topic in order to personalize the teaching task. With this platform, teachers and students can annotate videos with topics, comments, web resources, and other kind of metadata to improve their teaching and learning activities. The development of video-lectures is usually considered as a high cost activity for teachers. Our low-cost approach, based on the publication of video-recorded traditional lectures, has still proven to be useful to students. It is expected that the previously described strategies will have an impact on student learning, by providing a mechanism for reflection and exchange

of different views on the contents of the courses. The main objective is to transform the project into a collaborative and interactive platform for learning. This line of development is also highlighted by other researchers [26, 53, 54].

From a technological point of view, we believe that Semantic Web technologies allowed us to develop a flexible environment, in which we can add new features in a simple way. We also think that HTML5, JS, NodeJS, SPARQL stack works as a good prototyping platform since it reduces programming and testing times. New versions of OpenFING server and clients are being developed using NodeJS and HTML5. In the near future we expect to extend the Semantic Enricher component using two approaches: querying LOD, and using Natural Language Processing of documents.

From the evidence collected by this work, we can conclude that OpenFING is perceived by students and some teachers as an appropriate resource complementary to learning, both for preparing for assessments and outside of revision periods. Further research is needed on how to develop students' competencies when using OpenFING, for example, in order to champion a better practice for note taking, so as to improve the support for student learning and make the most of the study experience. Obtaining evidence from the students' experiences could shed light on the specific uses, preferences, strategies and needs of the engineering students. Additionally, further research would uncover why those teachers willing to implement changes in their teaching practices have not done so yet. To maximize the understanding of their needs and how best to support them in the development of active teaching strategies with the use of OpenFING and other resources, FING has the UEFI, specifically conceived to support staff regarding technology-enhanced learning practices.

To conclude, the development of active teaching strategies needs to take into account the context of each course, depending on its size, budget and viability. The challenge lies in disclosing and further developing the processes involved in the relationship between the teacher's learning design of the course, the lectures as teaching interventions, OpenFING recorded lectures as learning resources, and the students as independent learners.

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