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Creation of audiovisual presentations as a tool to develop key competences in secondary-school students. A case study in science class.

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ABSTRACT

New curricular plans based on key competences create the need for new educational proposals that allow their development. This article describes a proposal to develop key competences through project-based learning. The project's objective is the creation of a digital video. The following study was carried out with students in their final two years of non-mandatory secondary-school, in the subject of "Physics and Chemistry". The students created didactic documentary videos describing different aspects of kinematics. The planning of the project focused on to involve the students in all steps of the process, in order to be able to evaluate the competences developed during each part of the project. The results showed an important improvement in both the digital and science competences. It was also shown that the necessary stages to create an audiovisual presentation involve the use of the competences related to communication, personal initiative or learning to learn; this provides an opportunity for the student to develop said capacities.

Keywords: *Key competences, project-based learning, didactic video, non-obligatory secondary-schooling, kinematics.*

INTRODUCTION

At the end of the twentieth century, the Organization for Economic Co-operation and Development (OECD) proposed a system to evaluate students in their last years of secondary education. This system was a tool that verified the abilities and knowledge that the students had acquired necessary for integration and participation in modern society (PISA 2000). At first the tests were done in the areas of mathematics, reading and problem solving; however, it was soon seen that these tests should be extended to other fields, introducing a wider range of competences. In this way the project for Definition and Selection of competences was created, establishing the concept of key competence and its areas of applicability of the following years (DeSeCo 2005:4). According to the OEDC, a key competence is defined as:

> *A competency is more than just knowledge and skills. It involves the ability to meet complex demands, by drawing on and mobilizing psychosocial resources (including skills and attitudes) in a particular context*

From an educational standpoint this was an important innovation, as its application to school curricula enabled a change from traditional, closed bodies of knowledge to a more cross-curricular perspective (Rouvrais et al. 2006).

Competences in Spain

Initially, the OECD defined nine key competences divided into three categories: Use tools interactively, Interact in heterogeneous groups and Act autonomously (DeSeCo 2005). Using these as the starting point, the European Union defined a series of key competences (EU 2006) that cover all areas of knowledge and were adopted by member states. The following table shows the correlation between European key competences and their adaptation in Spain, the latter under the name of basic competences (MEC 2006).

Table 1. *Comparison of European key competences and their adaptation in Spain (basic competences).*

European Union (key competences)	Spain (basic competences)
Communication in the mother tongue	Competence in linguistic communication (LC)
Communication in foreign languages	
Mathematic competence and basic competences in science and technology	Mathematic competence (M)
	Competence in knowledge of and interaction with the physical world (KIPW)
Digital competence	Information processing and digital competence (IPD)
Learning to learn	Learning to learn (LL)
Social and civic competences	Social and civic competence (SC)
Sense of initiative and entrepreneurship	Autonomy and personal initiative (API)
Cultural awareness and expression	Cultural and artistic competence (CA)

In Spain, the curricula developed incorporated competences in the case of mandatory education (BOE 2006a; BOE 2006b). They were also included in the university education reforms brought about by the European Higher Education Area (MEC 2003; Riesco 2008). There is however an intermediate stage spanning ages 16-18 called Bachillerato (the final two years of secondary school, non-mandatory, prior to university), in which the competences are not taken into account as an element of the curricula and instead are mentioned in passing, as in article 2 of RD (Spanish law) 1476/2007 (BOE 2007): "The finality of Bachillerato is to provide students with an educational grounding, intellectual and human maturity, knowledge and abilities that will allow them to develop social functions and to join adult society with responsibility and competence."

This means that the competences do not appear in the curricular development of the final two years of secondary school, at least explicitly. This seems incoherent, taking into account that the educational stages prior to and following the non-mandatory stage do have competence-based curricula. The objectives of Bachillerato pursue the best possible preparation of the student for their future navigation in society (BOE 2007), which appears to coincide with the objectives established for mandatory education; we consider, then, that it is viable to approach learning during Bachillerato using the same competences (UE 2006; González 2012).

In this sense, this study outlines a proposal of project-based learning, which looks for work on and improves of key competences by non-mandatory secondary students in scientific-technological studies. We believe that it will be seen that the applied methodology is easily extendable to other areas of study.

Project-based Learning

Project-based learning consists of student-developed research on topics of interest to students; this research forms the core that the elements of the teaching-learning process are linked to. This means, as stated from the beginning of this learning, that the students must choose the topic and play the leading role in their own learning process (Katz & Chard 1989). This guides their interest and motivation towards the object of study and simplifies the student's learning process (Tatar & Oktay 2011). In addition to this, Aurora Lacueva (1998) considers that an educational project belongs to this category if it has duration of three to four weeks and a high degree of participation of the students at every stage of the process.

Students' involvement in building their own knowledge (Bell 2010) must be particularized to the choice of topic, approach to be used, structure of group work, attainment of results, writing of conclusions and communicating the project. This teaching strategy therefore promotes the communication, negotiation and collaboration abilities necessary to share the different ideas that evolve during the process. These characteristics are shared by Thomas (2000), who adds that the project should be the principal educational strategy, structured by directed questions, promoting the construction of knowledge and be realistic. In this way, students can develop the capacity to think up hypotheses and solve problems through projects related to their local environment (Pewnim et al. 2011).

In addition, it seems that technology is an ideal tool for this type of teaching, as its use in project-based learning creates a link to real-world situations, making the students take part in various actions that lead to the cooperation (Reeves 1999; Ringstaff & Kelley 2002; Gu, Zhu & Guo 2013; McCarroll & Curran 2013). Furthemore, ICT favors creativity and reflection on importance of making decisions (Ezquerra, Iturrioz & Díaz Pérez 2012).

As for curricular content, they obtain new knowledge that derives from their own research and exploration (ChanLin 2008). In short, it seems that the fulfillment of a school research project as the core of a teaching strategy can have a positive impact on multiple dimensions of learning.

In this sense, actions derived from the use of new technologies in science teaching allow different abilities to be worked on, such as gathering and analyzing data, backing up hypotheses and research, facilitating the building and communicating of knowledge, promoting students' independence, improving their productivity or confronting difficulties successfully (Ruthven, Hennessy & Brindley 2004; Hennesy 2006). For all these reasons the combination of these tools with project-based learning emerges as a natural and effective option, connecting curricular content and the way today's students interact with their environment. This fact has been taken into account by an increasing number of teachers who have decided to add technological tools to their assignments (Ramírez et al. 2011).

We must differentiate these methodologies from the numerous activities that aspire to the category of project-based learning but allow students little or no power of decision or initiative, e.g.: homework assignments to search for information without its analysis or laboratory experiments that consist in following instructions.

Audiovisual media

A very important part of our social interaction and much of what we learn is presented in audiovisual form (Ezquerra 2003; Aguaded 2005), which makes it fundamental to promote the handling audiovisual of media at an academic level (Senado 2003, Tan & Towndrow 2009; Masats & Dooly 2011). The most common use of audiovisual media in schools is the viewing of movies, documentaries or TV series by students, followed by their critical commentary (Perales-Palacios & Vilches-González 2005; García 2011).

In addition to these, the existence of websites such as YouTube, understood as an environment for visual learning, the search, selection and application of audiovisual media in the classroom have become far easier. This tool permits users to share and see documentaries, making possible a more cooperative, participative and interactive learning. This resource is widely used among students, who often spontaneously search there for complementary study materials. We find that teachers have an excellent opportunity to help them participate in a critical selection of said content (Mitra et al. 2010; García-Barriocanal et al. 2011). With this tool one brings science closer to students' day-to-day life integrating it into their usual way of obtaining information. Another advantage is that visual media can show real scientific concepts that are difficult to access via other types of communication, which can help students develop alternative conceptions.

Another, much less common, option is to film and create digital videos (Ezquerra & Polo 2011). This can be done either by the teacher (Ezquerra 2010; Koscianski, Ribeiro & Da Silva 2012), who later shows the results to the students, or the students themselves can make the videos, giving rise to a much more interesting and enriching project (Torres, 2009; Piliouras, Siakas, Seroglou 2011; Harness & Drossman 2011). In this article we will show an educational proposal based on the methodology of project-based learning where the guideline is the creation of audiovisual documents by students.

RESEARCH DESIGN

Using the characteristics of participating students, we designed a sequence of actions - educational proposal- to analyze how the students created a documentary video (Manso & Ezquerra 2014). The objective was to evaluate how this process enables students to collaborate, acquire key competences, work on school science topics and develop audiovisual abilities. We focused on Information processing and digital competence and Competence in knowledge of and interaction with the physical world. The search was stated as qualitative study using interviews.

Study sample

The study took place at a secondary school in a town in the south of the autonomous community of Madrid and one of the authors was the teacher of the group and he led the entire process. The socioeconomic environment is lower middle- to middle-class. 35% of the inhabitants are immigrants. Our sample consists of whole classroom, 12 students (5 boys and 7 girls) in non-mandatory, university access secondary education, aged 16 and 17.

The students were divided into three groups of four students, each group creating a video. The generic topic assigned was the same for all groups: kinematics, but the specific topic was chosen by each group. The remaining aspects of the video were developed freely by the students.

Steps of our educational proposal

The proposal to be described in the following schematic was designed with the aforementioned intention of involving the students in the entire creation process, as well as the evaluation of the student's academic progress:

1. Initial evaluation of audiovisual and scientific knowledge possessed by the students. We designed a specific questionnaire for each topic.
2. Two sessions to explain the use of the proposed video editing program.
3. Formation of work groups and selection of kinematic topic to be developed: horizontal projectile motion, parabolic projectile motion and uniform circular motion.
4. Information search and rough draft (this initial document including a first summary based on the information search). Our interview focused on how the students did it.
5. Script generation (adaptation of the initial text to audiovisual requirements). The script had to detail the sequences planned for filming. Afterwards, we analyzed how the students did it.

6. Filming of sequences planned in technical script (document including all information necessary to film scenes). Coordination of cameras, sets, costumes, actors...The students were asked about the way they did it.
7. Edition and production of final video with help of initial tutorial.
8. Final evaluation of audiovisual and scientific learning by students. We repeated the initial evaluation with some minor adaptations.

RESULTS AND DISCUSSION

In the following we describe the analysis carried out on the described educational process. The focus of the analysis is to compare the results with the specific abilities worked on and their associated competences.

Initial evaluation

In order to check students' evolution it is key to know what prior knowledge the students possess in relation to audiovisual abilities and the scientific topic to be worked on. So, we asked students about their audiovisual capacities and scientific knowledge as follows:

***Table 2**. Some of the questions used*

Audiovisual capacities	Scientific knowledge
Which subjects have your teachers used audiovisual documents in?	Give an example of uniform linear motion
What kind of audiovisual documents?	What do you understand composite motion to be?
How have your teachers used audiovisual documents?	What do you know about parabolic projectile motion?
Have you ever filmed with a videocamera?	Do you think that horizontal projectile motion is usual in your day-to-day life?

Audiovisual knowledge

First, we focus on the use of audiovisual media for academic purposes, and on the other hand, on personal use.

The result for academic use of audiovisual media indicates that the students had never previously made didactic videos and that the use of audiovisual media in their classrooms had been limited to viewing commercial films. But, we observed a much higher level of personal use of audiovisual media. The actions that the students repeated most often were viewing and copying videos from YouTube to their computers. On the other hand, a high number of participants said they have never or seldom partaken in actions related to the creation of audiovisual media, such as editing their own videos, creating a script or directing a short film.

Furthermore, we saw that the students who participated in this project had used technological resources to search for information and, to a certain extent, to manage it (identify, compare, judge, order hierarchically, select and save). These results show abilities related to the Information Processing and Digital Competence (IPD). However, they neither generated new information nor communicated their knowledge through this medium. I. e., the students have not yet developed or used this double function, to transmit and generate, as well as receive, information and knowledge, necessary to be truly digitally competent.

Knowledge on the scientific topic

To evaluate the students' previous knowledge on the topic to be treated in the video, the following questions were asked:

- *Give an example of one of the following motions: uniform linear motion, uniformly accelerated linear motion, horizontal projectile motion, parabolic projectile motion, uniform circular motion and uniformly accelerated circular motion*

The examples given by the students show some understanding in the case of linear and circular motion, uniform (*walking, or a big wheel respectively*) as well as accelerated (*starting to run or driving curvy road respectively*). however, composite motions caused some confusion, which is a logical result taking into account that this topic had not yet been covered in the classroom. For example, they identified parabolic projectile with javelin or basketball throw, but they confused horizontal projectile with linear motion.

- *What do you understand composite motion to be?*

The analysis of the students' answers allows these to be split into three groups:

a) Those that state that it can be divided into two parts, uniform linear motion and uniformly accelerated linear motion.

b) Those who state it can be separated into its components.

c) Those who state that it is a motion in which there are different magnitudes.

Option a) was chosen by 41.6% of students, b) by 25% and c) by 16.7%. 16.7% did not answer the question. As a) and b) are correct but incomplete, as a first estimate we can say that students' ideas on this subject indicate that it is a familiar topic.

On the other hand, students were asked for examples on these topics drawn from their day-to-day lives. Results show students were more familiar with linear motion, both accelerated and not, and somewhat confused about projectile motion. In general we detected that kinematics were not present in our students' daily lives.

We analyzed the results of the questionnaire with the students. This type of discussion develops the competence in knowledge of and interaction with the physical world (KIPW). We were also able to observe, to a certain degree, the interpretation and application of their knowledge.

It should be pointed out that during the interactions with the students it became clear that they had never been the protagonists of their education; they had never been asked for their opinion on what they should study, why and how it should be studied. Our impression is that they had never received a satisfactory answer to the question “what is this good for?” We perceived a clear change in their attitude when exposed to a proposal of this type, which they can select the topic.

Information search and rough draft

During the first part of the creation of the audiovisual document, the different groups searched for the necessary information on the Internet, making use of different websites. They consulted didactic material from the [Spanish] Ministry of Education's program, Descartes, as well as the content from the websites of different secondary schools and other websites dedicated to teaching secondary-school science. However, they did not use any textbooks.

The initial text by all three groups shared similar characteristics. All the information found and used was highly relevant to the task, as each type of motion was adequately described. The theoretical explanations given by all groups included the equations of motion, characteristic parameters and illustrating examples. These actions were done entirely and spontaneous by students. Let us indicate that these actions are close to traditional classwork.

Throughout the entire process, the teacher gave feedback to the source of information and the academic level of the information. He tried to take into account what information would be relevant to elaborate the video. For instance, the teacher proposed not to use excessive mathematical expressions, as the as the audiovisual format is not suitable to reading.

In this first stage of creating the video, the different actions undertaken by the students require capacities related to certain competences, among them the IPD and the KIPW. The former is necessary for the bibliographic search, using different strategies to access, decipher and select information, and the latter for the students to be able to use the information. In addition to these, an indirect use of two further competences takes place: linguistic communication (LC) and learning to learn (LL), although we did not go deeply into this aspect.

Specifically, information treatment requires comprehensive reading and coherent writing skills in order to communicate the information one has found. It seems reasonable to think that learning to learn skills are employed insofar as students must reflect on the state of their knowledge on the assigned topic and develop a strategy as to what information was necessary, how to search for it and what learning objectives the project entailed.

Script

The scripts created by the three groups follow the information detailed in the initial text closely. In all three cases the final result, defined as the technical script, have the correct structure and include all the information necessary to film the planned sequences.

The scripts created by the three groups closely follow the information detailed in the initial text. In all three cases, the final result had a correct structure and included all the information necessary to film the planned sequences. Despite this, the teacher had to give a lot of indications. Specially, it was necessary to underline the importance of images, that is, that the students must avoid letting words and text dominate over the images (Mathewson 2005). Initially, the students only took the dialogue into account.

This phase is extremely important, as at this point the information must be adapted to audiovisual requirements. The necessary actions involve the interaction with the physical world and linguistic competences. The students had to analyze and transform the information in order to use it in an unfamiliar context. But, step by step the images began appearing in the script spontaneously: trajectory, the parabola, the velocity vector…

In addition, they had to create a dialogue for the video, adapting the initial text from a more narrative structure to a more dynamic and interactive medium. This task of approximating real speech is a notable factor in all audiovisual creation process (Feldman 1990; Pérez Tornero 1994). However, this action seemed obvious to the students. That is to say, the students took this aspect of the project upon themselves and did not view it as “pointless schoolwork”. As soon they chose the topic, students had good ideas for their videos. For instance, the parabolic projectile group knew that playing football would be a suitable example of this kind of motion.

Filming

Each group filmed their own images and they did 3 or 4 sequences. The filming took place daily in one-hour sessions and they used 4-5 days to complete the filming. The students did both theoretical demonstrations and experiments on their topic.

A high level of organization was observed within each group, in which each member fulfilled a different role (camera, directing, acting, etc.). During the filming process the students had to handle videocameras and choose which scenes to use and how best to present the relevant information. All three groups used high-resolution videocameras (720p or even 1080p), which was slightly problematic when it came to edition.

During this stage the students work involves the following competences: KIPW, IPD and LL. We would also like to show, as a sign of the students' implication, the efforts they made with the props to stage their small production. We must also take into account other dimensions of the project; these were group projects, which seem to indicate that the students may work using the social and civic competence (SC), as well as the autonomy and personal initiative competence (API). This is because the group members discussed the different ideas they proposed; it seems reasonable to think that they made use of social skills to relate to each other, cooperate, work as a team and make decisions.

Edition and final video

Given that cameras generate videos with mp4, mov, mts or avi formats, some of which are incompatible with the video editor we used, the clips had to be converted to a lower quality format that was compatible (wmv) and they needed to help with this task. Specifically, the teacher indicated that there are several converter video programs, and he had to show and explain how these programs work. However, students were able to look for a converter program and run it, later. So despite that, initially, the students showed doubts, finally they seemed to handle these undertakings successfully. We think, from their comments, they put their previous ability to use videos into practice. We must remember that young people often seek, find, download and interchange YouTube videos (European Commission 2008; Nielson 2010:58). And, these actions require the selection of a specific audiovisual format, so we think this gave the students previous practice/experience.

The exposition of each group's topic presents a similar structure, in which an explanation of the topic is narrated. To this end, the students show fragments of a classroom exposé using a blackboard, mounting sequences filmed outside the classroom in between classroom shots. At the end of the videos they included outtakes, which show that this type of project can be fun and creative without losing its didactic nature.

The analysis of the videos shows they are highly related to the proposed technical scripts. We can assume that the organization of the concepts they wished to transmit and the filming of sequences followed the order the students initially proposed. In general terms, the videos are mainly based on sequence shot presentation, i.e., uncut sequences, of the typical characteristics of each type of motion, and solving theoretical problems with relation to the topic at hand. For example, one of the groups (parabolic projectile motion) used a sequence in which a ball was kicked to solve a problem they had proposed: finding the initial velocity with which it was put in motion.

During this final stage, the students' work is related fundamentally to competence IPD, and both LC and API competences may also be involved. The mounting of the filmed sequences requires managing audiovisual information, searching for clear and effective communication. This implies

generating a product coherent with audiovisual standards. In addition, they had to face using video edition software, many of them for the first time.
Finally, this last phase is the corollary to a complex project, which implies fixing concrete knowledge out of initially diffuse information. This requires making decisions, responsibility, critical thinking and teamwork. It is necessary to develop flexibility towards others' ideas and motivates personal initiative, interpersonal relations and the capacity to improvise (Collazos & Mendoza 2006).

Final evaluation

The evaluations described in the following have the object of contrasting knowledge on the scientific topic and audiovisual knowledge gleaned thanks to the process of audiovisual creation.

Knowledge on the scientific topic

Students' knowledge on the topic was evaluated by asking questions similar to those asked at the beginning. The answers obtained at this point of our study were more adequate than those given at the start. Furthermore, the students carried out a self-evaluation of their degree of knowledge of the types of motion. They said they had improved their notions about the different motions after finishing the video and we also observed an increase in the students' perception of these types of motion. Clearly the sample size is too small to generalize our results. Had that been our goal, in addition to a larger population to study, an analysis of what other elements had influenced the learning process would have been necessary.

In order to study the process of project-based learning, the students were asked to compare this type of project with those that they usually did (written papers, directed laboratory experiments, etc.) The aspects to be contrasted were: hours dedicated, effort, collaboration within the group, originality of the process, motivation to carry it out, usefulness for learning concepts and knowledge acquired. The answers received allow project-based learning as a type of work requiring more hours and effort, but comes across as original, motivating and useful when it comes to acquiring knowledge and favoring teamwork.

Audiovisual knowledge

In order to evaluate acquired audiovisual knowledge we used different types of analysis. We repeated the initial questionnaire that posed questions relative to the students' audiovisual abilities. We studied and categorized the specific actions that had been carried out and did multiple interviews to get a better understanding of this aspect.

The results of the interviews indicate the students' self-evaluation of their capacity to do certain acts. The data show that the students feel capable for the most part to do almost all of the things necessary to create an audiovisual document. Specifically, a high number of students stated not having any difficulty obtaining audiovisual material or with its edition. A large majority of the students stated they felt capable of making an audiovisual document with their own resources (their camera, computer, etc.), while only two students gave negative answers. Of those who answered affirmatively, the majority considered that they could perform part of the process (only script and filming) or the complete process (including edition) if the work were done in a group. However, a considerable percentage, one out of four, does not feel capable of converting videos to different formats. But, when we asked the students which actions they found more complicated, they said that they found the initial text more difficult. They argue that in order to create the literary text they started from zero, whereas the technical script is made by re-elaborating the literary text. Summarizing, after finishing the project, more than half of students felt capable of carrying out a similar project the following year, whereas less than half either responded negatively or did not answer.

On the other hand, we grouped the data in order to contrast the initial and final audiovisual skills. We used the initial audiovisual questionnaire to make a graphic of initial evaluation (Figure 1a: initial evaluation). Here we can see that the students stated that the actions repeated most often were viewing of videos and copying of videos from YouTube to their computers. Moreover, a high number of participants (>80%) said they have never or seldom partaken in actions related to the creation of audiovisual media, such as editing their own videos, creating a script or directing a short film.

This graphic contrasts with the final evaluation (Figure 1b: final evaluation). You can see that our results indicate that after having completed the project, the students feel they are capable of performing actions which they previously did not believe themselves capable of. So, if we compare these initial results with the final evaluation, we can see that the majority of the answers have risen all across the table, markedly so in the columns on the right. That is to say, the students feel that their capacity to handle the different steps of the process of audiovisual creation has increased. This in particular is true for creating a script and video editing, the answers to which have passed in their majority from one extreme to other, i.e., from never (initial questionnaire) to somewhat (final questionnaire). Moreover, students actually made their videos, so that, they really increased their ability and their perception.

We also observed that they had passed from a heterogeneous distribution of abilities to a fairly homogeneous one (see Figure 1).

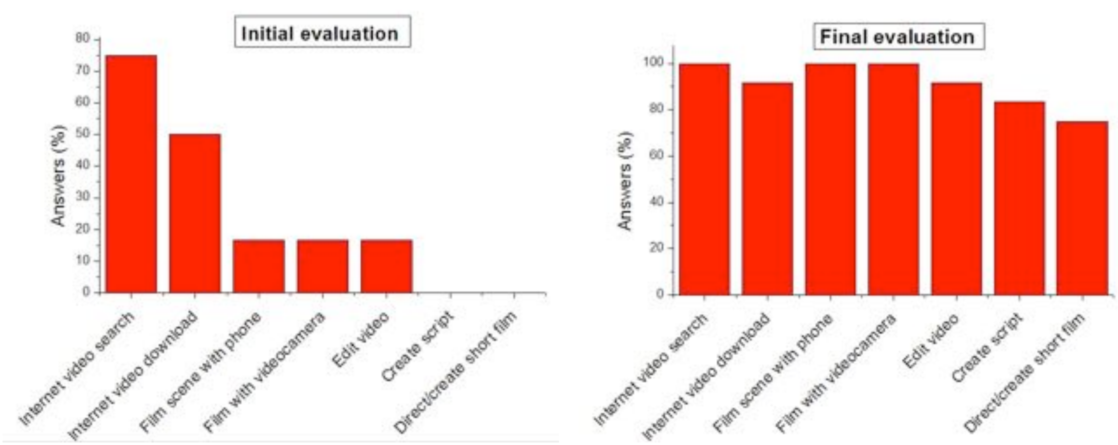

Figure. 1. *Students' self-evaluation of their audiovisual capacities, before and after making the video.*

CONCLUSIONS

Many individual studies report gains from cooperative learning in science compared to traditional instruction (e.g., Acar & Tarhan 2008; Balfakih 2003; Chang & Mao 1999). However, other studies failed to find gains (e.g., Topping et al. 2011; Hanze & Berger 2007; Faro & Swan 2006). But, not all these studies espoused the same construction of cooperative learning. Provided the evidence that structured cooperative groups work better than unstructured groups (Webb et al.

1998; Lumpe & Staver 1995), we believe that design of educational proposal in project-based learning is an essential factor and this tend to improve different capacities implicit in key competences. In this sense, we have a very structured approach to creating videos. We hope that this scheme can serve other teachers. Also, we think that this structure can serve other teachers to assess how to develop video creation, if they decided to use this method in their classroom.

Moreover, in this study, it has been possible to assess certain aspects such as information management, ICT abilities, knowledge on the subject matter or the ability to do research, without the students perceiving the tasks as more difficult or provoking rejection or boredom (Chu 2009; Chu, Tse & Chow 2011). In addition, it seems that communication, negotiation and collaboration abilities are promoted, all necessary to the joint discussion of the ideas proposed during the development of the project (Gómez & Insausti 2004). These stages and their results show how our proposal affects different abilities and skills. And maybe, this can encourage other teachers to try this method out with their students.

Moreover, we believe that the task of converting the collected information into audiovisual language plays an important part in developing many of the competences worked on here. Namely, the students were forced, starting at the search for information, to think up a sketch, elaborate an initial text, create a script and, additionally, prepare, organize and carry out the filming and posterior assembling and edition of images. In short, to transform linear discourse into a multi-channel message. The complexity and novelty of these actions entail the need to organize the work, arrange locations and timeframes divide responsibilities, create a hierarchy of priorities, etc. All of these capacities seem to be tied to the LL and API competences, as well as the SC competence, due to the difficulties inherent to this type of work.

Let us recall that the information the students gathered from different sources was in text form, i.e. one word after another. However, both reality and the audiovisual format generally present multiple channels at the same time (speech, images, text, music, etc.). This fact led them to transpose the content. Obviously, they had to adapt the initial text to a, to them, unusual format. This change was not brought about directly by the teacher, but was initiated by the students' proposals; the teacher's only role was to help the students complete their objectives, once these had been precisely defined by the students. We believe this task provoked the development of the linguistic competence in a way that is difficult to work at using other methods.

On the other hand, and due to the characteristics of this concrete project, the digital competence, ICT, has been one of the most exercised. The students made use of their preexisting abilities with video cameras, managing computer equipment, Internet searches, etc. The students indicated at the end of the project that they felt capable of putting their new knowledge about the computer programs used (digital video editing, video format conversion, etc.) to use. In general we can say that although the creation of a digital video as a tool for autonomous learning required a greater effort and more time than the students' usual assignments, but it proved to be a satisfactory task, as declared by the participants in this study.

In addition and in our opinion more importantly, the project's evolution caused the students to need to use an ample arsenal of tools to organize and manage information, as well as orient it towards a previously established learning objective. It is our opinion that all of this effort to make use of their knowledge is quite different from the traditional approach, which interrogates students on their knowledge in contexts unrelated to these concepts. On the contrary, during this project students had to use their knowledge in concrete situations with objectives comprehensible to them and while attempting to create a product shared by the group.

It would seem that the combination of these technological tools in the context of a project-based learning strategy appears as a natural option. Specifically, we believe it allows to efficiently connect curricular content to the way current-day students interact with their environment. This fact has been taken into account by a growing number of teachers who have decided to include tools of this type in their assignments (Ramírez et al. 2011; Annetta, Cheng & Holmes 2010).

Ultimately, our analysis, which includes the participating students' opinions, indicates that the subjects felt an important improvement of their abilities in relation to the KIPW competence (scientific competence). E.g., the students began unable to identify the motions they were to study, of at best considering them rare in their daily lives, and at the end were able to recognize them as a frequent and mundane.

In any case, the analysis of the improvement seen in knowledge of these scientific topics cannot be extended beyond what we have done in this study; we of course do not conclude that learning has taken place due exclusively to the creation of videos. Here we only show that improvement was observed. This improvement could be due to many factors such as the initial search for information, the creation of the text and its posterior reelaboration to create the script, the filming process or to the teachers comments throughout the process. We leave open the question of which effects each part of the process has on the learning process.

Based on our experience, we would like to indicate that teachers showed no intention of obtaining a professional audiovisual. Nowadays anyone has access to very advanced media that were unthinkable just a few years ago (HD cameras, video editing programs, voice recorders...) but at most schools there is neither the media nor the personnel typically found at professional productions. A very different goal is that our students become excited about the creative process and the teacher takes advantage of it to boost their learning.

We would advise that, given the technical complexity and the multitude of formats and possibilities, it is a good idea to do a small test before starting the process. In particular, we recommend choosing a camera, shooting a few short scenes and on our computer use the editing program to mount the scenes, dub the sound and add FX, then check to see if the audiovisual document can be reproduced correctly on another computer. A possible problem is that sometimes a camera's format only works on some computers.

Lastly, as we hope to have shown in this text, it is convenient to let the students make mistakes and try again, to boost their use of their particular skill set in a class setting and their use of dialogue and allow them to search for solutions to the problems that arise in the complex process that is the creation of a scientific documentary. The evaluations described at each step of the process are designed with this idea.

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