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Working in Terms of Competences: Activities Designed Using Active Methodologies

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1. Introduction

Spanish Higher Education is converging towards the creation of a European space of mutual recognition of University degrees. In order to achieve this objective, three changes have been introduced: a regulation that affects the structure of degrees, a common measurement system for the accomplishment of degree recognition (the ECTS) and a quality control system. The adoption of the ECTS (European Credit Transfer and Accumulation System) involves a conceptual reform of the organisation of the Higher Education curricula, as new models of training are to be created based on student's own work. Universities must design new curricula based on the development of competences that prepare students for accomplishing functions and tasks specified in their academic and professional profiles. In other words, there is an increasing concern that a significant result of this process will consist of a transition towards a new Higher Education system, highly based on student's own work. On the other hand, there is evidence concerning the two main facts that influence student's learning. First, students improve their own learning when doing, making, writing, designing, creating, and solving. Passivity dampens students' motivation and curiosity. Second, when students enrol in a course of their own choice, their learning motivation increases.

Therefore, two of the main implications of this new model are that students are now relocated to the centre of the educational system, and training is now oriented towards to achievement of results. In other words, we are evolving from a system based on the traditional transmission of knowledge, to a new one based on the development of competences (ICE, 2006; Gonzalez & Wagenar, 2003). Moreover, every degree's competences must be based both on the identity of the profession to be undertaken by students and by demands in labour. This facilitates the identification of the necessary educative elements for achieving the established goals, and implies that within each subject, lecturers must develop activities that will allow students to develop the competences established in their academic profiles. Therefore, this new system also implies a change in the role of lecturers.

In Sect. 2 we explore in further detail the changes in the role of the lecturer. In Sect. 3, we elaborate on the meaning of "working in terms of competences", lay out the competences

we propose for development, and demonstrate how the use of active methodologies is essential. In Sect. 4, we shall work on the continuous evaluation method, an essential tool for generating a good atmosphere, and a framework for working based on competences in the ECTS. Finally, in Sect. 5 we describe some activities designed for students based on this method.

2. The new role of the lecturer

The adoption of a system based on student's own work implies that lecturers cannot follow the traditional method of a one-way flow of information from lecturer to students. Rather, the role of the lecturer is to act as a mediator who exploits the considerable wealth of knowledge and experience that already exists in an average classroom. In other words, information should flow not only from lecturer to students, but also from students to lecturer and from students to students. However, it would be an unrealistic expectation if lecturers took for granted that students would spontaneously and actively involve in tasks on their own, therefore it is vitally important to motivate the students to actively participate in the learning process. The role of the lecturer is to gradually steer students towards active participation, enhancing also their confidence. The objective is to create, as early as possible, a co-operative climate within the classroom.

To achieve this goal it is necessary to set the rules of the ground, which must be known by all participants from the very beginning of the course. Lecturers must not assume that students know what is expected of them, or that they will quickly learn the rules of the game naturally as activities develop, as this would affect negatively the confidence of students, would waste time, and is a threat towards the concept. In other words, at the beginning of the course, students will be explained the way in which they will work and how their performance will be evaluated. Handouts must contain clear answers to the following questions: What is the problem / What has been done by other researchers and where you can contribute / What have you done / Which method or tools have you used / What are your results / What is new and good, What is not good / Future research.

3. Working in terms of competences

3.1 Competences

The old curricula was organized according to objectives; however, the new curricula is organized according to competences. This entails that subject contents must be reoriented to develop these. The term *competence* conceptually means "complex and integrated ability to perform a task" (Lasnier, 2000). This implies a radical change in the organisation of curricula as well as a substantial change in education and learning methods, where students, not the lecturer should be located to the centre of the educational tasks. Therefore, lecturers will design activities that generate learning situations focused on the development of students' capacity of resolution of problems and skills that should reproduce what happens in real life situations.

Taking into account the fact that learning through experience is much more helpful than passive attendance in a classroom, and that Physics laws are behind all daily phenomena, we will describe some activities framed within the Physics subject that facilitate work with students in terms of competences. In our case, the sentence "work in terms of competences"

implies that lecturers, in addition to a masterful class and laboratory work, will design activities where not only the specific competences of the Physics subject are developed, but also more generic ones (ICE, 2006). The generic competences we are interested in developing are: the capability of applying knowledge to practice, research abilities, personal initiative and an enterprising spirit, the ability of working independently, improvement of the knowledge of English language, spoken skills, the ability to make public presentations, and basic computer skills. In other words, these activities try to facilitate the refocusing of the Physics subject contents including practical aspects and to favour the development of hands-on abilities as well as the personal initiative of students.

3.2 Active methodologies

The fact that we are currently in a transition from a model focused on education towards a model focused on learning implies that active methodologies become a necessary tool for developing student competences. In other words, the underlying fact is that learning in terms of competences means that the methodology is the vehicle to make this objective possible.

Although is no 'best' methodology in absolute terms, nonetheless, there are aspects to consider. First, for low-level objectives, such as acquisition and understanding of information, any methodology will be suitable and equally proper. Second, for higher-level objectives, such as the development of critical thought and independent learning, student-centred methodologies are more adequate and effective. Thus, is possible to affirm that educational methodologies based on students active participation, where learning capacities depend directly on students' development of activities, implication and commitment, provides better training than traditional one-way lectures, as participative methodologies generate a deeper, more significant and lasting learning. They also facilitate the transfer to other contexts. This indicates that the change of the educative model implies a more relevant type of methodologies or learning strategies. However, we must take into account that a unique best methodology does not exist; the best methodology will be an adequate combination of different situations designed in an intentional and systematic way. As a result, the chosen methodologies become the vehicle through which students will learn knowledge, abilities and attitudes, that is to say, will develop competences. We must take into account that if we want to become to be effective with our learning methodologies, we must also establish criteria regarding the volume of information and knowledge that our students will handle.

4. Continuous evaluation

Considering that it is a reality that what is not evaluated is devaluated, it is of vital importance to evaluate each of the activities undertaken with students; therefore, an effort must be done in this direction (Stecher & Davis, 1990; Gonzalez et al. 2006). When we questioned ourselves what is the best way to evaluate when working in terms of competences, we realized that the use of continuous evaluation facilitates the generation of a suitable atmosphere for working with this methodology and that it is a useful tool for working in accordance with the ECTS framework. Another important point is that a correct evaluation of each activity is mandatory because, as might be expected, students' motivation increases.

We will propose some activities based on active methodologies with the purpose of developing specific competences, apart from generic ones. These activities are framed within a global program of continuous evaluation and include exams and laboratory practice, where students will be clearly informed from the beginning of the academic year the percentage weight of exams, of laboratory practices, and how will each of these activities contribute to the final mark of the subject.

There are many manuals that explain methods to build different evaluation tests and describe their advantages and disadvantages (Zabalza, 1991; Casanova, 1999; Rosales, 1981; Lafourcade, 1973; Bloom et al. 1975; Stecher & Davis, 1990; García-Ramos, 1989). However, apart from the type of test used, the percentages coming from each of the mentioned fields, which add up the final mark, must be clearly established at the beginning of the course, which will depend on the skills or competences we wish students to develop. Finally, another important aspect favoured by continuous evaluation and by active methodologies is to create an atmosphere where students study to learn and not only with the sole purpose of passing their exams. This implies a continuous evaluation method useful for the rest of their lives. Finally, we can see the Bologna process is an opportunity to improve our educational practices.

5. The activities

We are going to describe some of the activities we have been using during recent years, designed for working in the way previously explained, with students of first year subjects such as “Fundamentals of Physics I” and “Fundamentals of Physics II” contained in different specialities of Industrial Engineering degrees. In what follows, we will describe the evaluation and the analysis of their use. The third activity can be developed during the years it takes to complete a University degree.

5.1 Activity 1

The motivation of this activity came from the fact that learning through one owns experience is much nurturing than learning through passive attendance. Physics laws are behind of all daily phenomena therefore is easy to design experiments that explain these phenomena in a very simple way. On the other hand, although it seems rather strange to undertake Physics experiments outside of a laboratory setting, simple experiments can be designed at very low cost using materials easily available at home. We hereby define “homemade” experiment as a very simple experiment, made with tools and objects easily available at home that show daily phenomenon easily understandable under the laws of Physics.

5.1.1 Description

The first activity consists of a design of the one of the so-called “homemade” experiments (Vilaplana & Gomis, 2008). This experiment will be undertaken with tools and objects easily available at home, and will show a phenomenon of daily life that can be understood in terms of the Physics behind it. Every student will design a homemade experiment and give to the lecturer a card containing the sections described in Fig. 1. Students must also show to the rest of the class, the result of the experiment, supported with a spoken presentation. The

lecturer will make the card available to all, uploading it on the Physics subject website allowing students access to a wide range of examples which may also be downloaded.

Fig. 2. shows a picture of a homemade experiment. A boiled egg is moving downwards as a consequence of the pressure difference between the inside and outside of the container. The pressure inside the container is lower than outside pressure because the container is in thermal contact with cold water (i.e. water with ice cubes). Should the container be in thermal contact with hot water, the egg would move upwards.

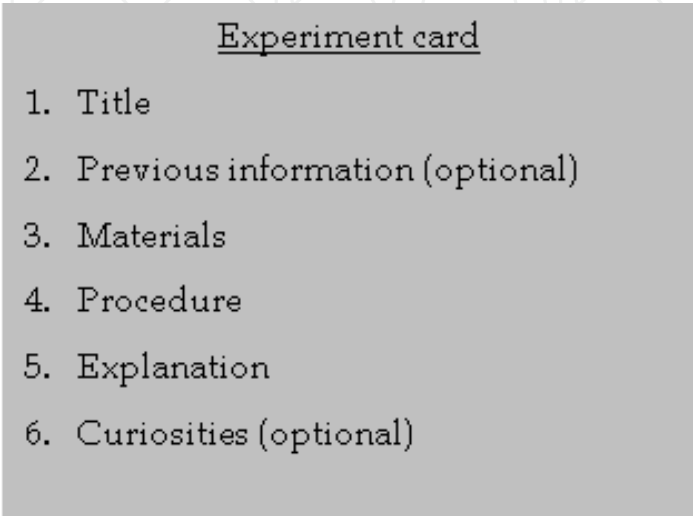


Fig. 1. Experiment card and its sections



Fig. 2. Egg moving downwards by pressure difference

5.1.2 Evaluation

As we mentioned earlier, this activity is framed within a global program of continuous evaluation where different parts of the course, such laboratory practices and other activities, like the one we are describing, contribute to the subject's final mark. Likewise, at the beginning of the course, students will be clearly informed about the percentages of each field that will contribute to the final mark. In our case, we established the percentage marks of the exams and laboratory practices higher than the percentage marks of the rest of the activities. As students realize that continuous evaluation allows them not to find themselves with accumulated workload prior to exams, they are generally happy when doing these continuous evaluation tasks, despite the overall low percentages we assign to these activities. For this particular activity, 60% of the activity mark is given when the card is completed and handed to the lecturer, and the other 40% is given after the verbal presentation.

5.1.3 Analysis

We have observed good implications of students when undertaking this activity. In general, students' motivation has been rather high. This activity develops students' curiosity, creativity and capacity of working in a more autonomous way. Furthermore, this activity contributed to provide the Physics subject a more practical and integrated quality of the subject. In other words, students learn through the development of hand-on skills. Apart from this advantage, actually undertaking the experiment and delivering a spoken presentation in the classroom, contributes to the improvement of their basic computer skills and spoken presentation skills respectively.

A drawback we have found when we started to carry out this activity is that, the higher is the number of students, the greater is the necessary time to accomplish the activity, and therefore we recommend developing this activity when the number of students is less than forty or fifty (Martinez, 2006).

5.2 Activity 2

The motivation for developing this activity arises from the fact that autonomous student learning and personal initiative shall be skills very useful for them in real situations in their future jobs. We have called this activity "Designing multiple-answer questions".

5.2.1 Description

This is a supervised project carried out by groups of two or three students, which consists on the design and implementation of multiple-answer questions using Hot Potatoes™ software (Half-Baked Software, 2005). This activity is one of the new methodologies that the Applied Physics Department of the Higher Polytechnic School of Alcoy (Polytechnic University of Valencia) has applied during recent years in order to adapt the first year subject "Fundamentals of Physics II" of the Mechanical Engineering degree, to the European Higher Education Area (EHEA). The "Fundamentals of Physics II" subject covers mainly Physics contents of mechanics. Since year 2000, in our Physics Department, we are using multiple-answer tests as a teaching and evaluation methodology. The tests have been developed with questions and answers that have been used with students for many years (Gomis et al., 2001). In order to adapt the teaching methodologies to the EHES, we have

proposed the design and implementation of several multiple-answer questions to groups of students that will count with the help and guidance of the lecturer. Hot Potatoes™ has been the software used for the implementation of exercises because it allows the design of exercises and to make them available to all via the Internet (Gomis et al., 2007).

The activity has been organized as follows. Work should be carried out by groups of 2 or 3 students. The first thing students must do is to Install Hot Potatoes™ in their computer. Then they have to read the Hot Potatoes™ manual and become familiar with the program. After that, they have to translate into Spanish a string of 15 multiple-answer questions provided by the lecturer giving also the correct answer along with the detailed solution. Then, a string of 12-13 multiple-answer questions similar to the previous ones, along with the detailed answer and a string of 12-13 original multiple-answer questions together with the detailed answer have to be written. Next, they have to use Hot Potatoes™ to create the test by using the last 24-26 questions. Finally there is an oral presentation to the rest of the class. In order to monitor the work carried out by the groups some meetings should take place, approximately every two weeks, where students present the work carried out so far and discuss the problems and questions they have encountered.

Fig. 3 shows the main window of the JQuiz module of Hot Potatoes™ that is the part of the program used to create the multiple-answer questions. This module allows the user to write a question together with all its possible answers stating the correct one. Fig. 4 shows an example of the web page generated automatically by Hot Potatoes™ where a question related to *work and energy* is shown. The results of this pilot project in the form of multiple-answer questions, ready for use in the Internet, can be found at the subject website: http://personales.alc.upv.es/osgoi/ffii0809/Extra/Test_Hot_Potatoes.htm.

5.2.2 Evaluation

The evaluation of this activity shall be done as follows. Students must prepare a technical report explaining all the work carried out. This counts for 50% of the activity mark. The oral presentation to the rest of the class is the other 50% of the mark. As a whole, this activity contributes to a 10% of the total mark of the subject.

5.2.3 Analysis

This activity allows students to improve the knowledge of Physics, obliging them to revise and become masterful in a part of the Physics theory described during lectures. However, in addition to the specific competences of the subject, we want students to develop some generic ones. In what follows we enumerate some of the generic competences that we have been working on. The first one of these generic competences is to reinforce autonomous student learning. This has been carried out by guiding students through the task of designing the test questions where they work on their own with the supervision of the lecturer. Another competence is the ability to use a software program new to them. In this case we have chosen to use Hot Potatoes™.

The improvement of the knowledge of English language is another competence that has been worked on by taking as a starting point of the work a collection of multiple-answer exercises written in English given by the professor, and also by reading the documentation of the Hot Potatoes™ software originally written in English. Additionally, as students have

to do an oral presentation to the rest of the class, we want them to acquire the ability of presenting their work in public (e.g. by using the PowerPoint™ software program). With the competences enumerated above we want students to carry out in their first year course, a project as similar as possible to the one to be undertaken at the end of the degree, in terms of both richness and variety.

In general, members of the groups have transmitted the usefulness of carrying out this activity because it is a project that covers different aspects such as: autonomous student learning of Physics, student auto-evaluation, computer software, oral communication abilities, etc.

We, as lectures, have found this small project a very valuable experience for a first year course at university because all of our groups of students have carried out good jobs that can also be checked from the Internet link shown above. We plan for the future to extend gradually the number of groups that carry out this kind of work and also cover all the areas in Physics such as fluids, thermodynamics, translational dynamics, etc. However, we want to point out the difficulty in supervising this kind of activity, in our particular case, where the number of students is usually higher than one hundred. This fact limits the number of groups than can be guided by the teacher.

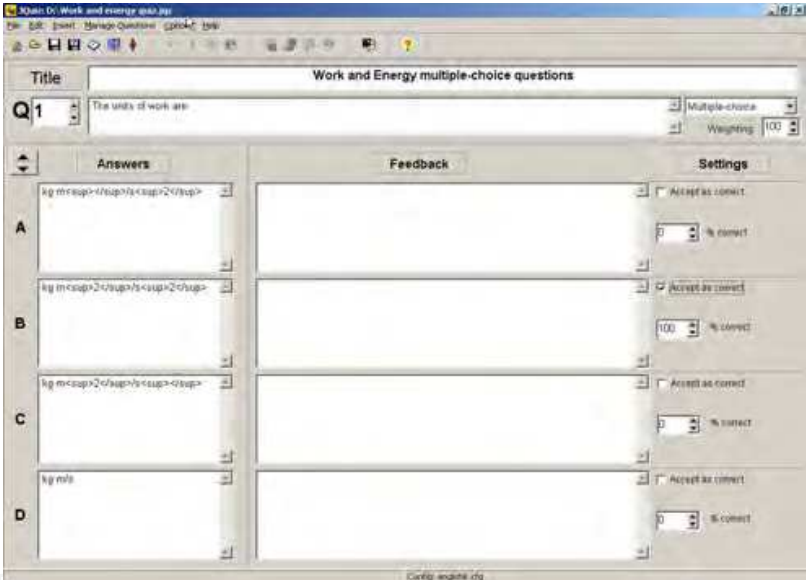


Fig. 3. JQuiz module of Hot Potatoes™ used to create multiple-answer exercises.

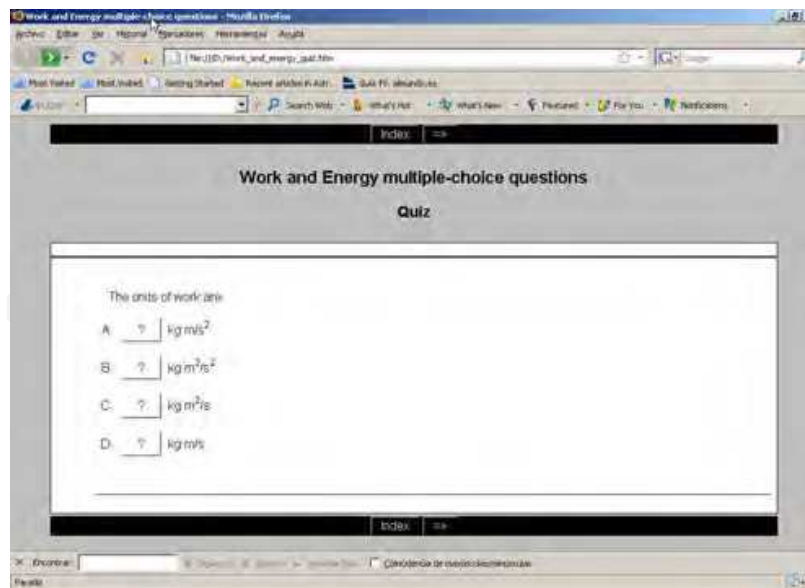


Fig. 4. Screen capture showing the web page with one question on work and energy.

5.3 Activity 3

The motivation for developing this activity arises from the fact that it takes years to learn and develop public presentations skills consciously adapted to the unique and varied audience situations we shall encounter during our professional lives. We have called this activity “Preparing an audience-fit presentation”. This activity is part of the two previous ones and it has been explained for general contexts. However, this skill extensively used in marketing, can also be used in different subjects.

5.3.1 Description

During the several years it takes to complete a university degree, we have a great opportunity for preparing ourselves for real life situations. Such is the case of learning how to adequately prepare presentations for their deliverance in public, a skill that we shall probably use during the rest of our lives.

More and more, students are asked to prepare PowerPoint™ presentations in order to deliver to an audience, the results of their work. Many manuals will assist students in using the software, choose colours, backgrounds or visual transitions. However, it is a key fact that content must be prepared in such a way that the audience, within the environment where the presentation takes place, can actually understand what the presenter has to say.

This activity is intended to help students to develop their competence when presenting to an audience, and to understand the importance of transmitting their messages arising from their work, in a manner than can be understood.

Developing the competence

During the years it takes to complete a degree, it is advisable to do as many presentations as possible. The only way to learn how to do great presentations is by actually doing them, being subject to different situations where different messages need to be put forward to diverse audiences. This author has seen over the years, time and time again, that those students, who made the effort to prepare presentations to the best of their knowledge, are

today competent presenters who do great presentations in front of different types of audiences.

Preparation is paramount

One of the key factors about learning how to be competent with presentations is to have invested some time in their preparation and rehearsal.

Selling the product

Putting a presentation forward to an audience can be also be seen as if we were selling the results of our work to people who might buy it, just as if it was a product. But first, potential buyers need to understand what the product is actually about. When companies develop products and put them into shops for sale, they tell us what the product is about, what is it useful for, and tend to inform us about the main features of the product.

When we are going to do a presentation, students will be knowledgeable with their work, however the audience might not know so much about the topic, therefore contents have to be put forward to them in a manner that at least they have the chance to understand what they are being explained. After all, students might have spent long hours preparing their work, want to be understood by the audience, and will probably have just few minutes to present the results of their work.

Organising the presentation

In what follows we will provide guidance about how to prepare an audience-fit presentation.

- 1.- Presentation content
- 2.- The environment
- 3.- Doing the presentation

First: Presentation content

Make the core message clear. It seems to be a human feature, but when we design our own product and want to tell other people about it, we many times forget to tell what the most important features of the product are. For instance, the most important feature of a wristwatch is that it tells the time. No matter how beautiful the watch is, if it does not perform its main function correctly, people will think it is not useful.

When designing the contents of the presentation, do not forget to clearly address the most important message you have to say, as what might seem obvious to you, might indeed not be obvious at all to your audience.

One way of doing this is actually telling people, which is the core message we want to say. When we make emphasis on the core message and put it forward in a clear manner, we have a greater chance of succeeding when delivering our messages to a varied audience.

No matter how excited you are in trying to show to the public how hard you have worked, stick to your point and say your core message clearly. Despite how easy we make it for the audience, they might have seen some presentations already and might not be paying their full attention. Psychologists argue that the attention of a listener goes flat after only 45 minutes.

Fig. 5 shows the impact on the audience of selecting an appropriate font size. Select a size that is readable in the presentation room.

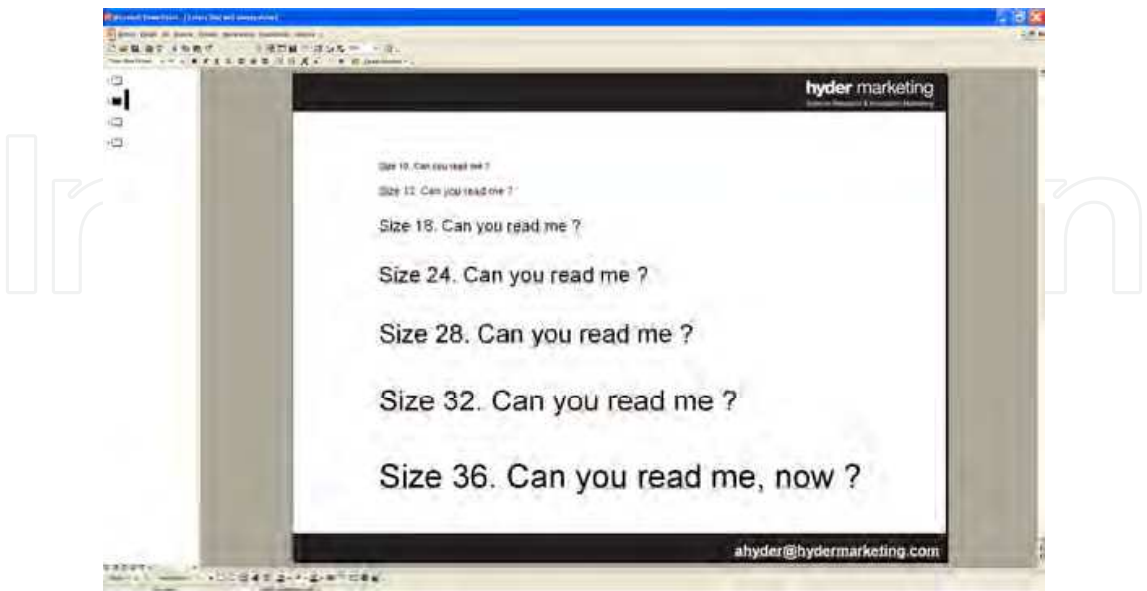


Fig. 5. Different font sizes

Colours. Use colours that will also be appropriate for the light environment of the classroom. A rule of thumb is to use dark letters with a light background or vice versa. Try different colour combinations, adapted for the room where the presentation will take place. For instance, try using light colours such as white with dark backgrounds such as black. Fig. 6 shows an example of different colour combinations. Do not use colours that cannot be seen.

Balance the content. Use few sentences: perhaps 3 short sentences per slide. Keep the text adequate in length, better short than long, making sure you use the core keywords that are necessary to get the message across. Fig. 7 shows an example of balanced content, whilst Fig. 8 shows an example of a slide overloaded with content.



Fig. 6. Choose visible colours

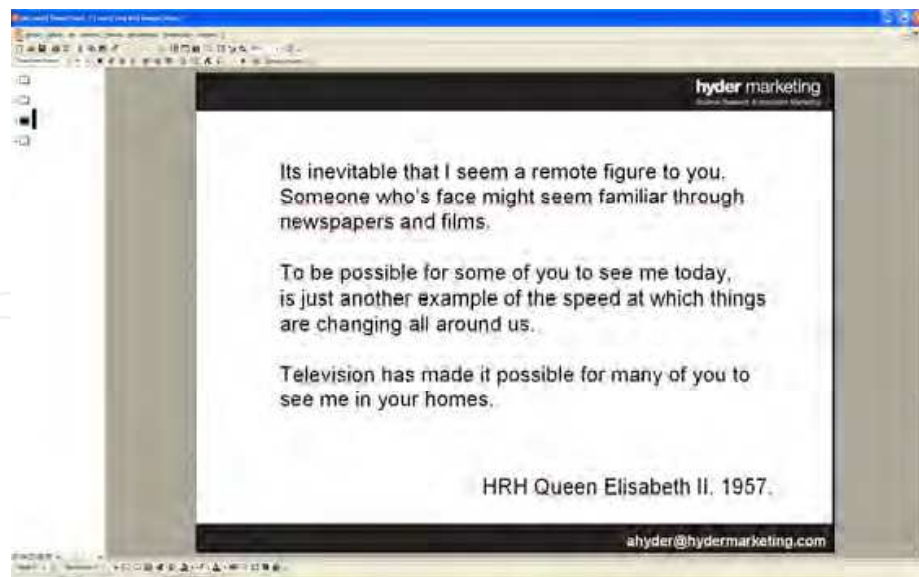


Fig. 7. Balanced content

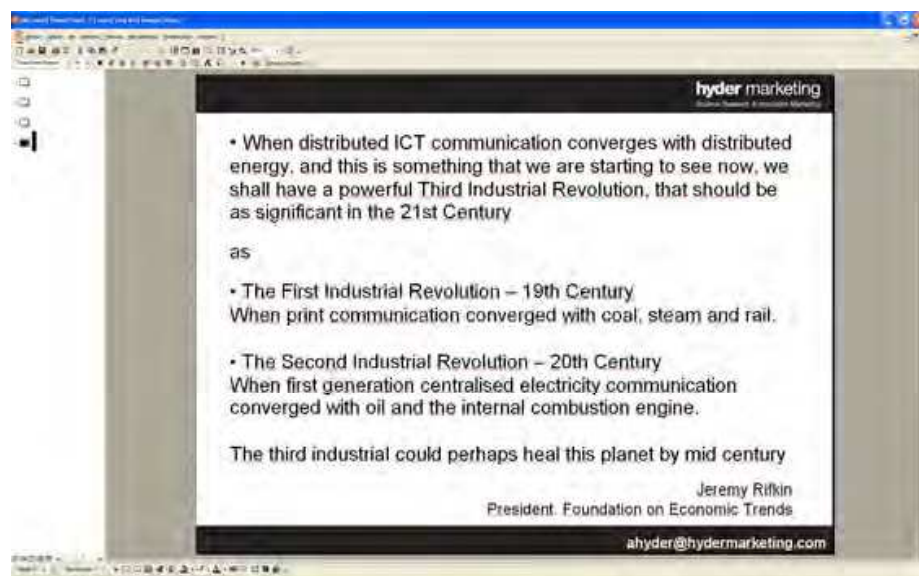


Fig. 8. Overloaded content

Second: The Environment

The environment refers to the room where the presentation will take place, the available resources such as projectors and sound systems, and the audience that will attend the presentation.

When a presentation is designed taking in mind the room and the audience that is actually going to see it, there is a higher chance of getting the message across.

Walk around the classroom and put yourself in the situation of all the audience that will be sitting there. Sometimes the resources are not adequate, for instance the screen might be small. In such a case, you will have to adapt the font size. If you are going to give the presentation in a room that you do not know, or cannot visit prior to the presentation, do

not hesitate to ask someone who knows about the room and the available resources that you need for your presentation, such as loudspeakers.

Third: Doing the presentation

Preparation is paramount. One of the factors to success is to do rehearsals with the presentation once it is complete. Not only will rehearsals help us to test what we are going to say and help us to polish mistakes, but also they help us to master our presentation skills. Perhaps one of the best ways of organising the content is to use an introduction slide that provides an index of the slides to come.

A standard sequence could be the following, which should go along with a verbal presentation.

1. - Introduce yourself and the team your represent.
2. - What is the presentation about.
3. - Brief overview of the topics to be addressed and the outcomes.
4. - Then do the actual presentation.
5. - Finish with a conclusion.
6. - Thank the audience and ask if there are any questions.

Make yourself clear when you speak. Whether you speak with or without a microphone, make sure your voice can be heard in all parts of the room.

Stick to the time limit. Usually when giving a presentation, we are subject to a time limit that is imposed on us. Whatever the time limit is, try your best and stick to it.

If we have adequately prepared and rehearsed the presentation, even if anything goes wrong at the time of presenting, if we have clear what we want to say and actually say it, the audience will still have the chance of receiving our core message. Preparing and then rehearsing a presentation is one of the key factors to success, and the skill developed when doing this will be very useful for different presentations we will give during the rest of our lives.

5.3.2 Evaluation

It is useful to provide feedback to presenters, in order to let them know how well they did from the point of view of the audience.

Whether presentations are made in groups of students or on an individual basis, those students who made up the public, can use the card shown in Table 1 in order to provide feedback to the presenter.

Presentation review card	
Name of Presenter:	Reviewed by:
	(Rate 0-10 points)
I could adequately read the presentation	
I could hear the presentation correctly	
I have understood the core message(s)	
Presentation is well balanced and organised	
Presentation is complete	
Presentation was finalised with a convincing conclusion	
Presentation could be adequately followed in the room	
Presentation and Presenter were professional	
Presenter made the presentation interesting	
Presenter complied with the allocated time	
Total points (max. 100):	
Comments	

Table 1. Presentation review card

Once you have rated all students or groups you will be able to compare, from the point of view of the audience, how well you did.

5.3.3 Analysis

This activity was intended to help students to develop their competence when presenting to an audience, a skill that will help them to train for real life situations. Emphasis was made on the importance of putting across the core messages arising from their work, in a manner than can be understood by the audience in each specific environment. Presenting in public in real life situations, require the same skills when presenting to peer students, but with the increased aggravator that the members of the audience will not be known, fact that will increase our nervousness.

Over the years, we have witnessed how those students, who made the effort to prepare adequate presentations for different audiences, actually achieved mastery when undertaking presentations in public, ensuring that the audience has the opportunity to understand the core message.

It is habitual that at the time of giving the public presentation, things do not always happen as we expected, therefore all accumulated experience will help to keep things under control. Preparation is paramount.

In the classroom, all students are in the same situation: they are there to learn and keep learning. Therefore, we have an opportunity if we consciously use the years it takes to complete a university degree to train ourselves for real life situations, doing as many presentations as possible, which will definitely contribute to our personal success.

6. Conclusion

Having used these activities within a global program of continuous evaluation during the past three years (Vilaplana et al., 2007; Vilaplana & Gomis, 2008), our overall assessment is positive. We have observed a number of advantageous results. For instance, students' motivation increases as their duties are spread out during the duration of the subject; therefore they do not find themselves with accumulated workload prior to exams. This means that students can follow the subjects of Physics easier. Another advantage is the combined development of specific and generic competences. Each degree compiles the specific competences to be developed, as demanded by society. Their developments greatly depend on the active methodologies used in activities. In other words, the nature of these activities leads to an active student attitude. In brief, it is clear that it is possible to achieve a much more meaningful and integrated learning when continuous evaluation is used. Acknowledgment is also given to the design of activities based on active methodologies. Moreover, we have tested that development through one's own experience is much more helpful than learning through passive attendance.

On the other hand, we have encountered some short backs when trying to reach our purposes. One of these is related to number of students that are enrolled in a subject. Large groups difficult the successful completion of these activities due to the excessive time needed. We have concluded that an adequate number of students would be around forty or fifty. Another challenging concern is the time needed by students to undertake each activity. Learning within the ECTS framework implies that we should take this aspect into account, and not overload students with excessive hours of work. Beside this, it is part of role of lecturers to change student habits of study. Therefore, institutions should make an effort in providing lecturers with adequate training, so that they can improve the required skills for their new role as facilitators and can gradually encourage their students to participate actively during lectures.

Having mentioned the advantages and disadvantages we have reached to the conclusion that the use of continuous evaluation and active methodologies, as well as the change in lecturer role and the active participation of the students in the class, altogether make it possible to work in terms of competences. Continuous evaluation and active methodologies facilitate the generation of an adequate atmosphere for working in this way. To accomplish this, it is imperative that lecturers are trained for their new role as facilitators. These ingredients, when combined, will naturally drive students towards the accomplishment of

active participation. Finally, we have observed that the use of continuous evaluation and the use of active learning methodologies make possible that student not only study to pass their exams, but to learn.

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