

# E-LEARNING APPLIED FOR TRAINING ON SAFETY AND HYGIENE IN ELECTRONICS ENGINEERS DEGREE

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**Keywords:** e-Learning, Asynchronous discussion forum, Periodical online quizzes, Virtual laboratory.

**Abstract:** The use in the university of new teaching resources by e-learning, is becoming in a common practice, encouraging student participation, and improving academic achievement in learning the subject. An experience in the Safety and Hygiene course of Electronic Engineering degree, at the University of Cordoba –Spain-, has been developed by using different techniques like discussion forums, online quizzes, and a novel and powerful tool: a set of virtual laboratories about noise and vibrations at labour environment which are based on internet. These virtual laboratories promote the learning by different viewpoints like theoretical training, legal knowledge, learning videos, self-training exercises and simulation of use and working of real equipment for field measurement. These virtual laboratories had been evaluated by students who use them, being the results which are reflected in this work, highly satisfactory.

## 1 INTRODUCTION

Last years, the increasing of e-learning resources in Higher Education, in Spain and others countries in the world is a reality. Students are very integrated with these technologies because they obtain a feedback on their work nearly in real time.

E-learning is not a “gift-wrapping” of materials of the traditional on-line courses (Fischer, 2003). The participation in e-learning of the students does not only depend on personal factors or on preferences, but also on the nature of the technology employed and on the pedagogy followed. An effective learning environment should be very well organized and it should be made quite clear what is expected of students (Swan, et al., 2000). The main challenge should be, in addition to the organization of the course, the teacher’s participation and the student-to-student and student-to-teacher interactions in the activities proposed. The teacher’s role is fundamental since he/she has to propose issues of interest, trigger participation in the course, and make an effort to understand any difficulties the

students may have. Therefore, teachers should not limit themselves to being a mere means of transmission but should acquire a more complex protagonism (De Laat et al., 2003).

Fowell, Southgate & Bligh (1999) suggest that students are best served by the provision of a diverse range of assessment methods as individual methods may disadvantage some students. They also suggest that from the teacher perspective, using a selection of methods allows performance from different sources to be related. Seale, Chapman & Davey (2000), who investigated which types of assessment students found most motivating for their learning, found that having a range of assessment opportunities was most motivating. They also found that the relevance and content of the assessment appeared to influence student motivation as well as the enthusiasm of the teachers. Feedback on performance, especially that of a formative nature, has been shown to be a valuable tool in the learning process enabling students to assess their own progress and understanding and remedy any weakness exposed by the assessment (Zakrzewski & Bull, 1999). However, for this feedback to be

effective it needs to be provided early in the learning process and have some degree of prescription about how to improve performance (William & Black, 1996). Fowell, et al. (1999) argue that the presentation of results also require the provision of effective feedback to students, in both summative and formative assessment tasks, enabling students to identify their strengths and weaknesses in order to improve future performance.

The basic objective of this work was to encourage the acquisition of skills by the students and to improve the global teaching-learning process in Engineering studies. For this purpose, a modification of the teaching methodologies used in the subject of Safety and Hygiene at Work was approached, starting from the traditional teaching based on teachers' classes and examinations, and arriving at another kind which combined several techniques, such as asynchronous discussion forums, online quizzes and group tutoring, among others.

## 2 METHODOLOGY

With the European Credit Transfer System (ECTS) the workload of an average student during an academic year of 60 credits should be comprised between 1500 and 1800 hours, so that it is vital to establish a teaching methodology aimed at integrating the acquisition of knowledge and skills by the students by distributing their workload coherently with the objectives and assignation of credits.

The Safety and Hygiene course at work has a total of 4.5 ECTS assigned to it, so that it is necessary to draw up a students' work programme with a total between 112 and 135 hours of work. The main themes dealt with in this subject are:

1. Evolution of Safety and Hygiene at Work.
2. Health. Professional risks.
3. Legal aspects on Safety and Hygiene.
4. Concept of work accidents. Factors.
5. Techniques of analysis in safety.
6. Operative techniques in safety.
7. Personal protective equipment (PPE).
8. Industrial Hygiene.
9. Theoretical Hygiene.
10. Physical environmental agents: Noise and vibrations.
11. Physical environmental agents: Environment Thermal.
12. Protection against electric shocks.
13. Design of place for video display terminal users.

The general structure of the course is shown in Figure 1.

As a teaching support tool it included the use of the Moodle e-learning platform, concretely with the employment of asynchronous discussion forums, periodical online quizzes and a Virtual Laboratory in Noise and Vibrations.

### 2.1 Asynchronous Discussion Forums

The asynchronous discussion forum is a communication tool extensively employed in on-line courses to improve the interaction with students and obtain a fast feedback of their knowledge, doubts and opinions. Gibbs, Simpson, and Bernas (2008) cite the benefits in learning from the asynchronous discussion forums since the students control the communication and access to information by means of this tool.

<p><i>Theory classes: 21h.</i></p> <p><i>Practice classes: 11h.</i></p> <p><i>Expositions and seminars.</i></p> <p><i>Specialized tutorials (with physical presence or virtual):</i></p> <ol style="list-style-type: none"> <li>1. Collective: 4h.</li> <li>2. Individual: 2h.</li> </ol> <p><i>Directed academic activities:</i></p> <ol style="list-style-type: none"> <li>1. With a teacher: 9h.</li> <li>2. Without a teacher: 9h.</li> </ol> <p><i>Other personal autonomous work:</i></p> <ol style="list-style-type: none"> <li>1. Study hours: 32h.</li> <li>2. Preparation of personal work: 9h.</li> <li>3. Participation in the forum: 4h.</li> <li>4. Preparation of group tutorials: 3h.</li> </ol> <p><i>Examinations:</i></p> <ol style="list-style-type: none"> <li>1. Written exam: 2h.</li> <li>2. Oral exams.</li> </ol>
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Figure 1: General structure of the course.

In this subject, the forum has been configured as an obligatory discipline for all the members of the group and with an automatic monitoring of the answers and questions posed by e-mail to all the group members. In addition, their participation is gratified with 10% on the final mark, taking into account the quality of the contributions of each of the participants. The objective sought with the use of the forum is to maintain the constant attention of the group on the topics proposed, to encourage the investigatory spirit of the students in the supplying of solutions to the problems posed, and, therefore, to evolve an improvement of the group's knowledge,

directing from a distance the questions-replies put forward. In spite of the well known advantages of the forum, some authors like Hew and Cheung (2003), through two cases studied examining facilitators' habits of mind in a synchronous online discussion concluded that over 30% of the students presented an "awareness of own thinking" and were "open minded". In this sense, the teacher's role in the forum is fundamental. In the forum of the Safety and Hygiene at Work course the performance of the teacher with respect to the contributions of the students to the forum is twofold: when the students pose their doubts on the subject in question the teacher does not interrupt and waits for other students to answer the question, so that, if the answer is correct, he/she does not have to intervene or only does so to praise them or complete their contribution in this course. On the other hand, if the forum activity flags the teacher proposes some new debate issues related to the theme of the subject. Finally, the themes discussed in the forum are pooled through practice sessions in which students prepare an oral exposition in groups of 4 or 5 and debate with the rest of the group on the opinions expressed in the forum.

## 2.2 Periodical Online Quizzes

To maximize the students' achievement, the teachers need to receive effective feedback from them by means of different tools (Dobson, 2008; Seale, 2000). Using online quizzes in the e-learning platform it is aimed to motivate the periodical study of the students at the rate programmed in the subject and to analyze the strong and weak points of the subject. Each quiz is open for 4 days and the time estimated for its completion varies between 30-45 minutes depending on the theme in question. The questions come with multiple or paired answers and the order both of the questions and the answers is in a random form. As the structure of the course is divided into differential blocks, at the end of each theme the student has to do the corresponding quiz.

A second action stage consists of analyzing the results of the quizzes, observing the questions with most wrong answers, the most correctly answered ones, the percentage of participation, etc. For this purpose, tutorial sessions with the complete group are organized in which these concepts are debated, reinforcing and ensuring those in which the worst results have been obtained.

## 2.3 Virtual Laboratory

An important part of the software applications currently being developed are oriented towards teaching and the transmission of knowledge. This type of application seeks to stimulate the end user with educational technology and to facilitate the acceleration of learning thanks to the application's interactivity.

One important factor in the increase in the use of new technologies as a teaching tool is the expansion of the software through Internet. Internet is the means which brings these complementary teaching tools nearer to any user so that they can benefit from them at any moment (Jimenez, 2009).

The main objective that it is aimed to fulfil is the development of a software application which makes up for the absence of information experienced by students of technical studies when acquiring theoretical knowledge and carrying out practical classes in laboratories, specifically in the classes corresponding to experimentation with the instruments for the measurement of vibrations and noise.

The secondary objectives are:

- To develop an application containing information referring to the instrumentation and measurement methods.
- The application has direct access to the regulation in force on the protection of the health and safety of workers against risks related to exposure to machine vibrations.
- To include extensive information on the possible effects on workers brought on by vibrations and noise.
- The software has a complete training tutorial for expert technicians.
- To permit the user to become familiarized with some of the measurement instruments by means of the simulation of their functioning in different work places.
- To permit the updating of the information it contains through a resource manager with a database which contributes dynamism to the application itself.
- The virtual laboratory has a general interface for the presentation of different applications related to Work-related Risk Prevention.
- The web page works in a "multiplatform" environment. The application can be used in any computer regardless of its operative system.

- It is intuitive and easy to use as it is aimed at people who do not necessarily have any extensive knowledge of the subject.

### 2.3.1 Description of the Software

In the portal developed it is aimed to concentrate in one single software all the aspects necessary for a specialist in the prevention of work-related risks: noise and vibrations (Figure 2).



Figure 2: First frame of the virtual laboratories on work-related noise and vibration portal.

With it, the drawbacks which real laboratory learning entails disappear:

- The high cost of instruments for measuring noise.
- The need for a teacher to supervise the operations carried out in each machine.
- The need to fit out a laboratory in order to carry out these practical classes.
- The need to adopt a timetable to set up the practical classes.

The aspects included are as follows:

- A tutorial to guide the technician, supplying him/her with information on different physics fields dealing with noise and vibrations, the instrumentation to be used in measuring them, the regulations in force, updated, to be applied during that measuring process together with the different configuration parameters to be used in controlling noise, and a series of tutorial videos which facilitate the understanding of the handling of the devices related to this theme.
- Gallery in which there is a useful educational illustrated reference with information on all the machines and instruments employed.
- Virtual Laboratory or Simulation of a dosimeter, a sonometer, a calibrator with its respective measurement and calibration processes, and vibrometers.

- Analyses of results, interpretation of images, carrying out calculations, resolution of cases, etc.
- Flexible interface for access to information available.
- Opportunity for the learner to repeat the practical activities as many times as he/she considers it necessary until the didactic results wished are achieved.
- The learning timetable is established by the users themselves in accordance with their needs.
- Possibility of use of software at all times.

#### 2.3.1.1 Tutorial Module

In this module all the norms and legal ordinances related to the prevention of work-related risks, the technical documentation of the measurement teams, etc., can be found. Also, due to the fact that in work-related risk prevention the legal regulations are of vital importance, the user disposes of a tutorial with the legislation in force in order to find out the regulations concerning vibrations and noise at work. The information given is classified in accordance with the existing norms, including laws, royal decrees and directives.

The information given in the tutorial is structured in the following way:

- Physical properties of vibrations and noise: in this section an extended definition of vibrations and noise is made.
- Parameters which define the vibrations and noise at work: In this section each of the parameters intervening is defined.
- Spectrum analysis of vibrations: In this section some physical aspects of the vibrations phenomenon are described in relation to their study in the frequency domain.
- Vibration and noise measurement techniques: In this section, the diverse practices employed in measuring are described, depending on the situation, the objective, the place and conditions of the environment in which these measurements are made.
- Effects or pathologies of vibrations and noise on people: In this section, a detailed description is given of the effects that the work-related risks being studied can cause.
- Control systems: In this section, the methods for improving the vibrations and



noise or for restricting them to tolerable levels are described.

- Control systems in the source
- Vibration uncoupling systems
- Control systems by Individual Protection Equipments (EPI).
- Organization controls.
- Vibrations and noise in industry: In this section the risks that it is possible to localize in industry are detailed.

**2.3.1.2 Help Module and Consult Video-Tutorial**

The Help module consists of a series of documents in an HTML format, which explain the functioning of each of the sections making up the program.

Some videos are used for providing complementary information on certain aspects included in other modules of the application (Figure 3).



Figure 3: Video-tutorials.

**2.3.1.3 Simulation Laboratory Module**

The user can access to a laboratory in which he/she is shown a series of simulations in order to prepare him/her in the measurement of vibrations and noise and the interpretation of his/her results. As an example, some of the simulations available are:

- Calibration process: Simulation of the calibration process of a vibrometer controlling a possible incorrect calibration.
- Vibrometer: Simulation corresponding to the handling of this measurement device.
- Simulation in work places.

**3 RESULTS AND DISCUSSION**

Using the first two activities described in 2.2 and 2.3 sections, forum and periodical quizzes, it has been

possible to check the progress of the group with respect to the subject by means of its marks and participation in the forum. Some of the most interesting themes proposed in the forum were the debate on the difference between risk and hazard, with a participation of 21%, and the question asking what type of risk a burn was, with a participation of 35.7%. With regard to the quizzes, 66.7% of the students who completed 90% of the quizzes placed online during the academic year passed the theory exam. Conversely, those students who only did 33% of the quizzes did not pass the final exam.

For the evaluation of the Virtual Laboratory a survey with 26 questions divided into the following categories was made (see Figure 4):

1. Help.
2. Easy to use.
3. Encourages motivation.
4. Multisensorial.
5. Promotes learning.
6. Adequate theory content.
7. Assessment of the interface environment.

These questions were scored on a scale of 0-5, and, in addition, the students were asked about the advantages and drawbacks of the use of the Virtual Laboratory by means of a free-answer question, expressing their opinions and feelings about it. Over 50% of the students commented on their usefulness and great similarity with real laboratories as one of the main advantages. However, nearly 30% pointed out that the principal drawback was the bad quality of the videos and the excessive documentation in the tutorials.

The evaluation in future courses, whereas the improvements that will be introduced from gain experience, allowing access to a reliable diagnosis in relation to the advantages and disadvantages of this kind of training tools.

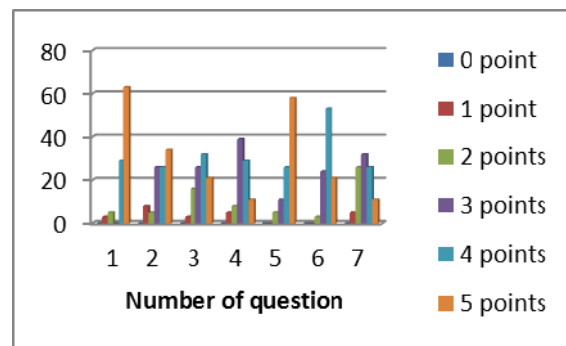


Figure 4: Results of questions 1-7 on the VLs.

## 4 CONCLUSIONS

By putting into practice this e-learning course combining the teaching strategies mentioned, such as the asynchronous discussion forum, online quizzes and group tutoring, we have succeeded in increasing the degree of skill acquisition by the students, at the same time as controlling the effort necessary for this depending on the evolution of the course programmed.

The teaching strategy most valued by students was the Virtual Laboratory, both for its theory content and its great similarity to the real laboratory. Second, it was demonstrated that the online quizzes controlled the periodical efforts of the students, and their results can be seen quantitatively in the number of passes obtained in the final examination. Finally, the forum has been extremely useful for the resolution of questions dealt with in the class, with feedback being obtained from students participating in it of the issues triggering their interest most. The success of this type of learning undoubtedly depends on the students, and, basically, on the role assumed by the teacher who has to be involved in the use of the VL, in the analysis of the results of the online quizzes, and in the participation in the forum.

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