Revista Educación en Ingeniería
ISSN 1900-8260
Julio a Diciembre de 2014, Vol. 9, N°. 18, pp. 130-143 • © 2014 ACOFI • http://www.educacioneningenieria.org
Recibido: 09/05/2014 • Aprobado: 18/10/2014

PROPUESTA PARA EVALUAR EL APRENDIZAJE EN UN NUEVO PLAN DE ESTUDIOS DE INGENIERÍA, EN EL CONTEXTO MILITAR

A PROPOSAL FOR THE LEARNING EVALUATION IN A NEW ENGINEERING CURRICULUM WITHIN A MILITARY CONTEXT

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Resumen

En el contexto del proceso de Bolonia, se han adaptado los métodos habituales de evaluación para mejorarla con respecto a la adquisición de las habilidades de los estudiantes. Esta es una de las cuestiones claves en las carreras de ingeniería, que implica la transformación de los sistemas tradicionales de evaluación en sistemas de evaluación continua. El trabajo ha sido desarrollado en un grado de ingeniería mecánica que se ofrece en un centro universitario, en un contexto militar. La implementación del nuevo plan de estudios ha planteado serias dudas sobre su idoneidad, ya que es la primera vez que los guardiamarinas deben obtener un título en ingeniería para ser oficiales de la Armada. Se pretende lograr una correcta aplicación del nuevo plan de estudios, tratando de evitar el fracaso de los estudiantes. Se presentan los métodos de enseñanza y las técnicas de evaluación utilizados para conseguirlo, así como los resultados de las asignaturas de primer año. Por otra parte, se analiza la influencia del sistema de evaluación continua en la calidad del proceso de aprendizaje, porque en la medida en que sea eficaz, si dicho sistema se suma a una metodología de enseñanza adecuada, puede contribuir a prevenir el fracaso del sistema educativo. En síntesis, un sistema de evaluación basado en la evaluación continua debe contribuir a una buena calidad de aprendizaje.

Palabras claves: proceso de Bolonia, evaluación continua, aprendizaje, contexto militar, habilidades

Abstract

In the context of Bologna process, the usual methods of evaluation have been adapted to obtain a better assessment of the acquisition of students' skills. This is one of the key issues in the case of engineering degrees, which involves the transformation of the traditional evaluation systems into continuous evaluation systems. This work has been developed in a mechanical engineering degree which is offered at a university center within a military context. The implementation of the new curriculum has raised serious doubts about its adequacy, since it is the first time that midshipmen must obtain a degree in engineering to be officers of the Navy. We pretend to get a smooth implementation of the new curriculum, trying to avoid students' failure. We show the teaching methods and the assessment techniques used to get it. We present the results obtained in subjects offered at the first year of the degree. The influence of continuous evaluation system on quality of learning process has been analyzed. If the teaching methodology is the proper one, an effective evaluation system could help to prevent the failure of the education system. An evaluation system based on continuous assessment should contribute to a good quality of learning.

Keywords: Bologna process, continuous evaluation, learning, military context, skills

Introduction

The Sorbonne Joint Declaration (1998) pointed out the Europe of knowledge as an important concept to advance the European process. The Declaration emphasized the essential role of universities in developing European cultural dimensions and, in addition, it encouraged the creation of the European Higher Education Area (EHEA). One year later, these ideas were consolidated in the Bologna Declaration (1999), which made possible giving a boost to the EHEA. Since then, the called Bologna Process has been advancing in the European university community.

In London Communiqué, in 2007, the European Ministers of Education pointed out the relevance of curricula reform, where learning outcomes and student workload are the basis for successful application of the European Credit Transfer and Accumulation System (ECTS). ECTS (ECTS Users' Guide, 2009) is the credit system for higher education used in the EHEA, concerning all countries engaged in the Bologna Process. ECTS is a learner-centered system for credit accumulation and transfer based on the transparency of learning outcomes and learning processes. It aims to facilitate planning, delivery, evaluation, recognition and validation of qualifications and units of learning as well as student mobility. ECTS credits are based on the workload that students need in order to achieve expected learning outcomes. Workload indicates the time students typically need to complete all learning activities (such as lectures, seminars, projects, practical work, self-study and examinations). 60 ECTS credits are attached to the workload of a fulltime year of formal learning (academic year) and the correlated learning outcomes. In most cases, student workload ranges from 1,500 to 1,800 hours for an academic year, whereby one credit corresponds to 25 to 30 hours of work.

In the system previous to Bologna Process, a credit is the number of hours which a teacher lectures. Specifically, a credit corresponds to 10 teaching hours. The ECTS credit, however, measures the total workload of student learning to achieve the objectives set out in the curriculum. Briefly, we can say that there is a fundamental difference between the ECTS system with the previous system of credits. All the learning activities which are being made by the students in order to pass a course are taken into account by the ECTS system when we are implementing the credits in the curriculum.

It has been necessary to make changes with regard to the initial situation of Higher Education which existed before the Bologna Process. Specifically, the demand of carrying out changes in the structure of university degrees has been recognized. To achieve the proposed goals, it seems clear the need of introducing innovations in teaching and learning processes.

The Ministry of Education and Science is responsible for higher education in Spain. On the way to convergence with the Bologna Process, the Ministry of Education and Science established, by Royal Decree 1393/2007, the regulation of university official education. This involved the adequacy of the legal framework to hold the new structure which emanated from the Bologna process.

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In this new model, the design of a university degree should have more elements than the simple description of the learning contents. A curriculum should be considered as an implementation project of university education. The curriculum leading to a degree should have as its primary aim the acquisition of skills by students. Therefore, the traditional focus on content and teaching hours should be supplemented. The Royal Decree states that special importance should be given to methods of learning as well as the procedures for assessing the acquisition of skills.

Traditionally, higher education has used the final examination as a method of assessing the level of knowledge of students (Boud and Falchikov, 1989). Accordingly, it is possible to assume that the learning process of students has not been taken sufficiently into account. With the implementation of the new model, based on the Bologna standards and guidelines (ENQA, 2005), the teacher must not be only concerned about correcting students' results. The teacher must lead the students and carry out the assessment of their learning process (Kourilsky and Wittrock, 1992). In this way, students could be better placed to achieve their objectives. The way the students achieve the skills related to their learning is closely related to the way of carrying out the evaluation (Miller et al., 1998).

In this context, this work has been developed in order to study the application of continuous evaluation in a new engineering degree which is required for the training of future officers of the Spanish Navy. It is important to note that this kind of degree is implemented in Spain for the first time. The problem arises when we consider the high number of students that fail in engineering degrees of Spain. This is important because the graduation rate of the Spanish Navy officers was 90% over the past 10 years. With the introduction of new engineering curriculum, based on the Bologna model, the objective sought to achieve is a graduation rate not lower than 75%.

In this paper, we present the methods and results that we obtained in the first year academic degree in Mechanical Engineering which began to be taught in 2010 to the future officers of the Spanish Navy. To resolve the problem, we used teaching techniques and methods based on the Bologna guidelines, where continuous assessment plays an essential role.

Educational context

Our attention is focused on mechanical engineering degree taught at the University Centre of Defence (CUD is the acronym for its name in Spanish), located at the Military Naval School (ENM is the Spanish acronym) of Marin. The CUD is created from the Law 39/2007 of the military career which states that along with military education and training, will be required to access the official scales to obtain a university degree.

In the case of the Spanish Navy, the Law also indicates that the CUD will be located in the ENM and will be assigned to a public university. Consequently, the CUD is governed by the Universities Law and the regulations applicable to the university with which it assigns. The CUD located in the ENM established, in 2010, the affiliation agreement with the University of Vigo as a university centre which teaches the courses leading to the official qualification degree in Mechanical Engineering. The adaptation of Spanish engineering degrees to the Bologna Process, led to the University of Vigo to launch, in 2010, the new degrees in engineering pertaining to the industrial branch.

Since its creation in 1717, the Spanish Navy is an institution with strong traditions and customs. The various contingents that make up the Navy are trained in appropriate schools for each task. Among the various training centres and schools of the Navy, it stands out the Military Naval School (ENM), whose mission is to train future officers, or midshipmen, of the Navy. Although it is known that the historical background of the Naval Academy goes back to the first quarter of the eighteenth century, it established its present name in 1913 and its current location in 1943. The ENM, as a military educational institution, is aimed at training future naval officers of Spain. As such institution, has taught to the midshipmen different subjects since its existence. The subjects taught are of two distinct areas. On the one hand, the specifics subjects of military education were taught. On the other hand, sciences and technical subjects

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such as mathematics, electricity, technical drawing, thermodynamics, among other subjects, were taught too. More information about ENM is available at the Spanish Defence Ministry website. For the subjects of non-military nature, this situation has changed since the creation of the CUD. Currently, the scientific and technical education is organized in the curriculum of the degree in mechanical engineering. In the past 25 years, there have been several curricula for the training of midshipmen of the Spanish Navy, but none has been a drastic change like the one implemented in 2010. In this sense, it is the first time that the midshipmen must obtain a degree in engineering to be officers of the Navy.

In this military educational institution, classroom attendance by students is mandatory, resulting in benefits for training and student learning. Also, some continuous assessment methods were applied before implantation of the degree in mechanical engineering. In some cases, assessment of student learning was done through periodic testing in the classroom. In other cases, assessment of learning was carried out through work that students had to develop outside the classroom and deliver later to the teachers. With this background, the conditions required to successfully implement a university degree under the guidelines of the Bologna Process, were the proper ones.

Continuous assessment

An evaluation method should be focused on improving, advancing and developing the education of students (Astin, 1991). In the new model, the student must demonstrate that it has acquired a predetermined group of skills for the different subjects. For this reason, the evaluation systems are thought as the way of measuring the level of skills and competences acquired by the students.

An evaluation system based on the Bologna guidelines should not be exclusively founded on a final exam method. Otherwise, a final exam should be considered as a part of the evaluation system. The evaluation system should implement different procedures or evaluation methods which should be complemented by a final exam (Brown and Glasner, 1999). The evaluation systems used in the subjects studied in this work are those based on continuous evaluation.

Continuous evaluation could improve the evaluation method, due to the possibility of increasing its credibility and validity (Hoste and Bloomfield, 1975; Falchikov, 2005; Dixon and Rawlings, 1987). On their works, these authors considered the advantages of continuous evaluation, in front of the criticism incurred as an easy option. One of the advantages of continuous assessment is to serve as a tool for monitoring the students. Teachers can follow the process of student learning in clear and prompt way. It also provides a range of evidence of results achieved and the level of skills they have developed (Coll et al., 2007).

Continuous evaluation systems have increasingly been used in the last years at Spanish universities, mainly as a result of the Bologna Process. The process of adapting to the new model was supposed to be finished in 2010. Therefore, we should assume that Spanish universities make use of the new model since 2010-2011 course. Before finishing the adapting term of Spanish universities, different utilization experiences of continuous evaluation can be found. Most of them are experiences that state the usefulness of continuous evaluation.

Artigas et al. (2008) specifically state that continuous assessment improved appreciably the success rate of students. The work also noted that continuous evaluation is a profit for students thanks to the feedback which they get on their learning. The same work was carried out on a subject of an industrial engineering degree. We find it interesting to mention this case due to the resemblance that exists between the degree of mechanical engineering, which is studied in our work, and the industrial engineering degree. We have also seen fit to mention the work of Vinhas and Paiva (2010) as they performed a retrospective since 2007, when methodologies of the new model were introduced in a mechanical engineering degree, until the year 2010.

We can find a number of works that show both the methodology and the results which were carried out in

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university degree courses to adapt them to the model based on the Bologna guidelines (Bidon-Chanal et al., 2009; Cano, 2011; Clariana et al., 2011; De la Nuez et al., 2011; García et al., 2009). In all these works, continuous assessment is the principal approach that allows to design different methods and techniques used by the authors to assess students learning. However, most of the articles are based on adapting, to the new model, of existing degrees at Spanish public universities. In our case, a university degree is implanted in a military training centre in which there was no university degree previously.

In conclusion, we can state that continuous evaluation systems are a way of evaluating the learning process and students' skills which seems to be extensively accepted.

Academic subjects analysed at the curriculum

Authors of this paper are currently teachers of CUD, and also have teaching experience in other university centres.

Two subjects of the curriculum were analysed in this paper. Specifically, we analysed the subjects of Physics and Graphic Expression (Technical Drawing). These subjects are representative of first course in mechanical engineering at any university in Spain. Both, Physics and Graphic Expression have now been taught in the CUD during the first term of 2010-2011 academic year. The following is a description of the characteristics of both academic subjects.

Physics is taught in the first year of mechanical engineering at CUD. In our case we are interested in Physics I, which is given in the first four-month period of the academic year. Physics I is a mandatory subject in the curriculum. This subject is considered basic in the curriculum of mechanical engineering. The subject of Physics I consists of 6 ECTS credits. It is divided into four main sections: Introduction, Kinematics, Dynamics, and Vibrations and Waves. One of the specific objectives of Physics I is to provide students with an overview of the physical world, as well as a sufficient basis to face up to all subsequent academic subjects. It also seeks to develop the skills and abilities needed to solve technical problems related to physics. As a result, students acquire a set of abilities and skills following completion of the course. It is intended that students acquire the understanding and the domain of the basics of the general laws of mechanics, fields and waves, and its application for solving problems of engineering. The specific skill related to the area of knowledge of the subject of Physics I, is expounded below.

Graphic Expression is taught in the first year of mechanical engineering at CUD. Graphic Expression is a mandatory subject and it is considered basic in the curriculum of mechanical engineering. This academic subject consists of 9 ECTS credits and it is divided into five main blocks: Introduction to Projective Geometry, Descriptive Geometry, Graphical Representation Systems, Technical Drawing and Standardization. The main specific objectives of the course are as follows. First, knowing, understanding, and applying a body of knowledge on the fundamentals and standards of the engineering drawing in its broadest sense, while enabling the development of spatial ability. Second, it is important acquiring the capacity both for the abstract reasoning and the development of efficient strategies and procedures in solving graphic problems, within the context of tasks and projects usual of engineering. Finally, it is essential using the graphical communication among technicians, through the carrying out and interpretation of plans, according with the rules of Technical Drawing, and involving use of new technologies. As a result, students will acquire the skill for spatial vision and knowledge of graphic techniques. This specific ability is gained both by traditional methods, metric geometry and descriptive geometry, and through applications of computer aided design.

Teaching methods and evaluation systems used

First, we are going to explain the teaching methods and techniques used in the selected subjects. Then, we shall develop the evaluation systems used as we consider that the choice of the evaluation systems are determined by the teaching methods. The teaching and learning methods which are common to the subjects Physics I and Graphic Expression

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consist of magisterial lectures, practical lessons, small groups' seminars, collaborative learning and individual attention (Knight, 1995). These methods are part of a common strategy of continuous evaluation. During magisterial lectures are taught the theoretical contents that correspond to the thematic units for each subject. In practical lessons are posed exercises and problems related to the theoretical contents, which are solved individually or in groups. The small groups' seminars are based on developing reinforcement activities to learning under the supervision of teachers. These activities consist of resolution of practical cases linked to the theoretical content of the subject. Collaborative learning is encouraged in the practical lessons, which require the active participation and collaboration among students. The individualized attention to students, as support of the work of learning, takes place in different situations. This individual attention from teachers is done when exercises are posed in classrooms, during the practical lessons. Likewise, teachers are available to students in order to resolving their doubts and queries that arise during the study of the subjects.

As we stated, the previous teaching methods are used in both subjects. In addition, there are others specific methods to each of the subjects.

Due to the scientific and experimental nature of the subject of Physics I, students conduct some laboratory sessions, where they perform a series of practical experiences. Subsequently students will must prepare and deliver reports related to the laboratory experiences.

Moreover, given the nature of Graphic Expression, students should be familiar with the engineering projects. Evidently, technical drawings are used in engineering projects. For this reason, we used the methodology of project-based learning (Dym et al., 2005). Throughout the semester, students organize themselves into groups and each of the groups will conduct a project. Each of the members will collaborate into their group in order to contributing and complementing the knowledge necessary to achieve the completion of the project.

Not only the Physics laboratory experiences but also the projects, developed by students in Graphic Expression, contribute to collaborative learning. The evaluation systems used in each of the subjects are presented separately below.

Physics I: Evaluation tools and techniques

The following evaluation techniques were used to evaluate learning and skills acquired by students:

- Overall theoretical and practical exam at the end of the semester
- Five theoretical test at the end of each thematic block
- Solving exercise books. Students will have to solve and deliver eight exercise books with five standard problems in each of them
- Delivery of reports of laboratory experiences. Students will prepare and deliver those reports

With regard to evaluation and qualification criteria, the overall mark on the subject will be obtained from weighted average of marks which have been got in the following sections:

A. Theory and problems exam (A): 50 %
B. Other activities (continuous evaluation): 50 % divided in:
   - Theoretical partial test (TT): 25 %
   - Solving exercise books of standard problems (SP): 20 %
   - Delivery of reports of laboratory experiences (RL): 5 %

To pass the continuous evaluation, students must pass at least two theoretical tests, four exercise books and one laboratory report. Only in this way the continuous evaluation mark will be valid towards the final mark. The final mark of any student will be calculated from the formula:

$$FM_p = 0.5 \times A + 0.25 \times TT + 0.20 \times SP + 0.05 \times RL$$

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Graphic expression: evaluation tools and techniques

In this case, the evaluation systems used to evaluate learning and skills acquired are listed below.

Solving exercise books (SP)

Throughout the semester and during practical lessons, a serial of exercises will be posed by the teacher. Students should solve those exercises individually or in groups in and out of the classroom. Subsequently students should deliver the exercise books to the teacher, who evaluates it according to criteria previously communicated to students. Delivery deadlines must be met and students must deliver at least 95% of all exercises books. Otherwise the mark for the subject will not be taken into account. By solving properly the exercise books, students get a percentage of 20% of the final mark.

Minimum knowledge exam (KE)

There will be a final exam including all the contents of the subject, both theoretical and practical. The final exam may include multiple-choice tests, reasoning questions, problem solving and development of practical cases. It is required achieve a minimum score of 5.0 out of 10 possible in order to pass the course. The minimum knowledge exam has a maximum score of 40% on the final mark.

Project (P)

Throughout the semester, students will carry out a project related to the thematic of course. The project will be developed in parallel with the syllabus of the subject and will cover most of the aspects reflected in it. The project will be conducted in small groups of students which will be organized the first three weeks of class. The rating of the project will have three elements:

- First delivery (score of 30%): group mark
- Second delivery (score of 20%): group mark under evaluation by other groups
- Project presentation in classroom (score of 50%): individual mark:
  - 0 if the presentation is not satisfactory
  - 5 if the presentation is satisfactory
  - 10 if the presentation of all members of the group is satisfactory

The percentage of the project on the final mark is 25%.

Continuous assessment test (AT)

Three assessment tests will be implemented throughout the semester. Tests will be of short duration with multiple-choice questions. The attendance at the three tests is mandatory and enforceable to pass the course. These tests have a percentage of 10% on the final mark.

Personal qualitative rating (QR)

It allows teachers assessing some skills as the participation, attitude, leadership within the group, ability, interest in the subject, etc. Its percentage on the final grade is 5%.

The final mark of any student will be calculated from the formula:

$$FM_G = 0.2 \times SP + 0.40 \times KE + 0.25 \times P + 0.10 \times AT + 0.05 \times QR$$

With the evaluation systems used in Physics I and Graphic Expression, it is intended that students become more responsible and they do not delay the study of subjects to the days before the exam. Students should keep up to date the study and work on the thematic contents of the subjects to achieve their goals. It aims to encourage self-learning among students, trying to stimulate and awaken interest in the subjects. In short, we want to get students learn for themselves to resolving the problems.

Results

We will present the results obtained by the students of the University Centre of Defence (CUD) in the

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subjects studied, together with the results obtained by students from other similar curricula. The object is to do a comparative analysis and provide a measure of success in implementing the new plan which has begun to teach in the CUD.

Therefore, we considered it appropriate to present the results of students outside the CUD but coming from two different data sets that are likely to be compared with the mechanical engineering degree of the CUD. On the one hand, we have decided to present the results obtained by the students of the curriculum that existed before in the Military Naval School (ENM) before implantation of mechanical engineering degree. On the other hand, we thought it appropriate to present the results obtained by students in some mechanical engineering degrees belonging to public universities in Spain. These degrees were introduced in 2010 according to the guidelines of the Bologna model. First, we present the results obtained by the students of the ENM, both of the previous curriculum as the mechanical engineering degree of the CUD. Both groups of students are midshipmen, but they represent the before and the after of the implementation of the new model. Second, we present the results obtained by students from four mechanical engineering degrees from some Spanish public universities. We intend to show the pass rate obtained by the students who have studied mechanical engineering at Spanish public universities since the introduction of the new model in 2010. The object is to compare these results with those obtained in the University Center of Defence.

It should be noted that students in the Spanish public universities (non-military) must pay a reasonable tuition fees to study a university degree. Moreover, the number of students enrolled in Spain each year in engineering degrees is of the order of several tens of thousands of candidates. In contrast, in the Military Naval School is enrolled only an average of 70 candidates each year, who will be the future officers of the Spanish Navy. When these candidates are admitted, study and living expenses and tuition fees are paid by the Spanish state.

New model versus previous model in the University Centre of Defence

To make a comparison of the new system with the previous traditional system, in this section they are shown the results obtained by the students of the University Centre of Defence (CUD) during the 2010-2011 academic year, and also are shown the results obtained by students who studied the previous curriculum.

We must keep in mind that the new system assumes the continuous assessment as a method of evaluation of student learning. With respect to the previous curriculum, the difference is that the evaluation of students in the previous system is based in the method of the final exam. However, as noted at the end of section 2, some techniques of continuous assessment were used, which had a relatively small weight in the evaluation of the student.

By comparing both curricula, we aim to analyse and assess the impact of implementing the new model. It is intended as a first approximation, to obtain a measure of success achieved in the model implementation. In this case, the rate of students who pass the evaluation in the subjects analysed, may provide a measure of the success.

The results are shown in tables 1 to 4. On the one hand, they present the results obtained by students in the new university degree adapted to the Bologna model. As mentioned above, the subjects are two: Expression Graphic and Physics I. These subjects are mandatory in the degree of Mechanical Engineering which is taught in the CUD from 2010-2011. On the other hand, the tables present the results obtained by the students of previous curriculum, of which last academic year was 2009-2010. Since the subjects are not the same, the ones chosen for comparison are the most similar in the previous curriculum to the subjects in the new curriculum. These subjects are Graphic Expression Techniques (GET) and Mechanics (M). Obviously, the first subject is homologous to Graphic Expression and Mechanics is homologous to Physics I.

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Tables 1 and 2 include the results of evaluation concerning GET and Graphic Expression.

Table 1. Results of the ENM students in the existing curriculum until 2009-2010

Subject:	Graphic Expression Techniques (GET)	
Curriculum:	It is not awarded any university degree	
Students	32	100,0%
Pass	29	90,6%
Fail	3	9,4%

Table 2. Results of the ENM students in the new curriculum (2010-2011)

Subject:	Graphic Expression	
Curriculum:	Mechanical Engineering	
Students	71	100,0%
Pass	61	85,9%
Fail	10	14,1%

Tables 3 and 4 include the results of evaluation in Mechanics and Physics I.

Table 3. Results of the ENM students in the existing curriculum until 2009-2010

Subject:	Mechanics (M)	
Curriculum:	It is not awarded any university degree	
Students	63	100,0%
Pass	57	90,5%
Fail	6	9,5%

Table 4. Results of the ENM students in the new curriculum (2010-2011)

Subject:	Physics I	
Curriculum:	Mechanical Engineering	
Students	71	100,0%
Pass	62	87,3%
Fail	9	12,7%

New model in CUD (military context) versus new model in Spanish universities (non-military context)

In this section, we intend to compare results from two different contexts of mechanical engineering curricula. It is noteworthy that in all cases, curricula have been implemented in the same academic year (2010-2011) following the guidelines of Bologna.

The differences between the two contexts are explained below. First, we have the results obtained by students in the curriculum implemented in a military context, that is, the mechanical engineering degree which is taught in the CUD. Furthermore, we present the results obtained by students from five degrees in mechanical engineering from various public universities in Spain. That is, students belong to university degrees outside the military context.

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While tables 2 and 4 of the previous section correspond to the students of the CUD, tables 5 and 6 show, respectively, the results obtained in the subjects of Graphic Expression and Physics I, by students from engineering degrees of a sample of Spanish public universities. Obviously, these public universities belong to a non-military context.

Table 5. Results in Graphic Expression in the new curriculum from a sample of public universities (2010-2011)

Subject:	Graphic Expression	
Curriculum:	Mechanical Engineering	
Students	598	100,0%
Pass	340	56,9%
Fail	258	43,1%

Table 6. Results in Physics I in the new curriculum from a sample of public universities (2010-2011)

Subject:	Physics I	
Curriculum:	Mechanical Engineering	
Students	585	100,0%
Pass	208	35,6%
Fail	377	64,4%

To discuss the results in the next section, we considered the relationship between the evaluation method used and the rate of passing students. To do this, we studied whether there was a relationship between the percentage of students who passed the subjects and the fact of using continuous assessment as an evaluation method. We defined two variables X and Y, where X represents the dichotomous variable "the continuous assessment was used" and Y represents the rate of passing students. The variable X will take the value "1" if the continuous assessment was used as an evaluation method and it will take "0" otherwise. The variable Y is a continuous variable between 0 and 1 that provides the empirical probability of the passing students in the subjects of Graphic Expression (GE) and Physics I (P). The data were presented in the table 7 that shows the results obtained by students in the new curriculum at the CUD compared to the results obtained by the students in the sample of Spanish public universities (SPU). To analyse the relationship between the variables X and Y we calculated the point-biserial correlation coefficient by formula:

$$r_{pb} = \frac{N * \sum y_1 - N_1 * \sum y}{\sqrt{(N_1 * N_0 * (N * \sum y^2 - (\sum y)^2)}}$$

where:

N_1: number of times in which X = 1
N_0: number of times in which X = 0
N: $N_1 + N_0$
y_1: sum of the values of Y where X = 1
$\sum y \sum y$: sum of all the values of Y
$\sum y^2 \sum y^2$: sum of the squares of all values of Y

The point-biserial correlation coefficient is r_{pb} = 0.9366 in this case. The result indicates that a high rate of passing students matches up with the use of continuous assessment.

Table 7. Empirical probability and the use of continuous assessment (CUD and SPU)

Subject - Centre	GE - CUD	GE - SPU	P - CUD	P - SPU
X	1	0	1	0
Y	0.589	0.569	0.873	0.356

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Discussion

Next they will be carried out an evaluation and analysis of the results obtained by students in the new curriculum compared with the results of the previous curriculum and with other public universities.

As it was indicated in the section on educational context, it is the first time that a university degree is required for the training of future officers of the Spanish Navy. Therefore, the comparison that arises is to analyse the academic performance between two curricula. On the one hand, we want to know the pass rate in the curriculum that students were taking in the ENM before 2010. On the other hand, it is interesting to know the pass rate of students who are part of the first year of the new curriculum, which is implemented in 2010. Consequently, it would be useful to compare the pass rates of both curricula to draw conclusions as to the suitability of learning and assessment methods used, and to have a measure of success or failure of the implementation of new curriculum.

Noting the results obtained by students in the curriculum prior to 2010 (Tables 1 and 3), we can see a very close pass rate to 91%. This value is consistent with the graduation rate of graduates from the ENM in the last 10 years, since this is 90% (as was indicated in the introduction). Looking at the results for the new model (Tables 2 and 4) considering an average value, we can say that in the new curriculum of Mechanical Engineering, over 86% of students exceeded the subjects analysed. In the introduction it was stated that the graduation rate goal for the new model is 75%. It is conceivable that the graduation rate of future graduates (by the year 2015) will be not very different from the 86% pass rate cited above. This hypothesis could be considered close to reality if we take into account the fact, very usual in Spain, that the first year of a university degree is the hardest for students. Therefore, the number of students who fail to finish the degree usually depends on the results obtained by students in the first year of the degree. It is hoped that the graduation rate of future graduates might exceed the target value of 75%. A very significant fact in view of these values is the small difference between the results achieved by students in both curricula.

Keep in mind that in the new plan the level of academic rigor is much higher than in the previous plan, because the new plan is a university level in engineering. This explains that there is between 3 and 5% fewer students passing subjects, but 86% is a value much higher than the pass rate obtained in the engineering degrees in Spanish universities (average pass rate around 50% in the first year). Moreover, in both cases these results were obtained using, a greater or lesser extent, continuous assessment techniques for learning of students. In the Mechanical Engineering degree, continuous assessment had been established by the special importance that Bologna model gives to the procedures to assess the acquisition of skills. To a lesser extent, in the curriculum that is now expiring, some techniques of continuous evaluation were applied. It should be noted that in the curriculum which is expiring, the subject of Graphic Expression Techniques was elective. Therefore, the number of students is significantly lower than the number of students in the subject of Mechanics.

The results of both cases may surprise because of they are very similar. Taking into account the specific features of military training in Spain and its differences with the university education, implementation of a university degree in this environment was a risky step. Therefore it raised serious doubts about its success. The fact of requiring a university degree to be an officer of the Armed Forces has been a dramatic transformation into an institution with deep roots such as the Spanish Navy. These changes have created uncertainty as to their proper implementation. Also some people had considered the possibility of failure in the implementation of this curriculum in the Armed Forces, where due to circumstances it is not allow a level of student failures similar to those in the engineering degrees in Spanish universities. This is because a student in a school of the Armed Forces involves a very high cost for the Spanish state in front of the very lower cost of a student in a public university. A midshipman does not pay the accommodation and meals when he/she lives in the Military Naval School. In fact, the successful implementation of a university curriculum in the Armed Forces can be considered a particularly difficult challenge, which has not successfully achieved some of the surrounding countries.

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Moreover, the way students are admitted into the Military Naval School is also different from the rest of Spanish public universities. There are a relatively small number of places each year, between 60 and 80 for Spain, and candidates must compete, taking into account the marks obtained on completion the last course of their studies. Then, they must overcome physical and psychological tests, along with a language test. Students with better marks can choose the places offered.

We need to establish a comparison between the results obtained in the CUD and the results obtained in the sample of public universities. The results shown in Tables 5 and 6 indicate that the number of passing students in the sample of Spanish public universities is really low compared to the number of passing students in the CUD (see Tables 2 and 4). Specifically, public universities have obtained rates of passing students in Graphic Expression and Physics I, below 60% and 40% respectively. These values contrast with those obtained in the CUD, which are 86% and 87% respectively.

Both the CUD and the public universities in Spain have implemented their plans of study following the guidelines of the Bologna process. However, the results obtained by the students are quite different. Given that both the CUD and the degree of engineering that is taught there have been implemented without the existence of a previous university degree, we could explain the results that have been obtained. With the CUD has been a considerable change in the education of the midshipmen of the Spanish Navy. Both the methods used for teaching and learning as the evaluation system which is showed in this paper, are designed to fit the context where they would be used. The background existing at the ENM was adequate to implement a curriculum according to the Bologna guidelines. Therefore, teaching and evaluation techniques have been successfully adapted and they have contributed to minimize the failure of students.

In the case of Spanish public universities, the results obtained may be influenced by a possible inertia to change brought about the Bologna model. Most of Spanish universities have steered a course of actions during several years that can cost some time it is changed. However, we think that Spanish universities will get, in the coming years, a significantly higher pass rates to which they have obtained in the first year of implementation of the Bologna model. In part, due to adapted teaching methods and evaluation systems used, based on the new model, it is likely that we have avoided a failure in implementing the new curriculum in the CUD.

If we evaluate the results, it seems to be possible that continuous evaluation could be able to get a high number of passing students. If this were true, we believe that continuous evaluation helps students achieve their goals. It may therefore be inferred that a continuous evaluation is a successful evaluation system. This seems obvious if we think that the ultimate goal for a student is to get a passing grade in the course. However, not only getting pass students is the goal of an evaluation system. The teaching method and the evaluation system should achieve a reasonably high number of passing students, which could prevent the failure of the education system. Besides this, the evaluation system should contribute to a good quality of learning.

Conclusions

Continuous assessment can positively influence the quality of the learning process. Due to the characteristics of continuous assessment, evaluation of competences and skills acquired by students is being conducted while it is developing the activity of teaching. That is, there is not an interruption between the teaching phase and evaluation phase, as usually happened in a traditional approach. Unlike in the traditional approach, both phases and activities overlap mutually. Therefore, both activities, teaching and assessment, are walking together during the academic year. Thus, there is not a disconnection between them, which makes it possible for students to feel more motivated to carry out the study and preparation of the subjects.

From the above it would appear that the connection between teaching and evaluation helps to improve the learning process, and achieve greater quality. Because

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students receive information on their rate of learning, this would allow them to change methods and habits, and they will know how they will be evaluated in a practical way. Then they could reorient their learning if necessary, and gradually acquire knowledge and skills which must be developed to study a subject (Nicolau and Ruiz, 2010).

When students are encouraged to work continuously, they feel more responsible because they are managing, in a sense, the results they are getting. We could say that students are acquiring a commitment to themselves, and they are conducting a self-learning task.

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Los puntos de vista expresados en este artículo no reflejan necesariamente la opinión de la Asociación Colombiana de Facultades de Ingeniería.

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