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Redesign of Syllabus and Evaluation Procedures to Improve University Teaching in Subjects Related to Industrial Engineering in the Context of the European Higher Education Area*

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A process of integration is currently taking place to adapt our methodologies to the new guidelines established by the European Higher Education Area (EHEA). This situation is profoundly changing the way that university subjects are taught. As a part of this, we have to modify the teaching–learning process in terms of syllabus, didactic procedures, evaluation methodologies, etc. The main focus of this paper is on how to restructure several subjects in Industrial Engineering. The chief goal is to improve the work of teachers. Several weaknesses have been detected and justify the need for measures to improve the efficiency of teaching and evaluation.

Keywords: syllabus; teaching–learning process; evaluation; industrial engineering; European Higher Education Area

1. INTRODUCTION

CURRENTLY, WE ARE FACING A PERIOD OF PROFOUND CHANGE in the mid-term future in the area of European university education. The European Higher Education Area (EHEA) [1, 2] will form the common framework for university education in European Union countries [3]. The redefinition of higher education objectives involved in the European process of standardisation brings with it innovations in the way that education is approached that have been evolving in universities for some time. Success will depend on the specific actions of both teachers and students, who have become the core stakeholders in this reform.

The construction of the EHEA is a process that began with the Sorbonne Declaration (1998) and was consolidated and expanded in the Bologna Declaration (1999). In the Declaration European education ministers urged the European Union member states to develop and implement a series of actions aimed at promoting the higher education dimension and, in particular, curriculum development, institutional cooperation, mobility plans, and integrated programmes of study, training and research. In 2001, the Prague Communiqué added some lines regarding learning as the crucial element, highlighting the active role of universities, higher education institutes and students in the realisation of the standardisation process. In addition, the EHEA has been made more attractive with the development of quality assurance systems and certification and accreditation procedures [4]. The Bologna Declaration made a commitment to achieving its goals before the end of the first decade of this century, and consequently most member and associate states of the European Union have implemented or planned the necessary reforms to adapt their national higher education systems.

This document describes research carried out by a team of professors, led by the author, who teach a variety of subjects in the Industrial Engineering programme at the University of Malaga. The study contributes to the process of adaptation to the requirements in the Bologna Declaration.

A fundamental issue was to define the problem clearly. An initial diagnosis was made using the previous experience of teachers and brainstorming sessions with the students in the classroom. Several areas in teaching and evaluation practice that could be improved on were detected in a total of four representative Industrial Engineering subjects in the Spanish university context. Ultimately, the subjects under study are characterised by their inflexible and traditional methodology. Specifically, the areas for improvement are as follows.

- Priority is given to the teaching process, and the necessary role of the learning process is forgotten. Thus, students have a secondary function in the classroom.

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- Topics are strictly structured in lessons based on content with little or no coordination.
- There is a need to assess teaching because the methodologies involved are based only on lectures. Students are supposed to take notes on what they consider most relevant.
- Lack of certain technological resources.
- Limited professor–student interaction and coordination.
- Low levels of coordination and cooperation between teaching staff.
- Absence of supplementary materials to complement teaching.
- Somewhat deficient teaching methods.
- Evaluation mechanisms are based on a final exam. Therefore, progressive and continuous evaluation is missing.

The main consequence of this situation is that the efficiency of the learning process is very low since there is no interaction.

The purpose behind the present study was to respond to these weaknesses. The EHEA is a relatively new development and, despite the fact that much has been written in recent years on the highly relevant subject of the implications of the EHEA model for the Spanish university system, and that research has been increasingly detailed, we have not found a similar study with specific emphasis on Industrial Engineering subjects.

2. THEORETICAL FRAMEWORK

As in other fields of knowledge, the teaching of Industrial Engineering subjects within the University framework has been changing in line with the demands of the current educational system. Hence in recent years there has been an emphasis on the use of lectures in the teaching–learning process [5, 6] to the detriment of other aspects that could be taken into consideration in a more detailed way for evaluation, such as, for example, the students' work. The requirements of the European model are changing this trend.

The following list highlights the core ideas of the EHEA with respect to teaching [7]:

- Learner-centred teaching
- The role of the teacher as the facilitator of learning
- Clearer definition of objectives and competencies
- New organisation of teaching activities, essentially in blocks, including seminars and practical classes
- Changes in the organisation of learning: modules
- Preparation of the individual for autonomous, yet accompanied, learning
- Emphasis on the use of learning tools, not just the accumulation of knowledge
- Balance between the demands on and support for learning
- Teaching adapted to curriculum parameters: continuity
- Teaching revolving around the following aspects: intellectual, social, practical and personal.

The new system forces us to rethink teaching. We cannot carry on with traditional classes. Classes will have to be planned and developed with learners and their specific needs at the core of the process. Teaching has to be restructured around the students and their particular characteristics and motivation to learn [8]. The three basic components that have to be taken into account in the teaching process are: large groups (lectures), small groups (seminars, workshops, etc.) and tutorials. Curricula need to be interdisciplinary and modular in order to make them more adaptable to the continuous changes in the teaching–learning process.

The active role of the students in their own learning must be enhanced in the new system and resources must be provided to allow them to achieve this to the full. This is a key point. A lack of resources could jeopardise the process. Furthermore, students must be prepared for ongoing training, or rather life-long learning.

Undoubtedly, the concept of *quality* takes on a crucial role in the new process of teaching–learning that is promoted by the new EHEA philosophy [9]. This is due to a variety of reasons such as greater competitiveness, high levels of achievement required, etc.

The quality in education evolves over time. The current trend is increasingly focused on the global effectiveness of the education offered. This trend reflects industrial evolution, which has seen considerations of quality shift towards the organisational capacity to offer high quality products and services. Education is not an isolated or temporary phenomenon, but rather forms part of a group of greater macroeconomic trends. This does not mean that traditional concepts of quality, such as good pedagogy, are no longer valid. Indeed, an effective strategy for total quality must incorporate traditional perspectives of quality. New approaches to guaranteeing and managing quality in education mean different things in each case [10].

The quality of education that is available depends in the final analysis on the performance of the students. Different methods, guidelines, procedures and rules have always been used to guarantee the quality of the teaching provided. It is true that, traditionally, quality has often been interpreted in a rather narrow way, focusing on the particular features of the service provided, and the new system attempts to change this. In this sense, a good example is teaching quality that is becoming more and more important. Its assessment is now a requirement to achieving high standards of quality in higher education.

The quality methods in question are those relat-

ing to total quality management and the ISO 9000 requirements [11]. Several of these methods demand that actions influencing the quality of education be carried out by competent and qualified staff, and always from the perspective of meeting the needs of the client, i.e. the student. For instance, a Quality Function Deployment based methodology can be used to increase the effectiveness of a course and its instructor [12].

A common feature of all types of education is the greater importance given to student performance (learning effectiveness) and the overall efficiency of the education offered. The student is the focal point of the system, as endorsed by the EHEA. This is the reason for the increased interest in total quality management methods. Despite the greater attention paid to organisational factors such as the necessary conditions to guarantee quality, effective education cannot take place without significant dedication by teachers. The methods employed in optimising quality in education are doomed to failure if they fail to support the internal motivation of teachers or are incapable of maintaining or improving their levels of training [13].

The need to improve teaching practice and all that this implies, such as the teaching–learning process, motivation to learn, evaluation, the student–teacher relationship, links between the university and business, etc., is clearly illustrated in many recently published books and papers. We can highlight, for example, the study by Benito and Cruz [14] that tackles the new issues for university education raised by the EHEA. Special emphasis is placed on active methodologies (cooperative learning, problem-solving or case methodology), continuous academic evaluation, evaluation and learning, technological resources, and research into teaching. Furthermore, the Spanish Ministry of Education and Science has published proposals for revamping educational methodologies in the universities [15].

As a starting point for our research, a previous study by Alfalla and Machuca [16] was taken in which the teaching staff, course contents and teaching methodology used are the three aspects that are explored. These aspects are important to university training. Their study focuses on the subject *Production and Operations Management* in the Industrial Engineering programmes. They were analysed empirically at Spanish universities, based on a survey of the total population of instructors in this discipline. The study concentrates particularly on the third element mentioned previously, specifically the teaching methods used, assessment methods, didactic material and support tools, all basic to effective teaching in that discipline. The main conclusion is that the teaching process is remarkably traditional, using typical oral lessons, supported by the blackboard and presentations with slides. Students have to prepare individually to pass the final exam. On only a few occasions were case studies, working in teams, or laboratories considered to be didactic tools.

Another interesting study by Ruiz *et al.* [17] describes the experience with the subject *Management Control* in the Business Management and Administration degrees. It proposes a teaching guide following the guidelines of the EHEA system. It was written by the lecturers involved in the process. The key conclusion is that the teaching guide facilitates the coordination of different groups of faculty members and uniformity in terms of methodology and evaluation systems because of the detailed way in which its objectives, activities, schedule and evaluation system are set down.

The paper presented here is an extension of the above studies, and considers more subjects and topics to be analysed. Therefore, it involves a major undertaking. This is one of the main novelties of this research.

3. OBJECTIVES OF THE STUDY

The main aims of the study were basically as follows:

- evaluating teaching process to detect weak points and opportunities for improvement; gathering students' opinions regarding theoretical and practical content as well as that of other teachers linked to the subjects involved in the study;
- identifying the skills of students in order to maximise them in the teaching–learning process;
- establishing the teaching resources to increase the efficiency of the teaching–learning process;
- building university-to-business relationships in order to complement teaching practice;
- involving students in the project to familiarise them with established procedures that may also be useful to them in their professional careers;
- improving coordination between the teachers involved and between participating students; and
- developing new syllabi for the subjects to cover current requirements.

In short, it is an attempt to draw up a complete set of guidelines to reflect the main features of the teaching–learning process as established by the EHEA. As we will see in the Conclusions, the objectives above have largely been met, or are well on the way to being met. It is hoped that these improvements will continue to be implemented over the next few academic years to ensure that the plan continues to work correctly. The idea is to make use of the current transition period to implement the procedures that have been developed.

The previously outlined objectives make up the essence of the new EHEA approach. They have been modelled in terms of a group of hypotheses to be verified or refuted. The present empirical study aims to investigate them. The hypotheses are described as follows [18–21].

Hypothesis 1: It is necessary to improve traditional teaching methods and adapt them to new requirements. Teaching should not be carried out solely through lectures. It is rather the student who should take on the role of central participant.

Hypothesis 2: Many current teaching materials that are obsolescent and lacking in educational rigour need to be reformulated and improved to adapt them to changing demands.

Hypothesis 3: Teachers play a facilitating role in the new process in the sense that they are responsible for guiding the student in their learning tasks.

Hypothesis 4: Assessment and grading methods need to be modified, given the degree to which they are becoming ineffective. This comes as a consequence of being based on traditional methods that prioritise teaching over learning, while it is the role of the student that needs to be emphasised.

Hypothesis 5: Study programmes need to be restructured to make them more practice-focused, rather than built around traditional lectures.

Hypothesis 6: Teaching aids such as blackboards, OHTs, slides, computers, etc., play an essential role in the new model.

Hypothesis 7: Tutorials are not merely useful for resolving individual questions. They should be converted into a student resource covering three different areas: academic, social and professional.

Hypothesis 8: There is a need to include the experience of real companies in order to adapt the theoretical content to the real business world.

4. DESCRIPTION OF THE EXPERIENCE AND METHODOLOGY

The key task was to modify the curriculum and the evaluation procedures of the different subjects taught by the teachers on the research team. These teachers are members of the Higher Technical School of Industrial Engineering at the University of Malaga.

The subjects that formed the basis of study are as follows.

Business Administration: Fifth-year course of the Industrial Engineering degree at the Higher Technical School of Industrial Engineering.

This subject gives a general perspective of business, explaining the concept of a company and the different types of companies. In addition, the functioning of the main subsystems or departments involved in a company is described. The financial, marketing, administration and production departments are considered.

Quality Management: Fourth-year course of the Industrial Engineering degree at the Higher Technical School of Industrial Engineering.

This subject considers the importance of Quality for companies. The concept of Quality and its implications are explained. It also analyses how to implement a Quality Management System according to international standards, such as ISO 9001, in order to achieve customer satisfaction.

Industrial Organisation: Fifth-year course of the Industrial Engineering degree at the Higher Technical School of Industrial Engineering.

This subject is aimed at developing the issues related to a production system: products and services, costs, processes strategies, capacity, plant layout, location of factories, work methods and measurement, logistics, inventory management, planning, programming, control, etc.

Human Resources: Fourth-year course of the Industrial Engineering degree at the Higher Technical School of Industrial Engineering.

This topic focuses on human resources management in a company. Workers are an essential pillar needed to achieve the planned objectives. Topics such as training, compensation, selection process, working groups, work organisation, etc. are raised.

Our experience in carrying out the study includes:

- an initial diagnosis;
- setting of objectives;
- setting tasks to meet the objectives;
- carrying out a diagnostic procedure to ascertain the initial situation;
- developing a questionnaire for students that would illustrate the strengths and weaknesses in teaching practice and the perceived needs;
- information gathering via the questionnaire;
- analysing the information statistically;
- drawing conclusions;
- making proposals for improvements in curriculum design and evaluation procedures;
- implementing improvements; and
- following up and controlling the actions taken.

It must be remembered that the study is taking place in real time. The follow-up and control of the actions taken is ongoing. The data provided here will feed back into the system and contribute to future improvements.

Throughout the period in which the study was carried out, meetings of participating teachers were held with the aim of establishing common ground through group activities such as brainstorming, presenting individually gathered data, etc.

The actions forming part of the research *methodology* are outlined below:

1. Developing a questionnaire on evaluation
2. Interviewing students
3. Encouraging the active participation of both students and teachers
4. Analysing the students' work
5. Reporting on the teacher diaries for improving efficiency at work and wider recognition
6. Adapting didactic materials for each subject
7. Applying IT applications to the teaching of subjects, especially their practical aspects
8. Using evaluation tools agreed on with students
9. Designing training strategies to help students work on the course content in the most efficient way possible
10. Encouraging students to participate in practical sessions
11. Comparing the students' post-project results in the subjects with those from previous courses
12. Contrasting the initial objectives with the results achieved at the end of the study.

We assessed the impact of the study in terms of the interest and motivation apparent among students towards those subjects that were included. There were regular research coordination meetings in order to evaluate the ongoing study and to have critical reflections of the participants in the working group. The evaluation of the emotional climate of the working group and the students when involved in the experience was very important.

In terms of research stages, we have: planning, implementation, follow-up and control, and conclusions; these were spread, as can be seen in Fig. 1, over seven months. The chronology corresponds to January to July 2007.

In the following academic years, the findings have been, and will continue to be, presented in meetings with students to explain how they are applied and the actions that have been undertaken to provide improvements.

5. FINDINGS AND DISCUSSION

The results that were obtained during the study were based principally on data from the questionnaire that was handed to the students plus the conversations with them in class. The information was collected after a reasonable period of time had elapsed to allow the students to be as objective as possible in evaluating methodology, syllabus and the work of the teacher.

The questionnaire itself was designed using basically closed questions with a 5-point Likert scale. Open questions were also used so that students could express their opinions and the teachers could discover what other areas of their work needed improving.

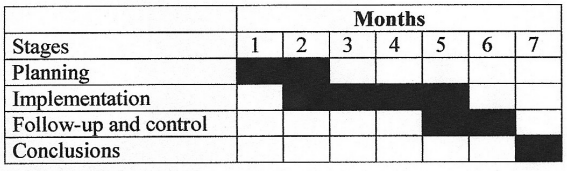

Fig. 1. Timeframe of the study.

The global results obtained from all the questionnaires given to all the subjects are displayed here.

5.1 Total population of the study

143 students were included in the study.

5.2 General student information

The following points show general student data.

Age distribution: Students aged 20 are the largest group (28.67%); aged 18 (17.48%) are second and aged 22 are the third largest (15.38%).

Gender distribution: Males represent 79.02% and females, 20.98%.

Distribution of repeating students: Non-repeating students make up 64.34% of the sample and repeating students 35.66%.

Attendance distribution: Very high attendance: 55.94%. High attendance: 27.97%. Average attendance: 13.29%. Low attendance: 1.40%. Very low attendance: 0.70%.

Work and study distribution: Students who only study represent 72.73%. Students who are working and studying are 26.57%. The rest, 0.70%, did not respond.

5.3 Aspects considered

All questions here are of the closed type with the higher numbers on the 5-point Likert scale representing higher degrees of satisfaction. Responses are supplied for each case, as well as the numbers of those who did not answer (DNA), the mean (M) and the standard deviation (SD). The results are shown in Tables 1–8.

Having analysed the information gathered, the members of the working group were able to confirm one of the initial hypotheses, which posited the existence of strengths and weaknesses in the teaching of the subjects included in the study. The main objective is, and will continue to be, to eliminate or at least reduce the effects of the weaknesses detected. In essence, the aim is to satisfy the needs of the student to the greatest extent possible, ensuring a minimum level of quality regarding syllabus, methodology and evaluation of teaching. Nevertheless, these aspects need to be adapted to the students' real needs, and they need to meet the demands of the European Framework of Higher Education.

We will now make a global evaluation of the subjects involved in the study, highlighting the most relevant aspects observed by the working group.

Overall, the students who answered the questionnaire attended class with a high or very high

Table 1. Communication between student and teacher

	1	2	3	4	5	DNA	Total	M	SD
1.1. Interaction in class	6	15	53	49	16	4	**143**	**3.39**	**1.47**
1.2. Accessibility of the teacher in his office	5	18	35	47	23	15	**143**	**3.51**	**1.50**
1.3. Readiness of the teacher to help	1	8	24	70	35	5	**143**	**3.94**	**1.70**
1.4. Teaching style adapted to students' needs	2	20	52	53	12	4	**143**	**3.38**	**1.46**
1.5. Students encouraged by teacher to raise questions and doubts	1	18	43	61	19	1	**143**	**3.56**	**1.52**
Frequency	***15***	***79***	***207***	***280***	***105***	***29***	***715***	**3.56**	**1.52**
Percentage	***2.1***	***11.0***	***29.0***	***39.2***	***14.7***	***4.1***	***100***		

Table 2. Class management

	1	2	3	4	5	DNA	Total	M	SD
2.1. Setting objectives and signalling main section of each topic	1	14	48	53	23	4	**143**	**3.60**	**1.54**
2.2. Explanatory style	2	21	53	58	9	0	**143**	**3.36**	**1.46**
2.3. Clarity in explaining concepts	4	17	52	52	17	1	**143**	**3.43**	**1.48**
2.4. Ordered presentation of content	2	9	28	67	36	1	**143**	**3.89**	**1.67**
2.5. Maintaining student interest and attention	7	24	44	57	9	2	**143**	**3.26**	**1.44**
2.6. Mastery of the subject by the teacher	3	12	36	60	31	1	**143**	**3.73**	**1.59**
2.7. Transmission of knowledge	3	10	56	53	15	6	**143**	**3.49**	**1.50**
2.8. Clear answers to student questions	5	14	41	53	29	1	**143**	**3.61**	**1.54**
2.9. Teacher present in class	3	2	4	30	100	4	**143**	**4.60**	**2.13**
2.10. Teacher punctuality	2	9	18	46	67	1	**143**	**4.18**	**1.84**
2.11. Friendly attitude towards students	2	12	25	61	42	1	**143**	**3.91**	**1.68**
2.12. Enjoyable/relaxed classes	6	26	45	47	15	4	**143**	**3.28**	**1.44**
2.13. Valuing of student opinions by teacher	5	17	35	62	17	7	**143**	**3.51**	**1.50**
2.14. Positive attitude by students in general in class	2	10	52	52	22	5	**143**	**3.59**	**1.53**
2.15. Breaks	42	27	23	29	20	2	**143**	**2.70**	**1.45**
2.16. Number of students in class	12	18	40	51	19	3	**143**	**3.34**	**1.45**
Frequency	***101***	***242***	***600***	***831***	***471***	***43***	***2288***	**3.59**	**1.53**
Percentage	***4.41***	***11***	***26***	***36***	***20.6***	***1.88***	***100***		

Table 3. Subject contents

	1	2	3	4	5	DNA	Total	M	SD
3.1. Syllabus contents adapted to proposed objectives	2	13	41	62	18	7	**143**	**3.60**	**1.53**
3.2. Topics conform to content	0	7	38	77	19	2	**143**	**3.77**	**1.61**
3.3. Number of topics (amount of subject matter)	5	12	35	53	37	1	**143**	**3.74**	**1.60**
3.4. Coverage of the topics	7	8	58	55	13	2	**143**	**3.42**	**1.47**
3.5. Overlap of contents with other subjects	18	33	46	24	15	7	**143**	**2.89**	**1.42**
3.6. Student proposals regarding content taken into account	21	28	55	19	0	20	**143**	**2.59**	**1.47**
3.7. Up-to-date contents	2	8	46	64	14	9	**143**	**3.60**	**1.54**
3.8. Usefulness of contents for professional career	6	15	34	59	21	8	**143**	**3.55**	**1.52**
Frequency	***61***	***124***	***353***	***413***	***137***	***56***	***1144***	**3.41**	**1.47**
Percentage	***5.33***	***11***	***31***	***36***	***12***	***4.9***	***100***		

Table 4. Practical classes

	1	2	3	4	5	DNA	Total	M	SD
4.1. Sufficient practice	10	30	45	39	19	0	**143**	**3.19**	**1.43**
4.2. Practical sections apply theoretical content	4	17	42	55	20	5	**143**	**3.51**	**1.50**
4.3. Teacher involvement	3	8	48	57	24	3	**143**	**3.65**	**1.56**
4.4. Evaluation of individual practice	7	15	49	46	17	9	**143**	**3.38**	**1.46**
4.5. Evaluation of practice in group	21	21	46	29	6	20	**143**	**2.82**	**1.43**
Frequency	***45***	***91***	***230***	***226***	***86***	***37***	***715***	**3.32**	**1.45**
Percentage	***6.29***	***13***	***32***	***32***	***12***	***5.17***	***100***		

Table 5. Teaching resources

	1	2	3	4	5	DNA	Total	M	SD
5.1. Suitability and sufficient quantity of resources used	8	18	61	31	8	17	**143**	**3.10**	**1.42**
Tools used									
5.2. Blackboard	10	4	32	55	39	3	**143**	**3.78**	**1.61**
5.3. Transparencies	23	17	43	38	13	9	**143**	**3.01**	**1.41**
5.4. Slide projector	66	15	24	17	11	10	**143**	**2.19**	**1.63**
5.5. Website for the subject	67	23	25	7	1	20	**143**	**1.80**	**1.86**
5.6. Use of computer room	81	15	7	8	8	24	**143**	**1.71**	**1.91**
5.7. Additional information (bibliography, articles, photocopies, . . .)	17	22	49	40	9	6	**143**	**3.01**	**1.41**
5.8. Classroom debates, congresses, conferences, seminars, etc.	75	21	18	12	2	15	**143**	**1.79**	**1.86**
Frequency	***347***	***135***	***259***	***208***	***91***	***104***	***1144***	**2.58**	**1.48**
Percentage	***30.3***	***12***	***23***	***18***	***7.95***	***9.09***	***100***		

Table 6. Tutoring

	1	2	3	4	5	DNA	Total	M	SD
6.1. Teacher gives tutorial timetable	4	12	25	57	42	3	**143**	**3.86**	**1.66**
6.2. Sufficient number of tutorial hours	8	26	38	40	21	10	**143**	**3.30**	**1.45**
6.3. Types of tutorials proposed (face-to-face, virtual, . . .)	12	24	40	29	10	28	**143**	**3.01**	**1.41**
6.4. Teacher keeps to timetable	9	12	32	51	30	9	**143**	**3.60**	**1.54**
6.5. Teacher encourages students to go to tutorials	6	24	40	47	19	7	**143**	**3.36**	**1.46**
6.6. Accessibility of teacher	6	9	45	51	24	8	**143**	**3.58**	**1.53**
6.7. Student attendance at tutorials	25	29	47	18	2	22	**143**	**2.53**	**1.49**
Frequency	***70***	***136***	***267***	***293***	***148***	***87***	***1001***	**3.34**	**1.46**
Percentage	***6.99***	***14***	***27***	***29***	***14.8***	***8.69***	***100***		

Table 7. Evaluation system

	1	2	3	4	5	DNA	Total	M	SD
7.1. Evaluation criteria known to students	8	27	44	39	19	6	**143**	**3.25**	**1.44**
7.2. Evaluation system is suitable to subject	9	24	54	34	12	10	**143**	**3.12**	**1.42**
7.3. Continuous assessment	24	29	37	26	10	17	**143**	**2.75**	**1.44**
7.4. Aspects evaluated (exams, exercises, written work, classroom participation, attendance, reviews of texts and articles)	12	23	50	28	14	16	**143**	**3.07**	**1.42**
7.5. Importance given to traditional exam	5	9	32	49	30	18	**143**	**3.72**	**1.59**
7.6. Required level is fair with respect to class work covered	6	14	34	49	23	17	**143**	**3.55**	**1.52**
7.7. Speed in returning results	11	17	38	29	10	38	**143**	**3.10**	**1.42**
Frequency	***75***	***143***	***289***	***254***	***118***	***122***	***1001***	**3.22**	**1.43**
Percentage	***7.49***	***14***	***29***	***25***	***11.8***	***12.2***	***100***		

Table 8. Distribution of global scores

Evaluation	Frequency	%
1	0	0
2	16	11.2
3	56	39.2
4	57	39.9
5	11	7.69
Did not answer	3	2.1
Total	143	100
Mean: 3.45		
Standard Deviation: 1.48		

frequency, which means that the data can be considered representative. There is a large majority of men (almost 80%) compared with women (around 20%) in the sample. A quarter of the students have jobs, which helps them understand the practical side of the subjects. The great majority are studying the subjects for the first time.

Given all the findings, we can make the following assessment of each of the dimensions comprising the study.

Communication between student and teacher

In general, questions relating to communication between teacher and students are scored highly. The most frequent response to each item is 4 on the 5-point scale. The attitude of the teacher towards the students is highlighted as is the encouragement to ask questions.

Communication between student and teacher in the classroom depends to a large extent on how well the former grasp new concepts. Once the

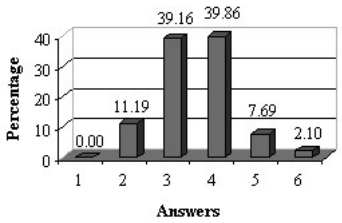

Fig. 2. Global results in terms of percentage for every answer from questionnaire. Answer number 6 represents 'did not answer' (DNA).

material is digested and learned, students begin to ask their teacher questions, thus forging a new relationship.

Class management

Here responses are grouped around 4, and the most valued aspects are: attendance and punctuality of the teacher, clarity of explanations, friendly attitude towards students and keeping the students' attention. Helping the students to obtain an overall vision of the subject by frequently telling them where they are in relation to the objectives and the topic as a whole was also highly valued.

The teachers attempt to keep the students' attention focused on the topic in question, to make classes enjoyable and to improve the transfer of knowledge. This is a direct result of student feedback.

Class size did not seem to be a problem in any of the classrooms. There was only one case of this kind where students complained. It is always better to have smaller classes in order to ensure greater interaction and thus greater efficiency in the teaching–learning process. Students also believe that breaks in classes help in this respect.

Subject content

In this area, we find that 3 is the average score, and that there is a greater spread of responses. In general, students appear to be satisfied with the subject contents, scoring them as up-to-date and useful for their careers. They also seem to agree with the coverage of the subjects, although there are some discrepancies. There is, however, a lower level of satisfaction with the number of courses and some students find that the contents of some subjects overlap with others. They also feel that their own proposals regarding content should be given more attention.

It is worth noting that in subjects related to engineering, there is often a gap in the contents of the course and the advances in some of the fields covered. The students detect this and the teacher makes an effort to transmit the new knowledge. A crucial aim of the teacher must be to instil in his/her students the need to develop their basic knowledge of trends in modern tools and subsequent projects. We must not forget that as soon as the students move out into professional world, which is usually up-to-date on all innovations, they must not find a noticeable gap between the knowledge that they acquired at university and that required outside. This will ensure that they are able to deal with their work more successfully.

Practical classes

In this section, responses cluster around 3, pointing to a moderate degree of satisfaction. More specifically, the results of the questionnaire show that students complain about the insufficient number of practical classes and would like to see an increase. They note that these should be based on illustrative exercises, problem solving, case studies, etc. They also feel that practical work, both individual and in groups, should play a greater role.

Having said this, however, in the case of engineering one of the main areas of dissatisfaction is the overload of practical work in certain subjects. Nevertheless, this is fully justified as it is essential for consolidating theoretical knowledge and putting it into practice. This cannot be done in any other way.

Teaching resources

This is perhaps one of the weakest areas, given that the subjects are basically taught through lectures and problem solving, using the blackboard almost exclusively as a medium. The average mark does not even reach level 3.

Of all the teaching resources, students clearly favour the improvement of the technological resources. Because of the great interest that web sites generate and their suitability for the majority of the subjects, students recommend using them. Furthermore, an increased use of computer rooms is requested. Whatever the available resources, the sequencing of the subjects is essential to optimise learning.

Tutoring

Tutoring is in general scored satisfactorily, given that teachers observe their timetables and are normally accessible, although it is true that there should be more encouragement for students to attend tutorials. Furthermore, with an average score somewhat above 3, there is room for improvement. The most highly valued point is that the teachers make their timetable known.

We should point out that tutorials are used infrequently by students in general, except when examinations are approaching, which is when attendance at tutorials improves. It is worth noting that in some cases of smaller groups many doubts are resolved during the class itself, making the need for tutorials unnecessary.

Evaluation system

Scoring slightly over 3, it is clear that the evaluation system currently in use is not considered to be highly suitable. It must be said, however, that in some cases students could not give well-

founded opinions as they had not yet been examined. The evaluation system is usually presented to the students and deemed suitable by them, but with some exceptions. The system comprises an examination along with some marks for class or project work.

Students believe that the traditional examination has a disproportionate influence in the final grade. Further, there are occasional complaints regarding the enormous workload necessary for the final exam. The great majority are in favour of a system of continuous assessment. Given the large number of classes, however, a continuous assessment of student work is not feasible.

Global evaluation of the subject

An important percentage of those questioned responded with medium–high degree of satisfaction (between 3 and 4). While this is a positive result, it should not lead to unfounded optimism as the level of dissatisfaction is considerable.

We can highlight the fact that the scores of the data obtained are in general above average in terms of the positive global score, most probably as a consequence of the smaller number of students involved, which lends a positive bias to the results.

6. USEFULNESS OF THE EXPERIENCE AND FUTURE COURSES OF ACTION

In the interests of improving teaching practice in the subjects covered, as well as other subjects, the methodology of the study is based on the opinions of the students. Having evaluated the different aspects of the teaching–learning process, we have been able to pinpoint certain issues that could be improved. The results of the experience can be broken down into a list of improvements needed to be made in the subjects with the aim of achieving the proposed goals. The main points of the action plan are as follows.

Student–teacher communication

- Draw up a questionnaire for evaluation purposes.
- Reduce the number of students per teacher to ensure closer guidance during the course.
- Emphasise the need to clear up possible doubts about material covered, so as to avoid problems with the upcoming subjects.
- Even when the results are average, better teacher–student relationships should be encouraged, and there should be incentives for increased teacher accessibility.
- Student presentations should be developed, incorporating teacher corrections.

This should allow us to confirm the arguments posited in *Hypothesis 3*.

Class management

Present an outline at the start of the class, clearly stating objectives and the practical use of the topic to be covered.

Feedback can be obtained from the students using questions related to the subject.

Hypotheses 1 and 3 are confirmed.

Subject content

- Explain the importance of the subject matter for the students' professional career.
- Use current examples.
- Fit the number and timing of the topics to be covered to the course length.
- Gather student suggestions at the end of each term to improve course contents for the following years.
- Reduce overlapping course content to the minimum necessary to ensure understanding.

This confirms *Hypothesis 5*.

Practical classes

- Increase the number of practical classes.
- Use case studies involving real companies covering the final topics of the course when the students have reached a fuller understanding of the subject.
- Update the practical lessons and give the students reasons and objectives to carry them out, so that they are not just the application of theoretical tools studied in class.
- Promote practical sessions that involve teamwork.
- Avoid overloading the student with too many practical sessions in certain subjects.

As with the previous area, *Hypothesis 5* is confirmed. With regard to *Hypothesis 8*, it is confirmed only in part.

Teaching resources

- Design a website for the subject that contains essential information, such as the objectives and methodology of the subject, supplementary exercises, additional reading and bibliography, web links of interest, etc.
- Make greater use of the computer room to promote computer-assisted learning or virtual learning.

Hypothesis 2 is thus confirmed, as is *Hypothesis 6* in part. The use of other complementary tools was not highlighted, given that these are typically already used.

Tutoring

- Encourage students to go to tutorials.
- Use flexible timetables.

Although these points do not confirm *Hypothesis 7* as it stands, it must be pointed out that students are still heavily influenced by the traditional notion

of tutorials. Nevertheless, their interest in approaching other topics, mainly relating to careers, has been noted in class. This means that the idea of the tutorials should be extended from the teachers' office to the classroom.

Evaluation system

Apply a system of continuous assessment.

Consider the possibilities of continuous assessment of classwork and projects, and consider reducing the importance of traditional examinations.

This then illustrates *Hypothesis 4*.

In addition to everything outlined above, it would be interesting to carry out *complementary activities* that can help students to understand their subject better. Visits to companies, for example, can provide valuable learning experiences for students, as long as the learning objectives to be covered are clearly established. Additionally, conferences, seminars, talks and workshops can be organised, to which businesspeople and professors researching in areas linked to the subject can be invited as speakers. This would provide a practical vision and greater insights into business realities.

As far as the usefulness of the study is concerned, it is necessary to point out that it has yet to be evaluated fully, which means that the course of action is still open. Nevertheless, the group is generally quite happy with the study and its findings. All the demands required of the study at the start have been met, both in terms of quality as well as in learning and experience gained.

7. CONCLUSIONS

The traditional process of teaching has to be modified so that students are taught how to learn as established by the European Higher Education Area (EHEA). It is necessary to decrease the influence of subject contents, oral lessons by teachers, individual study by students, exams, classrooms, etc. Conversely, other aspects have to be enhanced, such as multidisciplinary topics, problem/project based learning, supervised learning, practical lessons, working teams, self-evaluation and peer evaluation, working rooms, etc. Teachers have to improve their expertise in order to include all these aspects in their methodologies.

The paper also provides a comprehensive framework that can be adopted to evaluate the usefulness of an instructional approach using a student survey via a structured questionnaire. A set of hypotheses were posed and they were almost completely validated.

The novelty of this research is the combination of several subjects related to Industrial Engineering, analysing the teaching–learning process through a multi-topic questionnaire. The final objective was to understand the current situation and to establish different ways to correct the inefficiencies detected and guidelines to improve that process. It is important in that it addresses students' demands.

Although this work applies to a specific environment, the results and conclusions obtained could be generalised to other engineering degrees because the problem profile is approximately the same. With some limitations, they could even be extended to other degrees due to the general nature of the questionnaire. Therefore, it is possible to channel efforts to generate results that can be of use to the rest of the university community.

The future for this work will provide continuity by including more subjects and degrees, which would allow the importance of, and the adherence to, the requirements of the new European educational model to increase steadily. We should not lose sight of the deadline for the implementation of the EHEA in 2010. This will mark a point of no return, but it will not be the end of the process, merely a staging post along the road of continuous improvement. It should be noted that it is the road to follow for teachers and students alike in their journey towards convergence in the improved efficiency of the university education system.

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