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A Pilot Study on the Adaptation of Mechanical Technology Modules to the European Higher Education Area*

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As part of a Mechanical technology module taught at Burgos University, a pilot project is presented which aims at a smooth transition from a teaching-based system to a learning-based system. This changeover is justified by student procrastination and passivity and backed by recommendations from institutions and business organizations. The objectives of this research are defined in terms of greater effectiveness, measured by the quality of the grades, and greater efficiency of the process, measured by the percentage of students sitting the exam and by the percentage of students that successfully complete the module. It also aims to strengthen oral and written communication skills and teamwork. Lecture methods give way to a combination of lectures and cooperative and collaborative learning techniques, which entail designing objectives, working materials, timetables, and assessment procedures. The introduction of active learning methods led to an 8% increase in the percentage of students attending the exam, a 31% increase in the percentage of students successfully passing the module, and an increase of 0.55 points in the grades awarded to students. A survey gained insight into student satisfaction with educational methods and the way in which they reinforce oral and written communication skills and teamwork.

Keywords: cooperative learning; collaborative learning; participative lecture; education; teaching-learning; European Area for Higher Education EHEA

1. INTRODUCTION

IN VIEW OF THE BOLOGNA PROCESS and its planned introduction in the 2010/2011 academic year, it was considered prudent to begin the progressive adaptation of a Mechanical Technology module to the European Higher Education Area (EHEA). By doing so, our intention is to ensure a smooth transition for both teachers and students from the present system fundamentally based on teaching by the university professor, to the future system, fundamentally based on student learning. Other reasons that justify initiating this process of change, apart from avoiding a sudden break between both systems, are as follows:

- Procrastination and passivity shown by students on courses leading up to the 2006/2007 academic year.
- The recommendations made by institutions and business organisations, which have culminated in the Bologna process.

As well as pursuing a smooth transition between both of the aforementioned systems, the pilot study also seeks to achieve the following objectives:

- Increase student attendance at tutorials.
- Improve both the effectiveness and the efficiency of the learning process in relation to the subject matter. Effectiveness is measured in terms of grades and efficiency in terms of the percentage of students sitting the exam and the percentage of students that successfully complete the module.
- Improve oral and written communication.
- Stimulate teamwork.

1.1 Student behavior

Mechanical Technology is taught in the third year of the Industrial Engineering course at Burgos University and students are required to have successfully passed modules on Materials Science, Material Elasticity and Resistance, and Statistics, before starting the course, to ensure that they possess the knowledge needed to understand the subject matter, and start at a similar level.

Nevertheless, passive attitudes may be observed in the classroom, as students neither question nor comment on the subject matter, neither do they respond to the questions put by the teacher. This passive attitude, linked to the pilot project in a pilot project conducted in the 2004/5 academic year [1], involving a hypermedia application for the study of pneumatics that incorporated an access control module to monitor student activity, it was found that the subject matter was mainly studied on dates preceding the exam, which corroborated the passive attitudes that were observed in the classroom activities.

We consider that this passive behavior has its

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origin in procrastination or postponing serious study of the subject until the last moment. Procrastination arises from a feeling of apathy, a consequence of poor preparation among students and insufficient motivation to study, which, when associated with a fear of failure, means that the student prepares the tests quickly, at the last moment, and the response is the postponement of the work until it is too late in the day.

These feelings and behavioral patterns are by no means exclusive to the Mechanical Technology module at Burgos University, but are very generalized, as is evident from the bibliography [2–13]. They begin in the family [2], continue into primary education [14], and in secondary education [15], and they have expanded with the globalization of modern means of communication.

Apathy is a complex feeling caused by numerous factors, among which are overprotection of children in the home [2], speculation and enrichment without effort, experienced in Spain over the past 10 years, unrestrained late-night leisure activities, electronic media, TV, computer, consoles [16], underrating areas such as grammar [14], which are essential for the analysis and summary of the subject matter. The University can also contribute to this feeling of apathy in the following ways: the possibility of simultaneous student enrolment on various course modules with incompatible hours [7]; the high number of courses offered by the institution with respect to those that the student has to follow, made attractive by often entailing low requirements; the fact that non-attendance at an exam is not counted as a failure, which extends the average stay of the student to six years, on a 3-year degree course [10,13]; scant time for the development of subject matter and unsatisfactory methods for modern students.

There are a large number of studies in educational literature [17–21], which clearly demonstrate that instruction-based education generates worse results than active learning, in which students have to analyze and summarize the subject matter, resolve problems, complete assignments, answer questions, formulate their own questions, explain and debate, which helps them develop better cognitive skills and leads to a change in attitude.

1.2 Recommendations by institutions and business organizations

The ultimate aim of the EHEA is to create a more uniform educational system, which increases international competitiveness and facilitates student and teacher mobility [22–25]. The intention is to move towards certain basic common principles, which will facilitate student mobility, preparing students for future employment in a European context [22, 24, 26] and creating professional, and personal links that will strengthen cohesion between European Union member states [22, 23, 27].

In this system, the profile of our educators transcends the mere transmission of knowledge. A good part of our activity should be dedicated to guiding and orienting students mainly in their academic careers, but also in their professional and personal ones [22, 26, 28, 29]. In other words, in addition to technical content, a series of skills and values should be communicated which are found in any working situation [22, 28].

Higher education in the future will differ considerably from what has been undertaken up until now. These days, students are at the centre of all educational tasks, and they have to learn to learn. The role of the teacher therefore moves from teaching to being a builder of bridges, a mediator between the student and the activities to be undertaken. This change implies that students should participate in much more active ways than at present. It is for this reason that the use of active methodologies are recommended, which make the student the main actor in the education process [23, 28–30].

1.3. Framework of study module

The 1967 plan took place over three courses: the first two were shared and the third was divided into two specialities: Industrial structures and installations and Machinery Construction. Students qualified as Mechanical Engineers in one of the two specialist areas. All subjects were taught over one year and no optional subjects were included in the plan.

In the 1999 plan, 153 of the total 235.5 credits are key subjects, 28.5 are obligatory, 24 optional, 24 voluntary and 6 refer to end-of-course projects. They differ fundamentally from the latter on the following points:

- The Mechanical Technology Module underwent a 40% reduction in its teaching hours, similar to that experienced by the other modules;
- Optional and voluntary modules represent 20% of the course syllabus;

Table 1. Past, present and future of mechanical technology module

Plan	Course	Period	Nature	Classroom hours	Credits
1967	3rd year	Annual	Obligatory	150	
1999	3rd year	Quadrimestral	Key subject*	90	235.5
2010	3rd year	Semestral	Obligatory*	30	240
	3rd year	Semestral	Obligatory	60	

* Key subject = an obligatory subject on the degree course for all Spanish universities. Obligatory = an obligatory subject on the degree course at the University of Burgos.

- The duration of most modules is four months;
- The Polytechnic School offers 4.8 credits for each optional credit that the student has to follow;
- The specialist subjects are removed and the student assumes responsibility for his or her own curricular development.

Student passivity has substantially increased in the current plan, although there are no studies that endorse the idea of that being due to the changes introduced. The 2010 plan, which is presently undergoing verification, is projected over four years, divided into semesters, in such a way that optional subjects are reduced by 5% and the Polytechnic School offers 2.5 credits for each optional credit that the student has to follow.

Mechanical Technology maintains its presence, but is now taught over two semesters. The first of three ECTS credits is applicable to the specialist areas of Mechanics, Electronics and Industrial Organization, and the course contents concern general knowledge that should be held by all industrial engineers: tolerances, operations with benchmarks, manufacturing processes, and the use of standard measurement instruments in dimensional metrology. Teaching only continues in the specialist area of Mechanics in the second semester, examining the design and selection of manufacturing processes as well as dimensional metrology.

The competencies that have to be studied and evaluated on the Mechanical Technology module, according to the contents of the study plan, which were taken from Order CIN/351/2009 of 9 February, are as follows:

- Competent oral and written work in Castilian Spanish;
- Capacity to work in a team;
- Self-study skills;
- Basic knowledge of production and manufacturing skills;
- Knowledge applied to manufacturing systems and processes, metrology, and quality control.

Table 2 shows the current results and those envisaged under the 2010 plan. It is stated in the annual report on the degree qualification that no distinction is made between full-time and part-time students in the calculation of the current graduation rate. The latter 34% balance their educational activities with their work activity, and they therefore need more time to complete their studies. Another factor is that the current study plan has a high teaching load that is concentrated into three academic years, which leads to a high percentage of exam absenteeism in certain subjects and is a demoralizing factor for students.

Likewise, the abandonment rate is explained in relation to the intense yearly teaching load in the current study plan. Those students that have selected the qualification but who lack a clear vocation to be an engineer, or those without sufficient capacity to absorb scientific-technical knowledge at university level, are prone to abandon mechanical engineering studies. Moreover, socio-economic booms such as those of recent years have led some students to abandon their studies to join the world of work. These are the arguments given in the annual report on the plan to justify the results obtained by students and to aim for improvements in the new plan.

Despite the plan having a quality guarantee system, which monitors compliance with objectives, contents, evaluation systems etc., the success of the plan will depend on the changes it entails in the approach of students and teachers. As teachers we should create situations so that the student learns; the student should accept that learning demands an effort.

1.4 Novelty and importance of present study

There is a wide and varied range of experiences in the literature on education, which highlights the importance of active methods in teaching-learning [17–19, 21]. There are also strategies that aim to strengthen other skills, such as oral communication [31], team work [32] and values such as cooperation, responsibility, negotiation, tolerance, etc. [33, 34].

However, the only experiment [13] found in connection with Mechanical Technology as a subject seeks to improve the teaching-learning process through a management system based on ISO 9000 and on the EFQM model. Its aim is to improve the management of departmental resources to introduce improvements into the teaching process. This work only describes the system that was introduced, but it does not analyze the impact that it has on the teaching-learning process and the subject matter. Therefore, one of the novelties of this work is its analysis of the impact that active learning has on the learning of Mechanical Technology.

The Mechanical Technology module breaks down into 252 objectives, which encompass the

Table 2. Actual and foreseeable results in the Mechanics module under new study plan

Indicator	**Current average value**	**Envisaged results**
Graduation rate*	40%	60%
Abandonment rate**	26%	20%

* Graduation rate = Percentage of students that finish teaching within the period envisaged in the plan, or within one additional academic year with respect to their intake year.
** Abandonment rate = Percentile relation between the total number of students in one intake year that should be awarded the qualification in any one academic year and that did not enrol in either that year or in the earlier year.

technical knowledge that the student should acquire throughout the course. The novelty lies in the teacher developing only those objectives which, due to their complexity, would demand too much time and effort from the student. Classroom time therefore becomes available which is divided into sessions in which the student works on the remaining objectives, and in which the teacher responds to the questions formulated by the work teams, and sessions in which students present their assignments.

2. METHODOLOGY UNTIL 2005/2006 ACADEMIC YEAR

Before conclusions are drawn from this pilot study, the methodology used to develop the subject matter and the assessment process in earlier courses needs to be presented. This information is summarized in Table 3.

Up until the 2003/2004 academic year, the concepts taught on the module were presented by the teacher in a lecture on the subject. The assignments for private study were also worked through in the classroom by the teacher, without verifying whether students had in fact studied them earlier. In the case of laboratory practicals, the student was given a guide detailing the steps to be taken for each of the practical experiments.

In the 2004/2005 and 2005/2006 academic years, in addition to the above, students were given a series of revision exercises 15 days before the exam. The solutions were not handed out until two days before the exam, to ensure that they completed the exercises and attended the tutorials.

Assessment was in the form of exams that centered on technical knowledge of the material, which is the standard procedure in schools of engineering [35, 36].

3. METHODOLOGY FROM 2006/2007 ACADEMIC YEAR

Bearing in mind that students will consider their behavior normal in terms of procrastination and passivity, and that institutions recommend a change of teaching methods, centring them on student learning and on lifelong learning, a methodology is needed in which responsibility for learning falls fundamentally on the student. As well as concepts, attitudes also have to be learnt that are applicable in a great variety of contexts and circumstances, both work-related as well as for lifelong learning [32, 37].

The selected methodology combines lectures, cooperative learning, and collaborative learning. The lecture method is used for those concepts, which because of their complexity, would otherwise require too much time and effort from the student [38, 39]. The learning plan is structured in detail by the teacher, which is a characteristic of cooperative learning [20, 40, 41]; however, there is no division of tasks between the team members, who perform the tasks individually, in order to arrive at a consensus, later on, through dialogue and negotiation on the final form of the proposed objectives, which is also a characteristic of collaborative learning [20, 40, 42-46].

Despite the drawbacks of the groups being formed by the students themselves [41, 47–48], this system was used because of the impossibility of forming groups with compatible timetables, as the high number of options on the course, along with the diversity of personal situations, made it impossible for them to be formed in other ways. The groups are formed of four people, as larger groups are more difficult to coordinate and some students might drop out, or be unable to attend, whereas groups of fewer than three people are not sufficiently diverse for interaction to take place [41].

It is expected that the student will remain actively engaged in pursuing the objectives and that those students with a better understanding will support the weaker ones, such that the former will consolidate the knowledge held by the latter [45]. The intention is to improve oral and written communication skills, autonomous learning, and team work. Cooperative learning fosters cognitive skills such as effectiveness, analysis, summarization skills, information searches, etc., and social skills such as cooperation, responsibility, reasoning, tolerance, etc. [31–34].

Table 3. Teaching methods until 2005/2006 academic year

Academic Year	2002/2003	2003/2004	2004/2005	2005/2006
Teaching method	Lecture		Lecture	
	Practicals		Practicals	
			Assignments posted on the departmental website	
			Key to solutions posted two days before the exam	
Assessment	Exam: Theory 3 points. Assignments 7 points Partial eliminatory exam, towards the end of November, on process selection, moulding, plastic deformation, tolerances and adjustments, operations with limits. Final exam in February, covering all aspects of the subject matter			

In cooperative learning, the teacher emerges as the 'conductor' of 'facilitator' of the learning process, carefully setting the objectives, the working material, timetables, and the assessment, and facilitating the way forward for students to attain the desired objectives [36, 41, 45].

3.1 Objectives

The subject matter of Mechanical Technology may be divided into six topics that contain 252 objectives, which constitute the different learning levels in the taxonomy proposed by Bloom [49]. The wording was intentionally explicit and it was taken into account that the objectives had to be fulfilled within a feasible timeframe for the subject. The following objectives were proposed for the topic of moulding.

1. Describe the molding process.
2. List the advantages and disadvantages of the molding process.
3. Classify molding processes in terms of the duration of the mold.
4. Describe the applications of disposable molds.
5. Identify the applications of permanent molds.
6. Describe the components of a molding process, using a graphic representation.
7. List the materials used in the construction of models.
8. List the advantages and the disadvantages of wooden models.
9. List the advantages and disadvantages of metallic models.
10. Briefly explain the purpose of the model's angles of departure.
11. Explain the purpose of the die holders in the models.
12. Describe the properties of a mold.
13. Classify molding sands by their degree of humidity.
14. Describe the influence of sand grain size on the properties of the piece.
15. Explain the impact of the sand grain shape on the properties of the piece.
16. List the conducts that form the distribution system, ordering them in the direction in which the fluid circulates.
17. Describe the purposes of the pouring cup.
18. Briefly describe the different pouring procedures.
19. Explain the purposes which the riser should serve.
20. Calculate the strain produced by metal static pressure.
21. Design the distribution systems.
22. Design models that take account of contraction rates in the material.
23. Design risers that fulfil their purpose.
24. Classify casting procedures according to the material used for the construction of the mould.

3.2. Timetabling

The subject at present is worth 9 credits, such that each credit corresponds to 10 teaching hours, as the work of the student is not taken into account. The present total of 9 credits is equivalent to 7.5 ECTS credits [50]. On the basis that the ECTS credit is equal to 30 hours of student work, the programme is as follows:

- 90 hours of classroom attendance (A), of which 34 hours are used by the teacher to introduce the most important concepts on the course, and 56 are used by the students in the following way: 12 hours for teamwork, 24 hours for laboratory practicals and 20 hours for oral presentations of the proposed activities.
- 45 hours of teamwork outside the classroom (FA).
- 90 hours for individual work and exam preparation.

The allocation of hours to each topic is shown in Table 4.

3.3. Assessment

Assessment allows information to be collected, at any time, on the teaching–learning process and guides its progress whenever the results are not as expected. It also provides information to set the objectives in a new curricular process, as well as on the effectiveness and efficiency of the methodology in use [51].

Assessment has to center on the skills developed in the subject matter, and the assessment criteria must be clear and transparent [52].

In our case, developing the objectives, the oral presentation, and laboratory practicals constitute 40% of the mark. The final exam accounts for the remaining 60% [39, 53–54].

The 4 points for the proposed activities break down in the following way: 0.6 for analysis and summary of the subject matter; 0.6 for the written presentation; 0.55 for teamwork; 1 for approaching and working out the problems; 0.6 for the oral presentation, and 0.65 for laboratory practicals. All the marks are collective, except for the oral presentation which is individual and which is used to monitor the individual contributions of each group member. Taking the final marks into

Table 4. Allocation of hours by topic

	Lectures	Student	
Topic	**Hours**	**Hours (A)**	**Hours (FA)**
Selection of processes	1	1	2
Molding	2	4	6
Plastic deformation	6	8	11
Tolerances, adjustments	3	3	5
Metrology	10	28	10
Machining	12	12	11
Total	**34**	**56**	**45**
	90		**45**

account, the maximum impact on the final grade is 6% for written communication, 5.5% for team work, and 6% for oral communication; the remaining 82.5% corresponds to technical knowledge of the subject matter.

The assessment criteria for the written presentation are syntax and spelling. Those for the oral presentation are communicative capacity, organization, and visibility of written information on the board, mastery of the subject matter, the module units, and the responses to questions from fellow students and the teacher.

The timetable for handing in assignments is circulated at the start of the course. Their assessment and oral presentations mean that the progress of the teaching/learning process may be monitored, and where necessary corrective action taken.

Lack of positive independence [41, 55] is assessed by observing such failings as blocks of objectives fulfilled to a different extent and depth, lack of uniformity in written work, procedural mistakes, and mistakes in the units.

Theoretical objectives account for 1.8 points from a total of 6 exam points, and problems and exercises in laboratory practicals for 4.2 points. With a view to detecting free readers [43, 53], who might survive in the groups, the following requirements to obtain a pass in the subject module are laid down:

1. to obtain marks in all parts of the exam;
2. the global mark should be over 2.4 out of a possible 6 points.

3. ANALYSIS OF THE RESULTS

Figure 1 shows that the use of the new methodology was accompanied by an increase in percentage passes, whereas percentage absences fell. Students who are not present at exams do not abandon the module, but postpone it for subsequent exams, extending their stay in the institution. The percentage of passes for the academic year 08/09, although it fell with respect to the academic year 07/08, remained at the same level for the academic year 06/07. It is logical that there may be fluctuations, though it is important that they occur at a higher average level than with the lecture hall method.

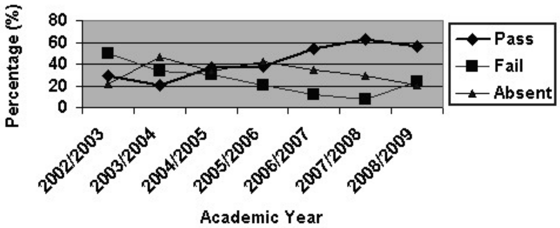

Fig. 1. Absences, passes, and fails as percentage of students enrolled.

Table 5. Exam attendance by methodology

	Exam attendance		
	Present	Absent	
Lecture method	226	130	**356**
New methodology	147	61	**208**
	373	**191**	**564**

A comparison of those courses which used lecture methods, and those which used the new methodology, may be seen in Table 5.

As Table 5 is a contingency table in which the marginal totals as well as the sample size may vary, an approximate procedure based on Wilk's G^2 statistic [56] is used to test the hypothesis of independence:

$$G^2 = -2 \cdot \begin{bmatrix} n_{1.} \cdot \ln n_{1.} + n_{2.} \cdot \ln n_{2.} + n_{.1} \cdot \ln n_{.1} + n_{.2} \cdot \ln n_{.2} \\ -n_{11} \cdot \ln n_{11} - n_{12} \cdot \ln n_{12} - n_{21} \cdot \ln n_{21} - n_{22} \cdot \ln n_{22} - n \cdot \ln n \end{bmatrix} \tag{1}$$

thus, $G^2 = 3.04$ for the data in Table 5. $\chi_1^2(3.04) = 0.085 = \mathrm{p}$, $\alpha = 5\%$, on which basis it may be said that a statistical relation exists between the methodology in use and exam attendance.

However, taking account of the tendency observed in Fig. 1 and the approximate nature of the method, in order to establish whether or not an association exists between both variables, the Student's t test was applied to the difference in the percentages of absent students [57]. Calling p_1 the percentage of absences with the lecture methods and p_2 the percentage with the current method, and establishing the null hypothesis as Ho: $p_1 \leq p_2$, by applying the t test [57]:

$$T = \frac{p_1 - p_2}{\sqrt{\frac{(n_1-1)\cdot S_1^2 + (n_2-1)\cdot S_2^2}{n_1+n_2-2} \cdot \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \tag{2}$$

$T = 29.53$, which corresponds to a critical level of $p \approx 0$, leading us to discard the null hypothesis and to accept that the percentage of absences associated with the current method is below the percentage of absences associated with the lecture methods. In order to determine the degree to which both percentages differ, the size of the effect is calculated using the following expression [57]:

$$d = \frac{p_1 - p_2}{\sqrt{\frac{(n_1-1)\cdot S_1^2 + (n_2-1)\cdot S_2^2}{n_1+n_2-2}}} \tag{3}$$

giving $d = 2.57$, which corresponds to a probability of 99.49% in N(0,1). This indicates that 99.49% of students under the current methodology have a possibility p of not being present at the exam, which is below the average for the lecture method. Thus, it may be said that the percentage of students attending the exam has increased from 63% to 71%, which agrees with the results presented in [48].

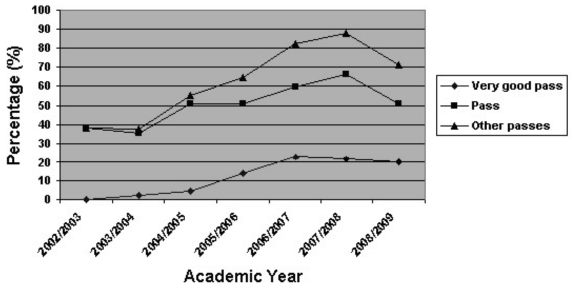

Fig. 2. Learning results as percentage of students present at exam.

Table 6. Academic performance in relation to methodology

	Academic performance		
	Pass	Fail	
Lecture method	112	114	**226**
New methodology	118	29	**147**
	230	**143**	**373**

Figure 2 shows the percentage of passes, 'very good' passes, and other pass marks, obtained by those present at the exam. It may be seen that effectiveness, measured by the quality of the qualifications, and efficiency, measured by the percentage of exam candidates and by the percentage of those that pass the module, improve with the current methodology, despite the fall in percentage passes for the 08/09 academic year.

The accumulated results of learning as a function of the methodology used, with respect to the number of students present at the exam, is presented in Table 6

$G^2 = 37.32$ is obtained from (1), which gives a critical level of $p \approx 0$, which tells us that there is an association between the methodology in use and academic performance. Yule's Q ratio [56] was used to measure the extent of that relationship, which is given by the following equation:

$$Q = \frac{n_{11} \cdot n_{22} - n_{12} \cdot n_{21}}{n_{11} \cdot n_{22} + n_{12} \cdot n_{21}} = -0.61 \qquad (4)$$

In other words, there is quite a strong relationship (Q = 0.61), between the fails and the lecture method. Performing the proportional difference test on the passes gives us: T = 87.26, $p \approx 0$ and d = 9.28, which tells us that the proportion of passes for all students following the lecture method is below the average for the current methodology. The probability of passing the subject has increased from 49% to 80%, improving the efficiency of the process [48, 53].

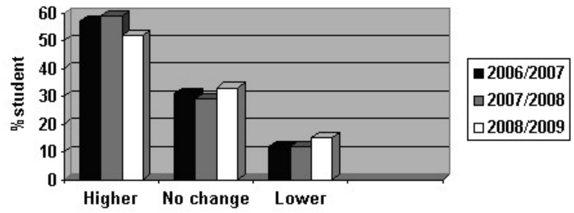

Fig. 3. Comparison of evaluation of competencies and overall exam mark.

Students following the lecture method with passes in the subject obtained an average mark of 5.65 out of 10, with a standard deviation of 0.82, whereas those following the current methodology obtained a mark of 6.20 with a standard deviation of 1.08. Applying the statistical tests in (2) and (3) to the difference in means gives us: T = –4.34; $p \approx 0$ and d = 0.57, which tells us that 71.57% of students following the lecture method obtained a mark of below 6.20, which implies that the current method improves the effectiveness of the learning process.

In order to appreciate the influence that the evaluation of competencies has on the overall grade, the former qualification is compared with the grade obtained in the exam by each student, which was the procedure used to mark the student in the lecture method. Figure 3 shows that the percentage of students whose global marks are higher is unchanged, and lower with respect to their exam marks. On average, 52% have improved their mark, as against 15% whose marks have fallen, such that, in general terms, it may be said that the assessment of skills, such as oral and written communication and teamwork, improve the marks obtained by the students. Moreover, 18% of passes would not have passed had they followed the lecture method, as their exam marks were between 4 and 5 out of 10.

Table 7 shows the maximum possible mark and the average mark obtained for the skills under assessment. They are all above average, except for analysis and summary of the subject matter, which is therefore the skill in need of most attention. The most common mistakes occur in the interpretation, comparison, differentiation, and formulation of the concepts. To remedy these weak points, the groups have to go over those objectives that have not been sufficiently well developed. To do so, an interview is held with

Table 7. Results of skills assessment

Skill	Analysis and summary	Spelling and syntax	Approaching and working out the problems	Teamwork	Oral presentation	Laboratory practicals
Maximum mark	0.6	0.6	1	0.55	0.6	0.65
Average mark obtained	0.18	0.39	0.61	0.34	0.46	0.45

the group, in which the teacher explains the errors they have made and guides them towards the best way of solving them. The students cannot move on to the following activity until they have corrected their earlier errors.

5. STUDENT SATISFACTION SURVEY

The assessment allows information to be extracted on the efficacy and the efficiency of the teaching/learning process. However, the teacher should also be aware of the way in which students perceive the methodology, to be able to modify those concepts that the students consider weak. With that end in mind, a survey was conducted on 40 students, which is shown in Table 8. As it is a low participation, the results may not be generalized, but they serve as a preliminary study to stress that we are moving in the right direction.

Indicators identified in bibliographic references [36, 39, 41, 48, 55] were used to ensure the validity of the questionnaire, as well as in the contributions of the members of the research team. Its reliability was measured using Cronbach's method, which gave a value of 0.81, slightly above the required minimum.

With regard to written communication, the students considered the reinforcement of the analysis and summarization of the subject matter in a positive light, as well as the way in which measurement units were dealt with.

The oral presentation was positively assessed as it was useful training for the final end-of-course project, according to the observations made by five students in the survey. They admitted to nervousness and complained about the random allocation of the oral presentation, as worries over being chosen to make the next presentation distracted their attention from its actual preparation. This complaint cannot be remedied, as it is one of the systems adopted to monitor individual responsibility.

Table 8. Survey of student satisfaction

Score	Very negative 1	2	3	4	Very positive 5	Avg. $\bar{x}$	Variance S^2
1. Assess what the written activities have meant for you with reference to:							
1.1. Strengthening your capacity to analyze the subject matter						3.6	0.69
1.1. Strengthening your capacity to summarize the subject matter						3.75	0.59
1.3. Attention to the detail of the semantics and the syntax of written work						2.9	0.84
1.4. Attention to spelling						2.98	0.92
1.5. Attention to units of measurement						3.55	0.85
2. Assess what the oral presentation meant to you, with reference to:							
2.1. Ability to speak in public						3.15	0.88
2.2. Ability to organize available resources						3.25	0.44
2.3. Ability to control your voice and vocabulary						3.23	0.82
2.4. Ability to respond to the set questions						2.9	0.74
3. Assess teamwork in reference to:							
3.1. Your contribution to the team						3.75	0.59
3.2. The contribution of your colleagues						3.63	1.03
3.3. Interpersonal relations						3.78	0.82
3.4. Shared hours	Difficult				Easy	2.43	1.09
3.5. Number of meetings	Insufficient				Too many	2.98	0.82
3.6. Collaborative work	Weak				Intense	3.25	0.89
4. Assess your degree of satisfaction with the proposed method, with reference to:							
4.1. Hourly workload for the student	Insufficient				Excessive	4.33	0.43
4.2. Content developed by the teacher						4.1	0.90
4.3. Assessment method	Strongly disagree				Strongly agree	3.43	0.74
4.4. Assessment criteria						3.43	0.54
4.5. Scale of assessment criteria						3.25	0.49
Make any observations that you consider relevant to the proposed work							

Teamwork is positively assessed, but the students highlight the difficulty of finding times when they are free to meet.

The students consider that this methodology has an excessive workload, which coincides with the passivity and procrastination shown in the earlier survey. There are nine students who consider the subject matter excessive in the 9 credits which make up the subject module, according to the observations made in the survey, which is a reflection to take into account in the preparation of the new study plans.

Finally, they indicate their agreement with the proposed assessment system.

6. CONCLUSIONS

In accordance with the objectives proposed in the introduction, the moment has come to present the strong points of the learning/teaching process identified thus far in the research.

There is no culture of attendance at tutorials, as increased attendance occurs as a consequence of the obligation to correct the mistakes made during the preparation of the assignments. This means that attendance is forced and is *a posteriori*, when it should take place before handing in each assignment, with a view to receiving the necessary guidance on those concepts that the group is unable to resolve by itself.

The percentage of students present at the exam has increased from an average of 63% with the lecture method, to an average of 71% with the current methodology. A positive trend is observable as knowledge of the method becomes more widespread, which means it is foreseeable that the results may improve when active methodologies are introduced across the board in all subjects and courses.

The efficiency of the methodology is reflected in the percentage of passes, which has risen from 49% with the lecture method, to 80% with the new methodology. Its effectiveness has also been favorably affected, as the average mark increased by 0.55 points, rising from 5.65 to 6.2 out of 10

Strengthening oral and written communication is positively assessed by the students, and positively influences the marks that they obtain.

The students positively value their contributions and those of their fellow students, and there are no signs of excessive interpersonal conflicts. There were difficulties in timetabling the meetings, which meant that they did not take place as frequently as they wished. This problem will be resolved in the new study plans which will greatly reduce the range of options, switching from the 24 optional subjects proposed at present to 5 optional subjects proposed in the new plan.

In addition to the improvements in overall grades, this research has facilitated: active participation in the preparation of the new plan; division of the material between the two modules, spreading their contents over a longer timeframe, setting the objectives, contents, competencies, methodology, evaluation system, and timetabling of the module activities. It has, moreover, contributed to understanding that in the EHEA the way in which knowledge is gained (learning to learn) is more important than the knowledge itself.

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