EDULEARN16

8TH INTERNATIONAL CONFERENCE ON EDUCATION AND NEW LEARNING TECHNOLOGIES

BARCELONA (SPAIN)
4TH - 6TH OF JULY, 2016

CONFERENCE PROCEEDINGS

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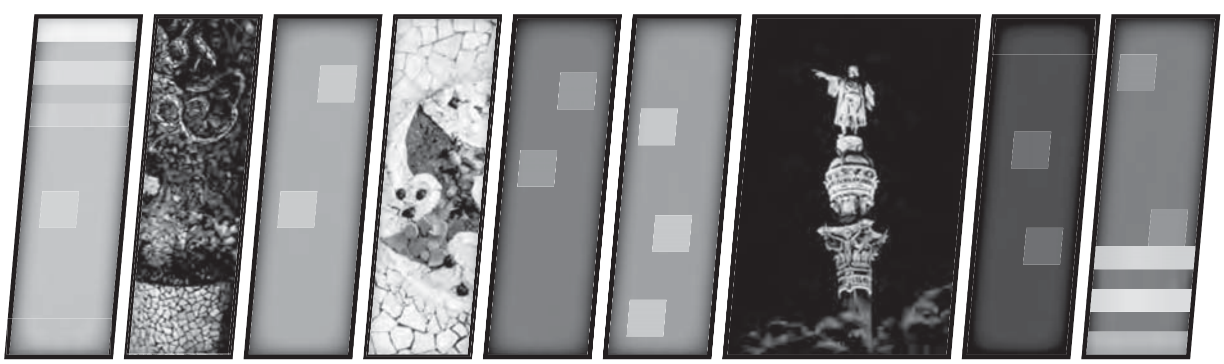

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RELATIONSHIPS BETWEEN THE STUDENTS EFFORTS AND THEIR ACADEMIC RESULTS. A CASE STUDY: MECHANICAL ENGINEERING DEGREE

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Abstract

The introduction of the Bologna process in Spanish universities has implied greater effort to improve teaching-learning processes, the outcome of which may be measured by improvements in academic outcomes. These improvements are seen in tools such as Problem-Based Learning, Project-Based Learning, Cooperative Learning, e-learning, etc. They all serve to encourage student-centered learning. The main purpose of this investigation is to conduct a comparative analysis between the time that students invest in their course and their academic performance. The study involved students at the Engineering Faculty of Bilbao, following the Degree in Mechanical Engineering at the University of the Basque Country (UPV/EHU). There are a number of background studies that assess this relationship on the degree and that check whether student involvement is in line with the expectations of university organizations (higher educational degree system). In this research, following the collection of various datasets from students, the information is analyzed to establish correlations. These lead to proposals for action that are explained in context, to promote clear improvements in the teaching-learning process.

Keywords: Teaching-learning, learning achievement, performance rate, engineering.

1 INTRODUCTION

The Bologna Process began a new era in Spanish universities. New degrees were introduced and the European Credits Transfer System (ECTS) was adopted to improve academic and work mobility. There were also quality assurance arrangements in support of the modernization of the educational system, so that the needs of a changing labor market would be met. Moreover, the proportion of jobs that required higher skills increased.

The European credit is the unit of academic measurement that represents the amount of work a student has to do to meet the goals of the curriculum. A university degree is awarded having passed each subject module that forms the curriculum. The ECTS integrates theoretical and practical lessons, as well as other targeted academic activities (lectures, seminars, projects, etc), including the estimated hours of study and the classroom hours for the student to pass a subject module. The minimum number of hours per credit is 25, and the maximum number is 30 [1]. So, the workload over an academic year ranges between 1500 and 1800 hours.

The framework of the European Higher Education Area (EHEA) focuses on the needs of individual students, with a new concept of the teaching-learning process. It changes the model of traditional education to Student-Centered Learning (SCL). This is a process of qualitative transformation for students in a learning environment, aimed at enhancing their autonomy and critical ability [2]. Improvements to the teaching-learning process have been developed with tools such as Problem-Based Learning, Project-Based Learning, Cooperative Learning or E-learning. The key points of this new teaching-learning process are:

- Active learning.
- Critical and analytical learning and understanding.
- Increased student responsibility and autonomy.
- A reflective approach to the teaching-learning process involving both student and teacher.

The progression from traditional teaching systems to more participatory systems requires a strong dose of commitment from students and teachers. These changes have improved academic outcomes in the Spanish university system [3-9]. However, the daily experience of teaching has raised questions

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in relation to differences between the actual and the planned workloads of students that are necessary to gain a degree.

The aim of this article is to present and to analyze measurements of student effort throughout the academic year and to compare the academic outcomes of students, seeking to identify different reasons for discrepancies and possible actions to remedy them and avenues for future analyses.

2 DEGREE IN MECHANICAL ENGINEERING AT UPV/EHU

The degree in Mechanical Engineering at the University of the Basque Country UPV/EHU has 240 credits; 60 credits per full-time academic year. The number of hours per credit is 25. The degree is structured in several modules: basic training, training in general engineering, and targeted training in mechanical engineering. Basic training is almost entirely in the first year, while general engineering is divided between the second and the fourth years. The contents of mechanical engineering are taught in the third year, enhanced with elective modules in the fourth year.

The teaching degree forms part of the model promoted by the University of the Basque Country. It is a cooperative and dynamic learning model called IKD, (Ikaskuntza Kooperatibo eta Dinamikoa), a collaborative, multilingual and inclusive model that emphasizes the need for students to master their learning processes, so that their training is integral, flexible and adapted to the needs of society. The teaching-learning process fosters and enhances autonomous and significant student learning through the use of active methodologies and continuous assessment and encourages the acquisition of established competences. It is a learning approach characterized by innovative teaching methods that aim to promote learning through communication between teachers and students. Students are taken seriously as active participants (or even partners) in their own learning, fostering transferable skills such as problem-solving, and critical and reflective thinking.

The degree in mechanical engineering attempts to follow the IKD model, although there is limited implementation of active teaching methodologies. Almost completely integrated in the first year, the extent of its implementation is increasing in the other three years and over 50% of all teaching activities are now active teaching methodologies. The first promotion of students graduated in 2012/13, with a significant proportion of students having followed the earlier curricular plan, so their experiences were not appropriate for analysis. It was therefore decided to wait until 2014/15 for comparisons of the data on success rates with the results for student effort, given that the graduates had started their studies before the introduction of the new degree course.

3 METHODOLOGY

Quantification of student effort was done for each subject. However, this quantification was not uniform between subject modules, as it was dependent on the approach of each teaching team towards the subject. It varied depending on the type of personal work required and the intensity and type of teacher supervision.

There is therefore an initial difficulty in gathering consistent data under the same conditions. In response to this dilemma, the results of general surveys conducted at the University at the end of the year were employed. The Teacher Evaluation Service conducts this campaign at the end of each academic year. Students in each group, following each teaching mode (seminars, lectures, computer practicals, classroom practicals, industrial practicals) and subject module complete the surveys, so the methodology and system may be considered comparable. The survey is divided into three parts: the first part contextualizes the group; the second is a brief self-assessment by students; the third and the lengthiest part is where students express their opinions on the teaching-learning process.

Contextualization includes questions such as gender and age, number of students attending class, attending tutorials, difficulty of the subject, and the number of private study hours. This question was selected for the development of this study (table 1).

Table 1: Student survey

BACKGROUND DATA ON THE GROUP OF STUDENTS	
Number of hours of private study per week you spend studying this subject: 0-1☐ 2-3☐ 4-5☐ 6-7☐ 8 or more☐	

The Teacher Evaluation Service collects the questionnaires and processes the results, sharing them with each teacher, as they are confidential, at the beginning of the following academic year. Therefore, the responses to the question on the number of out-of-class hours for all the subject modules of the degree were compiled, during the first semester of 2015/16, with the collaboration of the majority of the teaching staff on the degree course. However, data on three subjects was unavailable, either due to unwillingness to share the information or for other reasons such as sick leave or a change of employment.

Performance and success rates for each subject were collected; the University has provided these figures since the introduction of the degrees and the quality assurance systems. The performance rate is the percentage of students who pass a subject module over the total of all students enrolled in that subject. The success rate represents the proportion of students who pass the exam over total examinees. Classroom experience indicates that when surveys are conducted at the end of each teaching period, they rarely involve students who will drop out. Comparisons are therefore more appropriate with the success rate, which also sums up the behavior of the group better than any other indicator, by grouping the dropout and performance rates (Table 2).

Table 2: Success rate and academic year 2015/16.

Year/degree	Success rate (%)
First	61.93
Second	65.98
Third	66.09
Fourth	95.97
Degree	69.80

4 RESULTS

The analysis was done once the data on the number of private study hours and success rates had been collected. The number of weekly classroom hours was chosen as a parameter for comparison, rather than credits, because some of the subject modules on the curriculum are quarterly and others annual. Mechanical technology elective modules were included, although the four (English, French, and two Basque) language modules were not.

According to the estimated workload for the ECTS, for each classroom hour the student should complete 1.5 hours of private study. For comparative purposes, the percentage of students was selected who reported having spent at least as many hours in the classroom as on private study: 1 hour classroom time and 1 hour private study. The difference (0.5 hours) is set aside for preparation of the final tests and the exam itself.

The comparison was established in relation to the success rate, rather than the performance rate, because by conducting the surveys at the end of period of taught classes in all subjects, students who have dropped out will have stopped attending class. The performance rates also include the results for dropouts.

Tables 3 and 4 summarize the results by subject, grouped by years: the percentages of students who reported spending the same number of hours or more on private study than in the classroom (A) and their success rates (B). The difference between the two percentages (B-A) shows the difficulty of passing a subject module with the commitment level that is specified in the curriculum.

Student effort is an average value, which means it is very difficult to establish how much deviation is permissible between the success rate and the percentage of students meeting the minimum working hours. It may be noted that only one first-year subject module gives a negative value. In other words, a total of 15% of students were unable to pass the course despite saying that had dedicated sufficient time to do so. Differences of less than 20% only occurred on three subject modules; one per year over the first three years.

However, the proportion of subject modules with percentages that differed more increased over the years. In the first year, only one subject module (6 ECTS) had a difference of over 50%. In the second year, 4 of the 9 subjects exceeded 50%, with 24 ECTS of the 60 that make up the full course. In the third year the proportion increased: the difference exceeded 50% in 4 subjects (33 ECTS). In the fourth year, two of the four mandatory subjects also exceeded the rate of 50% (12 ECTS). The elective modules (24 ECTS) had differences of over 90%

Table 3: Students effort and success rate first and second years.

Year	Subject	ECTS	Classroom teaching Weekly/h	A Hours face-to-face: Yes/No (%)	B Success (%)	B-A (%)
1st	Algebra	6	4	38.8	66.5	27.6
	Calculus	12	4	39.5	55.8	16.2
	Graphic Expression	9	3	51.1	35.4	-15.7
	Fundamentals of Computer Science	6	4	32.3	82.6	50.2
	Physical Basics of Engineering	12	4	36.3	67.8	31.5
	Chemical Fundamentals of Engineering	9	3	45.7	84.2	38.5
	Statistical Methods of Engineering	6	4	33.0	53.6	20.6
2nd	Economy and Business Administration	6	4	3.8	61.32	57.5
	Thermal Engineering	6	4	9.3	57.97	48.7
	Fluid Mechanics	6	4	Non reported	73.20	---
	Fundamentals of Electrical Technology	9	3	Non reported	47.49	---
	Industrial Electronics	6	4	18.9	54.38	35.5
	Automatism and Control	6	4	17.0	93.28	76.3
	Materials Science	6	4	8.9	82.41	73.5
	Applied Mechanics	9	3	53.9	67.95	14.0
	Production & Manufacturing Systems	6	4	15.2	71.43	56.2

Table 4: Students effort and success rate third and fourth years.

Year	Subject	ECTS	Classroom teaching Weekly/h	A Hours face-to-face: Yes/No (%)	B Success (%)	B-A (%)
3rd	Machine Kinematics and Dynamics	9	6	22.2	94.68	72.5
	Machine Design	9	6	0.0	60.98	61.0
	Elasticity and Strength of Materials	9	6	13.9	64.04	50.2
	Industrial Structures and Buildings	9	6	33.3	47.14	13.8
	Mechanical Technology	6	4	8.3	90.70	82.4
	Hydraulic Installations and Machines	6	4	11.1	58.33	47.2
	Thermal Machinery & Facilities	6	4	Non reported	25.79	---
	Extended Graphic Expression	6	4	42.1	72.46	30.4
4th	Project Management	6	4	46.4	95.60	49.2
	Integrated Management Systems	6	4	12.2	96.40	84.2
	Environmental Technologies	6	4	16.0	95.80	79.8
	Integrated Management Systems	6	4	34.6	83.02	48.5
	Industrial Architecture(1)	6	4	26.3	96.43	70.1
	Mechanical Design Using FE Method(1)	6	4	6.4	100.00	93.6
	Manufacture of Tools(1)	6	4	0.0	100.00	100.0
	Computational Fluid Mechanics(1)	6	4	5.7	100.00	94.3

Note: (1): elective subjects

5 DISCUSSION AND CONCLUSIONS

The results showed that students pass the subjects throughout the curriculum with less dedication than the 25 hours per ECTS. Only one module showed a higher level of effort, while three were under a difference of 20%. Only one subject had a higher level of effort, while three were below the 20% difference. In contrast, there were a large number of subjects in which the proportion of students who passed without reaching the required level of dedication was significant.

The low levels of commitment among students, directly linked to their results on many subject modules are worrying. This relationship was tighter in the first year, where active methodologies are implemented, decreasing in the second, the third and the fourth years of the degree course. In view of the academic outcomes, it is estimated that further implementation of active methodology in the second and third year in subject modules could have some influence on academic performance. Moreover, it could confirm whether the reason for lower performance in these years corresponds to an effective modification of the education system from an almost fully active teaching model in the first year to methods with less active teaching, in the second and the third years. Further studies should corroborate this situation, increase the collaboration of all teaching staff and inquire into the causes of low dedication among students, even in those subjects with higher rates of performance and success. In that regard, teaching teams have to consider whether the different results between courses are provided exclusively by active methodologies or different levels of academic standards.

Moreover, the surveys have gathered the perceptions of students at a particular point in their academic career. In view of the results, the question arises of how graduates perceive their academic effort throughout their degree course, so as to assess the data that is obtained in a wider context. This additional information should be complemented by new data collection campaigns and their comparisons in the future.

The analysis by years has shown that the involvement of teachers in the first year in active teaching methodologies is accompanied by greater commitment from students, also improving performance and success rates. The study has confirmed that the adoption of active teaching methodologies improves student involvement in the teaching-learning process and increases the effort that they are willing to make to pass their subject modules. In conclusion, widespread use of active teaching methodologies will lead to greater student involvement and greater academic dedication owing to underlying motivation.

ACKNOWLEDGMENTS

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