

# Use of active learning and assessment approaches for competences acquisition at the School of Design Engineering ETSID

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## Abstract

In the context of the Bologna process, the European Universities are currently working on the implementation of a three cycle system, with degree programmes based on profile, learning outcomes, competences and student workload. This implies a change of paradigm: from teacher-centred to student-centred teaching, learning and assessment, which require the use of active learning and formative evaluation strategies. This work is focused on the analysis of the incorporation of active teaching methods and alternative evaluation approaches carried out in the different subjects that conform the Bachelor Engineering (BEng) Degrees actually offered at the School of Design Engineering ETSID (Polytechnic University of Valencia, Spain), in accordance with the Bologna process.

## 1. Introduction

Europe is currently involved in the Bologna Process, which aims at creating a European Higher Education Area (EHEA), by promoting comparability and compatibility between the European higher education systems and institutions [1]. Thus, the Bologna Process is intended to facilitate mobility, improve employability and reinforce Europe's international competitiveness. The Bologna Process was initiated in 1999, with an agreement that was signed by the European Ministers of Education: the Bologna Declaration [1]. Since then, several coordinated and convergent reforms in the higher education systems across Europe have been undertaken, that must be completed in 2010.

One of the main objectives of the Bologna Process is to structure higher education according to a three cycle system, with degree programmes based on profile, learning outcomes, competences and student workload [2]. Such educational system must provide the necessary competences for preparation for the labour market at all levels. According to Lasnier [3], competences are defined as “a complex know-act based on the effective integration, mobilization and adaptation of knowledge, attitudes and skills within similar situations”. University degree programmes should be defined in terms of professional competences that comprise both generic competences (common to any degree) and subject-specific competences (related to a field of study) [2].

The implementation of a competences approach for the design of educational programmes involves the review of teaching, learning and assessment strategies to be used, in order to guarantee the development of the required competences. This necessarily implies a change of paradigm: from teacher-centred to student-centred teaching, learning and assessment, in which teachers act as facilitators and guides, and students, in turn, play an active role and take the responsibility for their learning. The aim is then that students learn efficiently. It is therefore necessary to adopt teaching and assessment approaches that highlight active and dynamic learning and, thus, encourage students to develop more creative, autonomous and responsible work, and that allow them to acquire the desired competences. In this context, active learning [4-6] and formative assessment [7, 8] are adequate strategies to be combined with traditional ones.

This work is focused on the analysis of the incorporation of active teaching methods and alternative evaluation approaches carried out in the different subjects that conform the Bachelor Engineering (BEng) degrees actually offered

at the School of Design Engineering ETSID (Polytechnic University of Valencia, Spain). As result, most selected teaching and assessment methods have been identified and compared for every year and degree.

## 2. Description of the study

The implementation of teaching and assessment approaches to form competences at the School of Design Engineering ETSID, in accordance with the Bologna process, has been evaluated for the following three years BEng degrees: Electrical Engineering, Electronic Engineering, Mechanical Engineering, Chemical Engineering and Design Engineering.

The analysis of the use of such educational methods has been performed from the data included in the Course Guides of these degrees that are annually on-line reviewed and updated by teachers at ETSID. These Guides comprise information related to the teaching/learning process of every subject, according to a common model adopted at the Polytechnic University of Valencia [9]. Among others, teachers indicate in these Guides, the teaching and evaluation methods that are going to be employed in every subject, by selecting them within several proposed options that are listed in table 1.

Table 1. Proposed teaching and assessment methodologies.

Teaching methods	Evaluation approaches
Lecture	Written examination
Cooperative Learning	Oral presentation
Problem-Based Learning	Mind map
Case method	Report
Project-Based Learning	One minute question
e-Learning for autonomous work	Diary
	Portfolio
	Project work
	Case work
	Data recording (observation checklists, rate scaling...)

From the analysis of these Course Guides, most selected teaching and assessment methods have been identified and compared for every year and degree. Additionally, the incidence rate of these methods with regard to traditional ones (lecture and written examination) has been determined as well. This study has been focused exclusively on the core subjects of the five BEng degrees, which are actually taught at ETSID. The number of subjects that has been finally considered for this work is shown for every degree in table 2.

Table 2. Subjects considered for every degree.

BEng degree	Subjects
Electrical Engineering	23
Electronic Engineering	27
Mechanical Engineering	27
Chemical Engineering	25
Design Engineering	29

## 3. Results and discussion

### 3.1. Active learning

Results of this survey concerning the implementation of active learning are displayed in figure 1, for the BEng degrees offered at ETSID. Although the lecture is still used in almost all core subjects at ETSID, it is observed that, in accordance to the requirements of a competences approach, there has been a move to the use of a variety of active

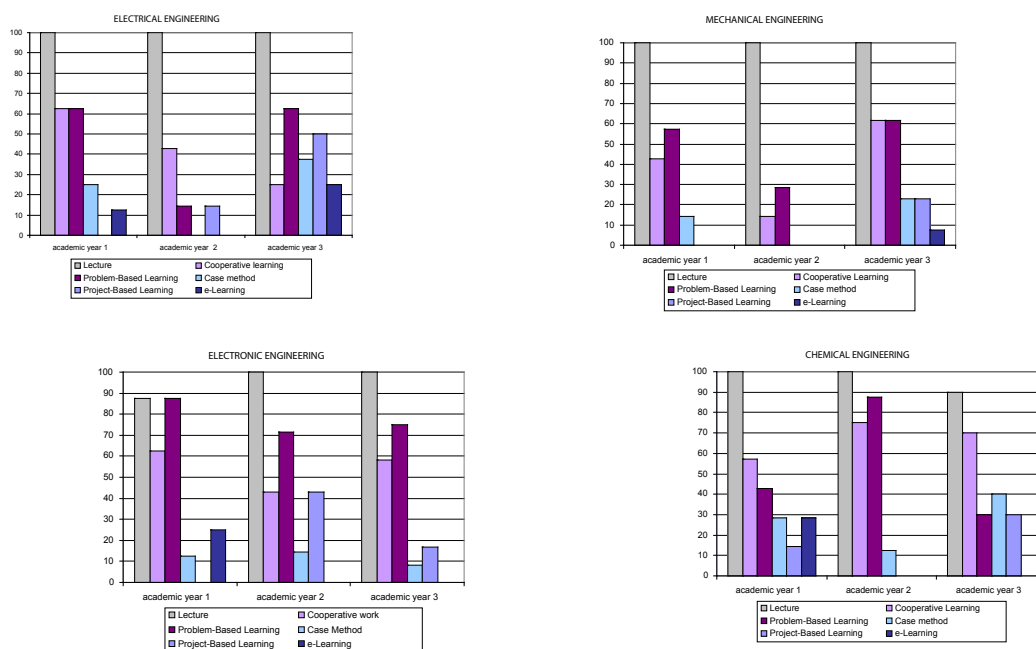
learning methodologies in all the degrees under study. A combination of different teaching approaches is observed in all cases: Cooperative learning, Problem-Based Learning, the Case Method, Project-Based Learning and e-Learning are currently used together with lectures. However, depending on the degree and the academic year, different tendencies are noted.

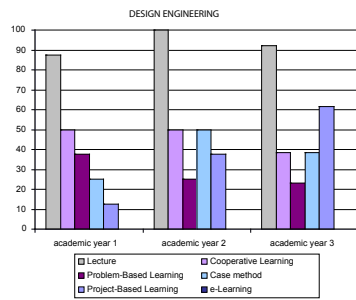
It has been observed that the preferred active teaching methods in the Electrical, Electronic, Mechanical and Chemical Engineering degrees are Cooperative Learning and Problem-Based Learning. These are the most widely used approaches for the three academic years of these degrees: about 40-60% of the core subjects in every academic year employ at least one of these methods. A more significant use of these methodologies is noted for the Electronic and Chemical Engineering degrees, for which the incorporation of Cooperative Learning and Problem-Based Learning strategies raises up to 70-90%. On the other hand, it is also observed that Project-Based Learning and the Case Method are basically applied during the second and third years of these BEng degrees. In contrast, e-Learning is more often employed during the first year of these degrees although, in general, its use is still not very significant (less than 30%).

In the BEng of Design Engineering, active learning strategies are more uniformly employed and distributed along the three academic years. A closer inspection of these results for every year reveals that, whereas the use of Cooperative Learning and Problem-Based Learning is continuously reduced from the first to the third year, an increase of the use of Project-Based Learning and the Case Method is in contrast produced. On the other hand, e-Learning has still not been incorporated in this degree.

In general, during the first academic year of the degrees under study, the combination of lectures with Cooperative Learning and Problem-Based Learning strategies seems to be the most preferred option, maybe due to the fact that first years involve fundamental subjects and large class sizes. In contrast, third academic years, with more specific subjects and reduced class sizes, are the ones exhibiting a more significant application of the Case Method and Project-Based Learning strategies. It can therefore be concluded that the selected variety of educational methods is in some extent determined by the academic year, the class size and the specialization degree of the subject under consideration.

Figure 1. Use of active teaching methods for BEng degrees at ETSID.





### 3.2. Evaluation approaches

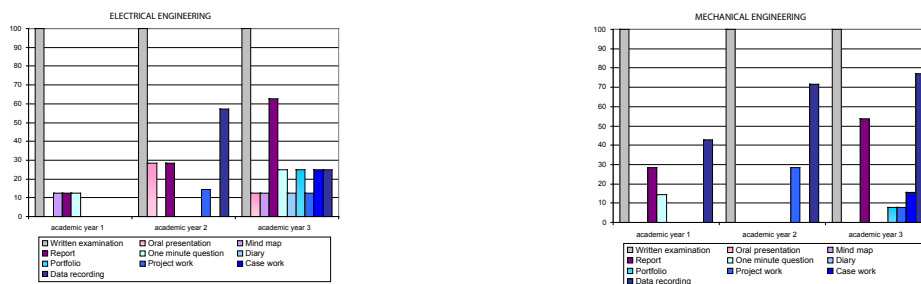
Results of this consultation concerning the implementation of alternative assessment approaches are shown in figure 2, for every academic year of the BEng degrees under study. In general, it is observed that written examinations are still predominantly used in all core subjects at ETSID. However, in accordance to the formative perspective of competences development, a wide range of evaluation strategies has also been incorporated in all these degrees. These are mainly focused on the integration of formative assessment that will allow competences development and acquisition to be continuously evaluated throughout a course. A large combination of different assessment approaches is applied in all cases for this purpose: report, project work, case work, portfolio, data recording, etc. Mind maps and diaries are only scarcely used in all the degrees under study. Moreover, depending on the degree and the academic year, different combinations of evaluation approaches are adopted.

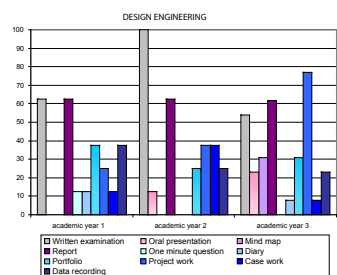
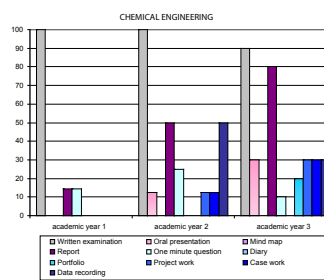
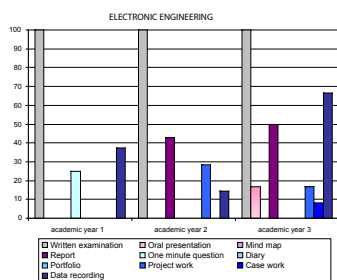
It is observed that the preferred alternative assessment strategies in the Electrical, Electronic, Mechanical and Chemical Engineering degrees are reports preparation and data recording. The use of these strategies tends to increase progressively from the first to the third year of these BEng degrees, so that during the last academic year 60-80% of the core subjects apply at least one of these approaches. It is also noted that the third academic year of these degrees is the one exhibiting the largest variety of assessment methods. During this year, evaluation is basically complemented with oral presentations, portfolios, case and project works. This is so, especially in the Electrical and Chemical Engineering degrees.

On the other hand, for the BEng of Design Engineering, there is a wide variety of assessment approaches all along the three academic years, together with a lower use of traditional written examination. The most employed evaluation approaches in this degree are reports and project works preparation. A closer analysis of these results for every year indicates that, whereas around 60% of the core subjects apply the report preparation during all academic years, the use of project works is significantly increased from the first to the third year, up to 75%. In contrast, the use of data recording and portfolios is continuously reduced.

In general, results show that during the first year of the degrees under study written examination is preferably combined with reports preparation, data recording and portfolios. However, during last years, a larger variety of evaluations strategies is used, in which project and case works are besides applied.

Figure 2. Use of evaluation approaches for BEng degrees at ETSID.





#### 4. Conclusions

This study has revealed the use of a wide range of active learning methods and formative assessment approaches, which are combined with traditional methods in the BEng degrees currently offered at ETSID. For these degrees, it has been found that for first years, lectures are basically combined with Cooperative Learning and Problem-Based Learning, while written examinations are mainly used together with reports, portfolios and data recording strategies. On the other hand, Project-Based Learning and the case Method are mostly preferred during the last years, in combination with reports, project and case works as evaluation approaches. These results confirm that a competences approach requires the simultaneous use of a variety of teaching and assessment strategies for every subject. Selection and incidence rate of these educational methods seems to be determined, among others, by the degree, the academic year, the class size and the specialization degree of the subject under consideration.

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