

# **E-Assessment and Mathematical Learning: A Spanish Overview**

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## **Abstract**

Assessment can be used to enhance student learning (formative assessment) or to control the apprenticeship (summative assessment). The two ways can be used according to the requirements or needs. Nowadays, the student must be the protagonist of his learning, and it is important that he receives immediate feedback of the learning process. The normal work or the real life for the current students includes the quick answers provided by technology. Therefore technology allows the development of new models of assessment easy to implement. Technology-supported assessments are already being used as a formative assessment and some influence in the summative sense of grading student achievement in some Spanish universities. After some general ideas concerning the learning process, this paper analyses the various ways in which technology is used in assessment activities of basic mathematical subjects in Spanish engineering degrees. The results are supported by the construction of a data base of Learning Guides (information provided by the universities to the students).

## **Introduction**

The teaching and assessment tasks are inseparable parts of the educational process. All teaching innovation should consider modifying the assessment method. The new degrees in engineering, adapted to the guidelines of the Bologna process, involve the assessment of the acquisition of competencies, and the technology should help in this task. Some ideas on the new forms of assessment are included in SEFIMWG (2013).

The assessment models might be closer to “the real work”. So if in the real work the Engineer is continuously using technology (including mathematical software) we have to promote the use of technology in the assessment tasks. Therefore, the e-assessment has become a common educational strategy in higher education.

In its broadest sense, e-assessment is the use of Information Technology for any assessment activity. Actually, the term e-assessment is becoming widely used as a generic term to describe the use of computers within the assessment process. In this paper we accept this definition and we will analyse any assessment task using computers.

The benefits of the online formative assessment have been identified in numerous research papers. In Gikandi et al. (2011) a report based on the literature, about online assessment, can be found. On the other hand, Computer Algebra Systems (CAS) have been used in the teaching and learning of mathematics for decades (see García et al., 2000; Meagher, 2000; García et al., 2009; Marshall et al., 2012), and its use in different

assessment activities has more recently been discussed (see Brown, 2001; Sangwin, 2004 and García et al., 2014).

In the first section of this paper we will present general ideas concerning teaching, learning and assessments according with the Bologna process. In the second part we expose the results of a study conducted with a sample of mathematics subjects from Engineering and Computer Science degrees from different universities, analysing the use of technology-supported (formative and summative) assessment.

## **General ideas for teaching, learning and assessments**

### **A new scenario for teaching and learning**

The Bologna Declaration and the creation of the European Higher Education Area have promoted a structural change in Spanish Universities. This change, which has been increasingly addressed in recent years, has not been limited to a mere restructuring of the academic curriculum, but has served to change the paradigm of university teaching. In this new scenario, the advance of constructivist methods in teaching practices seems to have become the hegemonic method. Some of the characteristics of such methods that are currently being imposed in general, not only within the field of mathematics, are as follow:

- Student-focused teaching.
- An increase in participation by the students themselves, favouring discussion between students and instructors and departing from the traditional method of teaching through lectures.
- The use of educational technology.

The change is now also affecting to the traditional methods of assessment.

### **The role of assessment**

Assessment is a core component for effective learning. The change from a teacher-centred instruction towards a learner-centred instruction and competencies-based learning implies the development of new assessment methods. If teaching and learning are based on acquiring competencies, then assessments must determine the acquisition of these competencies. There is a strong relationship between learning and assessment: *what is assessed strongly influences what is learned.*

Arguments for introducing CAS in assessment activities are well established (Meagher, 2000). Some authors have described the impact of the introduction of CAS in examinations (MacAogáin, 2002; Brown, 2001), and they concluded that using CAS gives students the opportunity to be more responsible for their own learning.

Moreover, assessment must be more than a summative assessment. A formative assessment with feedback is an important strategy that can help students take control of their own learning and develop critical thinking. Virtual learning environments such as Moodle provide many opportunities for high quality feedback and formative assessment (see Limniou and Smith, 2014). Furthermore, CAS may play an important role in any model of formative assessment in mathematics courses among engineering students. For example, CAS is a very useful tool for problem-based learning in mathematics.

Many instructors continue to feel that a good mathematics assessment must be restricted to a traditional exam (a collection of problems to be solved with pencil and paper). However, a good model of formative assessment about mathematical competencies, consistent with the literature on student-centred learning (see Baartman et al., 2006; Niss and Højgaard, 2011), should include:

- Team work for solving problems and doing projects, because collaborative learning has a higher efficiency than individualistic learning method (Hsiung, 2010; García et al., 2011).
- Online quizzes with feedback, using the corresponding Learning Management System, mainly MOODLE.
- Solving written exercises or problems related to the real world, using aids and tools (Díaz et al., 2011).
- Exams with free use of mathematical software, since it allows to evaluate more realistic mathematical competencies.

The e-assessment has many advantages over traditional assessment such as: flexibility, efficiency, lower cost and instant feedback for students.

## **A Spanish overview**

The use of different CAS in Spanish engineering degrees has gone through several stages. Initially, its use was restricted to the subjects of Numerical Analysis as a programming tool. Later, with the emergence of new, more versatile and friendly versions, its use spread to mathematics laboratories, performing different practices related to all subjects of mathematics (see García et al., 2000 or García et al., 2009). At present, in some Spanish universities, CAS are used in an integrated way in different approaches: For experimenting and developing teaching resources (Botana et al., 2012); for learning based on competences (Díaz et al., 2011); for developing small projects (García et al., 2011), etc. In this context, the students can use the available technology in all teaching scenarios. Our previous study, García et al. (2012) analysed the use of technology in the new teaching scenario according with the Bologna process.

The next step has been to analyse the use of the technology in the assessment's tasks. In the literature there are few references to works by Spanish authors, therefore it has been necessary a fieldwork.

## **The research work**

The aim of our research was to determine the actual use of technology in assessment activities in mathematical topics of Spanish engineering degrees.

The method applied for a quantitative study was selecting a sample of 44 Spanish universities, chosen according to the following criteria: All universities are public universities and they are disseminated between all Spanish regions. For each university we selected some engineering degrees, and analysed the use of technology in assessment activities of the subjects of Linear Algebra and Calculus mainly.

In this step we have analysed the Learning Guides (LG). The LG are documents that provide general information to the students including: competencies and learning objectives, contents, planning and chronology, teaching methodology and evaluation

model. It is compulsory to prepare the LG to be offered to the students at the beginning of each academic course. An example of an LG can be seen at <http://www.fib.upc.edu/en/estudiar-enginyeria-informatica/assignatures/M2.html>

Taking into account the large number of different engineering degrees offered by Spanish Universities, we have focused the study grouping the different degrees in three main blocks related to Information Technology (ICT), Industry in general (IND) and Construction and Civil Engineering (CCE). The following table outlines the data used in our study.

Degrees related with	LG analysed	LG including technology	LG including assessment tasks with technology
ICT	80	48	36
IND	71	52	39
CCE	50	34	32

For each LG, the information regarding assessment activities with the use of technology was analysed. We paid special attention to the following items:

- Evaluation of Laboratory sessions or reports of practical sessions
- Exams with computers
- Projects (in general and including the use of technology)
- Quizzes online

The following table lists the information obtained after the analysis of the LG

Degrees	ICT	IND	CCE
Laboratory sessions	26	30	30
Exams with computer	14	23	12
Projects	3	6	5
Quizzes online	6	3	6

We also have analysed the percentage in the final grade taking into account all assessment activities using technology. The figures are not homogeneous because the percentages are oscillating between 0 and 50%.

To analyse the differences between the target groups a study of proportions was made with a confidence level of 95%. Significant differences were noted: Computer examination between ICT and IND (p-value 0.0336) and evaluation of laboratory sessions between ICT and CCE (p-value 0.002).

Remark: Our research is focused on the use of technology in student assessment activities. Technological resources (such as optical or similar reader) are not considered because these resources only provide the final grade of the tests performed by students with pencil and paper.

## Conclusions and Future Work

The following conclusions are drawn:

- The use of technology in mathematical learning of engineering students is increasing.
- The most used technology is CAS, usually working in practical laboratory sessions.
- The use of computers in assessment activities is less frequent in the group of ICT degrees.
- The way of assessments using technology is not uniform. The most common ways are reports for practical sessions or exams with computers. Projects, quizzes online and other activities are less common.

The next step in our research will be a qualitative analysis. We are preparing a survey to be filled for a target group of selected teachers. The items of the survey are related with the way of teaching or assessing using technology.

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