Continuous Assessment in Civil Engineering Education
Yes, but with Some Conditions

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Abstract: Adapting Spanish curricula to the European Higher Education Area (EHEA) implies the introduction of continuous assessment. Continuous assessment is generally considered to enhance students' learning. The new methodology contrasts with the traditional Spanish method of assessment, based only on exams. This paper compares the student's learning under these assessment methods in Civil Engineering (Civ.Eng.). The results of 16 consecutive years of assessment of a technological subject (Hydraulic Engineering) have been analysed. Assessment during the first 8 years was performed only by final exams; and onwards by classroom exercises, computer tests in a Virtual Learning Environment (VLE) and final exams. Rates of students that passed are clearly higher in this latter period, what seems to support that a better learning is achieved under continuous assessment. However, when analyzed in detail, it is found that exams scores are significantly lower during the continuous evaluation period. Sometimes the appearance of a higher grade may mask a lower level of learning. The reasons lie in the psychology of the students, since they reduce their effort once a satisfactory score is achieved in the periodical training. The paper examines what elements should be incorporated to continuous assessment to improve student's learning.

1 INTRODUCTION

In the convergence of the Spanish curricula to the European Higher Education Area (EHEA), the assessment methodologies have entered in a new framework, in which the development of skills and assimilation of contents is assessed continuously, giving feedback to students during the learning period. This change in the assessment methods has been fostered by the development and spread of new tools as the Virtual Learning Environments (VLE), which opened many possibilities for transmitting information and interacting with the students.

In this framework, continuous assessment has been adopted by Spanish universities, which assume that assessing students throughout the course with periodic tests and courseworks will enhance their assimilation of knowledge and development of skills (Delgado, 2005; Hernández, 2012).

Civil Engineering is imbibed in this change period. Current Civil Engineering Degree, which nowadays concedes the capacity to fully develop the professional activity, is being substituted by a Bacherlor's Degree (B.Sc., 4 years long, that conceded limited professional qualifications) plus a Master of Science (M.Sc., 2 years long) (MCIN, 2009a; MCIN, 2009b). In most Spanish universities, the B.Sc. is being implemented, while the M.Sc. is under preparation. Besides, the current Civil Engineering Degree is being in extinction process, which is done coordinately with the introduction of the new titles.

The implementation of the new M.Sc. is the next step towards harmonizing the titles to the EHEA. For instance, at the Universidad Politécnica de Madrid (UPM), it will be introduced the next academic year 2014-2015. Therefore is necessary to design the subject's assessment methodology. Within the abovementioned extinction process, some technological subjects of the Civil Engineering Degree have been applying a continuous assessment methodology on recent years, in order to better adapt to the new EHEA requirements. The analysis of this experience may be useful for identifying weaknesses of the continuous assessment when applied to technological subjects, which is the objective of this work.

Continuous assessment provides certain

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advantages over other methods (García-Beltrán, 2002; Trotter, 2006; Isaksson, 2007; Joughin, 2009). The method enables the students to gradually assimilate knowledge and progressively develop their skills. Furthermore, the method provides information about the learning process. Students and teachers may be interested in this information which provides a feedback on the learning process. Moreover, the method is a student-centered learning system which offers a better preparation towards the final exam, as it may be similar to the exercises solved by the students in the periodic tests and courseworks.

Contrary to the previous advantages, several drawbacks have been reported (Yorke, 2003; Martínez, 2008), such as the difficulties to develop an ambitious theoretical content in the course program, since theory is partially substituted by practice. Moreover, continuous assessment cannot be effectively implemented in large groups, because individualized attention to the learners requires a substantial time commitment from academics.

Since a link between what the students must learn and what is actually being evaluated must be established, teachers must choose the most adequate assessment method. The assessment should be understood as a tool for improving students learning. (Dochy, 1997). To design a continuous assessment system, various evaluative activities with different relative weights must be defined (Gallardo, 2010; Gallardo, 2011). In addition to this, it has to be decided if the final grade is obtained only by the continuous assessment results, or if a final exam is also performed (Haghnegahdar, 2013). The use of this periodical assessment is not a substitute for final exams but is an important complement in order to define a students' learning focused assessment method (Dochy, 2007).

The M.Sc. Civil Engineering has a highly technological content. Students are required to develop the highest cognitive categories, such as: application, analysis, synthesis and evaluation (Bloom, 1956). Technological subjects are oriented to produce final designs or solve specific management problems. Those designs and problems are always unique and have to match with the site or system specific characteristics. In this type of subjects a final exam is highly recommendable. In this type of subjects, partial skills have to be joined to achieve a final objective. Different partial skills can be evaluated separately through continuous assessment, but their aggregation towards the final objective can be only evaluated in a final exam.

This paper contrasts the students' learning under two different assessment methods in a technological subject in higher education. In the first method the grade depends only on the final exam mark, whereas in the second, the grade depends on the combination of the final exam mark and the periodical exercises ones, as continuous assessment practices were implemented. The comparative analysis of the assessment results under both methodologies (continuous and traditional only by exam) may be useful for detecting critical points, which would help in designing and applying the assessment methodology on the future M.Sc. Civil Engineering subjects.

2 STUDY ON THE ASSESSMENT OF A TECHNOLOGICAL SUBJECT

Results of assessing a compulsory subject of the Civil Engineering Degree, Hydraulic Engineering, are described and analyzed. In line with the objectives, this section is organized as follows: first a brief description of the subject is presented, second the evolution of the assessment methods is described, third the factors which may influence the assessment are analyzed, fourth the students' performance results are presented and finally, the investigation leads to an interesting discussion regarding students' learning performance.

2.1 Subject Description

Hydraulic Engineering is a technological subject of the 5th year of the Civil Engineering Degree at the UPM. This degree consists of six academic years and a final project (syllabus is shown in Figure 1). The subject has a highly technological content. Students need to have a strong scientific basis which is provided during the first two academic years and a technical previous background that is acquired during the 3rd and 4th years of the degree. The bases of the syllabus of this degree are established by law (MEC, 1983). The basic academic data of the subject are:

- Compulsory subject of the Civil Engineering Degree.
- Teaching is annual and is divided into 2 terms.
- The form of teaching is 120 hours of lectures during 30 weeks and about 500 hours of student study (equivalent to 19 ECTS).
- The first term (15 weeks) covers the topic of dams.
- The second term (15 weeks) is dedicated to water

distribution systems, pumping technologies, hydropower and irrigation.

- The subject provides students skills and qualifications for: planning, developing, projecting, managing the construction and operating hydraulic engineering systems.
- The number of students for the 16 years of the analysis is, on average, 450.

SCIENTIFIC TRAINNING					
1ST YEAR	Algebra	Calculus	Physics	Chemistry	Technical drawing (I)
2ND YEAR	Mathematical Analysis	Mathematical Methods	Mechanics	Building Materials	Technical drawing (II)

TECHNICAL TRAINNING							
3RD YEAR	Statistics	Differential Equations & Numerical Methods	Strength of Materials	Geology	Electricity & Electronics	Topography	English (I)
4TH YEAR	Structures	Concrete structures	Hydraulics	Urbanism	Geotechnics	Economy	English (II)

TECHNOLOGICAL TRAINNING							
5TH YEAR	Steel Structures	Hydraulic Engineering	Roads & Highways Engineering	Port & Coastal Engineering	Transport Engineering	Art & History of Civil Eng.	Specialization in: - Transport - Structures - Hydraulics - Urbanism
6TH YEAR	Construction	Projects	Railroads Engineering	Water & Wastewater Engineering	Business Admin.	Laws	

Figure 1: Syllabus of the Civil Engineering Degree (MEC, 1983).

2.2 Evolution of the Assessment Methods

Before the EHEA, students were generally assessed only by a final exam. The final grades were proportional to the score on the exam. There were usually three final exams. The first exam (ordinary exam) was at the end of the second term in May or June. Students who failed this test had two resit exams, one in September and another in December. Marks were within the range 0 and 10. A 0 grade involves a very poor performance and 10 an excellent one. The pass mark is 5.

As a result of the adaptation to the EHEA, the continuous assessment method has been included in the evaluation process. The method considers several activities carried out by the students during the course, such as attendance to lectures, classroom tests or courseworks, and an ordinary final exam. The final grade is the weighted sum of the mark on the course activities and the score on the final exam. Students who achieve a grade lower than 5 fail the subject. In such case, learners have the two resit exams aforesaid in the previous paragraph and the final grade is equal to the mark on the exam.

The assessment of students for the 16 years of analysis may be divided into three periods:

- From the academic year 1994-1995 to 2001-2002, students were examined only by a final exam.
- A transition to continuous assessment started in the 2002-2003 academic year. The new methodology was completely implemented after two years.
- A continuous assessment period of 6 academic years, from 2004-2005 to 2009-2010. In this period, up to 40 monitoring exercises were proposed to be solved by the learners. Two types of exercises were performed: classroom tests and computer tests. Classroom tests were randomly proposed and solved by student during the lectures. The tests consisted of a theoretical or practical question related to the concepts that were explained during the lecture or in the immediately previous one. The exercises were completed in about 10 minutes. Computer tests were solved by students at home in a VLE (the Moodle application). The tests were composed of a unique exercise or several questions, both related to the lectures of the previous month. The exercises were available for one week to the students. They have to answer the proposed exercises in about one hour.

2.3 Analysis of the Factors Which Influence the Assessment

Several factors may influence assessment; among them are: those related with people involved in the educational process (students and academics), those related with contents and skills to be learned and developed, and those related with methodology (exams, exercises, etc.).

This section analyzes the progression of these factors during the study period. This analysis is necessary for discussing the results and drawing conclusions about the effectiveness of continuous assessment. The different facts evolved as indicated below:

- Students' profile and requirements to register in the subject have not varied. Pre-university profile has remained constant since 1996, when the later high-school education law became in force. In a similar way, the university profile has remained constant as well; there were no changes in syllabus neither in requirements for registering in the subject (four years of previous scientific and technical training).
- As stated above the syllabus of the Civil Engineering Degree didn't change during the period of study. That is to say, subject's contents and structure have not been altered. However, the contents were progressively adapted to the state of the art, but always following the main subject's topics (dams, water distribution networks, etc.). Total time devoted to each topic didn't change significantly.
- Additionally professional regulation has not been

modified during this period. Thus, subject's learning objectives have not change. In essence, students have had to acquire the same knowledge and skills.

- Academic staff has not suffered any important modification. The main academics have been in the same post during the period of study, and new staff has been recruited with the same profile.
- Assessment method shifted from a traditional, only by final exam, methodology to a continuous assessment methodology.
- Exams have kept its structure. The number of theoretical questions and practical exercises, the weights and the duration has been the same during the period of study. The difficulty of the exams has not increased. Proposed questions and exercises are used as base for preparing new exercises. New exercises were similar to the previous ones, since both look for accomplishing the same goals, because knowledge and skills to be assessed were the same.

2.4 Students' Performance Results

The results of these 16 years of assessment are shown in the next three figures. The rates of students that passed the subject during the period of analysis are displayed in Figure 2. This graph gives a first idea of the continuous assessment effectiveness. This first result has to be analysed in depth, to understand if the method accomplished its objectives. Further analysis is done with the help of other graphs, showing the evolution of the subject's grade and the evolution of the final exam's grade. These facts are summarized in Figures 3 and 4.

Figure 2 presents the rate and distribution of students that passed the subject during the regular academic period (ordinary final exam) and the students that passed after the extraordinary resit exams. In can be observed that once continuous assessment has been completely implemented (course 2002-2003) the rate of students that passed at the end of the regular academic period grown by 20%. It can be seen also that the rate of students that passed after the extraordinary resit exams is very small, ranging between the 2% and 4%. These data lead to the idea of the success of the continuous assessment method; but further analysis has to be done to estimate the accomplishment of the objective, which is not just a higher rate of students that passed but a better students' learning.

Figure 3 shows the evolution of the overall grades on the subject, discriminating the students that passed after the regular academic period and

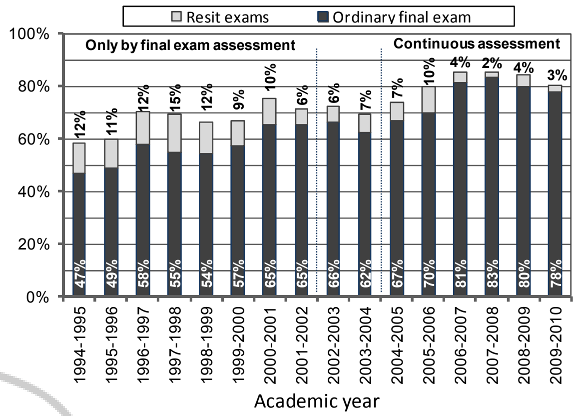

Figure 2: Rate and distribution of students that passed.

those that did it after the extraordinary resit exams. No upward tendency could be seen in the charts, with both lines remaining constant along time; which indicates that the assessment method does not influence the final grades of the students. It can be also seen that the students that passed after the ordinary call (average grade of 6.93) have a better performance than the ones that passed after the resit calls (average grade of 6.11). That was predictable, since the better students usually passed in the first call, making the difference between the average grades of the two groups.

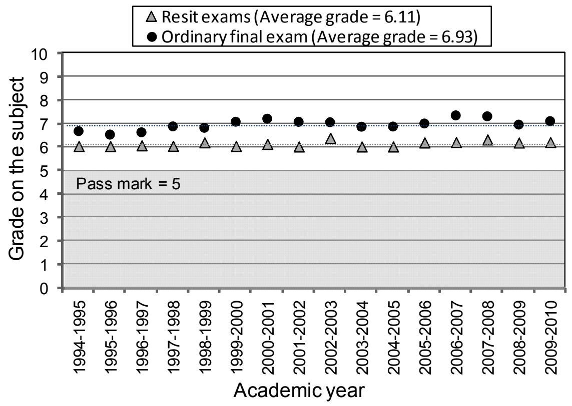

Figure 3: Evolution of the subject's grade.

Figure 4 is useful to understand in depth, the students' performance. It shows the evolution of the overall subject's grades compared to the evolution of the final exam's grades. Data of this figure has been computed only for the students that passed after the ordinary period. For the traditional assessment period both grades coincide, due to the fact that the only assessment tool was the exam. Then, is interesting to observe how a new tendency appeared when new continuous assessment tools begun to be operative (2002-2003 and onwards). This new tendency is clearer when the new assessment methodology was totally implemented. As can be observed, the students have a poorer performance in the final exam during the later years of the study period, those which corresponds the continuous assessment methodology. For the last 6 years of the study period the average grade (6.93) is 1.61 point over the average grade on the final exam (5.32).

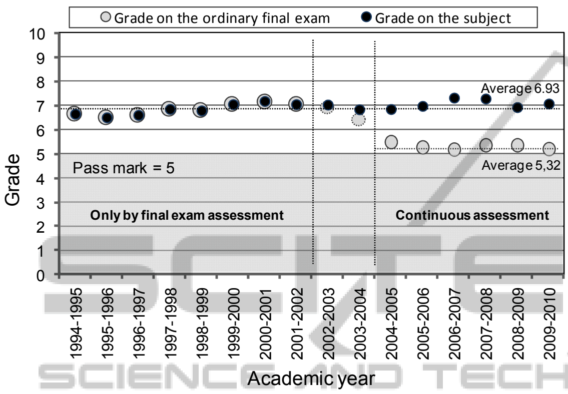

Figure 4: Evolution of the subject's grade vs. final exam's grade.

This fall of almost 25% in the final exam grades during the last 6 years, may be due to the change in the assessment model, because the other factors that may influence the learning process: the students (number and background), the subject (length, objective and contents) and the academics (main professors and background of the new ones); have not had significant changes during the whole period of analysis.

2.5 Discussion and Improvement Measures

It is acknowledged that the study have some limitations which should be consider when discussing the results. It is true that the long period of the experiment let to have more results on students' performance under the two methodologies; however it should be noted that during these long period the facts impact of the educational process may slightly change, impacting on results. Although the factors of the analyzed subject have remained stable through years, further analysis on small changes may be carry out to complement the results. The study has been done at an aggregate scale, comparing overall subject's grades and final exam's grades. Additional disaggregation of the analysis, regarding the evolution of the different questions and exercises, would be useful for detecting critical points on the students' learning process. Nonetheless, the experience on the assessment of a highly technological subject under these two systems and the comparison of their results provide relevant information; which may be useful for educators in order to improve the assessment methods of such type of subjects.

The analysis of the students' performance results leads to three interesting conclusions, which seem to be directly influenced by the assessment model:

- The number of students that passed the subject under the continuous assessment method has grown by 20% in comparison with the traditional assessment.
- The average grade on the subject throughout the years of study has remained steady (around 6.93 for the students that passed during the regular academic period).
- The average grade on the final exam under the continuous assessment has decreased in almost 25%.

In turn, aggregating these three conclusions it can be deduced that: although continuous assessment leads to better rates of students that passed, the performance of those students on the final exam is lower; so the initial objective of improving students' learning is not completely accomplished. There are three causes that explain those results:

- The first cause is located in the character of the subject. The objective of a technological subject in higher education is to solve a general problem or to produce a final design. This objective requires combining all the knowledge that is explained during the course. On another note, continuous assessment focuses on the day by day students' performance and may lose the view of the subject as a whole. This fact should be taken into account when designing the continuous assessment method. Thus, for technological subjects, midterm control exams may be introduced. These exams should require students to link together the contents that were previously explained, towards the resolution of a problem. So that they do not lose the overview of the subject.
- The second is located on the size of the group that is been assessed. In continuous assessment the students' learning process benefits from the feedback that is periodically given. The communication and the relationship students-academics are more difficult in large groups, so the effectiveness of this continuous assessment is reduced. In this sense, VLEs are useful tools that

simplify the work of academics and facilitate rapid feedback to students.

- The third one is located on the students' psychology. The periodic tasks that were performed during the course (room and VLE test), are assessed and provide a mark that is taken into account in the computation of the final grade. In this context students reduce their work towards the final exam, because they know that they could pass the subject with a lower grade in the final exam. So they relax and calibrate their effort. This circumstance should be considered when defining the tasks, the weights and the subject's regulations. For technological subjects, in which a final exam should be carried out, it is highly recommended to require an independent minimum grade in this exam.

3 CONCLUSIONS

During the last decade, the continuous assessment methods have been imposed in the new educational systems (as the EHEA). Presumably, under this assessment system, students are more involved during the course, resulting in higher rates of students who pass and higher grades. These factors are associated to a wider development of skills and a better learning performance. There is no doubt about the benefits of continuous assessment; but in technological subjects in higher education it should be implemented under some conditions. Otherwise it may lead to a poorer learning.

The case study shown in this paper proves that lower learning performances could be masked under higher rates of students that passed or higher grades. The reasons lie in the weighting of the different tasks and in the psychology of the students, since they reduce their effort once they achieved a satisfactory mark in the continuous training, loosing interest for the final exam. This final exam is an important assessment tool in technological subjects, in which students should link together all the parts of the course to solve a general problem or to produce a complete design.

To avoid this problem, some additional conditions should be introduced when designing continuous assessment, such as: to set midterm exams for providing an overview of the subject, to take advantage of the VLEs to offer a effective feedback to the students, and to set a minimum mark on the final exam, independent of the other course task' marks.

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