Applying New Educational Methodologies in Overcrowded Groups: Experiences in Basic Mechanics

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1. Introduction

By 2010-2011, European universities will have adapted their degrees to the new directives required by the Bologna process in the creation of the European Higher Education Area. The proposed educational model is based on the student workload required to achieve the objectives of a programme – objectives specified in terms of learning outcomes and competences to be acquired. The role of students becomes more important in the learning process. Active student participation is promoted, along with formative and continuous assessment.

However, the application of these directives entails a reorientation of most engineering studies in Spain, which is difficult to carry out in practice because of the particular features of Spanish higher education (Tovar&Cardeñosa, 2003). Different pilot experiments have been set up to achieve the adaptation of studies and methodologies, and a common conclusion has been drawn: these changes demand a considerable effort from lecturers due to the current student/lecturer ratio in Spanish universities and the fact that the amount of work is directly related to the number of students. In fact, the large number of students attending university classes in Spain often prevents the lecturer from providing education in an innovative way. This is the current situation on most Spanish engineering degree courses.

In this context, this chapter analyses the benefits and drawbacks that arise when changing teaching methodologies for overcrowded groups and describes possible strategies in order to accomplish the objectives set by the European harmonization. These strategies have been tested in the Mechanics major in several academic years, as explained in (Mora-Aguilar et al., 2008; Mora-Aguilar et al., 2009). Among them, e-learning methods appear as key elements able to compensate for the lack of resources necessary to make the changes required by the harmonization. In particular, e-assessment has been introduced in the Mechanics subject as an evaluation tool useful for conducting continuous assessment in large groups without increasing the lecturer workload.

The modifications have been gradually introduced in the subject with the aim of comparing results and drawing general conclusions that are discussed at the end of the chapter. These conclusions can be extrapolated to other engineering disciplines with similar problems.

2. The European Higher Education Area (EHEA)

The European Higher Education Area (EHEA) can be regarded as a higher education convergence process parallel to the economic and political agreements reached in the European Union. EHEA sprang from the Magna Charta Universitatum (Rectors, 1988), signed by European university rectors in 1988. After this first step, a series of institutional declarations (European Ministers Responsible for Higher Education, 1999, 2001, 2003a, 2003b, 2005) have settled the directions for the creation of this common higher education scenario in Europe.

One of the basic objectives, explicitly stated in those declarations, is achieving the mobility of professionals between the different countries, known as *cross-border employability*. The aim is to take up a system of easily readable and comparable degrees. This calls for a degree standardization process through the imposition of common structures (Clausen, 2005). One of the instruments for achieving this is the well-known European Credit Transfer System (ECTS), which establishes a unique *pattern* when it comes to *measuring* teaching contents. The significant formal reorganization of university studies implied by convergence, especially in countries like Spain whose starting point – its current higher education system- is quite a long way from the reference model (which is not very far from the present British system), also entails a redrawing of degree course contents themselves.

But the scope of the changes is not only formal and structural. The programme is even more ambitious because it is also aimed at transforming teaching methodology by focusing on the student learning process. It is a change in methodology. According to the Spanish government law defining the ECTS (Spanish Government, 2003), the new academic measures imply a new educational model to guide teaching programmes and methodologies. The proposed educational model is based on the student workload required to achieve the objectives of a programme, specified in terms of learning outcomes and competences to be acquired. The role of students gains significance in the learning process. Active student participation is promoted, along with a formative and continuous assessment.

3. Higher education in Spain: The case of the Mechanics major

The Spanish university system dates back to the Middle Ages. The oldest Spanish university is Salamanca, founded in 1218. The present system, however, is actually a descendant of the nineteenth century liberal university, inspired by the centralized French model. In the last few years, it has undergone the greatest growth in its history while, at the same time advancing towards a self-governing, and decentralized system.

As already mentioned, the higher education system is quite a long way from the model established by the EHEA. Nowadays, higher education is provided by both public and private institutions. Universities organize the studies grouping the subjects into curricula. The student obtains a university degree once a curriculum has been completed. The credit is the assessment unit and corresponds to ten hours of theoretical or practical teaching. Credits

are obtained by the appropriate verification of the acquired knowledge. This assessment is generally in the form of written, or occasionally oral, examinations, established by each university. The subjects included in a curriculum are grouped into two educational cycles and may be classified as:

1. *Majors*: Compulsory material present in all curricula leading to an official degree. These represent 30% of the subject load during the first cycle and 25% in the second cycle.
2. *Compulsory Subjects*: These are designated by the university as compulsory for the student within the corresponding curriculum.
3. *Optional Subjects*: The University establishes these subjects for students to choose from.
4. *Free-choice Credits*: All curricula must devote at least 10% of all credits to free-choice activities, which may be standard subjects, seminars or other activities that can be freely chosen from those offered by the university or by another university, if permitted by the corresponding joint agreement.

Most universities in Spain have tried, at different levels, to adapt their teaching methodologies to move closer to the EHEA. A common feature of all these new methodologies tested is that they are based on individual support for students to be performed by lecturers, turning their classical role of *transmitters of knowledge* into a new one of *personal supervisors*, guiding students in constructing their own knowledge. The main changes needed in order to achieve the European harmonization objectives are very difficult to carry out when dealing with overcrowded groups, as occurs in most majors taught in the first years at Spanish universities. This is especially true in the most difficult disciplines that have a high failure rate and, as a consequence, have a large number of students enrolled every year. In this case, personalized monitoring of students is unfeasible. This is still an unsolved problem and a challenge in the field of educational innovation.

3.1 The case of the Mechanics major

The Mechanical Engineering degree is offered by 51 centres in Spain. The Mechanics major is taught in the first year of the degree. At the Universitat Jaume I, it consists of 60 hours of classroom education, of which 30 are lectures, 15 are problem-solving sessions and 15 are laboratory sessions. It is preceded by core subjects of physics and mathematics, essential for tackling the subject successfully. In addition, Mechanics is a fundamental discipline and is the basis of other majors taught in the following years of the degree.

The students regard Mechanics as a difficult discipline. The difficulty of the subject taught requires constant work from students. But students are not in the habit of studying every day and many of them begin to study only when the final exam date approaches. They are not able to assimilate the subject properly in such a short time and, as a consequence, they either give up studying the subject or focus only on the first part – Statics. In the latter case, the student can pass the exam if he/she has studied properly but lacks the skills and procedures taught in the Dynamics part, which are fundamental for subsequent years. Thus, there are many students who do not sit the examination as well as a high failure rate.

As a result, traditionally, a large number of students enrol in the subject every year. A total of 236 students enrolled in the academic year 2006/2007. Only 90 of them were enrolling for the first time, but no more than 57 of the remaining 146 students had previously sat any examination the major. This large number of students greatly hinders the development of educational innovation in the subject.

3.2 The role of students and lecturers in overcrowded groups

As will be explained below, the new initiatives clash with the reservations of lecturers and also with the attitude of students who, in many cases, prefer to maintain the classical evaluation scheme rather than undergoing continuous assessment, which requires constant and continuous effort throughout the entire course.

Lecturers

In overcrowded groups, the high student/lecturer ratio prevents the lecturer from achieving educational innovation. As a result, teachers usually employ classical teaching methodology based on lectures and assessment in the form of a single final exam. This methodology does not encourage the students to study the subject continuously and results in a high failure rate, mainly due to the number of students who do not sit the examination. Besides, lecturers are usually more reticent than students about changes.

Many public administrations and universities are attempting to make the transition to the new European model without any cost. This means lecturers are feeling that their workload has considerably increased while their remuneration remains unchanged. Furthermore, lecturers are asked to apply many methodologies that require small groups of students, but this is not feasible because it is impossible to increase the number of groups without extra funding for studies. In addition to the financial issue, teachers are having problems with the calculation of ECTS credits, because of students' reticence in providing information about their weekly workload. Last, but not least, an increase in the time spent on teaching tasks means a considerable reduction in time spent on research. This matter is especially worrying for lecturers who have not yet obtained a permanent position at the university and who consequently need to obtain research results in order to improve their curricula vitae.

Students

The overall number of universities in Spain has increased considerably, approximately doubling over the last 15 years (Ministry of Education and Science, 2007). For that reason, nowadays, most Spanish students attend the nearest university to their home and consider university as an extension of school, particularly in large cities where accommodation is expensive. In this way, they do not experience living away from home (for instance, learning to cook, washing dishes and other skills that are useful in order to live independently). Faced with the choice of either living with their parents or in a university residence or cheap room, most choose to live at home.

University students in Spain have good information technology skills but often lack autonomy and maturity and, therefore, require personalized attention. They are used to working in the short term, but not to dealing with long-lasting tasks that require constant daily effort. Students are not in the habit of studying every day and prefer to study only during the last few days before the final exam. Consequently, many students do not sit the examination and there is a high failure rate. Moreover, their strategy for preparing for the assessment often consists of selecting the easier parts of the subject, avoiding studying the rest, which leads to an incomplete training for successfully tackling future subjects and following a professional career. In addition, they students are very demanding and aware of their rights. This is not necessarily a negative feature, but it could be very beneficial if the students used this feeling to ask for better ways of learning, encouraging university lecturers to improve their teaching. However, such consciousness and attitude are not usually accompanied by the assumption of duties and obligations, and students do not impose such high standards on their own work.

3.3 Pilot experiments

For several years, some pilot experiments have been set up to harmonize studies at Spanish universities, with varying results. These pilot experiments have tried to assimilate all formal, structural and methodological changes. But many problems have been encountered. One of the main problems has been the lack of legislation, or rather the existence of non-updated legislation, because it was not until 26th October 2007 that the Spanish government approved the law to organize official University Studies (Spanish Government, 2007) that alters the higher education classification system. This legislative gap is even worse in the case of degrees qualifying students to exercise regulated professions, like Mechanical Engineering, because conditions to be met in those degrees were not established until 18th-20th February 2009 (Spanish Government, 2009a, 2009b).

For this reason, most pilot experiments have been aimed at exploring methodological changes and measuring students' workloads. But even in this field there are difficulties because of the situation explained above.

4. New Trends in Education: e-Learning

It is a fact that the new generation of students is very interested in information technologies. Besides, electronic learning is now a reality that has been made possible due to the recent advances in technology. Both circumstances establish the possibility of accomplishing the changes in education we have mentioned using the e-learning paradigm. Web-based tools, if properly used, can be of great help for academics, especially when dealing with overcrowded groups. As will be explained in the following paragraphs, they can complement traditional methods, giving the learner a more effective experience.

4.1 Internet-based learning environments development

In some way it can be said that *distance learning* began with the invention of writing. But it is much nearer in time, during the last decades of the twentieth century, when the history of technology-based education began, stimulated by the rapid evolution of electronic technologies. Almost every step in this evolution of technology-based education was first taken by big corporations that needed to train their large number of employees located around the world (Bersin, 2004). The first stage in the evolution of this technology-based education arrived with mainframe and mini-computers during the sixties and seventies. The next step came with the use of video networks capable of providing live instruction. Later, the CD-ROM technology was vastly extended and applied to distance training. But it was not until the last few years that the development of the Information and Communication Technology (ICT) associated with the Internet has allowed the creation of new web tools which can be directly applied to the teaching/learning process at all levels. These new tools are being adopted in higher education, and are even changing the concept of education itself.

A degree of specification in the use of certain terms must be made due to the appearance of a new and relatively broad vocabulary related to this kind of learning. Nowadays, different definitions of the term e-learning (electronic learning) can be found in the specialized literature. In a broad sense, the term e-learning applies to any learning method that uses electronic technologies such as computers, multimedia systems, etc. But this expression

commonly implies distance education (as opposed to face-to-face education) and, more precisely, learning-teaching methods that use web-based services via the Internet.

It is easy to find a close relationship between the enormous increase in distance learning courses that have appeared during the last few years and the popularization of the Internet. Along these lines, even the name of these courses has turned into *on-line courses*. But the relationship between e-learning and the Internet goes far beyond this. If the term *Web 2.0*, (O'Reilly, 2005), also known as the *social web*, has emerged to describe the new web-based technologies that allow much more user interactivity (social networks, wikis, blogs, folksonomy), the expression *e-Learning 2.0* has arisen to refer to educational techniques that involve these newer Internet technologies. Some of these recently developed technologies are specially designed for educational purposes. Among them, it is possible to distinguish between Learning Management Systems (LMS) and Learning Content Management Systems (LCMS) (Rengarajan, 2001). The difference between the two kinds of platform lies in the fact that LCMS is more focused on learning-content management, while the aim of LMS is closer to learning-activity management. However, there are several software platforms that offer both types of tools, closely integrated. Some of these platforms are restrictive software, the most popular among them being WebCT, eCollege, Desire2Learn and Blackboard. But it is also possible to find high quality open-source platforms like Moodle, Sakai, Claroline, ATutor. One of the criticisms levelled at these platforms is the common lack of pedagogical control (Govindasamy, 2002), as the majority of these platforms are focused on technical considerations, ignoring a true pedagogic analysis. In this way, the whole load of this analysis has to be done by the teacher responsible during the implementation of these web-based tools.

4.2 Blended learning

It is well known that nowadays most higher education institutions have adopted the above-mentioned platforms in order to manage their range of e-learning courses. This situation is affecting not only their on-line courses but also many face-to-face courses that are progressively trying to integrate those e-learning technologies as very helpful tools.

This kind of educational system, which combines face-to-face and e-learning methodologies, is called *blended learning* (also b-learning). The same kind of concepts is behind hybrid learning or mixed mode learning (Ginns & Ellis, 2002). The extent to which these new technologies are introduced and applied in face-to-face courses can vary enormously from one course to another. In some cases the use of b-learning may be very slight; it may simply consist of the publication of some documents on the web or on-line tutorials. But, in other cases, the importance of the on-line learning can be much greater than the face-to-face part of the course. In some of those courses, the face-to-face part may be reduced to mere guidance, advice, or explanation of the web-based tools.

Obviously, the best way to use these e-learning tools will depend on the particular features of the subject taught and also on the characteristics of the students studying the subject (number, age, technological skills…). This integration process is being studied nowadays and a deep methodological and pedagogical analysis is still necessary (Kelly et al., 2007; Barnard et al., 2009). But what seems clear is that many campus-based higher education institutions are adopting blended learning approaches to a significant degree, and, more importantly, this process can be carried out maintaining consistency with the values of traditional higher education institutions (Garrison, 2004).

4.3 E-assessment

In its broadest sense, e-assessment is the use of information technology for any assessment-related activity. The term e-assessment is becoming widely used as a generic term to describe the use of computers as part of the assessment process. E-assessment can be used to assess cognitive and practical abilities. Cognitive abilities are assessed using e-testing software; practical abilities are assessed using e-portfolios or simulation software.

An e-testing system basically includes two components: (1) an assessment engine; and (2) an item bank. The assessment engine comprises the hardware and software required to create and deliver a test. Most e-testing engines run on standard hardware so the main feature is the software's functionality. There is a wide range of software packages. The software does not include the questions themselves, these are provided by an item bank. Once created, the engine uses the item bank to generate a test. The creation of the item bank is more costly and time consuming than the installation and configuration of the assessment engine.

E-assessment has many advantages over traditional (paper-based) assessment. The advantages include lower long-term costs, instant feedback to students, greater flexibility concerning location and timing, improved reliability (machine marking is much more reliable than human marking) and enhanced question styles incorporating interactivity and multimedia material. But there are also disadvantages: e-assessment systems are expensive to establish and not suitable for every type of assessment (such as extended response questions). The main expense is not technical; it is the cost of producing high-quality assessment items.

Focusing on large groups, e-assessment can make the teacher’s work easier. For subjects with a considerable number of students, standard exam correction can take an enormous amount of time. As a helpful tool for this purpose, most of the software platforms for e-learning, as presented in the previous section, include modules allowing different kinds of on-line assessment. They commonly provide tools that allow the conduction of multiple-choice questions, matching questions and short-answer questions. Depending on the kind of e-assessment chosen, it is possible to get automatic correction, allowing a huge time saving and immediate feedback for the students.

5. A Methodological Proposal for Overcrowded Groups

The difficulties mentioned in section 3 have been considered in order to propose a gradual adaptation to the new requirements in higher education deriving from the harmonization process. This proposal has been carried out in two consecutive stages (two academic years) which are detailed in the following sections. The first one deals with the adaptation of the learning program and the partial modification of the assessment system. The second one takes a further step towards the modification of the assessment system, introducing e-assessment in the Mechanics subject.

This scheme has been tested in the Mechanics major, already presented above, but the initial situation and problems found there do not differ from those arising in other engineering disciplines.

5.1 First stage: Adapting Content and Assessment

The first step in order to adapt the subject to the Bologna directives consisted of establishing the teaching objectives for the 2006/2007 academic year, which were the following:

1. To draw up the academic program in terms of skill and learning outcomes. This implied defining the different tasks that can be performed by a mechanical engineer and reviewing the subject program in order to adjust it to the new requirements and the allotted time.
2. To plan content classes in detail so that the lecturer could check whether the time management was realistic.
3. To adapt the assessment system with the aim of encouraging the students to study the subject every day and increasing their motivation by making the subject achievable and close to them.
4. To study the strategies and methodologies that best suited the subject, with regard to the constraints mentioned above.

In order to accomplish these objectives, different tasks were performed and the results are detailed below.

Before amending the program, an effort was made to contextualize the subject in the degree. In this sense, an analysis of the professional background related to the degree was conducted. As a result, a list of general and specific objectives (learning outcomes) was produced and those related to the Mechanics subject were extracted.

Besides setting goals related to content, we examined the skills and attitudes essential for any engineering work, realising that the subject should stress their development. Some of the basic skills developed were problem-solving ability, abstraction capacity, autonomy in learning and adaptation to new situations. Responsible attitudes also had to be promoted, as well as critical thinking and respect for the rules of use and maintenance of equipment and working tools.

Once the goals were clearly established, we analysed the existing subject program and methodology as well as the agendas and methodologies of the previous and related subjects. In particular, we reviewed the curriculum of subjects such as Physical Foundations of Engineering and Mathematical Foundations of Engineering and noted that, traditionally, some concepts already contained in the Physics subject were being taught again in Mechanics. As a result, some modifications of the subject were made. Specifically, we grouped some items, changed some laboratory sessions and removed several sections which dealt with issues already studied in previous subjects or considered to be less important for the future professional development of the students. These reductions allowed us to go into greater depth in the most important aspects of the subject.

Adaptation of evaluation and assessment

Teaching does not consist in simply following a set of rules or applying a particular technique, but requires thinking about how to engage the students in the learning process, and this is only possible through renewing teaching methodologies.

In this sense, the assessment process occupies a central role in teaching because it helps to ensure and verify the quantity and particularly the quality of the learning process. The process should be clear and known by the students and the weight given to each assessment element should provide the student with an idea of which objectives and contents are most important.

The assessment system was partially modified in order to encourage students to study the subject every day and increase their motivation by making the subject achievable and close to them.

The modification of the assessment therefore had a threefold purpose:

1. To spur the students on to greater efforts, bringing the subject closer to them and linking its contents to the knowledge they already had.
2. To encourage pupils to lose their fear of the subject and to sit the examination.
3. To adapt the assessment to the new program established.

Three types of assessment were used in order to achieve the above goals. The first one – **diagnostic assessment** or pre-assessment – provides the instructor with information about students' prior knowledge and misconceptions before beginning the subject. The second one, the **formative assessment,** takes place during the learning activity and provides the instructor with information on how well the learning objectives of a given activity are being met. The last one, the **final or summative assessment**, summarizes learners' development at the end of the course.

Two evaluation itineraries were considered and both are detailed in Table 1. The first one (A1) is aimed at students who regularly attend classes. The second one (B1) is designed for students who do not regularly attend classes because they have attended them in previous years, or who prefer to be assessed through a summative assessment. Itinerary B is the one previously followed in the subject, except for the initial test, and itinerary A includes the modifications carried out. In order to pass the subject the student had to obtain at least a 50% of the total score, for both itineraries.

Assessment type	ITINERARY A1		ITINERARY B1	
Diagnostic assessment	Initial Test (mandatory)	**0%**		
Formative assessment	Suggested Problems (Self-evaluation)	**0%**	Suggested Problems (Self-evaluation)	**0%**
	Laboratory Sessions (reports)	**10%**	Laboratory Sessions (reports)	**10%**
Summative assessment	Partial Examination	**45%**	Final Examination	**90%**
	Final Examination	**45%**		
	Final mark	**100%**	**Final mark**	**100%**

Table 1. 1st stage: Assessment itineraries in the Mechanics subject.

Firstly, the **diagnostic assessment** is a simple test, which takes place on the **first day of classes** and is not considered in the final mark. The test is marked quickly and its results are shown in blocks of content, so students realise the items they have mastered and the items they must review. It is a kind of motivating element as it requires only very basic knowledge of physics and mathematics. Secondly, the basic laboratory sessions review basic concepts in physics.

In order to encourage the students to study continuously and to achieve a change in their conception of the subject, there is a collection of **suggested problems**, a **partial examination** and **laboratory sessions** distributed throughout the course.

The collection of suggested problems has been designed to help the students in the self-assessment of their knowledge at the end of each content unit. These problems have the numerical solution included, but it is the student who must reach the result by their own means. The lecturer encourages the students to solve them on their own and to attend tutorial sessions in order to resolve any questions they may have. Due to the large number of students enrolled in the subject, it is not feasible for the teacher to set individual problems and to correct them one by one. For this reason, the numerical solutions of the problems are included and individual doubts are resolved in the tutorial sessions.

The **partial examination** is an optional test allowing the students to assess their knowledge of the first part of the subject and leave the second part for the final exam. If the mark in the partial exam is greater than or equal to 40%, the student will be assessed in the final examination only on the second part of the program.

The **laboratory sessions** are optional but part of the final mark. They are evaluated by means of a report reflecting the practical work done, while there is an analytical verification of the measurements taken in the lab.

Results from the first stage. Discussion

The results obtained from this stage were encouraging, with 33.47% of the enrolled students having passed, while the percentage had never exceeded 15% in previous years. The main reason was the increase in the number of students sitting the examination (53.39% of the enrolled students compared to 36.32% the preceding academic year), which confirmed the initial approach that one of the main reasons for the high failure rate observed in the subject is that students do not sit the examinations. It is important to point out that 89.87% of the students who sat the partial examination finally passed the Mechanics subject. That means students who studied more continuously achieved good results. Furthermore, the mean score for Dynamics was 42%. Another benefit observed was an increase in the use of the tutorial sessions for asking questions related to the subject, which proved that the changes introduced had motivated the students to study more continuously.

However, some important limitations were observed:

1. Little guidance was still given by the lecturer and should be increased, taking into account the student's profile.
2. One of the facts observed over the last few years in the tutorial sessions was that many students were trying to solve problems without having properly studied the theoretical foundation of the subject, and this problem had not been solved.
3. The time spent by lecturers increased considerably with the partial examination.

5.2 Second stage: Introducing e-learning tools

Due to the changes introduced, the number of students enrolled in the Mechanics subject fell by 17% in the academic year 2007/2008 (from 236 to 196 students enrolled). This was a good result considering that, every year, 90 new students begin their studies on this degree course.

The changes carried out were reviewed, with some being retained and others, such as the assessment, modified and improved, taking into account the limitations observed in the first stage.

The new proposal for the 2007/2008 academic year involved conducting educational developments in various fields in order to fulfil the objectives established above. In this sense, continuous assessment was proposed, not only to verify the degree of fulfilment of

the objectives, but also to guide the students in their learning process. In fact, if the assessment is problem-centred, a theoretical comprehension of the foundations of the subject is being assumed, and this may not be the case. Moreover, if the students are able to continuously self-assess, they will also be able to correct their deficiencies over time. This requires giving not only their marks, but also a list of the concepts or techniques in which they do not reach the objectives established for the major.

Alternatives considered, advantages and disadvantages

On the one hand, the implementation of continuous assessment in large groups, with more than fifty students enrolled, is really difficult to carry out by the lecturer because of the amount of time involved in correction tasks. For that reason, although this is a good methodology in order to encourage the students to study the subject continuously, face-to-face continuous assessment was ruled out in the Mechanics subject.

On the other hand, as the Universitat Jaume I is considered a face-to-face university, the faculty must teach a minimum number of classes, and it made no sense to develop an entirely virtual subject.

All these reasons lead inevitably to the development of a blended learning methodology. However, it must be remembered that there are a variety of activities that can be done within the framework of the b-learning methodology. Among these, e-assessment was considered as the most appropriate for the goals established above, i.e., to achieve the study of the theoretical foundations of the subject without a huge increase in the lecturer's work.

For the introduction of e-assessment in the Mechanics subject, the Moodle software (Moodle, 2007) has been used. Moodle is the acronym for Modular Object-Oriented Dynamic Learning Environment. It is a free software package for producing Internet-based courses and web sites. It can also be referred as a Course Management System (CMS), a Learning Management System (LMS) or a Virtual Learning Environment (VLE), although it also contains tools from a LCMS system. It is a modular system that offers considerable flexibility with the possibility of adding or removing functions at many levels.

Moodle platform is widely used in the Universitat Jaume I. One of its main advantages is that is easy to maintain and update. Except for the installation process, it requires virtually no maintenance by the administrator. Its interface allows the easy creation, management and usage of the course by the lecturer and also by the students. The registration and authentication of the participants is quite simple and secure and there is a large community continuously improving the software, based on documents and troubleshooting. It is based on constructivist pedagogical principles: learning is particularly effective when achieved through sharing with others.

Diagnostic and formative e-assessment

We have implemented the e-assessment for the diagnostic and formative assessments while the summative assessment has remained the same (paper-based). On the Moodle platform there are very different tools, but we have used two of them: Questionnaire and Task.

Two itineraries have been considered, as in the first stage. The first one (A2) consists of continuous assessment and is aimed at students who regularly attend classes. The second one (B2) is designed for those who prefer to be assessed through summative evaluation. Both itineraries are described in Table 2. Once again, the student had to obtain at least a 50% of the total score of the selected itinerary in order to pass the subject.

Assessment type	ITINERARY A2		ITINERARY B2	
Diagnostic assessment	Initial e-test (mandatory)	**0%**	Initial e-test (optional)	**0%**
Formative assessment	e-tests	**20%**	Suggested Problems (Self-evaluation)	**0%**
	Suggested Problems (Self-evaluation)	**0%**		
	Laboratory Sessions (e-reports)	**10%**	Laboratory Sessions (e-reports)	**10%**
Summative assessment	Partial Examinations	**38%**	Final Examination	**90%**
	Final Examination	**32%**		
	Final mark	**100%**	**Final mark**	**100%**

Table 2. 2nd stage: Assessment itineraries in the Mechanics subject.

Itinerary A is made up of four kinds of activities:
1. **Initial e-test**: This is a mandatory e-test for students who want to participate in the continuous assessment itinerary. This test was created on Moodle with the Questionnaire tool. The aim of this test is to determine the student's prior knowledge of the mathematics and physics required in order to tackle the subject properly.
2. **E-tests.** These are electronic tests carried out during the course for the various units of the major. They are composed of theoretical and practical questions and were also created on Moodle. The aim was to ensure that the students learn or, at least, read and understand the theoretical foundations of each subject unit before tackling the practical problems. These tests provide indirect guidance for students, because they allow them to check their knowledge in every unit of the subject and perform feedback.
3. **Suggested problems**: This activity remained the same as the previous year.
4. **Laboratory sessions**. The laboratory sessions are considered optional, but contribute to the final grade. They are assessed through an e-report on the practical work done and with theoretical calculus verifying the measurements obtained in the laboratory. The handing in of these documents was performed on Moodle using the Task tool, where the student is allowed to upload the e-report during a specific period of time.
5. **Partial Examinations (paper-based).** During the course there were two partial exams allowing the students to assess their knowledge of the first part of the subject and leaving the second part for the final exam. Only if the mark in each partial examination was greater than or equal to 40% would the student be allowed to be assessed only on the second part of the program in the final examination.

Questionnaires in Moodle

The Questionnaire is a powerful and flexible tool that allows the lecturer to design consistent tests and establish assessment strategies that would be impossible to carry out on paper. In fact, there is a wide variety of questions (multiple choice, true/false, short answers, gap-filling...) organized by categories within a bank of questions (for re-use in other courses). Questions can be created in HTML, with multimedia elements and can be imported from external text files. It is also possible to generate random questionnaires from

multiple choice questions stored in the bank. It has the great advantage that the time spent by the students can be limited and correction is immediate.
In the Mechanics subject, questionnaires have been used in the initial assessment and in the e-tests. Every questionnaire has an access page shown in Fig. 1 but the access button is only active the selected day and during the time permitted for doing the test, i. e., about an hour.

Fig. 1. Questionnaire access page.

Examples of theoretical and practical questions are displayed in the Figures 2, 3 and 4.

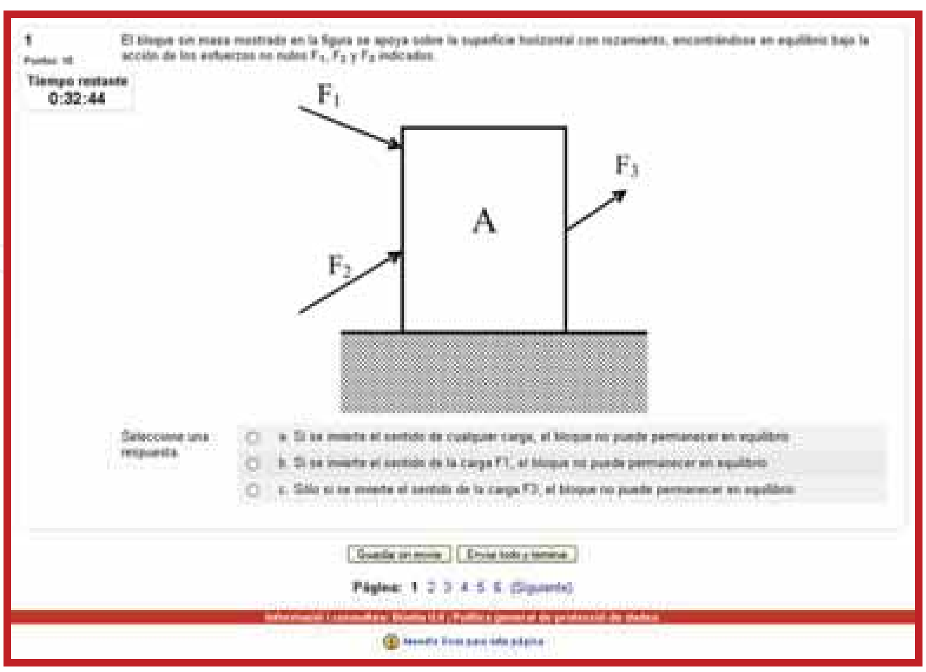

Fig. 2. An example of a theoretical multiple-choice question (Unit: Friction).

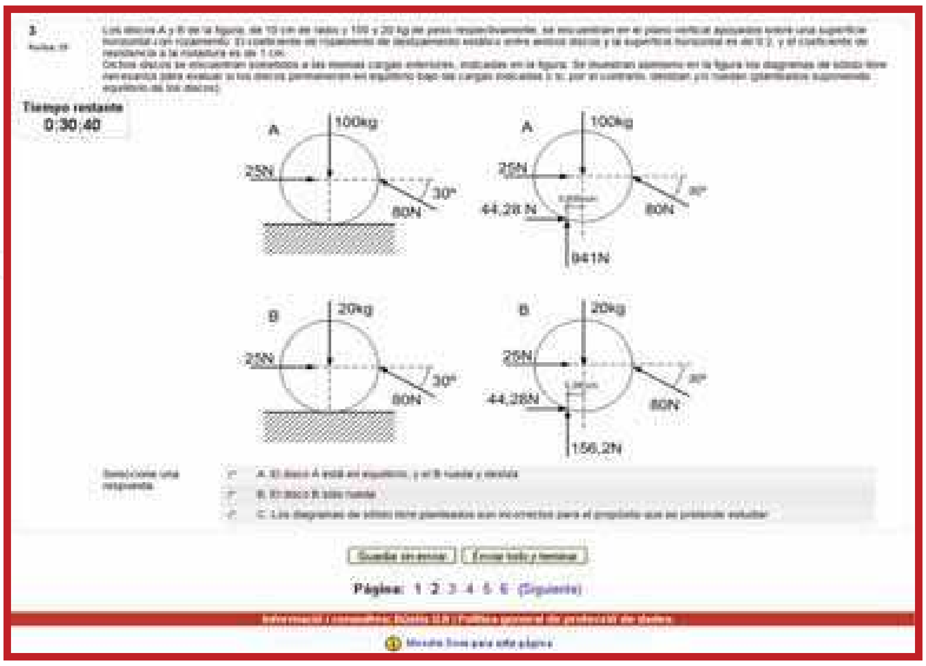

Fig. 3. An example of a practical multiple-choice question (Unit: Friction).

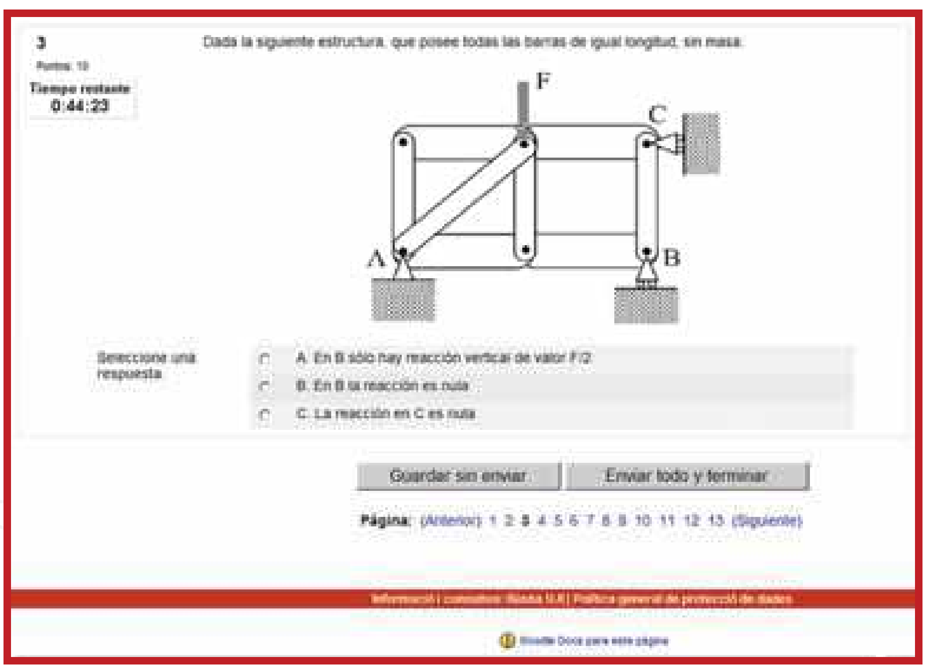

Fig. 4. An example of a practical multiple-choice question (Unit: Statics).

Tasks in Moodle

A Task is a Moodle tool that allows lecturers to assign work, which will be prepared in an electronic format and uploaded to the server. The documents are stored for later assessment, with the possibility of adding a review that will be sent to the student by e-mail.

For every task it is possible to specify the delivery deadline, which appears in the course schedule, as well as the highest mark that can be assigned to the task. The students can

upload their work (in any file format) to the server and it records the date they have uploaded it.
A global view of the different tasks, groups and lecturers has been developed in order to simplify the uploading of e-reports. The various tasks can be accessed from this page, shown in Figure 5.

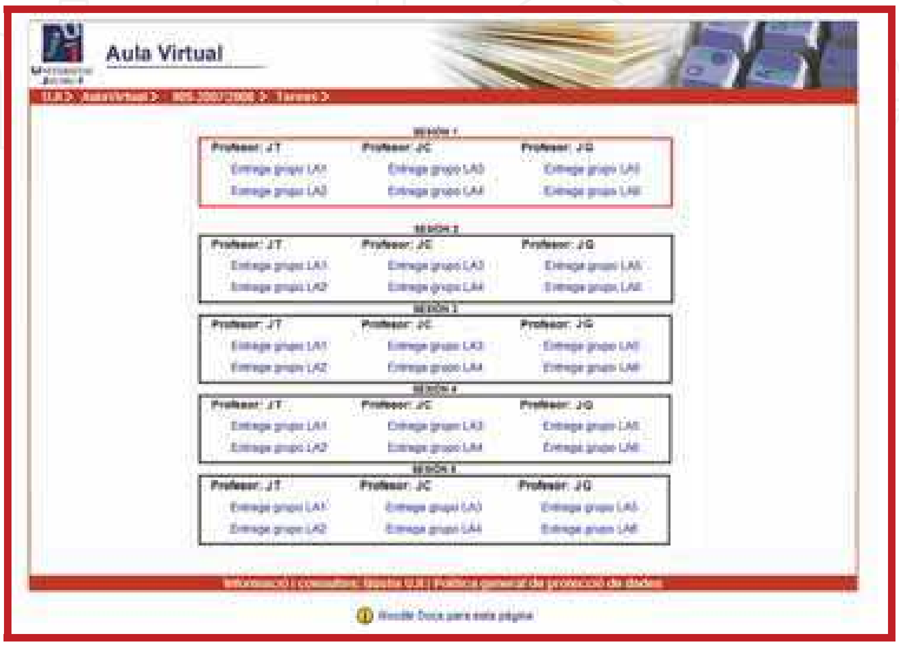

Fig. 5. Global view of tasks, groups and lecturers.

The lecturer can also check how many tasks have been scheduled, which are their deadlines and how many reports have been uploaded (Figure 6).

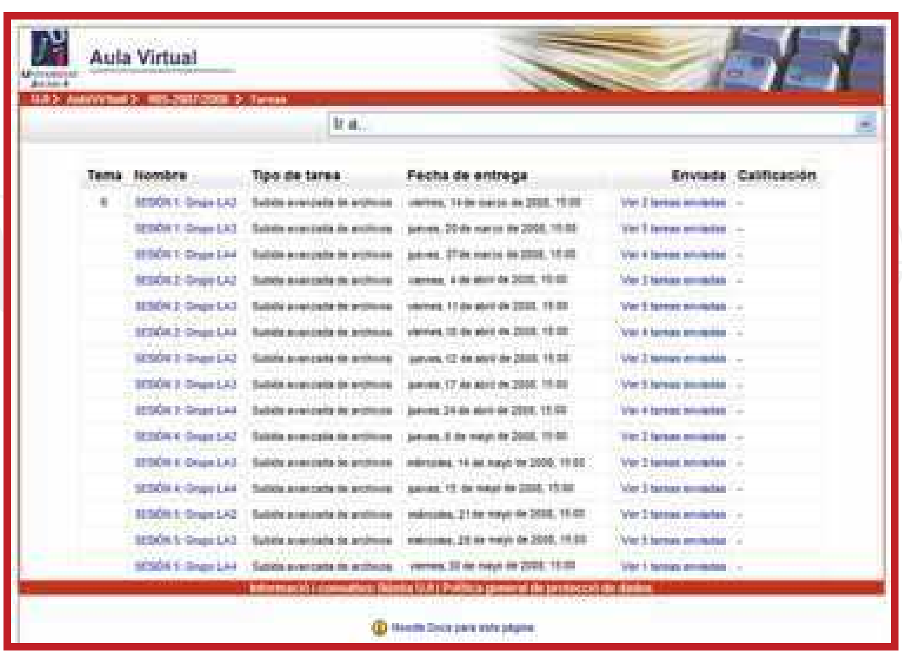

Fig. 6. List of tasks in the subject, with deadlines and uploaded reports.

From the main page shown in Figure 5 students can access their corresponding tasks in order to upload their e-reports. The task access page is also displayed in Figure 7.
The conditions for accessing the task are similar to those explained for the Questionnaire tool. In fact, a task can only be accessed during the period of time scheduled for it. This period usually lasts a week. During this week students can deliver their work and amend it as many times as they want, until the deadline of the task. Subsequently, lecturers will score the uploaded e-reports and students will view their grades on the same web-page.

Fig. 7. Task access page.

Results deriving from the second stage
The results obtained from the second stage are better than those obtained from the first stage of the gradual adaptation:
1. More continuous study has been ensured, according to the percentage of students that sat the e-tests and partial examinations. The percentage of students that sat the partial examination was 59.4% compared to 52.54% the previous academic year. The percentage of students that sat the e-tests was 68.2%.
2. The percentage of students sitting the examination has significantly increased, from 36% in the academic year 2005/2006 to 53.39% in the academic year 2006/2007, under the proposal presented in the previous section, and to 63% the last academic year (2007/2008) with the new proposal presented here.
3. 89% of the students who sat the partial examination did finally pass the Mechanics subject.
4. An increase in the use of the tutorial sessions for asking questions related to the subject has been identified, with a mean of 3 students per tutoring session. However, this is a very small number.
5. The percentage of enrolled students who passed the subject has also increased from 33.47% in the academic year 2006/2007 to 36% the last year. It must be pointed out that this percentage never exceeded 15% in previous academic years.

6. When asked, the students assess the initiative positively, but they complain about the workload.
7. No correlation has been found between the marks from the e-tests and the marks from the partial examinations.
8. The new proposal has slightly increased the lecturer's workload, which was already high with the previous proposal.

7. Conclusions and Future Work

The changes introduced at the second stage allowed students to study more continuously, improving the percentage of enrolled students sitting the examinations and the percentage of students passing the subject.
The task of guidance carried out by the lecturer has indirectly increased, by means of the feedback given to the students in the e-test results. The e-tests have also helped ensure a proper and continuous study of the theoretical foundation of the subject, which was not achieved in the first stage of the proposal. In this way, the students have been able to make a better use of their attendance in class.
But the lecturer's workload has increased, largely because of the introduction of the second partial examination, and also because of the e-tests. As no correlation between the marks in the e-tests and the marks in the partial examinations has been found, a more in-depth study should be carried out in order to ensure that the partial examinations could be replaced by e-tests, with a smaller workload for the lecturer.

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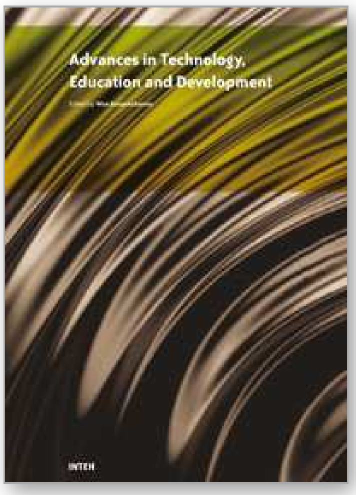

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From 3rd to 5th March 2008 the International Association of Technology, Education and Development organised its International Technology, Education and Development Conference in Valencia, Spain. Over a hundred papers were presented by participants from a great variety of countries. Summarising, this book provides a kaleidoscopic view of work that is done, all over the world in (higher) education, characterised by the key words 'Education" and 'Development'. I wish the reader an enlightening experience.

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