OmniaScience

Journal of Technology and Science Education
JOTSE, 2017 – 7(3): 291-312 – Online ISSN: 2013-6374 – Print ISSN: 2014-5349
https://doi.org/10.3926/jotse.265

INITIATIVES TO FOSTER ENGINEERING STUDENT MOTIVATION: A CASE STUDY

Encarnación Reyes, Alejandro Enfedaque, Jaime C. Gálvez

Universidad Politécnica de Madrid (Spain)

encarnacion.reyes@upm.es, alejandro.enfedaque@upm.es, jaime.galvez@upm.es

Received January 2017

Accepted July 2017

Abstract

There is little doubt that student motivation is essential in providing a beneficial learning experience. One way to produce such motivation is to stimulate it through suitable assessment methods. This paper shares the experience acquired by the authors, who are university lecturers in Civil Engineering at the Universidad Politécnica de Madrid, both through their assessment methods and feedback received via the modular object-oriented dynamic learning environment (Moodle) platform. During the last eight years the authors have progressively included increasingly dynamic methods in their teaching and assessment, with highly satisfactory results being obtained. The last three academic years have seen a test through co-assessment being added. In addition, during the last two an assessment exercise has been implemented through use of the aforementioned Moodle. Each test has a weight of 5% in the final mark for the module. After sitting the respective Moodle test, the students filled in a questionnaire that sought their views not only on the teaching methods but also on the degree of motivation they felt from such methods. As expected, the results showed that the students considered the internet-based Moodle platform to be useful. However, the most notable finding was that the majority indicated that alternative teaching and assessment methods (such as, among others, cooperative learning) were those that were most beneficial to their learning experience. Over 70% of the students thought that the use of the Moodle platform and other teaching and assessment techniques had motivated them with an average, high or significantly high intensity. In particular, the students highlighted the use of cooperative learning with 86% feeling that it helped them to learn.

Keywords **–** Student motivation, Civil engineering, Moodle, Student feedback, Construction and building materials.

---

1. Introduction

According to constructivist epistemology (or the study of knowledge acquisition), learning entails mental activity in which concepts are constructed and reconstructed through what may be termed a link-up of information through a highly complex process (von Glasersfeld, 1998). In such development, it is clear that motivation is paramount (Bravo, Amante-García, Simo, Enache & Fernandez, 2011; Omar, Jain & Noordin, 2013; Rodríguez-Largacha et al., 2015; Sun, 2014), something of which university lecturers will undoubtedly be aware. Many lecturers realise that after engaging students and transmitting their own knowledge of a given field, regardless of how well they teach their students, the results do not entirely depend on the work of the lecturing staff.

The degree of motivation with which students address academic activities, both in and beyond the lecture theatre, is one of the most influential factors in determining the level of learning reached (Bravo et al., 2011; Omar et al, 2013; Rodríguez-Largacha et al., 2015; Sun, 2014). It could be argued that a motivated student is one that is most prepared to face a task, focused on handling it, and persistent in addressing the difficulties faced, as well as one that invests more time and effort in learning than the unmotivated student. This offers not only a greater guarantee of learning success but also a significantly more consolidated learning experience. Conversely, a lack of motivation is a serious issue across all levels of education, from primary through to higher and even to post-graduate. The current difficulties faced by the world economy, and in the case of Spain the high rate of unemployment among young people, have undermined the possibility of students finding remunerated work upon finishing their university studies. Therefore, in the second-year Construction and Building Materials module taught at Universidad Politécnica de Madrid the authors have sought to develop student interest in learning. There is little doubt that a module should involve some form of assessment, given that in the majority of cases students are more interested in the mark they obtain for an assignment or test than the learning it entails (Gibbs & Simpson, 2004). It might even be argued that students become what could be termed strategists in obtaining the best results. This would not necessarily be negative, however, as it could be used in motivating students to implement certain techniques that steer them towards an improvement in their learning capacity. In a paradoxical sense, a priori this was not their objective.

For some time, published research has placed an emphasis on the need to bring change to the teaching of engineering in general and civil engineering in particular, with the aim of adapting it

to the needs of a professional career in the workplace (Felder 1996; Stephens & Richey, 2011). One reason involves the revolutionary development of technology which will have significant consequences for the engineers of the future. Another reason, however, entails employers requiring engineering graduates that possess a better balance of knowledge and skills and, to be more specific, transversal skills with the particular relevance of being able of working with multidisciplinary teams. Additionally, the objective of reform in the European Higher Education Area (EHEA) is to ensure more comparable higher education systems, providing a degree of standardisation and enhancing cooperation between higher education and the public and private sectors (the joint declaration of the European Ministers of Education (1999)). In response to these factors, the teaching techniques of the authors have been reconsidered and orientated towards a more skills-based approach that has given place to a more student-focused teaching, with added emphasis on communication (both oral and written), problem-solving, and teamwork skills.

Given the objectives of motivating students and adapting their knowledge and skills to the workplace, since the 2006-07 academic year the authors have implemented eight educational initiatives projects. They have dedicated a significant amount of effort to the Construction and Building Materials module and added more active assessment and teaching methods which they believe could enrich the more traditional approach. This, which has provided pleasing results, has involved an inclusionary approach that brings students into the whole process of teaching, assessment and feedback. As a result, many of the methods implemented – as well as the feedback received – have been both presented at conferences and published (Reyes & Gálvez, 2010, 2011). From the conclusions obtained from previous work, the particularly good results provided by the cooperative learning activities should be noted.

In the last three academic years, there has been an emerging major interest in improving assessment techniques by introducing co-assessment and developing the autonomous learning process by using new technologies, with both initiatives being planned to foster motivation among engineering students. The objective of this paper, hence, is to discuss these two initiatives carried out over the past years that have sought to foment and nurture an interest in learning.

The first of the two, which has been in place for three years, has involved co-assessment. Similar to other lecturers, the authors are committed to improving assessment methods. Such an objective has become a recurring point of debate and reflection in higher education. Published research has examined various opinions on assessment criteria, methods and use of information

technology (IT) (Badia-Valiente, Olmo Cazevieille & Navarro Jover, 2016; Jordi-Nebot, Pàmies-Vilà, Català-Calderon & Puig-Ortiz, 2013; Marcé-Nogué, Gil, Pérez & Sánchez, 2013; Gessa, 2011; Darby, 2007; Bleske-Rechek, Zeug & Webb, 2007; Coll, Rochera, Mayordomo & Naranjo, 2007; Keppell, Au & Chan 2006; Woolf, 2004; Dochy, Segers & Sluijmans, 1999; Glaser & Silver, 1994). In one study, Dochy et al. (1999) highlight the importance of student participation in the assessment process in higher education, with the relevance of self-assessment in the learning process in e-learning (Marcé-Nogué et al., 2013) and the need for more research being particularly noticeable. Other authors have placed emphasis on the relevant role of assessment in stimulating learning (Carless, 2003; Taras, 2002), especially with regard to group activities (Bushell, 2006; Cheng & Warren, 1999; MacAlpine, 1999). The authors of this paper have implemented an initiative with the view that co-assessed exercises could foster interest as students seek to show their academic credibility to their peers. In order to avoid irrational differences in marking, the assessment criteria and degree of difficulty have been studied with the intention of adjusting them by the lecturing staff. In addition, the staff felt that student involvement in peer assessment could be explored as a learning action in itself. Over the aforementioned three-year period, the authors constantly examined and analysed the initiative and identified the potential offered and the difficulties faced.

The second initiative, implemented over two years, has focused on the process of self-learning and self-assessment through use of new technology such as the Course Management System (CMS) of the modular object-oriented dynamic learning environment (Moodle) platform. The revision of the methods used on the Construction and Building Materials module has involved extensive use of information technology (IT) with constant uploading of resources. Students now have online access to information about the assignments and exercises set, lecture summaries, the module programme, presentations given, and questionnaires to provide feedback, all of which help their own self-learning and self-assessment. The platform also allows direct communication between the lecturing staff and the students, including distance tutorials and provision of administrative information about the module. However, for use of such a resource to become extensive (reinforcing the aforementioned point that the students become strategists that seek only to achieve a pass grade), it is necessary that it be included in the module assessment. In the case of this module, such use was fomented through the setting of two multiple-choice tests – completed before an interim examination – weighted to 5% of the total mark. The objective of this was to dissuade students from leaving revision until the day prior to the examination or cramming preparation. In order to make full use of the timing of the activity,

it was followed by a brief questionnaire that sought feedback on the teaching methods by stating how motivating they were. This paper examines what the authors acquired from use of multiple-choice and true-false tests, the feedback from the questionnaires on the two tests, and student motivation in general.

The results of the two distinct initiatives implemented and the opinion of the students and the lecturers are shown. The paper seeks to offer the authors' own teaching experience to study of integrating innovative teaching and assessment methods in motivating student learning in contemporary university education.

2. Methodology

The Construction and Building Materials module has two parts (Part I and Part II), with each representing 4.5 credits in the European Credit Transfer and Accumulation System (ECTS). The two are taught in the second year of the degree in civil engineering and provide a link between the core modules offered in the first year of the degree (graphic design, materials chemistry, mathematics and, among others, physics) and those of the following years (analysis of structures, concrete and steel structures, general construction procedures, hydraulics and hydrology, and rock and soil mechanics). The module studies a significant variety of materials used in civil engineering, not only from the purely scientific side but also from the practical and regulatory. Both Part I and II involve study of the properties of materials such as adhesives, coatings and paints, explosives, fuels, geotextiles, steel and other metals, woods, and with special relevance in Part II, concrete.

The teaching and assessment methods planned in the module have allowed adjustments and corrections to the system which have strengthened the learning process over the years. This has enabled students not only to acquire knowledge but also develop the transversal skills that are so important when graduates enter the employment market, such as teamwork, communication (both oral and written) and problem-solving skills. Within such a skill set, given that familiarisation with IT is considered to be paramount, proficient use of Moodle is of significant help (Ruiz, Gálvez, Benítez, Olivares & Reyes, 2001). This takes on even more significance when it is linked to the final mark for the module which is, as suggested earlier, a primary student objective (Gibbs & Simpson, 2004).

One initiative credited to have been beneficial in enhancing motivation is co-assessment where, in addition to the lecturer, students mark the work of peers (Gessa, 2011). This consolidates the learning environment, given that students prefer not to lose credibility in front of their peers and that it establishes a small but healthy degree of competitiveness. Such co-assessment serves as a learning activity, since the marking of exercises done by others requires a sound awareness of the assignment set.

The authors have noted an increase in requests for re-marking in the cases of both interim and final examinations. It should be noted that this, however, has not been accompanied by a reduction in the amount of pass grades awarded, which could to some extent justify such a rise. One explanation could involve disparity between marking criteria applied by the lecturing staff and the levels of student dedication required in studying the module. Avoidance of this, as well as excessive disparity in marking criteria, was another reason for implementing co-assessment.

The module examinations have involved both practical and theoretical exercises. The theoretical examinations entail a theme to be examined by the students, a series of short theoretical questions about the module subject matter, multiple-choice exercises or analysis of a case study in which possible errors should be identified. This paper has not considered either the multiple-choice or text-with-errors exercises, given that they involve objective criteria that are independent. The practical exercises examine a case study, within which a core knowledge of mathematics and physics is required.

As the majority of requests for remarking have involved exercises with an answer of an objective nature as regards marking criteria, an initiative has been implemented over three consecutive years. This has entailed dividing the students in three groups, in two of which they were required to examine a theme proposed by the lecturing staff and then carry out a numerical applications exercise. The third group was then assessed by a test that involved seven short questions.

The exercise was set during class time in one of the weekly four taught hours. Given that the respective class time was 50 minutes, it was divided in the three following tasks:

- Outlining the exercise and distribution of the examination papers (10 minutes)
- Carrying out the exercise (20 minutes)
- Marking the exercise by a peer (20 minutes)

In order to carry out the marking of the exercise by the students, the answers were provided in class. However, the students were free to decide both the mark given for the exercise and the factors that influenced the relative weight. The weight of the total mark for the exercise with the seven short questions was also left to the students. This system allowed checking of whether the lecturers were able to establish the most important part of the module or if all parts were considered equal.

Once this had been carried out (in class time), all the groups examined the marking done by the lecturing staff under the common criteria used in the module. In the cases of the exercises divided between theory and practice, the same weight was set for both. In the technical part, which involved a theme to be examined, a minimum level of attainment was required for the students to achieve a mark. The numerical part involved two parts in the mark at the same time: one given for the right approach to the problem; and the other part that entailed the numerical answer that led to a maximum mark being obtained if both were correct. In the short-question exercises, marking criteria involved aspects formulated in each of the questions, with the same weight being established.

This has been supplemented by inclusion of Moodle and the module web page that works as a tool designed for daily use. It allows fluid and constant communication between the students and lecturing staff. In addition to providing details of the main dates of the module programme and activities, it also includes information about regulations, presentations and visual materials. Furthermore, and in order to facilitate self-study and self-assessment, there is a resource bank available that stores exercises and questionnaires which cover the entire subject matter, as well as copies of examinations set in previous years that help students to become familiar with the assessment methods and type of exercise.

In order to foment use and take full advantage of Moodle, the last improvement has involved the inclusion of exercises included in the final mark for the module. This may be obtained by continuous assessment, with two interim examinations, or with a final examination. Regardless of this, the final mark for the module is considered to be the highest of the two possible previous. The reason is that the hypothetical case could emerge in which students obtain a higher mark from the examinations than with continuous assessment, though it should be noted that in the case examined in this paper it is the contrary that occurs. In essence, it is the mark obtained by continuous assessment that proves decisive in achieving a pass grade. The final mark is obtained by adding together the four interim marks, as shown in Table 1.

Part	Weight
Average of the two interim examinations	80%
Moodle tests	5%
Co-assessed test	5%
Cooperative exercises	10%
Total	100%

Table 1. The final mark through continuous assessment

The Moodle platform is also used to examine the influence of the type of question set, with both multi-choice and true-false varieties being used. In statistical terms, it would seem that the true-false test is significantly less difficult than the multiple-choice, given that each incorrect answer receives a penalty of one. Both tests involve 10 randomly chosen questions extracted from a database of 100 that consists of 25% considered to be easy, 35% at a middle point, and 40% difficult, with the questions and answers being placed in a random order. The questions are set in such a way that knowledge of the same concept is assessed in the form of both a true-false and multiple-choice question. For obvious reasons, when choosing questions randomly the probability of the same student encountering the same concept is extremely low. An example of the two types is given by Figure 1.

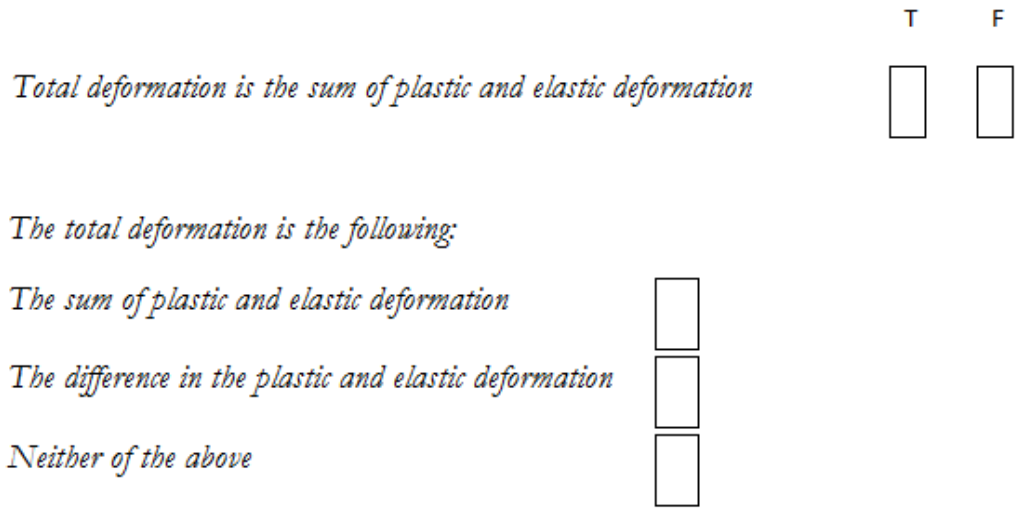

Figure 1. Example of a two-format question

During the week prior to the final examination, the students are allocated 10 minutes to sit each of the tests (they are allowed only one attempt). Once they have submitted the test does the

programme close. The students are not given the mark. When the two tests have been completed, the students may voluntarily answer additional questions about the degree of difficulty of the tests, the ease of comprehension of the questions and their opinion of the use of Moodle as a method complementary to traditional assessment methods. They are also asked if their motivation increased with use of co-assessment, cooperative learning and use of Moodle as an assessment tool.

3. Results and discussion

3.1. Teaching and evaluation initiatives

Over the past three academic years the number of students enrolled on the module is on average 354 per year. The percentage of students participating in the teaching and assessment techniques examined in this paper, out of the total enrolled, has been 72%. The results of the test with co-assessment show significant differences, depending on the nature of the exercise done. Figure 2 shows how the average mark obtained in the test with practice and theory, during the three respective academic years, offers a distinction between the marking carried out by the students and that by the lecturing staff. It also shows the marks obtained in the practice and theory parts.

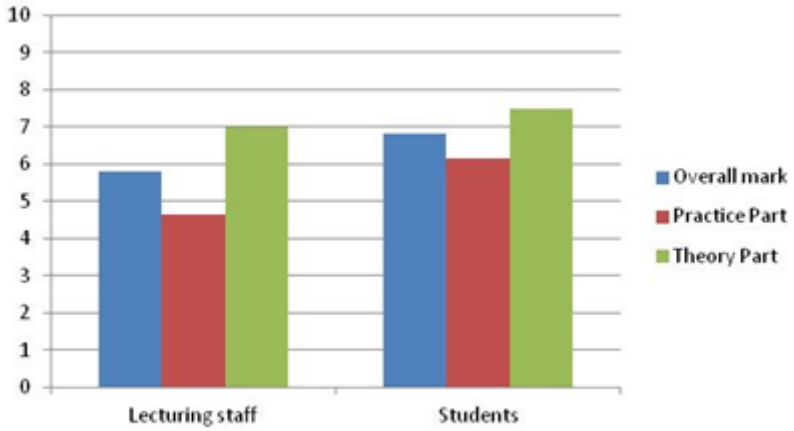

Figure 2. Average mark of the test with practice and theory parts

The marking scale ranges from 0 to 10, with five being the pass threshold. Figure 2 shows that an average mark higher than the pass threshold, regardless of who carried out the assessment. The

average overall mark given by the students is one point higher than that given by the lecturing staff. When considering only the theory part this difference decreases by a half point, with the average absolute value being the highest (reaching seven points in the case of marking by lecturing staff). On the contrary, the practice part gives the lowest mark, with assessment done by the lecturing staff being close to (and below) the pass threshold. Furthermore, in this part the difference in marks given by students and lecturers is higher and nears a point and a half.

Figure 3 shows the average weight given by the students to the practice and theory parts, with the majority of students giving equal importance to the two (50%). Two student groups of a similar size gave a weight of 60% to one of the parts: an average value of 20% to the theory part and an average percentage of 19% to the practice. Although the distribution is symmetric, it reveals a slightly higher percentage of students that considered the practice part to have more importance than the theory: 29% compared with 21%. Such a trend is the opposite to that found in the previous stages, with 60% given to the theory part and 40% to the practice (outline 6+4) and vice versa. The criterion followed by the lecturing staff entailed giving the same weight to both parts, using an outline of marking 5+5 that was also that mainly chosen by the students.

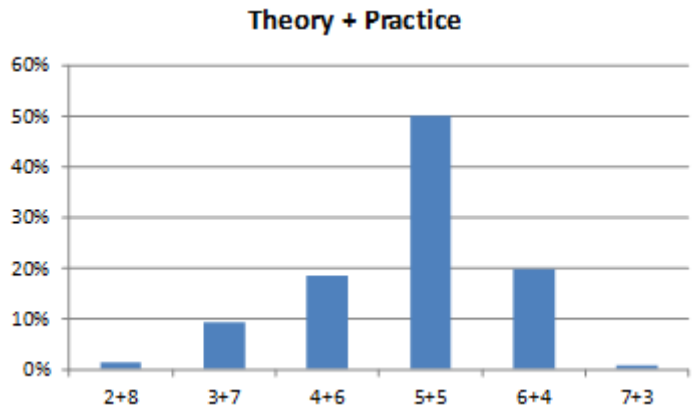

Figure 3. Weight of the theory/practice parts

Figure 4 shows the marks obtained by the students in the test that entailed seven short questions and involved specific aspects of the theory part of the module. It highlights how the results obtained by using the two systems of assessment were higher than the pass threshold and reached an average mark above six. Furthermore, the differences found between the two systems of assessment are around half a point lower.

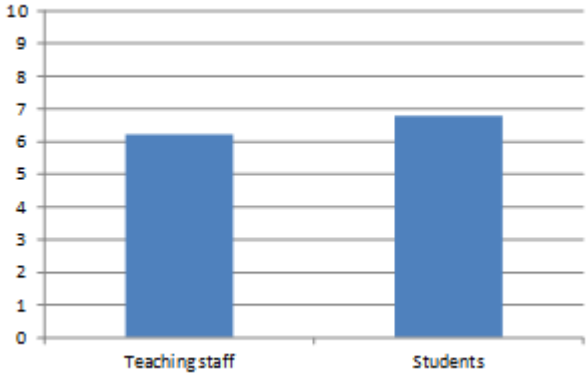

Figure 4. Marks of the tests of short questions

From the analysis of the two types of co-assessed tests, it can be concluded that in general the theory questions in the assessment criteria of students and lecturers are somewhat close. This suggests that the students are aware of the level of requirements to pass. Consideration of the results as an absolute value shows that performance is better in the theory exercises than the practice and even better when the questions have a more limited framework and concern specific issues. That is to say, the students answer short questions better than they respond in essays, given that they find composition of a longer text challenging when required to identify the most important aspects of a broad topic.

Examination of the marks obtained in the practice exercise shows a lower performance in the systems of assessment, with the grade given by the lecturing staff being close but below the pass threshold. Furthermore, in this part the differences in grades are the highest. When addressing tasks, the students find more difficulties in distinguishing when an approach is incorrect and the answer is beyond their reach. Of course, when the approach coincides with that shown by the lecturing staff and the answer is correct, no difficulty is identified. However, in the high number of possibilities of an error in the answer or the approach, the students find detection and evaluation more difficult. Given that the authors are deeply concerned by this, they plan to address this issue in the near future. It could be argued that certain aspects might be improved with the use of cooperative learning. As the lecturing staff have used this technique for several years and received good results (Reyes & Galvez, 2010, 2011), they would make some modifications focused on this objective in subsequent academic years: detection of errors in the approach to and answering of practice exercises, with the corresponding mark being in accordance with the level of difficulty.

3.2. Using the Moodle platform

This section shows the results of the second objective of the paper. The average mark of the Moodle tests performed during the last two academic years is shown in Figure 5. In two academic years the Moodle tests involved an average of 67% of the students passing the multiple-choice test and 93% in the true-false test. The average mark obtained in this latter case was significantly better than in the multiple-choice test, at around a point-and-a-half higher at more than seven. The preparation of the tests, both the questions and answers, was random and entailed all levels of difficulty so that the result could not be attributed to a repetition of the exercise.

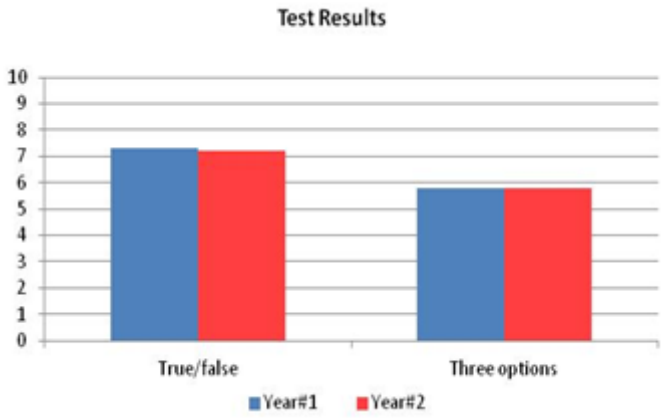

Figure 5. Averaged tests results

Figure 6 shows the degree of difficulty perceived by students and lecturers over the past two academic years, divided into true-false questions and multiple-choice tests. In general terms, it could be argued that students find the questions more complex than lecturers believe they should. However, differences may not be considered to be of significant importance except in the case of multiple-choice questions. In such a test, rather than finding a group of questions to be of low difficulty, the students perceived them to be moderately difficult: this meant that it was at this level where the differences of opinion were the greatest. The difficulty perceived by students in the three-option questions led to poorer performance (though students did still achieve a pass grade).

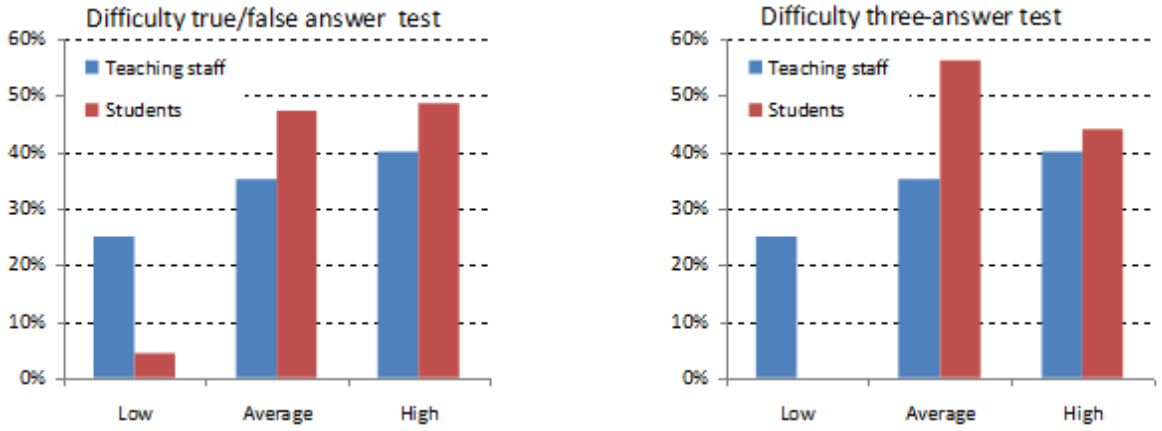

Figure 6. Difficulty level of the questions

Figure 7 shows that in the opinion of the students the questions were well set in all of the types of questions. Given that it also reveals that only around 10% stated that the questions were not well set, around 90% considered that they were written with an average or even better style. In this last group more than 50% on average, for both academic years, found the questions to be well or very well set. In this case, as the average results of the two academic years were reasonably positive, it could be concluded that the results were not influenced by incorrect question formulation.

Figure 7. Style and comprehension of the tests

3.3. Results obtained from pass grades

Involvement in the new teaching techniques and continuous assessment in the subject is optional: students can pass through final examination assessment by sitting only the exams, without any complementary activities. Regarding the number of pass grades, it may be said that there has been a relevant amount of students involved in continuous assessment during the last three academic years. Figure 8 shows the percentage of students that passed the Construction and Building Materials subject out of the students enrolled, considering the two modules and distinguishing the students who pass through continuous assessment or an end-of-module examination. This figure has been used to verify the influence of the use of new methodologies and assessment methods carried out in continuous assessment of those achieving pass grades. It should also be noted that most of the students who passed had undergone continuous assessment. The figure is 90% when considering only the students who pass.

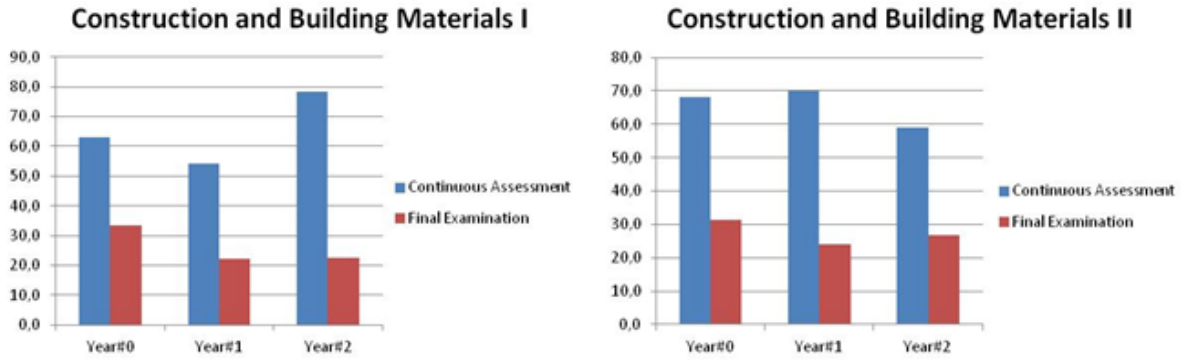

Figure 8. Percentage of students that pass the subject each academic year of a three-year series

3.4. Opinion survey on the teaching-learning techniques used

Along with the test questions related to the subject matter studied and difficulty, the Moodle platform has been used to set questions concerning student interest in the activities performed. The reason for asking such questions has been to gather effective feedback that would be of use in planning future academic years.

Figure 9 shows the opinion of the students about the use of Moodle as a teaching and assessment tool. According to the opinions gathered from the question Would you like the use of Moodle in the module to be nil, less intensive, equal, significantly more intensive or more

intensive?, the students found that the Moodle platform had added to their learning experience in the Construction and Building Materials module. This was reflected in that over 55% of the students, as an average value of the two academic years, believed that the use of Moodle should be more or significantly more , while fewer than 3% on average wanted it to be less.

The authors were also interested in receiving feedback as regards the idea that part of the continuous assessment mark was assessed through Moodle. This represented 5% of the final grade for the academic year. In this regard, the feedback from students was highly positive, given that around 73% of the students, an average of the results of the two academic years, felt that it was a good or very good idea. The results are shown in Figure 9.

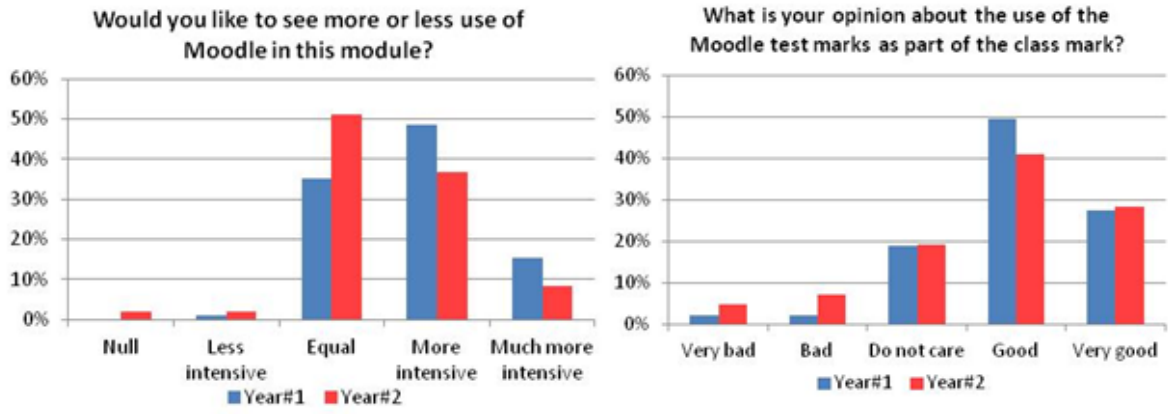

Figure 9. Opinion of the students on the use of Moodle

Lastly, in the last academic year three questions related directly to student motivation were added to the survey (the results are shown in Figure 10, Figure 11, and Figure 12). The first examines the question Does the use of Moodle or other lecturing and assessment techniques, such as co-assessment, foment your motivation to study the module? Figure 10 shows that in general terms students found all the activities carried out to be positive in enhancing their interest, and consequently, their results. Only around 27% of the students thought that use of the Moodle platform and other teaching and assessment techniques had motivated them almost either very little or nothing at all. Hence, around 73% felt that it had improved interest with an average, high or significantly high intensity. Figure 11 shows feedback on the question Did the cooperative learning technique help you to achieve a better understanding? In the case of cooperative learning techniques, the results were even better, since the percentage of students who thought

that these activities had not helped them to learn at all dropped to around 14%. Therefore, around 86% felt that it helped them to learn, and above 62% thought so at a high or significantly high level. Figure 12 shows student feedback about the influence of the co-assessed test on their own motivation, with the question Did your motivation to study the module increase when your daily assets were evaluated by one of your classmates? being asked. In this case, around 30% of the students thought that it had motivated them only a little or not at all. However, while around 70% said that it had significantly motivated them, around 20% felt so at a high or significantly high level.

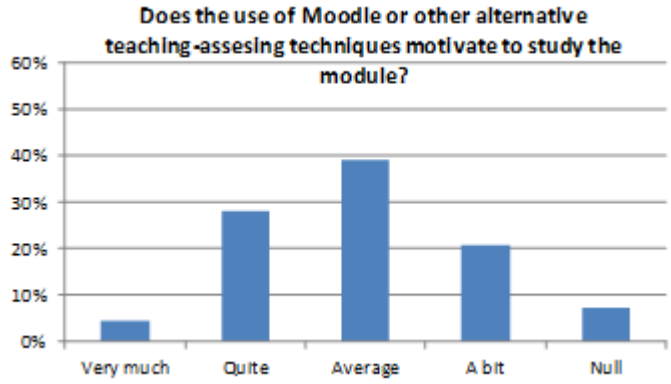

Figure 10. Opinion of the students on the lecturing and assessment techniques introduced

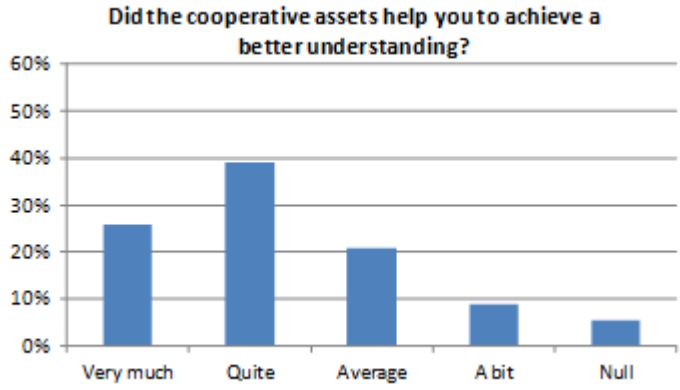

Figure 11. Opinion of the students on the use of cooperative learning

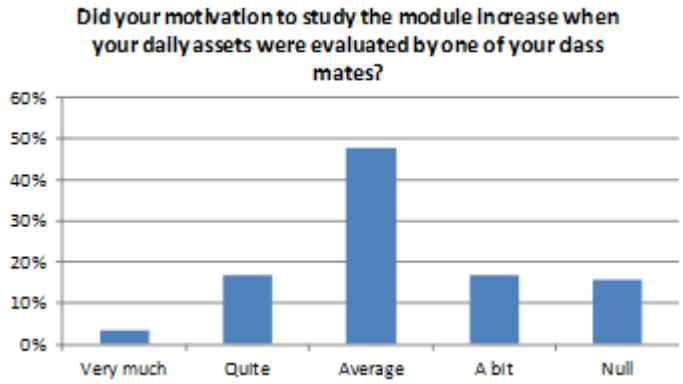

Figure 12. Opinion of the students on the influence of co-assessment on motivation

Additionally, a survey has been conducted by the lecturers involved in this work to obtain opinions on the learning-teaching techniques introduced. The opinion survey is based on the research in autonomous learning performed by Marcé-Nogué et al., (Marcé-Nogué et al., 2013), as the authors consider that the aspects they evaluated could be applicable to their case.

The two activities used were assessed by the lecturers thorough four parameters: the balance of the workload performed by the lecturers and the students (load), a suitable student level of academic maturity required for performing the activity (maturity), the effectiveness of the learning process (effectiveness), and the adequacy of the structure of the guided task (protocol). While this should be an indicator for lecturers and students to assess the student learning progress (effectiveness), the activity should also be a task of a guided and structured nature (protocol). Each activity was rated from 0 to 5, with the ideal case being considered five. Table 2 shows the results of the survey for the co-assessed test and the Moodle tests.

	Co-assessed test/ Moodle tests			
	Lecturer 1	**Lecturer 2**	**Lecturer 3**	**Truncated average qualification**
Load	4/4	5/2	4/2	4/2
Maturity	5/5	4/5	5/4	5/5
Effectiveness	4/5	3/4	3/4	3/4
Protocol	5/5	3/5	5/5	4/5
Total	18/19	15/15	18/15	16/16

Table 2. The final mark through continuous assessment

In the opinion of the lecturers, the load was insufficiently balanced in the case of the Moodle tests (a value of two), though in the case of the co-assessed test they considered that it was (a value of four). As regards the effectiveness in the case of the co-assessed test, it was considered moderated (a value of three). The maturity and protocol of both teaching activities and the effectiveness of Moodle tests obtained the results expected.

4. Conclusions

The conclusions extracted from the teaching experiences examined are those that follow. Regarding the first of the activities, the co-assessment method has fostered student motivation and compared the assessment criteria of the students with the lecturers. In all cases the criteria of the students were less stringent than those of the lecturers, though with small differences in the cases of the theory questions. The results obtained in the theory questions have shown that short and specific questions are answered better than theory questions in essay format. This suggests that students have difficulties in separating the essential from the remainder of the theory examined in the module. The greatest differences were found in the practice exercises, due to the greater degree of difficulty the students encountered in detecting errors in the approach and answer. Furthermore, the student level of performance achieved in these exercises was lower.

In the case of the Moodle tests, it could be concluded that the students found the questions to be more difficult than those corresponding to the difficulty level provided by the lecturers. Nevertheless, a high pass rate has been achieved in the two academic years in which it has been carried out. In addition, the marks obtained were significantly above the pass threshold in all cases, especially in the true-false test, even though it involved a penalty for incorrect answers. The feedback obtained showed that the style and understanding of the questions were both appropriate. Therefore, it could be argued that the formulation of the questions was not influential either in the difficulty perceived by the students or the provision of incorrect answers.

The most relevant conclusion, however, emerges from the finding that use of the Moodle platform provided students with a positive learning experience, both as a teaching-learning technique and as an assessment tool. The same could apply to the use of the co-assessment technique, from which most students have experienced an increasing interest in the study of the subject matter of the module. It is thus clear that students consider alternative teaching and assessment techniques, such as co-assessment and especially those based on cooperative learning,

significantly useful in obtaining both a better understanding and an enhanced learning experience from the Construction and Building Materials module taught by the authors.

The general opinion of lecturers involved in the survey conducted is that, in spite of initial difficulties (in particular, with the preparation of the Moodle tests), the experience has been a highly positive one. The downside associated with such initiatives, however, is undoubtedly that lecturing staff need to devote more time to their teaching which means a considerable increase in workload.

Acknowledgment

The authors gratefully acknowledge the financial support provided by Universidad Politécnica de Madrid by means of the educational initiatives projects.

References

Badia-Valiente, J.D., Olmo Cazevieille, F., & Navarro Jover, J.M. (2016). On-line quizzes to evaluate comprehension and integration skills. *Journal of Technology and Science Education (JOTSE)*, 6(2), 75-90. https://doi.org/10.3926/jotse.228

Bleske-Recheck, A., Zeug, N., & Webb, R. (2007). Discrepant performance on multiple-choice and short answer assessments and the relation of performance to general scholastic aptitude. *Assessment and Evaluation in Higher Education*, 32(2), 89-105. https://doi.org/10.1080/02602930600800763

Bravo, E.R., Amante-García, B., Simo, P., Enache, M., & Fernandez, V. (2011). Video as a new teaching tool to increase student motivation. 2011 *IEEE Global Engineering Education Conference (EDUCON)*, 638-642. https://doi.org/10.1109/EDUCON.2011.5773205

Bushell, G. (2006). Moderation of peer assessment in group projects. *Assessment and Evaluation in Higher Education*, 31(1), 91-108. https://doi.org/10.1080/02602930500262395

Carless, D. (2003). Putting the learning into assessment. *The Lecturer Trainer*, 17(3), 14-18.

Cheng, W., & Warren, M. (1999). Peer and Lecturer assessment of the Oral and Written Tasks of a Group Project. *Assessment and Evaluation in Higher Education*, 24(3), 301-314. https://doi.org/10.1080/0260293990240304

Coll, C., Rochera, M.J., Mayordomo, R., & Naranjo, M. (2007). Evaluación continua y ayuda al aprendizaje. Una experiencia de innovación en Educación Superior con ayuda de TIC. *Electronic Journal of Research in Educational Psychology,* 5(3), 783-804.

Darby, J. (2007). Evaluating course evaluations: The need to establish what is being measured. *Assessment and Evaluation in Higher Education*, 32(4), 441-455. https://doi.org/10.1080/02602930600898577

Dochy, F., Segers, M., & Sluijmans, D. (1999). The Use of Self-, Peer- and Co-assessment in Higher Education: A review. *Studies in Higher Education*, 24(3), 331-350. https://doi.org/10.1080/03075079912331379935

European Ministers of Education (1999). The Bologna declaration of 19 June 1999. Joint declaration of the European Ministers of Education.Available online at: http://www.bologna-berlin2003.de/pdf/bologna_declaration.pdf (Last access date: january 14th, 2006).

Felder, R.M. (1996). The warm winds of change. *Chemical Engineering Education*, 30(1), 34-35.

Gessa, A. (2011). La coevaluación como metodología complementaria de la evaluación del aprendizaje. Análisis y reflexión en las aulas universitarias. *Revista de Educación*, 354, 749-764.

Gibbs, G., & Simpson, C. (2004). Conditions under which assessment supports students' learning. *Learning and Lecturing in Higher Education*, 1, 3-3

Glaser, R., & Silver, E. (1994). Assessment, testing and instruction: Retrospect and prospect. *Review of Research in Education*, 20, 393-419. https://doi.org/10.2307/1167389

Jordi-Nebot, L., Pàmies-Vilà, R., Català-Calderon, P., & Puig-Ortiz, J. (2013). Enhancement in evaluating small group work in courses with large number of students. Machine theory at industrial engineering degrees. *Journal of Technology and Science Education (JOTSE)*, 3(1), 11-22. https://doi.org/10.3926/jotse.5 5

Keppell, M., Au, E., & Chan, C. (2006). Peer learning and learning-oriented assessment in technology-enhanced environments. *Assessment and Evaluation in Higher Education*, 31(4), 453-464. https://doi.org/10.1080/02602930600679159

MacAlpine, J. (1999). Improving and encouraging peer assessment of student presentations. *Assessment and Evaluation in Higher Education*, 24(1), 15-25. https://doi.org/10.1080/0260293990240102

Marcé-Nogué, J., Gil, LL., Pérez, M.A., & Sánchez, M. (2013). Self-assessment exercises in continuum mechanics with autonomous learning. *Journal of Technology and Science Education (JOTSE)*, 3(1), 23-30. https://doi.org/10.3926/jotse.5 7

Omar, S., Jain, J., & Noordin, F. (2013), Motivation in Learning and Happiness among the Low Science Achievers of a Polytechnic Institution: An Exploratory Study Original. *Procedia - Social and Behavioral Sciences*, 90, 702-711. https://doi.org/10.1016/j.sbspro.2013.07.143

Rodríguez-Largacha, M.J., García-Flores, F.M., Fernandez-Sanchez, G., Fernandez-Heredia, A., Millan, M.A., Martinez, J.M. et al. (2015). Improving Student Participation and Motivation in the Learning Process. *J. Prof. Issues Eng. Educ. Pract.*, 141(1), article number:04014005. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000209

Reyes, E., & Gálvez, J.C. (2010). Experiencias Docentes en Innovación Educativa como Mejora de una Enseñanza Tradicional de los Materiales de Construcción. *Formación Universitaria*, 3(4), 13-24. https://doi.org/10.4067/S0718-50062010000400003

Reyes, E., & Gálvez, J.C. (2011). Introduction of Innovations into the Traditional Lecturing of Construction and Building Materials. *J. Prof. Issues Eng. Educ. Pract.*, 137(1), 28-37. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000033

Ruiz, G., Gálvez, J.C., Benítez, J.M., Olivares, M.A., & Reyes, E. (2001). Hacia un Enfoque Científico-Tecnológico en la Enseñanza del Hormigón Estructural como Material de Construcción. *Primeras Jornadas de ACHE sobre la Enseñanza del Hormigón Estructural, Madrid*, pp. 265–270.

Stephens, R., & Richey, M. (2011). Accelerating STEM Capacity: A Complex Adaptive System Perspective. *Journal of Engineering Education,* 100(3), 417-423. https://doi.org/10.1002/j.2168-9830.2011.tb00020.x

Sun, J.C.-Y. (2014). Influence of polling technologies on student engagement: An analysis of student motivation, academic performance, and brainwave data. *Computers & education*, 72, 80-89. Available online at: http://www.cidui.org/revistacidui/index.php/cidui/article/view/605 https://doi.org/10.1016/j.compedu.2013.10.010

Taras, M. (2002). Using assessment for learning and learning from assessment. *Assessment and Evaluation in Higher Education*, 27(6), 501-510. https://doi.org/10.1080/0260293022000020273

Von Glasersfeld, E. (1998). Anticipation in the Constructivist Theory of Cognition. International Conference on Computing Anticipatory Systems Liège, August 11-15, 1997. Published in D.M. Dubois (Ed.). *Computing anticipatory systems* (38-47). Woodbury, NY: American Institute of Physics. https://doi.org/10.1063/1.56332

Woolf, H. (2004). Assessment criteria: Reflections on current practices. *Assessment and Evaluation in Higher Education*, 29(4), 479-493. https://doi.org/10.1080/0260293310001689046

Published by OmniaScience (www.omniascience.com)

Journal of Technology and Science Education, 2017 (www.jotse.org)