Active learning in Mathematics Lab classes for Engineering students

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Abstract

Polytechnic University of Valencia (UPV) is a Spanish university focused on science and technology. Founded in 1968 as the Higher Polytechnic School, UPV became a university in 1971, but some of its schools like the Design Engineering School (ETSID) are older than 100 years.
One of the ETSID delivered degrees is Aerospace Engineering where from its outset in 2005 the use of innovative teaching methods based on technology has been promoted.
On the other hand, UPV started to build up a platform known as PoliformaT, which includes several tools such as document distribution, live chat, assignment uploads and online testing among others. This platform was available for all, UPV instructors and students.
In our case this technological change was taken not as an obligation but as an opportunity to move on and try to improve and modernize the learning possibilities of our students. Thus we started its use within our lab Mathematics classes in the first year of the Aerospace Engineering degree during 2007/2008 in which we were using DERIVE as mathematical software.
The following academic year we extended the use of PoliformaT from the beginning to all laboratory classes as well as in the corresponding exams.
During 2010/2011 we have started the last version of MATHEMATICA available at that time, MATHEMATICA 7, as mathematical software and have fully implemented the use of the platform in laboratory classes as well as in the corresponding exams. Students' motivation and perception to the subject has changed with the use of these new technologies and they are performing and learning satisfactorily. As a consequence their outcome has improved compared to that in the past.
Results and opinions from the students have been obtained and are also presented.

1. Introduction

The Bologna process was designed in the European Union to introduce a system of academic degrees that were easily recognizable and comparable, promoting the mobility of students, teachers and researchers and incorporating the European dimension into higher education [1].

Spain has supported this civic project since the beginning by establishing the institutional and legal foundations required to implement a university system where intellectual principles and professional capacities are recognized [2].

Polytechnical University of Valencia has been immersed in a changing process in order to adapt its degrees to this setting. In particular the BEng in Aerospace Engineering delivered at ETSID has been transformed from a 5 years degree into a 4 years degree. This has meant a deep

transformation of some subjects. One of these subjects is Mathematics which has moved from having 15 credits (10.5 cr. Theory/Problems & cr. 4.5 Lab Practice) to 12 credits (9 cr. Theory/Problems & 3 cr. Lab Practice). Hence Mathematics Lab classes realized with MATHEMATICA [3, 4] have suffered a 1/3 reduction in the number of credits assigned.

Hence using the educational platform known as PoliformaT and developed by UPV from the Sakai educational platform [5], in the last years has smoothened our transition during this last academic year in which we have been obliged to get most of the ICT in order to improve and modernize the learning possibilities of our students.

In this paper we will show some of the changes we have taken in the subject and some of the tools that we have used in order to fit it into the new environment.

2. Adapting Mathematics Lab classes to the new setting

We think that the 1/3 reduction in Mathematics Lab classes – from 90 minutes each week during 2009/10 to 60 minutes during 2010/11-- should not bring out a reduction in the contents covered since Mathematics is a basic subject and all topics treated here are really needed in the student's curricula.

Therefore adaptation cannot be just a temporal one but a comprehensive one:

- The student must work more outside the classroom, and less inside the classroom.
- The teacher must schedule the activities that the students are going to make on their own, so that they can be done independently.
- The teacher must organize the assessment of such activities.

The authors have adapted the contents and the sequencing of the lab sessions with the aim of making this process efficient. So, during this last year the students have been requested to prepare each session by themselves, the corresponding mathematical concepts having been covered in theoretical/practical classes in advance.

With this goal and by means of the Resources tool of Poliformat, the lecturers provide on a weekly basis the material with the information needed so that the students learn to solve the type of exercises to be worked and assessed in the following session.

Fig 1: Resources screen at PoliformaT

This way the student uses his recently mathematical knowledge achieved in the classroom, the aforementioned instructions and the MATHEMATICA software to do his assigned homework, either at home or at some of the free access lab rooms available at ETSID.

In addition to the instructions the students are also given a list of exercises that enable them to practice and check that they have really understood the topic.

During the first 20 minutes of each lab session are able to clarify any doubt that they might have and the lecturer shows the solution of the proposed exercises. During the last 40 minutes the students have to solve a number of exercises provided by means of the Tests & Quizzes tool of PoliformaT.

Fig 2: Tests & Quizzes screen at PoliformaT

These exercises are to be done individually by each student in the lab classroom while the instructor is available to assist the students that ask for it.

If desired it is possible to control the computer from which each student is doing his work by changing the Settings output at each session. In Fig 3 we find the screen of PoliformaT with a configuration in which the IP addresses allowed to interact are restricted, as well as the corresponding login, password and time selected for the exercise.
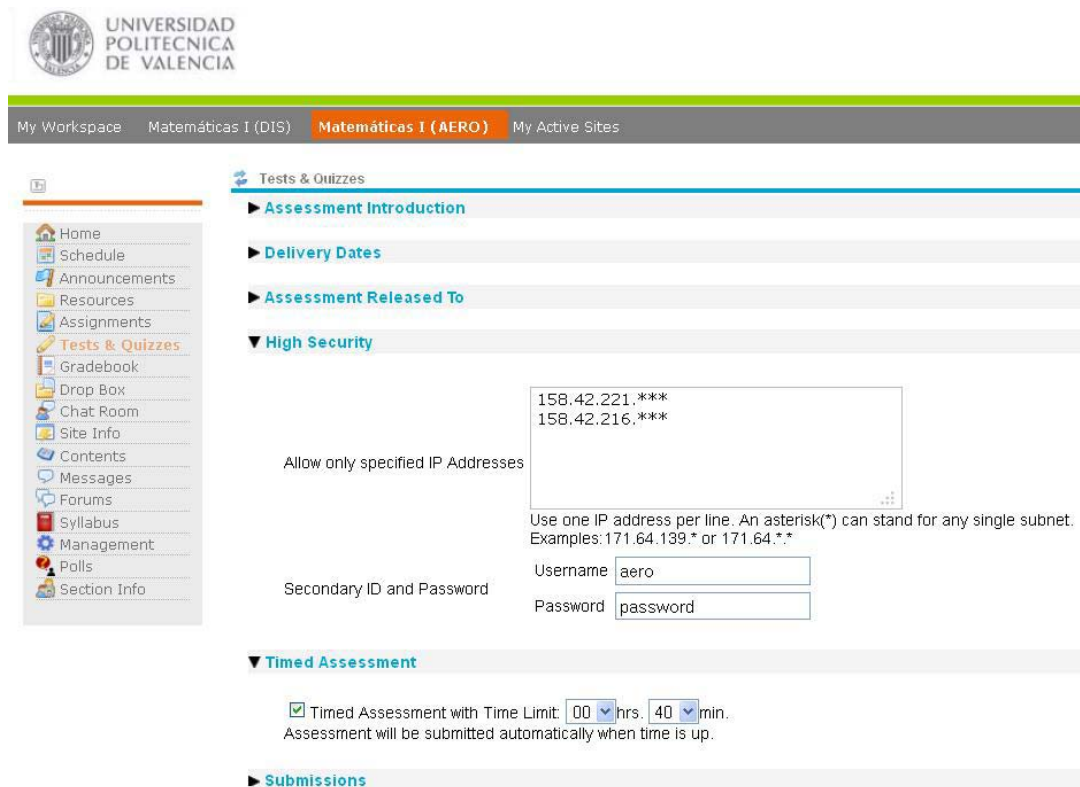
Fig 3: A test setting with PoliformaT.

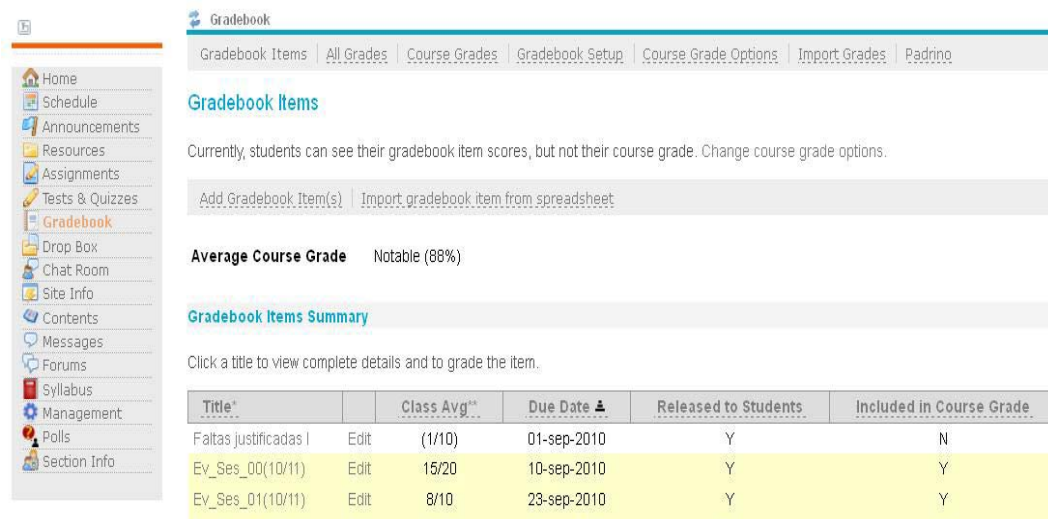All grading results may be automatically uploaded in a 'Gradebook' tool of PoliformaT.

Fig 4: A Gradebook screen with PoliformaT.

Selecting any session from the Gradebook we are able to see, filter and reorder the marks obtained by the students.

3. Marks

Next table contains the marks obtained by the students during 2009/10 and 2010/11 in the lab sessions.

Table 1: Lab session marks comparative

	$M1$	$E1$	M2	E2
2009/10	8.2	4.6	8.3	5.7
2010/11	9.4	5.2	8.8	n/a

In Tab 1, M_i stands for the mean obtained by the students during the weekly sessions in the classroom during semester i, E_i stands for the mean of the marks obtained by the students in individual exam during semester i.

At the time of submitting this paper students have not done the E2 exam and therefore is not available. This will be provided during the conference.

We may note that mean of the weekly sessions as well as the marks obtained in the exams have increased during 2010/11 in which the students had to prepare the lab sessions beforehand.

4. Students perception

During the course 2009/10 the first two authors consulted the students opinion on different issues in a completely anonymous way by means of the Polls tool [6]. The authors have used this tool again and repeated the same questionnaire during 2010/11. In the following tables we may compare the students' opinions

The first two questions are concerned with the organization of the practices itself. The questions, possible answers and results are shown in the Table 2.

Table 2: Perception of students on laboratory practice in general

Do you think that the number of practices undertaken is adequate to learn the content of the subject?	09/10	10/11
Yes	92 %	73 %
There should be more	4 %	14 %
There should be less	4 %	14 %

Do you think the assessment of laboratory practice in each session fits to the content developed in class?	09/10	10/11
Much	34 %	8 %
Enough	51 %	67 %
Little	15 %	26 %

It is clear that the vast majority of students have thought that practices that had been done were very consistent within the course. Even though we will make later some final comments it may be worthwhile that during 2009/10 we had 90 minutes lab sessions and the students did not have to prepare the sessions in advance and were able to learn about it at class and the authors' opinion is that 2010/11 students have understood the question as whether the each

session fits to the content developed during the first 20 minutes when the instructors really referred to the content studied in previous theoretical and problems classes

A second block of questions searched for the opinion of students about the benefits of using the platform in the laboratory practice sessions (Table 4).

Table 3: About the use of PoliformaT in laboratory practices

Using PoliformaT in the laboratory practices:	09/10	10/11
Makes easier to learn the contents of the subject	48 %	48 %
Makes more difficult to learn the contents of the subject	4 %	5 %
Makes no difference in learning the contents of the subject	48 %	47 %

I think that being evaluated in lab practice through PoliformaT at the end of each practice session is good for my learning:	09/10	10/11
Yes, it's good	73%	59 %
No, it is not good	8 %	11 %
I don't know	19 %	30 %

According to the results we see that the students do not have a negative perspective towards the use the platform (4-5% think it may more difficult using it and just 8-11% do not like being evaluated at the end of each session).

The following two questions try to seek the perception of the students on the MATHEMATICA software used and a possible transfer of this form of evaluation to Theory-Problem (Table 4).

Table 4: Students'opinion on MATHEMATICA and transferring the method to T/P

I think that the MATHEMATICA software:	09/10	10/11
Enables to understand better the theoretical part of the subject and I will be able to take advantage from it in the future	79 %	61 %
Is a tool I will use just for calculations	17 %	36 %
Whose learning does not reward, there are other software easier to use	4 %	3 %

Do you think it would be a good option that sessions of Theory-Problems carried out with a PoliformaT test during some day each week?	09/10	10/11
Yes, it would be good	57 %	48 %
No, it would not be a good idea	24 %	25 %
I don't know	18 %	27 %

Teaching in English is a relevant issue at Aerospace Engineering. Thus a final question was raised on this topic (Table 5).

It is worthwhile noting that classes were given in Spanish during 2009/10. However one of the teachers taught in English during the first semester of 2010/11, year in which a high academic performance project was implemented at ETSID with the aim of delivering at least 50% of the whole instruction in English.

Table 5: Students'opinion on being lectured in English

I think that receiving classes in English in 1st year is interesting:	09/10	10/11
Yes	31 %	33 %
No	31 %	22 %
Yes, with a progressive increase to the English teaching	38 %	45 %

Perhaps it should be wise splitting the group into English and Spanish teaching. The fact is that more than 2/3 of students were not happy to receive all the teaching in English from the very beginning versus 1/3 that supported the idea of receiving instruction in English from the very beginning.

5. Conclussion

During 2009/10 the students were able to prepare end learn on the topic to be worked out during each session in the first part of the class while during 2010/11 the students have been required to work before each session by themselves.

From the polls realized and the results obtained we find that the opinion on the lab classes has worsened, however we find the paradox that the results and their performance has improved.

Perhaps their impression comes motivated by their feeling that it would be better to learn and work the whole practice in the classroom and be able to solve immediately any doubt they might have. However it seems that this extra work for them has been rewarded in their overall performance.

In Table 2 the students express that the practices are appropriate to the course content and subject. In Table 3 we may see that most students think that makes easier (or there is no difference) to learn the contents of the subject by using PoliformaT, and think that being evaluated in laboratory practice through PoliformaT at the end of each practice session is good for their learning.

Finally, Table 4 shows that students are happy with the mathematical software used and consider a good idea to use the platform in order to improve its understanding of the theory-problem sessions

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