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The importance of knowing the starting level of knowledge

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Abstract

The aim of this work is to demonstrate the importance of the fact that from the beginning of the course students and teachers identify what is the initial knowledge level and the level that students must reach at the end of the course. This is important for the student because it will demonstrate the importance of the continuous assessment (Bologne methodology) and in the other hand, for the teachers to know the initial level of their students. It can give influence to detect deficiencies and solve them to a well ending course. This helps a lot to students with an initial lack of knowledge of the subject. This study carries out specifically in the Chemistry subject in the degree of Ingeniería de Diseño Industrial y Desarrollo de Producto (Industrial Design Engineering and Product Development) at Escuela Universitaria de Ingeniería Técnica Industrial (E.U.I.T.I.) of the Universidad Politécnica de Madrid (UPM).

Keywords

Chemistry, teaching-learning, educational innovation.

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1. Introduction

"Chemistry is all around you" as you can see in the video of the same title (http://www.youtube.com/watch?v=y6Zl7MsXbag) about the contributions of Chemistry at all areas of the society produced by The European Petrochemical Association (EPCA), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and International Union of Pure and Applied Chemistry (http://www.unesco.org/new/es/natural-sciences/science-technology/basic-sciences/chemistry/international-year-of-chemistry/).

The chemistry is, in spite of non being an essential subject in secondary education, absolutely important in all our surrounding living things. It has many applications in other scientific areas, such as medicine, materials technology, pharmaceutical industry, food industry, electronic industry, construction, environment,... It is necessary to point out that chemistry subject at high school curriculum in the engineering area, is not obligatory in 2nd course (*ORDEN ESD/1729/2008*). This fact joints with non-empathy from students to chemistry and causes many of them to enter the University with an almost non-knowledge of this subject. However in almost all degrees of UPM, chemistry is a compulsory subject in all the industrial first year degrees area (*http://www.upm.es/institucional/Estudiantes/Estudios_Titulaciones/EstudiosOficialesGrado*).

Chemistry teachers of first-year engineering degrees of UPM have created a platform called "Punto de Inicio" in the Virtual Campus (moodle), only for students enrolled on their first time in the subject (https://moodle.upm.es/puntodeinicio/niv/login.php) and a public one called Open Course Ware (http://ocw.upm.es/apoyo-para-la-preparacion-de-

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los-estudios-de-ingenieria-y-arquitectura/quimica-preparacion-para-la-universidad) for the retaken students in order to solve the lack of chemistry knowledge in the previous years.

The "Punto de Inicio" platform was created in the UPM to help students in basic subjects like: mathematics, physics, chemistry, English and technical drawing, in order to inform the student what should be the minimum knowledge needed to follow that subjects. In this platform questions of different levels of difficulty and with multiple choice options are proposed. All of them are offered in moodle and are free for all students enrolled in the first course. Students can access from July after their enrolment in the University. (Figure 1).

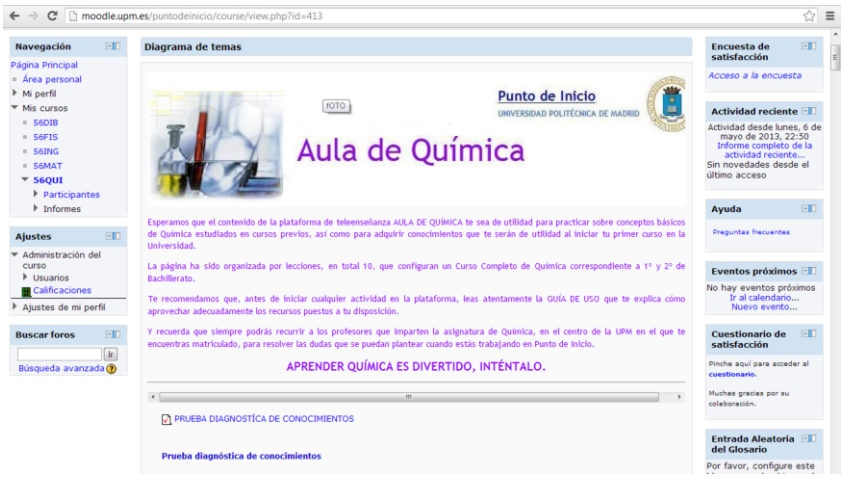

Figure 1. Image of the "Punto de Inicio" plataform.

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Our School Grade degrees have been introduced in 2010/2011 academic year and since the first moment the student has been informed about the existence of this platform, inviting him to use it. However, unfortunately, it has not got much participation.

Currently the E.U.I.T.I offers five degrees: Electrical Engineering, Industrial Electrical Engineering and Automation, Industrial Design Engineering and Product Development, Mechanical Engineering and Chemical Engineering. In its five undergraduate degrees, first-year chemistry teachers have agreed to develop an initial diagnostic test of Chemistry of the "Punto de Inicio" platform. This test was common to all students and performed in their first day of class in September. In this paper the results achieved by the degree in Industrial Design Engineering and Product Development are presented.

2. Methodology

Among the five degrees taught in EUITI, we have chosen the students of the degree in Industrial Design Engineering and Product Development. These students enter in our school with the highest cut-off mark in the PAU (Table 1), however, as they mostly did not take chemistry on secondary school they generally have got less knowledge on it (*http://innovacioneducativa.upm.es/observatorio/ficha-estudio/informe-demanda-upm-2011-12*).

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Table 1. Scores required to enter the E.U.I.T.I's degree programs. *(Course 2012/13)*

Grade in	**Score**
Electrical Engineering	8.378
Industrial Electronics and Automation Engineering	9.733
Industrial Design Engineering and Product Development	10.664
Mechanical Engineering	10.356
Chemical Engineering	7.907

To develop this experience, the "Punto de Inicio" platform has been used as a starting point. When the student enters in "Punto de Inicio", he can carry out some questionnaires, both to review and to know their level of knowledge. The questions proposed in the Virtual Campus (moodle) tell the student what should be the minimum level of knowledge they must have in chemistry in order to take the degree subject (Figure 2a). It is interesting to remark that the issues proposed in "Punto de Inicio" are classified into three levels depending on the grade of difficulty. Each question has four possible answers to choose, obviously the response time is restricted once the quiz starts, as it is shown in Figure 2b for the theme of atomic and molecular structure. The student can pre-select the level of the test he wants to do and he can also make as many quizzes as he wants as the questions are randomized and the possibility of doing it again is minimal.

Nevertheless, as the application in moodle is little demanded by students, teachers of first-year course in Chemistry of the five degrees taught at EUITI (UPM) agreed to develop a diagnostic test including questions of the "Punto de Inicio" where wrongness

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do not subtract points in the final marks. The idea of use these questions is that those students who had used the chemistry platform feel encouraged and motivated to see that their work was being rewarded and, on the other hand students who had not used the application will be feel invited to use it.

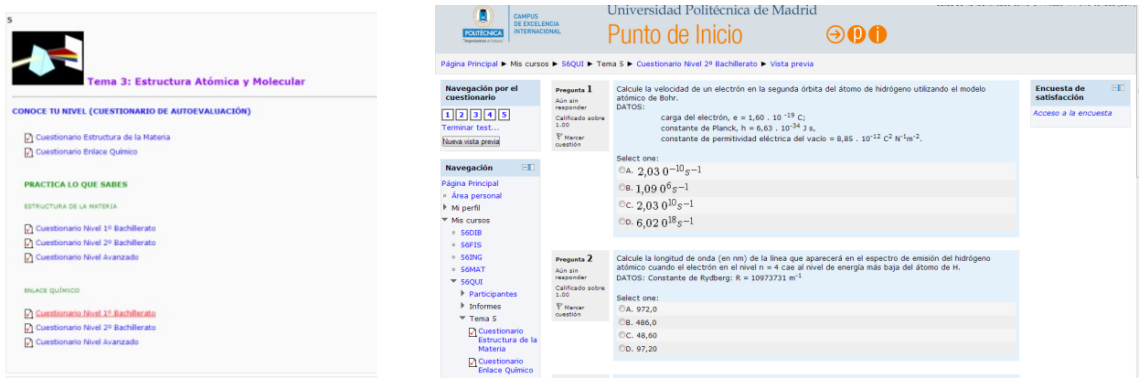

Figure 2. a) Image of the test of the theme of atomic and molecular structure.
b) Model of questionnaire.

Therefore, since the first day of class, after giving them the rules of the course, explaining the schedule with instructional design and the planning of learning activities, the students made the diagnostic test of previous knowledge of 20 questions. This test was performed anonymously in the classroom.

An active methodology was applied along the course, consisting of: Cooperative Actions (each two weeks group works tutored by the teacher) (Barajas 2008), Solving and Delivery Problems (individual problems which are solved in the classroom by the teacher or by a student), Individual preparation of two simple themes closely related to

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the initial summary, in these themes a number of very important questions are included to focus the student on the relevant items, fixing the day to correct them in the class.

As chemistry is an experimental subject, students attend to Laboratory every two weeks, trying to apply theory to practice. Likewise class settled test and exams are performed, to establish their knowledge and to set goals along the course goals along the course.

The final exam, common to all students in the five bachelor degrees, takes place in January.

3. Results

The number of students in Industrial Design Engineering and Product Development, who performed the diagnostic test were 76 students. The test results were not very satisfactory, as the 85.5% of the students who made it do not pass the test. The highest average mark obtained by any student in the class was 8.21 (Figure 3).

The test results were reported in a few days letting them know the basic knowledge they should have to follow the course. Therefore, in addition, in the first week of the course students were given a sheet with the minimal knowledge that they should know from their previous secondary school. Students should prepare a short work of these contents in order to revise them and thus be aware of what they need to know to start and carry on with the subjects, for example: Periodic Table of the elements, formulation, stoichiometry, concentration units, etc. These contents would not be developed in the classroom but if they have doubts they could assist to tuitions.

We have found that it has been very helpful to make students know their lacks in Chemistry. Chemistry is based on symbols, formulas and terminology, if anyone is not

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aware of these things from its beginning, little or nothing can be done to understand and learn the subject. Unfortunately, in our classrooms we have got a lot of students with a great unknown in chemistry.

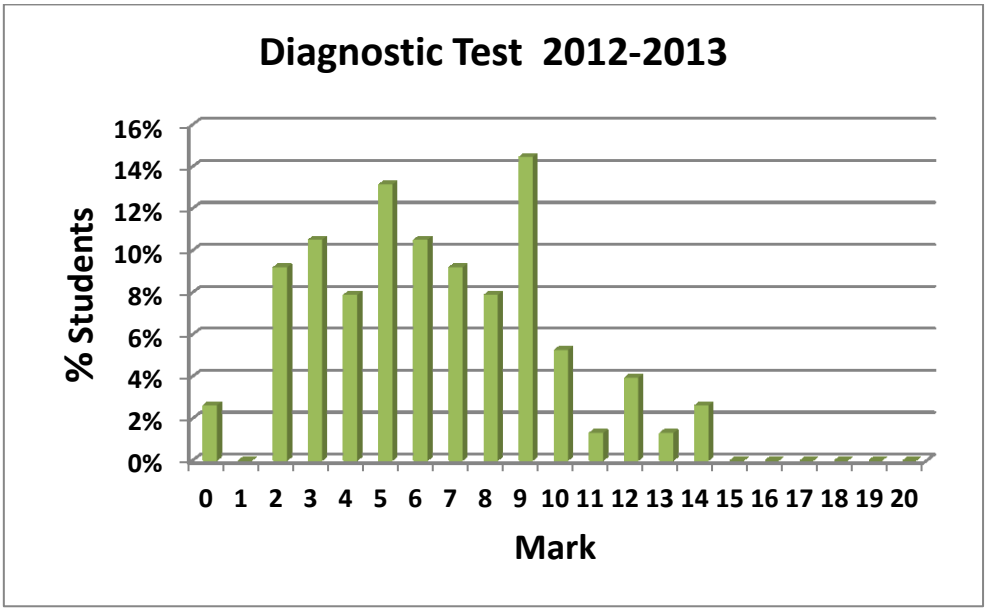

Figure 3. Number of correct answers in the diagnostic test

The above mentioned activities were scheduled and the time spent on each of them was established based on the number of ECTS credits according to the subject academic guidance. In Table 2, the credits dedicated to the different activities in Chemistry are shown and also compared with other subjects in the same semester of Degree in Industrial Design Engineering and Product Development (http://www.euiti.upm.es/EUITIndustrial/Estudiantes/EstudiosTitulaciones/ETTitulosGrado/ETTitulosOficialesGrado/GradIngDisInd/a9c9d51cf6069210VgnVCM10000009c7648aRCRD).

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Table 2. Number off credits dedicated in each basis subject of the first semester

	Calculus	**Linear algebra**	**Physics I**	**Chemistry**	**Technical drawing and computer aid design**
Theory	1.2	1.2	1.2	1.2	0.6
Problems	1.2	1.2	1.2	1.2	1.2
Laboratory	0.6	0.6	0.6	0.6	1.2
Personal study	2.8	2.8	2.8	2.8	2.8
Exams	0.2	0.2	0.2	0.2	0.2
Total Credits	**6**	**6**	**6**	**6**	**6**

After the implementation of the plan of studies, teachers that tutors the different subjects have been requested to check the credit number of it. Finally, it was established, that it was very similar to the initially proposed number of credits (Table 2) [10].

In order to confirm the previous data of Table 2, students have been pollen about the ECTS measurements. For this purpose, a survey was done, asking students the number of credits that had been used to study each subject making the different activities of it in the first semester (see Table 3).

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Table 3. Number of ECTS credits of student work, in his opinion, for each subject of the first semester.

ECTS	Calculus	Linear algebra	Physics I	Chemistry	Technical drawing and computer aid design	Total credits
According to plan of study	6	6	6	6	6	30
According to students	5.9	5.8	7.0	6.8	6.3	31.8

Comparing Table 2 and 3 shows that ECTS applied to each subject and work for their development are well dimensioned. The discrepancy observed in the chemistry subject could be due to the low level of knowledge of the students. This fact implies that students should make a greater effort in chemistry than in other subjects to achieve the required level at the course effort to achieve the required level at the course.

The total number of students enrolled in the subject was 106, Table 4. It is interesting to remark that not all of them have followed the ongoing assessment, because as it is established in the course's teaching guide (http://www.euiti.upm.es/EUITIndustrial/Estudiantes/EstudiosTitulaciones/ETTitulosGrado/ETTitulosOficialesGrado/GradIngDisInd/a9c9d51cf6069210VgnVCM10000009c7648aRCRD) students can chose exclusively for a final exam in January to pass the subject. However, 96.8% of the students who attended the final exam have followed the ongoing assessment. The data demonstrate low absenteeism rate obtained in the current

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academic year (7.55 %) (Table 5), it is interesting to observe that only 2.8% of those following the ongoing assessment give up.

Likewise, better results have been achieved over the previous year as it is reflected in the efficiency rate (42.45 %) and the success rate (45.92 %) (Table 6). Both rates are improved if we compare the results achieved by students enrolled in the course by first time, which are those that mostly follow ongoing assessment, reaching a success rate of 50% on first examination. Most of the students belonging to this group are those who performed the diagnostic test at the beginning of the course, since students that fail chemistry the year before and repeat it incorporated to the class later.

Table 4. Students of chemistry of the degree in Industrial Design Engineering and Product Development

	Enrolled	**Not presented**	**Presented**	**Faillers**	**Passed**
Continuos assesssment	94	3	91	47	44
Give up ong. ass.	12	5	7	6	1
Total	**106**	**8**	**98**	**53**	**45**

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Table 5. Percentage ratio between the number of absent students and the number of students enrolled in the course

Nº enrolled students		Nº absent students	Absenteeism rate
Once	64	5	7.81
Twice	31	1	3.23
Three or more times	11	2	18.18
Total	**106**	**8**	**7.55**

The fact of reaching the 50% in the rate success students that study this subject by the first time and remembering that only 14.5% of them pass the diagnostic test pleases and encourages us to continue working in this direction for the future academic years.

Table 6. Percentage ratio between the number of passed students and the number of students presented on their first time and resitted.

Nº of attemps	Presented	Passed	Success Rate
Once	60	30	50.00
Twice	24	10	41.67
Three times	9	2	22.22
Four times	5	3	60.00
Total	**98**	**45**	**45.92**

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4. Conclusions

The results achieved during the development of this course are very encouraging. The purpose of this project is that a student at the beginning of the course be aware of his knowledge level and provide him appropriate tools to learn forcing him to study more deeply the concepts that he did not understand. In single words, he will make a better distribution on his study time and work. This also allowed teachers to have a better planning of student workload emphasizing the non-clear concepts. Furthermore, the calculation of ECTS credits from the students fits well with the one proposed by the teachers, although students' appreciation were slightly higher. Despite the students' low level of knowledge in chemistry shown in the diagnostic test, the workload of the student was well sized and did not suppose them an enormous extra work. Obviously those students with lower level have had to study harder.

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ORDEN ESD/1729/2008, de 11 de junio, por la que se regula la ordenación y se establece el currículo del bachillerato.