Engineers, are marks important?

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Abstract *— There are different aspects that have an influence on student motivation: necessity of good marks, self-esteem, increasing knowledge and ability, getting short, obtaining medium and long-term objectives, applying knowledge in a real way, feeling that they are studying what they want, teacher attention and help, etc. These aspects can enhance or weaken student motivation depending of their use. Polls indicate that marks are the most important aspect for our engineering student motivation. This goal impedes and makes the other objectives difficult, like learning.*
We have developed a new experience in a final course lesson of Telecommunication Engineering. Before this experience the evaluation method was based on a final exam (80%), class work (10%), presentation (10%).According to polls, students consider that their effort was too great for the results obtained, and they prefer other optional lessons that increase their main marks. Now, we use an evaluation method where the student starts with a 9 out of 10 and the evaluation of the remaining 10% is based on the presentation. This method allows for the promotion of other objectives without influencing their percentile marks. We analyze how this evaluation method affects student motivation in comparison with the traditional evaluation method and how it affects student performance.

Index Terms *—curriculum, evaluation, interest, marks, motivation*

MOTIVATION

Academic motivation is a key factor in the teaching-learning process. According to [1] it can be considered as a collection of processes involved in the activation, conduction, guide and persistence of behavior. Motivating a student means to show him the path, to guide the student, guaranteeing that the required stops are followed in order to enhance and optimize the link among teaching and learning. Other authors prefer to define motivation from the perspective of a push and pull controlled by the teacher. Meece [2] considers that motivation is to help pupils and students in achieving their goals satisfactorily, following the teacher's approach. The expectation of the teacher about student activities and what students are willing to do might not match, not even intersect. To motivate is to achieve a common purpose, common goals, between teachers and students. These two definitions represent a small sample of work done about motivation by researchers, with different theories: self-determination [3], attribution [4], self-worth [5], expectancy-value [6] and goal theory [7][8].

Every researcher believes motivation is a key factor in the learning process, but their theories differ in the key factors for motivation. According to Dweck and Leggen, setting concrete goals implies a change in attitude against obstacles. In the learning process, individuals increase their level of effort and their willingness to engage in tasks proposed when a clear goal is set. We can divide goals or objectives into two families: *performance*, to demonstrate competence to others, and *learning*, to develop competence. Furthermore, goals can be considered as the materialization of incentives, which are divided into two categories according to the creator of the incentive: *intrinsic*, personal interests in learning, and *extrinsic*, external rewards or effects. Intrinsic incentives have a great dispersion between undergraduate students due to the diversity in origin, tastes, interests, personal context… The most common incentive for undergraduate students is an external one, forced by the university: grades. As individuals progress in the educational system, from school through high school to university, extrinsic incentives gain in importance against intrinsic incentives [9].

Some authors have proved that extrinsic rewards can undermine intrinsic motivation. It first appeared in 1971 [10] and the conclusion has been highly controversial since then. For example Cameron and Pierce [11] did a meta-analysis concluding that the undermining effect was minimal and largely inconsequential for educational policy.

However, more recent meta-analysis [12][13][14] disagree with the process followed and they assure that its conclusions were incorrect.

The main concern of undergraduate students is to pass or not to pass. Their goal is to pass subjects, optimizing the ratio grade/effort. Learning and developing capabilities are pushed to the background. They come to classroom strongly motivated to pass the subject and it is difficult for teachers to foster the influence of their intrinsic incentives in their motivation to enhance the learning process.

The goal of this research is to evaluate the effect of grades in engineering undergraduate students: motivation, learning and attitude.

CURRENT SCENARIO

In order to fully understand the motivation of the evaluation method presented in this paper, the current context of the Spanish Public University Education System in general and particularly of the Degree of Telecommunication Engineering of the Universidad Politécnica de Madrid, should be taken into account. It is not the purpose of this paper to extrapolate the results of this experience to other situations or contexts, but to present it as an experiment that fits this scenario and may help us to learn more about it.

Education context

Spanish undergraduate students wishing to progress to public University, must take an entrance exam called Selectividad once they have finished High School. The purpose of this examination is to serve as a selection criteria in order to enter University. Undergraduate students fill a list of degrees and Universities preferences and are arranged by the marks obtained in this exam, in order to assign them in one of the chosen Universities. As each public degree has a finite number of places, only students with best marks will be able to enter their first option University.

However, in the last decade in Spain, there has been an increase in the number of public Engineering Universities. The higher offer of places does not match the students' demand for these degrees. As a result, many Engineering Universities do not cover all public places, and all undergraduate students having passed the entrance examination, whatever their marks, are allowed to enter Engineering Degrees. Even though the Degree of Telecommunication Engineering of our University is one of the less affected, the entrance mark dropped from a 8.4 on 10 on academic year 2002/2003 to 6.88 on academic year 2009/2010, even though the number of places offered decreased from 350 to 300.

Engineering Degrees not adapted to the EEES in Spain, consist of five academic years, each of which has a different amount of subjects. In the particular case of Telecommunication Engineering of the Universidad Politécnica de Madrid, the degree has a total amount of 373 credits. One credit is equivalent to 10 hours of class and the average number of credits per subject is 6. To pass a subject a student must obtain at least a mark of 5 out of 10 and, in the curriculum of the Degree of Telecommunication Engineering of this University, attendance to classes is not compulsory, nor has any impact on marks. The first 178 credits, the equivalent to three first years, consist mainly of compulsory subjects. Once on their fourth year, students choose the core subjects of an itinerary that leads them to one of the five topics of specialization of this Degree.

Spanish Public Universities are forced by law to provide mechanisms that ensure the appropriate progress of undergraduate students. In the case of the Universidad Politécnica de Madrid, undergraduates willing to stay at University must at least pass 6 credits in their first year and 36 credits in two years. Even though in the particular case of the Degree of Telecommunication Engineering of our University, the pupils affected by these rules do not reach a meaningful number (in fact, only the 0.05% of students are dismissed), this system unavoidably forces students to focus their efforts in passing rather than in learning during their first year. Once they have reached second year, there are no further rules to ensure their progress, so ending the career becomes just a matter of time. The average time an undergraduate needs to end the degree is 7.1 years. During this process, a 6% of the pupils quit university. There is no system to truly help progress of pupils, and no tutorial support sessions for undergraduates not showing the right progression. An average pupil needs between 1.1 (for subjects understood to be 'easy') and 4.9 (for subjects understood to be 'difficult') examination periods to pass a subject. Academic averages marks of Spanish Engineering Degrees in general and particularly Degree of the Telecommunication Engineering of the Universidad Politécnica de Madrid are quite low, especially in the first academic years. Because students have to choose subjects for their specialization itinerary on the fourth academic year, it is common they use these subjects to raise their average marks (good to obtain best grants). In some cases this seems a result of a greater interest of pupils regarding this kind of subjects. In other cases, they just choose the easiest subjects.

Evaluation methods

Apart from the Education System context, evaluation methods have a lot to do with the academic results and the motivation of students [15]. The most extended evaluation method in the case of our Degree is the final exam. On most

subjects just the evaluation that pupils meet is a final exam taking place at the end of the semester. If they fail that exam, they have an additional examination session. Should the examination pass percentage be lower than 10%, pupils could go to another extra examination session. Only a low percentage of subjects (7%) try to use other evaluation methods such us continuous assessment or project-based evaluation methods. These attempts, however, often fail in compulsory subjects, as the number of pupils per professor is too high to establish a truly continuous assessment. The average number of students per group (that is, the number of pupils a teacher should take care of) is 70, even though this number may rise until 125 pupils per professor, which is the maximum stated by the University rules.

On most subjects, the key concepts to motivate students are skipped. Students are in a system where learning is just oriented to marks and exams, so they do not find their work meaningful and challenging. The evaluation does not take into account the improvement or the effort of students, but just the results obtained in a final exam. Motivation is left to the ability of each individual professor to offer students some challenging work in classroom. Moreover, as evaluation is only based on exams, students feel that assessments do not show their real knowledge about subjects, but their ability to pass the examinations.

Some professors try to do their best at motivating and teaching their students with continuous assessment evaluation methods in overfull classrooms, whilst other just keep with the traditional methods. Once reached the specialization subjects, the number of pupils per classroom decreases, so new methods can be applied. However, specialization subjects are usually split in two groups. Subjects in the first group apply properly continuous assessment and project-based evaluation methods, becoming challenging and as difficult as compulsory subjects. The second group of subjects does not apply properly the newer evaluation methods, and become easier subjects in which marks rise.

There are no common assessment rules and evaluation methods that should be applied to all neither subjects, nor measures (such as increasing the number of groups and thus reducing the group size) to provide professors with means for applying these methods. This increases the level and assessment disparity between subjects, lessens the students' and professors' motivation and disincentives the labor of teaching.

Undergraduate students' reaction to the scenario

The particular facts of this scenario lead the motivation of our undergraduates to be based on marks. While the professors' primary goals should be teaching so that their pupils could learn properly and apply their knowledge in the professional field, the pupils' main motivation is passing their exams. Pupils facing the evaluation of a subject are not worried about how much they have learned, but about what will the exam be like and which questions are most likely to be asked. This leads pupils not to try and learn the important concepts that will help them in their professional life, or the ones that interest them most, but the ones that will bring the better evaluation results. A considerable amount of pupils just try to accomplish the short-term goals that will lead them to the end of the career. First they try to pass enough exams on their first and second year to stay at University and then they keep on studying so that they can pass final exams. Once they reach the specialization itinerary, some pupils just choose the easier subjects so that their average marks rise.

The double-function of professors, the duality between the teacher and the judge of pupil's knowledge, is split apart. In most cases, the teaching activity takes place separately from the evaluation.

In the particular case of the Electronic Engineering Department of our School, the number of students choosing the Electronic itinerary in fourth course is low. Subjects such as the one in which the experience presented in this paper took place, are understood by the pupils to be difficult, and few of them enroll. Students often believe that the majoring should help them to increase their average marks, and as well-applied continuous assessment methods do not decrease the level of subjects, pupils believe their effort for passing is too great for the obtained marks. This belief often leads pupils to enroll other subjects that might not be that much interesting to them, but have higher passing percentages or higher average marks.

EXPERIENCE

Sample:

This experience takes place in a subject of fifth academic year (the last course) in Telecommunication Engineering at the Universidad Politécnica de Madrid. This subject is "Electronic Systems Engineering" for the curriculum in Electronics.

According to the curriculum described in the previous section, the students are who choose to pursue this subject, optionally in accordance with their interests. Such subjects are known as itinerary subjects and students must choose at least six of them. Due to the aforementioned causes (effort required, necessary work, grades average, and personal interest) the percentage of undergraduate students enrolled in the Electronics itinerary is low (approximately 10% of the last year undergraduate students, while the average number of enrollment in other itineraries is 35%).

This subject is only of theoretical content, and has an average enrollment in the years prior to the experience of 15 undergraduate students. The traditional assessment method is based on a single final exam that determines the 80% of the mark, and performing of volunteer works account for the remaining 20%.

The experiment is designed to be done for two consecutive years. The first part of this experiment is carried out in 2008/2009 with 17 undergraduate students enrolled in the subject and the second part in the academic year 2009/2010

with 19 undergraduate students enrolled. During the two years preceding the experiment (2006/2007 and 2007/2008), teachers of the subject have been keeping statistics.

Description of experience:

During the last two years carrying out this experience, it is offered to the students a choice between two different evaluation methods:

- **Traditional Method:** Like previous years, the knowledge acquired by students is assessed through a final exam. The mark obtained in this test determines the final 80% of the grade. The remaining 20% is based on an optional work (10% class exercises and 10% oral presentation).
- **Experimental Method:** With this evaluation system, all the students enrolled receive at least a score of 9 out of 10 in the subject. This minimum grade is independent of their effort, performance, results or marks. We can say that students start from the first day of course with a final grade of 9 out of 10. The rest of the grade (the remaining 10%) is evaluated through the oral presentation of a topic chosen by students. The execution and submission of this work is optional.

During the two years that the pilot project lasts, the undergraduate students have chosen the experimental evaluation method.

With this evaluation method all undergraduate students marks are high (at least 9 out of 10) what appears to solve one of the key concerns of students. However, another indicator that is being imposed (at least to apply to jobs abroad) is the rating based on percentiles. We still continue to adjust in a gradual way the grades of the undergraduate students varying the 10% of the grade according to the presentation work. Thus, undergraduate students who wish to have a high percentile and a high average grade have the opportunity to get it through the presentation of the optional work, and those who care only for the final mark (or simply pass) will cover their needs.

As a method of learning control and in order to compare results with previous years, we use the same final exam questions for partial exams. While the exam in the experimental evaluation method has no repercussion on the grade of the subject, the carrying out is obligatory for all the undergraduate students.

Indicators for the study:

During the development of this experience we want to observe several different factors which are detailed below:

- **Motivation:** As we can see in the first section of the paper, one of the greatest motivations of the undergraduate students enrolled in the studies is to pass and get the degree. Therefore, we can think that using this alternative evaluation method, the primary motivation is eliminated since all the undergraduate students get a grade of 9 out of 10. In this way ... how will this experiment affect the undergraduate students? Will motivation be lost as an incentive for learning? Will the main motivation be changed? Will it move to the percentile marks? If we remove the pressure from getting good grades, will undergraduate students maintain their interest in learning?
- **Class attendance.** By eliminating the final exam and knowing that the grades are not related to effort, work or knowledge ... how does this affect the number of undergraduate students attending classes? Will those who are only interested in passing leave the attendance to classes? What is the percentage of these students?
- **Obtained knowledge:** If we eliminate the pressure of the final exam, will students maintain the level of learning? We can believe that removing the "need" to study the undergraduate students will devote less effort. So will they learn less? Or on the other hand, eliminating the need to "pass", will students focus on learning the most interesting skills or the most required in their future work? Thus, is the obtained knowledge by the undergraduate students lower, greater or different?
- **Learned skills.** Taking a look at the professional world... are there new skills acquired? Are they valued? Are they different because of the experimental evaluation method?
- **Difficulty perceived by undergraduate students.** The topics list is maintained during the four years of study, as well as teachers who teach. Keeping these values constant, and only varying the method of evaluation, has the perception of difficulty changed? From the point of view of students, guarantying 9 out of 10, is the perceived complexity different?
- **Interest perceived by undergraduate students.** We want to measure how the experience affects the interest shown by students on the subject. As with the previous indicator, we keep constant the topics list, so the only variable is the method of evaluation. Will the perceived interest be changed? In which way?
- **Learning perceived by undergraduate students:** Keeping constant, as in the previous two cases, the topics list of the subject… Does the evaluation method affect to the learning perceived by the pupils? In what way?
- **Number of undergraduate students enrolled in the next year.** The application of this method of evaluation is carried out for two consecutive years. Assuming one of the conditions established in the previous section (students trying to improve their average mark in the last year), could we predict an effect triggered by the 9 out of 10 as minimum grade? Will this effect be real?

- **Special cases. "Parasites."** We must also assess what happens with one of the profiles of students described above. Those for whom the only motivation is the pursuit of the Engineering degree in Telecommunication. With the 9 out of 10 their goal are covered and they simply enroll the subject. Will this evaluation method increase the number of such students? In which percentage?
- **Role of judge of learning.** Linked to the previous point, what happens with students without any knowledge of the subject who obtain the minimum grade (in this case, 9 out of 10) without any effort? Is this situation fair? Are we eliminating the role of judge that the teacher usually has? Is this important? What consequences could have regarding to student, teacher, school or business?

RESULTS

We have obtained results from several different sources: exams, student polls, direct observation, subjective perceptions, and official academic data. Our experience has been developed from 2006/2007 academic year to 2009/2010 academic year. We use traditional evaluation for the first two years and new evaluation for the following two years.

First we want to analyze the influence of this evaluation over the student acquire knowledge. Real knowledge for the two first years is the mark average. This mark was based on a final exam (80%), class work (10%), and presentation (10%). In the following two years the mark is the average in the mandatory partial exams (90%) and presentation (10%). Partial exams had the same questions that the previous final exam, students just take the partial exams after the module explication. We want to find out the knowledge exactly without possible errors caused by different questions. Students do not have feedback about their partial marks (to avoid the motivation by student competition) but they knew our perception . Results are depicted in Figure 1 and we can see that they are very similar. We can check questions that need to learn data by heart are easier for traditional method students and, on the other hand, conceptual and system related questions are easier for the new experience students. Our perception is that students with the experimental method try to understand the global idea, avoiding data that is not important or relevant. Professors agree with this kind of teaching.

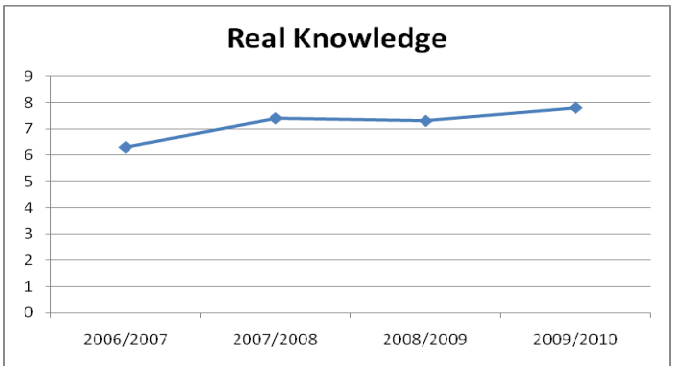

Figure 1

We also want to know the pupil perception about their knowledge and results are depicted in Figure 2. This is very surprising because is extremely equal, about 7.5 out of 10

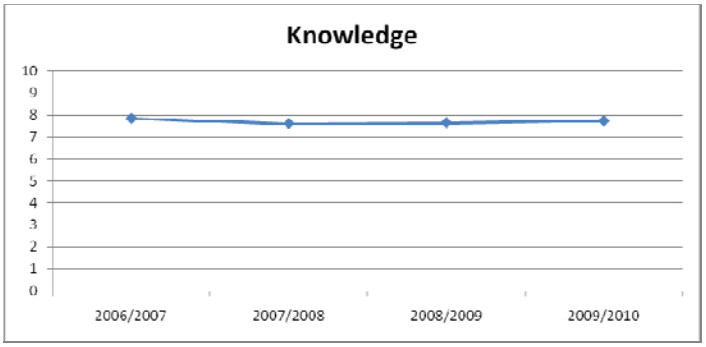

Figure 2

We use two parameters to measure students interest in the subject. First one is the class enrolling, because this is an optional subject and they can choose other subjects, and the second is class attendance over the total number of class register (Figure 3). We also use a poll to test students perception (Figure 4). Class enrolling increase from 15 to 19 in two

years and the percentage of people assisting to the class is almost the same. Course interest increases from 7 to 9 out of 10 too.

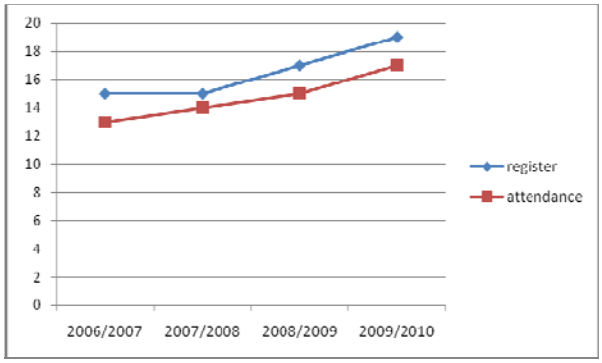

Figure 3

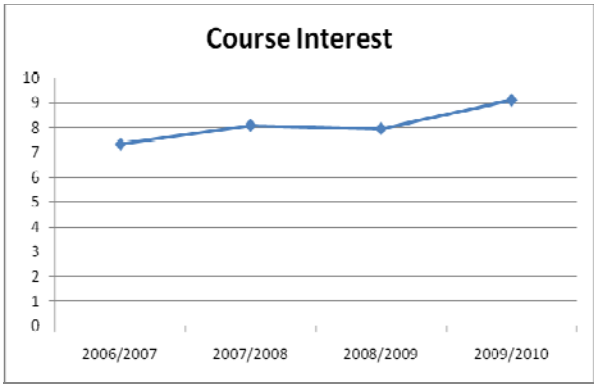

Figure 4

We use a poll and final marks to measure the subject difficulty. Results are in Figure 5 and Figure 6. In our opinion perceived difficulty is related to evaluation method, thus is, inversely proportional to marks, as we can see below.

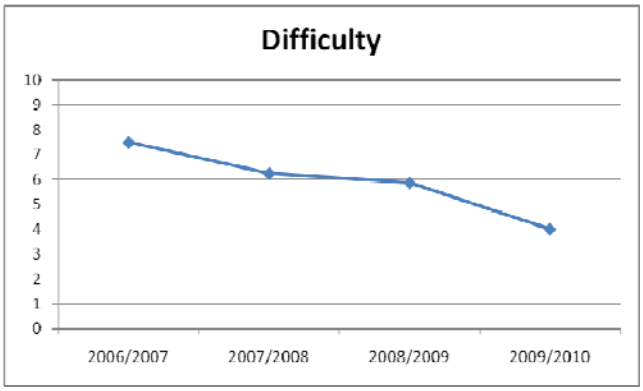

Figure 5

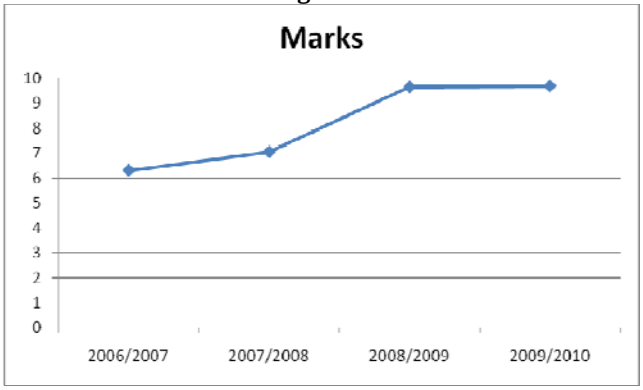

Figure 6

Finally we ask to our students their opinion about the evaluation method and in Figure 7 we have the answers. Of course, their decision is better than a one-sided decision. Furthermore, this evaluation method is more comfortable for all of them.

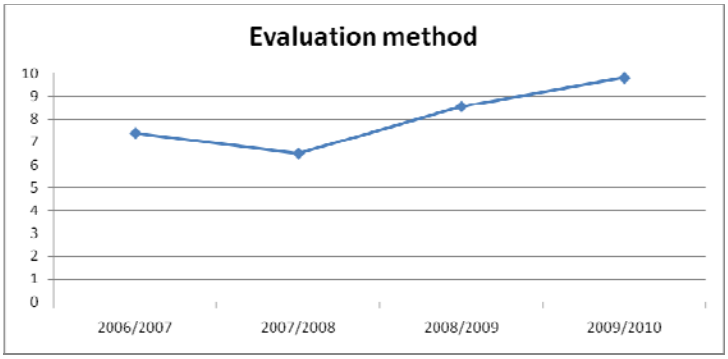

Figure 7

CONCLUSIONS AND FUTURE WORK

We will try to answer all the experience section questions based on previous results section. As we can see, with the new evaluation method the knowledge acquired by students is higher and their perception is almost similar. Class attendance is equivalent and parasites are the same percentage over the total. Also the students' interest is increasing, the difficulty is less and the evaluation method is greatly appreciated by students, and percentile has been saved with this new methodology. In our opinion these question have been answered. We want to denote that this experience is for a very specific scenario.

At this point there are several questions without answer. What about the role of judge of learning? Is this situation fair? Are we eliminating the role of judge that the teacher usually has? Is this important? What consequences could have regarding to student, teacher, school or business? It is very difficult to obtain answer because we have to talk to human resources department of different companies and, furthermore, the influence of a specific subject over the whole curriculum is not very important.

Now, we have to know how we can extrapolate our experience to other subjects (mandatory, massive…), other degrees, and other countries. Next step is to continue with this experience analyzing the evolution and try to include the method in a second year mandatory subject.

Finally, we want to talk with professors' community about these topics: Is this the perfect evaluation method? Do marks make sense? What is the influence of the evaluation method over student motivation? Engineers, are marks important?

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