

## **Education tools in Polytechnic School of Extremadura to improve Statistics and engineering education**

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Conference Key Areas: Mathematics and engineering education. Novel education tools for engineering programs. Engineering education research

Keywords: Engineering, tools, websites, Statistics

### **INTRODUCTION**

The underachievement of engineering university studies is related in general with several factors as academic, cultural, familial, social and nowadays economic problems. Research on students with good academic results and performance indicate that gender, school performance prior to University and the economics are important factors for future success. Academic performance also is influenced by others factors such as social integrator and on going study habits at home. (Milles et al, 2009).

The growing internationalization in Polytechnics Universities especially at engineering level is also of great importance.

The economic context in Spain, especially in the Autonomic Community of Extremadura and therefore, in our University is making our graduates have to seek a job outside of our borders and thereby compete with other engineers in the context of the European Economic Community. Our community of Extremadura is one of the Spanish communities that more education cuts are suffering in these last years. Now more than ever it is extremely important future professional preparation and the knowledge acquired by our students at the University of Extremadura.

The first years at Polytechnic School in the Extremadura University are usually very difficult for our students; generally the greatest difficulties are related to their bad study habits and lack of basic knowledge for the study of science. Our students have considerable short falls and limitations in terms of the capacity of solving basic mathematics and statistics problems arising in a great variety of daily applications.

On the one hand, we have observed that new students have poor understanding reading, poor capacity for synthesis as well as lack of the background knowledge of

basic science that our students should acquired in their primary and secondary studies.

For many of our students who encounter the statistics for the first time, some key questions arise –what the statistics is and what the statistics is for. We believe that one of the most serious problems is that we have to explain the important role to play Mathematics and Statistics in our students´ pedagogical knowledge that serves as a basis for their future education in order to improve other engineering subjects.

In our daily work as teachers we have all been concerned from sometime now about the potential problems in the global financial system, which have led to the present Spanish financial situation. In our country, the low rates of pay and limited funding for research drive young people and researchers to emigrate.

We have to try that our efforts have made a difference in helping our students to obtain skilled employment and therefore to achieve a competitive job in other countries of the European Economic Community.

Extremadura University, and our institution, Polytechnic School, should enhance our academic services to help our new engineering students in order to provide opportunities to increase their academic performance progressively and to satisfy their needs.

Psychological research and theory suggests that by having students learn through the experience of solving problems with real data, students can learn both content and thinking strategies suitable in the teaching philosophy promoted by the European Higher Education Engineering Area.

This paper presents a study of the tools provided by our Polytechnic School to facilitate the transition from high school students to our University in the learning of mathematics and statistics knowledge. This paper also presents a questionnaire to capture student opinions about web tools offered by our Polytechnic School titles in order to improve our students´ knowledge. To analyze the effectiveness, and make an initial estimate of the evaluation of these tools, we conducted a pilot test of the questionnaire with 68 students at the University of Extremadura.

The effectiveness of this methodology is not sufficiently tested empirically. In the last two academic years, experiences carried out with the appropriate procedures have produced results in favor of these tools, but they are not yet significant and next year some of them could disappear.

## **1 MATERIALS AND METHODS**

### **1.1 Instruments**

Engineering education has an international character in itself. It should promote opportunities for engineering students could participate in the international studies. The use of the new technologies such as e-learning will also be used to promote the internationalization of engineering programs.

In order to promote the interest of our students to continue their education by accessing the training of Statistics and Mathematics, it would be necessary to increase the visibility of supply and provide readily accessible data to allow in-depth knowledge of the statistical programs. As teachers, we have to show our students how to analyze the accessibility and visibility of the information network and propose a basic outline of information in the curriculum of an engineering program.

## 1.2 Zero- courses and virtual platforms

Since 2010, in Extremadura, the zero-courses and virtual platforms with self-assessment exercises have been used in the new Engineering Studies. These tools are widespread activities and are aimed at those high school students admitted for the first time in our Polytechnic School and they need to overcome their lack of training.

These courses are intended to update the knowledge already acquired in high schools, standardize the level of knowledge of students from different backgrounds and at the same time, try to accustom to the rhythm of university work. In the subjects introduced at the zero-courses are reviewed the concepts studied in high school, included in the official syllabuses of first and second course of Baccalaureate. Zero courses are becoming more numerous and have a greater number of students. However, this broad participation with these courses does not translate into a significant improvement in academic performance.

From the point of view of Statistical presents new concepts that they should be included in high school but not studied today. It is necessary that students understand the importance of concepts such as mean, standard deviation, population, sample, tests, inference, etc., in order to apply them to different subjects in the engineering curricula.

In Spain, the current economic recession is having a number of serious consequences for our students. As a result of cuts to our university education budgets, The Extremadura University is being forced to lay off instructors, cut down zero courses and otherwise increase the number of students per class. These could cause damage to the knowledge and learning process of our students. That makes it more difficult for them to get a job when they graduate.

Teachers are afraid that some of the zero courses could disappear next academic year.

In our engineering degree have a set of self-assessment questionnaires in some of the subjects they are studied. In this way students can check the level of their knowledge. The self-evaluation through virtual environments is perfectly feasible using evidence of objective response and allows activities that promote learning before, during and after the academic period. However, recent studies has shown that the use of self-assessment tools on the Web improves the learning of theoretical concepts but not practical learning as occur with laboratory practical [1].

From a theoretical point of view, the self-assessment has the advantage that it can face the diversity of students. That facilitates adaptation to different rates of learning according to the different characteristics of the student. Self-evaluation is particularly appropriate to teach and to learn how to value the individual learning they have carried out [2].

The presence of these courses and the quality of them it has been discussed and we can study future results of our students and comparing degrees of knowledge of our engineers. Despite the theoretical advantages of this, they have not been sufficiently developed in Spanish universities and there would be great differences in the materials offered by each university. We believe that this is due to two main reasons: increase the teaching load of teachers that also requires appropriate monitoring of student learning. The effectiveness of this methodology is not sufficiently tested empirically. Experiences carried out with the appropriate procedures have produced results in favour of this tool, but they are not yet significant.

We use the virtual classroom of Moodle and access is restricted to our students who have an e-mail account of the Extremadura Polytechnic University for which they should be registered in the respective courses. We incorporate different materials of The Statistical subject and other skills related with the work of student like study techniques and time scheduling. Self-evaluations can be performed as often as desired and statistics can be generated with the percentage of correct answers, the time taken to perform the tests and the number of hits on different materials. The most widely used self-tests are the subject of Statistical.

## **2 QUESTIONNAIRE**

### **2.1 Opinion Questionnaire**

The report of the study [3] shows the design of a survey conducted to assess the views of the new students about the usefulness of these instruments offered by the universities.

The questionnaire consists of 13 questions in four pages, with a brief presentation on the objective of the survey. The first seven questions are related to different aspects of the courses "zero"; the following three items are related to the self-evaluations; there are two questions to describe the sample (sex and age) and finally a control question over the opinion expressed. Most questions were developed based on multiple-choice Likert scale, with scores assigned to each item ranging from 1 to 5, depending on the degree of agreement or disagreement with statements that are expressed. Also is included an open question, to ask about highly rated aspects and issues to improve.

### **2.2 Statistical Analysis of the Engineering Studies of Extremadura**

Of 184 students enrolled in first year of computer engineering degree. The Survey was conducted by 68 students who had completed the Statistics zero course.

This paper provides a detailed analysis of the survey at the University of Extremadura where the total number of respondent students was 68. The questionnaires try to capture the feelings of the students.

The age range of the sample was 17 to 24 years, with an average of 18.8 years. The 72.1% of respondents were male, while 27.9% were women. To compare the two instruments: virtual platform and zero-courses, is realized a descriptive statistical analysis and a test to compare medians.

We present the final exam results and reduction of dropouts in the academic course 2012-2013.

## **3 RESULTS**

### **3.1 Statistics results**

Questions about zero courses: It has developed a survey regarding the importance that students attach to their participation in these courses.

Results from a survey are summarized in 6 points: difficulty (c1), place (c2), subject (c3), date and time (c4), professor (c5) and content (c6). All of them obtained a mean score between 3 and 3.9. Students considered the difficulty and the place where they taught as the aspects less important when making these courses. The most valued for each aspect rated from 1 to 5 and the 95% confidence interval.

The following questions were posed to assess student opinion regarding the importance of including zero-courses in the University. The 85.3% of respondents

agreed with this importance, while the 88.2% stated that they did not influence their choice of university. The 95.6% considered them useful and 73.1% would like to have more courses of this type. A 94.1% of respondents considered appropriate content.

The number of zero-courses that are offered was assessed with a Likert scale from 1 = insufficient to 5 = excellent. The average value was 2.38 and the median value obtained is equal to 2. The respondents considered scarce the zero-courses offered at our university.

On the question of the quality of different aspects of the zero-courses were considered 7 of them: issues (c1), number of hours (c2), explanations (c3), date (c4), professor (c5), content (c6) and materials (c7). Their mean score resulted between 2.9 and 3.5.

Fig. 2 shows the average value and its confidence interval of each one of those aspects.

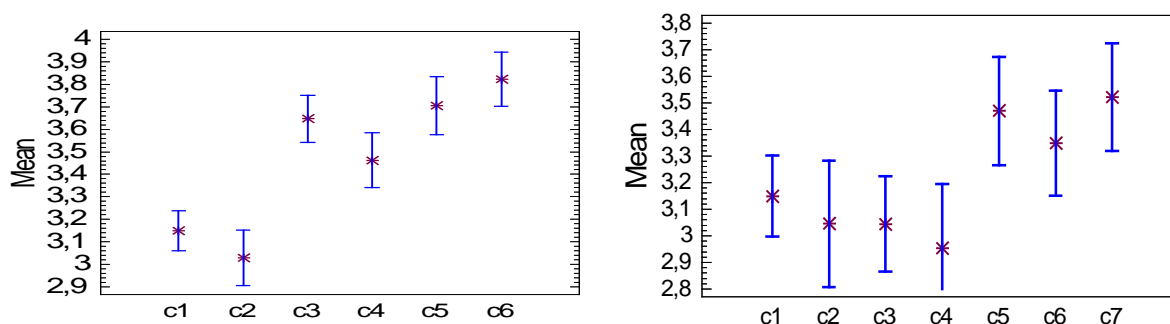


Fig. 1. Average rating and 95% confidence intervals of aspects about student participation in courses zero. Fig. 2. Average rating for the quality of courses and confidence intervals 95%.

In open-ended questions, the best aspects evaluated by the students were content and methodology (works and continuous assessment), while the least valued aspects were the schedule, the methodology of practices and explanations in class. A 73.1% of respondents explain that they would prefer to attend a zero course again in our university.

The overall assessment given by students about zero-courses on a scale of 1 to 5 is 3.3 with a standard error of 0.11 in the estimate. The 95% confidence interval for the average rating is 3.07 to 3.51. So the global assessment of those courses is positive.

Similarly was assessed, the degree of interest, in courses zero by students. The mean value was of 3.36 with a standard error of 0.09, a 95% confidence interval for the average rating of 3.17 to 3.55. So the interest of the students is slightly above the mean.

Questions about self evaluations: the degree of help that the self-assessments provide to students was assessed with a Likert scale from 1 = insufficient to 5 = very helpful. The average value was 2.91 and the median was 3. Respondents felt that the process of self-evaluation was good to support or improve the final result obtained in the first year of college

The 72.9% of respondents chose the self-evaluations as the tool that more help them to start the subjects of the first course in the university.

The mean value of the overall assessment of self-evaluations, given by students on a scale of 1 to 6 was 3.33 with a standard error of 0.12 in the estimate. The 95% confidence interval for the average rating was of 3.09 to 3.57. So the overall assessment of self-evaluations was positive.

For those students who evaluated both options, courses zero and self-evaluations, no significant differences were found between the two cases ( $p$ -value = 0.99 sign test for medians).

Table 1, shows the results of an opinion poll conducted on a voluntary basis to students who participated in the experiment once the academic year was ended and the final results were obtained in the Statistical subject of the first course of Computer Engineering degree with 6 ECTS.

The answers are based on an ordinal scale A1=nothing, A2=little, A3=something, A4=much, A5=too much, NA= No answer, for the first 6 questions and a quantitative scale for the two last questions.

C1. You know the philosophy of the European higher education EHEA.

C2. This experience fit the philosophy EHEA.

C3. The realization of this experience has helped you to understand the need for the use of statistical techniques in Computer Engineering.

C4. Monitoring this has helped you achieve a greater ability to understand and present results in reports.

C5. Participation in this experiment has helped to achieve greater capacity for work.

C6. The self-assessment system seems appropriate.

C7. State the approximate number of hours devoted to the realization of the experience.

C8. Score 1-10, that you give this experiment.

*Table 1. Results in percentages of the first 6 issues*

	C1	C2	C3	C4	C5	C6
A1	30.7	14.3	1.6	0.0	0.0	0.0
A2	31.2	9.5	7.9	3.2	9.5	9.5
A3	25.3	19.0	28.6	42.9	38.1	42.9
A4	11.2	30.2	49.2	49.2	44.4	41.3
A5	1.6	1.6	12.7	4.8	7.9	6.3
NA	0.0	25.4	0.0	0.0	0.0	0.0

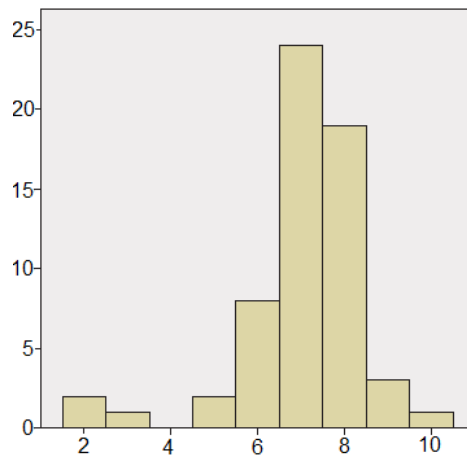
The third question is highlighted that over 60% of students answered that the experience had helped them enough or much to understand the necessity of Statistics in Engineering.

60 Students answered to the question about the number of hours of dedication of the student to this project. Highlights the large variability of hours spent on these tools. This is a fundamental aspect as it provides valuable information about the student's dedication in the face of ECTS credits estimation.

This variability may be due mainly to four causes. - Some students have found certain difficulties to manage the virtual platform. - Students entering college for the

first time have significant difference of the degree of prior knowledge of statistical concepts. - The difference between the importance and the interest that our students give to Statistical models in their future as a computer engineer. – Some students may make an incorrect estimation of the hours of dedication.

Last question about of the quality of the experience, students have considered qualifications from 0 to 10. Figure 3 shows that only three students got to experience a rating lower than 5.



*Fig. 3.* Qualifications of aspects about student participation in the experience.

Scores are considered very positive given the context of the experience in the University of Extremadura.

At the end of this chapter there is a report about exams results and dropouts.

In Spain students need to have achieved a certain ranking, grade or score, from 5.0 to 10.0 points in their qualification to pass to a new academic year.

Table 2, shows the students results or final marks (in percentages). In Spain, the University courses require degree score from A1= dropout, A2= failed 0.0 to 4.9, A3= 5.0 to 6.9, A4= 7.0 to 8.9, A5= excellent from 9.0 to 10.0.

*Table 2.* Results in percentages of the final marks

	Group A. 82 Students	Group B. 102 Students
A1	26.82%	40.19%
A2	32.92%	20.58%
A3	19.51%	12.74%
A4	18.29%	21.56%
A5	2.44%	4.90%

Table 3, shows (in percentages) a final evaluation of 68 students enrolled in both groups A and B, students attended zero courses and did their self evaluation.

*Table 3.* Results in percentages of the final marks

	Group 68 Students
A1	14.70%
A2	10.29%
A3	32.35%
A4	33.82%
A5	8.82%

### **3.2 Conclusions**

Students generally assessed positively the various questions asked in the questionnaires about support tools developed by our university. The University of Extremadura as well as Spanish universities have promoted zero courses facing to self-assessment tools. However, students surveyed show their preferences by self-evaluations comparing to courses zero.

The percentage of scores from 5.0 to 6.9 has increased, but more so from 7.0 to 10. What is a good result for the experience, but not quite significant because there are still dropouts.

## **4 SUMMARY AND ACKNOWLEDGMENTS**

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