

Gender performance in an Aerospace Engineering Maths subject with innovative pedagogical approach

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INTRODUCTION

Traditionally there are degrees in Spain in which there is a greater demand for students of a particular sex. For example, there are more female students in careers related to Health Sciences, Social, Law, Humanities and Arts (Nursing, Medicine, Psychology, Teaching, Fine Arts...). On the other hand, most engineering programs look more appealing to male students [1]. This fact also happens in other countries [2, 3, 4]. One of the main reasons for this choice is due to stereotypes about what a man or a woman can make which, as all stereotypes, need not be true and have been inculcated in society. Gender stereotypes exert a strong pressure among adolescents, which can determine the choice of one or another university career [5].

There are several gender studies about the female participation in engineering companies and in STEM related degrees [3, 4]. In fact, a great part of these studies are related with women in management positions [6, 7, 8]. A recent article at *The Atlantic* [9], recalling [10] and [11], mentions three key findings of smart groups, one of them being they had more women in their teams: *Teams with more women*

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outperformed teams with more men. Indeed, it appeared that it was not “diversity” (having equal numbers of men and women) that mattered for a team’s intelligence, but simply having more women. This last effect, however, was partly explained by the fact that women, on average, were better at “mindreading” than men.

On the other hand, BEng in Aerospace Engineering delivered at the School of Design Engineering ETSID in the Technical University of Valencia (UPV) [12], is one of the degrees in which the enrollment of female students is traditionally lower than male students. In this paper we analyze gender performance in STEM once at the university, particularly in a Maths subject of BEng Aerospace Engineering, in each of its different parts: Algebra, Calculus and laboratory practices in order to seek whether there is some performance difference.

1 THE LOCAL STAGE

BEng Aerospace Engineering is a 4 year degree where students are highly motivated, most of them having earned good marks in their pre-university studies. Herein, as in most engineering careers, there is a greater male demand (circa 80%).

The first course of BEng Aerospace Engineering consists of basic subjects: Business Studies, Chemistry, Computer Science, Materials Science, Mathematics I, Physics and Technical Drawing. We will deal in this paper with Mathematics I in which all students should achieve basic competencies and skills. It has got 120 contact hours (12 ECTS), 75% of them correspond to Theory/Problems (TP) sessions and the remaining 25% to Lab practice (LP) sessions. Topics covered in Mathematics I are Calculus of one and several real variables and Linear Algebra.

Under Bologna process students should get more involved in their learning and a new more active role from their side is to be encouraged [13]. In order to achieve this goal the authors have taken advantage of an educational platform developed by UPV based upon the Sakai project [14] and known as PoliformaT.

In Mathematics I we use methodologies that encourage our students to an active learning. Now, we describe briefly the methodology used in TP and LP sessions.

TP sessions are standard and at the end of each topic, the instructors propose the students a collection of problems in which a set of basic exercises/problems must be solved fluently. If the student does not know how to solve them, he should go to a tutorship with the instructor. Students have to perform along the academic year three exams related to Calculus topics and one related to Algebra. Also, before each exam the student must perform an assignment.

LP methodology used is based in flipped classroom. The process can be divided into 3 stages: pre-class, in-class and post-class:

- Pre-class: Instructors provide a guide in PoliformaT with topics and exercises that student work autonomously prior the Lab session.
- In-class: In the first part students discuss about the difficulties encountered. Next, they are evaluated by solving a set of exercises by means of PoliformaT.
- Post-class: Students can check their answers and scoring through PoliformaT. In addition, instructors will provide the correct answers.

Instructors assist students in all stages of this process. With this methodology, students *follow* the subject and do not just prepare it for TP exams.

2 GENDER PERFORMANCE AT MATHEMATICS FIRST YEAR

In this section we present the results performed during the academic year 2013/2014. In that academic year Mathematics I got 126 students enrolled with 102 boys and 24 girls. We will focus in the following aspects of the subject:

- Weekly Lab sessions
- Lab exam
- Calculus
- Algebra

The ratings presented in this paper have been divided according to the Spanish system. If x denotes the mark in a 0-10 scale, the grade is considered to be:

- *Excellent*, if $9 \leq x \leq 10$
- *Notable*, if $7 \leq x < 9$
- *Pass*, if $5 \leq x < 7$
- *Fail*, if $x < 5$
- *Not taken*, if the student has dropped this topic.

Fig. 1 represents the grades obtained by male and female students in the weekly Lab sessions. We can observe that female students obtained grades slightly better, all of them with a grade of Excellent or Notable and without dropouts. A 90% of female students and a 70% of male students obtained Excellent. In general marks obtained in Lab sessions are very good. This is because students have prepared the session previously and they can ask the instructor or a partner during the in-class evaluation.

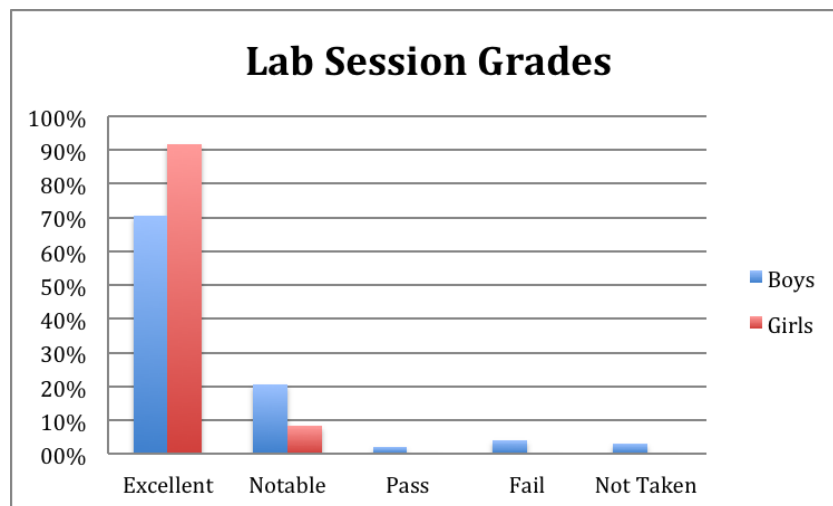


Fig. 1. Percentage of grades in Lab Sessions by gender

Grades concerning LP exams are represented in *Fig. 2*. Contents covered in these LP exams are Calculus, Algebra and their applications with the CAS Mathematica. Boys obtained more disperse marks than girls. Only boys have obtained the Excellent grade, about a 10%. An 84.3% of boys have obtained a mark greater or equal to 5. On the other hand, all girls get a grade between 5 and 9. About a 50% of girls obtained Notable and the other 50% a Pass grade.

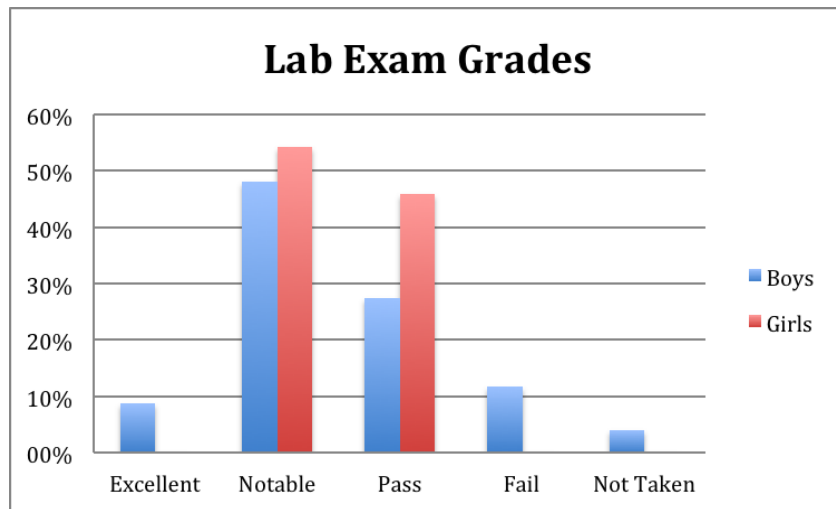


Fig. 2. Percentage of grades in Lab exams by gender

Grades obtained in the exams involving Calculus topics are gathered in Fig. 3. We observe that the percentage of male and female students that obtained a mark greater of 5 is similar. We appreciate that female students have been obtained better marks than boys, 71% of girls obtained a mark greater or equal to 7, while 52% of boys obtained this high mark.

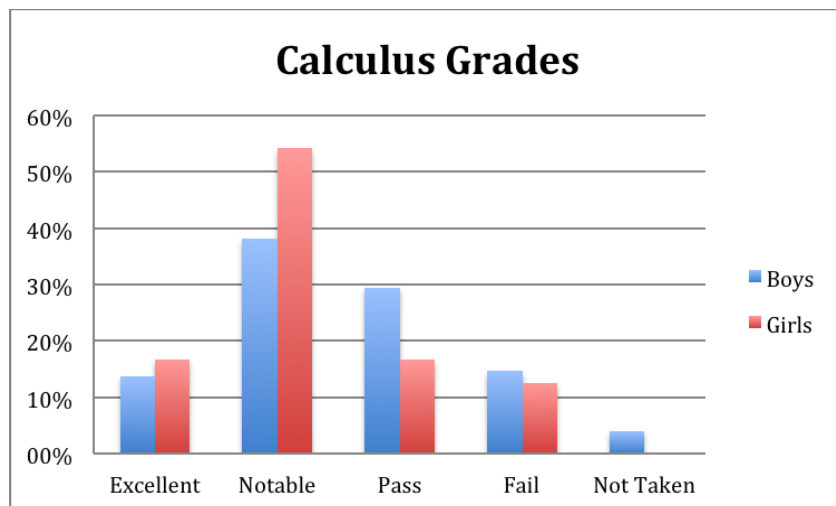


Fig. 3. Percentage of grades in Calculus by gender

Fig. 4 represents the grades obtained by male and female students in the Algebra exam. We can observe that male students failed this exam in a higher percentage than female students. In general, girls obtained better marks in this exam.

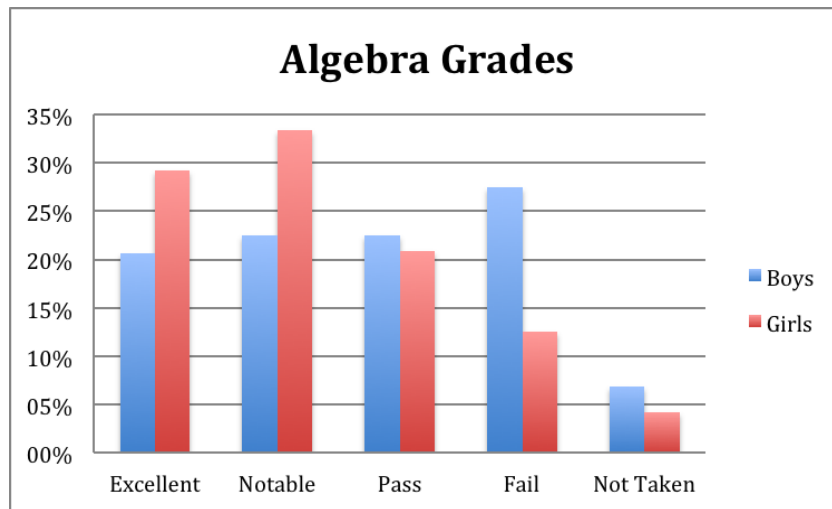


Fig. 4. Percentage of grades in Algebra by gender

We may point out that 3 male students dropped Mathematics I out.

3 SUMMARY

STEM seem to be less attractive for female students than for male students. This fact happens in Spain as in other countries. We have focussed in Aerospace Engineering at UPV where around 20% of students are female and we have analysed their performance compared to male students. Apparently there are no big differences. We have analysed the results performed during the last academic year which from our experience reflects no significant difference with other year results. In general all results are quite good as Aerospace Engineering students are highly motivated. The only slight difference observed is that, for very a small difference, female students get better results in the Algebra Exam and present lower dropout rates. On the other hand, male students have obtained the better marks in LP exams which were done by using Mathematica as CAS.

Further analysis with bigger perspective might be needed but from this analysis it seems that once inside there is no significant difference between the performance of both groups of students, male and female.

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