

Learning and academic success in engineering courses: Comparing 1st year students according to gender

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Abstract—This work in-progress research to practice paper analyzes the learning achievements of first-year engineering students, in order to observe if there are eventual gender differences. Studies suggest that women have higher enrollment rates and achievements in Higher Education. Women also dedicate more time studying and are more committed attaining their degree than men. Although the percentage of female students' application in Science, Technology, Engineering and Mathematics (STEM) courses increased in the last years, there is still a greater proportion of women choosing higher education in social sciences and humanities areas. A sample of 723 1st year engineering students (66.8% male) was analyzed according to their academic background, their social origin and their habits of study. The results do not differentiate the Engineering Students according to their gender in socio-cultural variables of origin, however they significantly differentiate the two groups of students in their habits of study. Female students show greater organization of their time and activities of study, being also more thoughtful and self-regulated learners. At the same time, at the end of the first semester, they present a higher rate of successful curricular units and higher average grades. Some implications are highlighted for the teaching-learning process in engineering courses.

Keywords— Higher Education; academic expectations; engineering students; learning outcomes; academic success; gender.

I. INTRODUCTION

The expansion of Higher Education (HE) in Portugal, during the last three decades, through the creation of new institutions and new courses resulted in a more widespread access of the population to this level of education. This expansion seeks to respond to the European community's goals of increasing the number of graduates among the

Portuguese adult population who enter the labor market (European target of 40% of young adults with HE degree in 2020) and to the effort for greater democratization and social justice in the access to HE [1]. This expansion has two main aspects that characterize the access to HE in Portugal: a greater diversity of students and the need to implement a *numerus clausus* system to the access.

The democratization of Higher Education access was logically reflected in an exponential increase of the number of students. In the 1970's there were 60,000 students in Higher Education Institutions (HEI), raising to 400 thousand in the academic year of 2002/3 (exceeding almost 650%). This increase was achieved through greater heterogeneity of the student population in terms of their sociocultural origin, academic skills, motivations and vocational projects [2]. By putting an end to "Elite Universities", Higher Education Institutions (HEI) started receiving students from rural areas, less favored social groups or ethnic minority groups, who tend to be less familiar with the academic culture and its challenges, as well as older students, who had already built family and started a professional activity[3].

The transition to HE is, therefore, particularly challenging for several subgroups of students, for example those who will need to reconcile professional activity and family with study activities, or even younger students, because some of them leave their parents' houses for the first time and have to build a new social and emotional support network [4,5]. At the same time, teaching methodologies changed and students are faced with less educational practices supported by school handbooks, with less close and less frequent feedback from teachers about their learning [6,7]. This learning and performance difficulties might be more frequent among male students, who tend to enter higher education with less studying competencies and lower average grades, although these variables are predictors of

academic performance of the first year of the university [8, 9].

In fact, the research points out that female students present more self-regulated behaviors, for example in classes participation, time management study, they are more responsible on group-work, as well as more critical in administration and logistics institutional teaching-learning conditions [10, 11]. Female students present deep learning approaches, defined by understanding rather than memorization approach [12, 13].

Another aspect to be considered is that, given the greater demand for HE, it was necessary to implement a numerus clausus system in the access to the vacancies of each institution and course defined by the Ministry of Science and Technology and Higher Education (MSTHE). Currently, the access to University is determined by a national competition in which entry is made according to an application mark, that weighs the student's ratings in High School and in national exams according to the specification of the courses. In Engineering courses, Mathematics and Chemical Physics are compulsory disciplines. As a consequence, students who are not placed in their first option courses end up being placed in second options, occupying the vacancies of students with lower average grades, generating a wave of displacement and dissatisfaction [14]. According to MSTH data, in recent years, about half of the students are not placed in their first choice courses, nor in the institution that they would prefer, with greater selection of candidates in the areas of health and engineering. In Portugal, this selection process of students is marked by the cultural origin of students, registering a higher percentage of students coming from disadvantaged social strata in courses of Humanities and Social Sciences, or attending courses at Polytechnic Institutions [15, 16].

Regarding courses in the fields of Science, Technology, Engineering and Mathematics (STEM), it is important to analyze the variable "gender" in this expansion. Even though the number of women in this group of courses has increased, certain social and career stereotypes are maintained, since they are clearly the majority in social sciences and humanities courses [2].

In this article, we want to analyze some of engineering students gender characteristics, as well as vocational options and academic performance. Some research indicates that women have higher enrollment rates and achievements and that they dedicate more time studying and are more involved in their degree than men, so it is possible to anticipate a better academic achievement.

II. METHOD

Participants

The sample is composed by 723 first year students from all engineering courses of one public university. Most of the participants are male (66,8%)

Instrument and Procedure

At the time of their enrollment at the university, students answered a social and academic characterization questionnaire, integrating three main topics: (i) Family socioeconomic origin, (ii) vocational options, in particular whether or not they were going to attend a course in a first choice institution, and (iii) the past level of basic and secondary schooling, including three questions about their study competencies (organization of their time and activities of study, surface versus deep learning approach and self-regulated learning). The students have been informed of the study's objectives, they were guaranteed the confidentiality of the information and they gave their informed written consent, also authorizing access to their academic classifications at the end of the first semester. The statistical treatment of the results resort to the package SPSS/IBM version 23.0.

III. RESULTS

In table 1, we describe students' socio-cultural background, previous academic experience and vocational options. According to some of the data collected, we indicate the following parameters:

- family socioeconomic status (SES), combining professional activity and degree of academic qualifications in four classes: low, medium low, medium high and high;
- if the student will have to leave the parents' house to attend HE (LH);
- if he/she is attending a course and a university of 1st option,
- the average grades of enrollment in HE (classification from 0 to 200)
- academic performance at the end of the first semester (average of grades on a scale of 0 to 20,
- number of curricular units (CU) attended with success, this means with a minimum classification of 10).

This description is made by gender, with only one third of the students being female ($n = 240$, 33.2%). The differences in the effective ratio and the means are evaluated in terms of statistical significance using the chi-square test and t-test according to the metrics of the variables under analysis.

Results suggest a balance of the socioeconomic origins of students of both genders, without a significant statistic difference in their distribution ($X^2 = 3.039$, $df = 3$, $p = .386$).

In Portugal, the majority of the students that are enrolled in HEI come from an intermediary social stratum, with about 20% of the students with low socioeconomic origins.

It is interesting to note a greater proportion of female students who leave their parents' houses to attend higher education in engineering courses ($X^2 18.159$, $df = 1$, $p = .000$), suggesting a higher female investment in higher

education and willingness to move, or a greater sense of autonomy to face the challenges of transition and adapting to HE, without close family support.

Table 1- Descriptive of students by gender

Variables	Male (N=489, 66.8%)	Female (N=240, 33.2%)
SES:		
- Low	N=83(17.2%)	N=54 (22.5%)
- Medium low	N=164(34.0%)	N=74 (30.8%)
- Medium high	N=182(37.7%)	N=87 (36.3%)
- High	N=54(11.2%)	N=25(10.4%)
LH (yes)	N=153(31.7%)	N=116(48.3%)
1st option	N=250 (51.8%)	N=126(52.5%)
1st option university	N=348(72.0%)	N=160(66.7%)
Study time and activities organization	M=4.05, SD=0.95	M=4.66, SD=0.64
Deep learning approach	M=3.85, SD=1.03	M=4.38, SD=.61
Self-regulated learning	M=2.51, SD=1.45	M=3.25, SD=1.09
Entrance average grade	M=152.46, SD=17.98	M=158.89, SD=17.31
1st semester mean	M=12.56, SD=3.24	M=13.82, SD=2.19
Nr. of CU approved	M=4.35, SD=1.55	M=5.16, SD= .18

Taking the vocational options of the students as a result of the policy of numerus clauses, we observe a very close percentage of students of both genders who attend a course of their 1st option, with a slight increase in the percentage of male students attending a university on their 1st option (even if this difference does not assume statistical significance: $X^2 = 2,337, df=1, p = 127$).

According to the percentage values obtained, regarding both genders, the percentage of students who reported being placed in a 1st option institution is higher than in a 1st option course, suggesting a greater attractiveness for the university and that many of these students will try to move to the course of their 1st choice at the end of the first year, particularly if the course they are attending does not correspond to their expectations.

In terms of study habits in High School, female students present a more positive self-assessment, in terms of behaviors and strategies, who seek a more efficient learning. Female students present better organization of their time and activities of study ($t = 6.078, p < .001$), a deeper learning approach ($t = 10.113, p < .001$), and greater self-regulation learning ($t = 7459, p < .001$).

Finally, the results of the survey indicate that female students do not only enter higher education with a higher average application grade ($t = -4.582, p < .001$), but that they also obtain a higher average grade during the first semester, and attend successfully a higher number of curricular units ($t = 7.011, p < .001$).

IV. FINAL REMARKS

Due to the expansion of Higher Education in Portugal, during the last few decades, the majority of male students remain in engineering courses (only one-third of students are female). This situation will be surely different depending on the engineering area of the attended course, but this difference, in favor of male students, is clearer in

computer courses. Regarding students who leave their parents' houses to attend higher education, there is a greater proportion of female students in this situation. This aspect may show that there is a greater investment in higher academic training as a way of achieving greater emancipation. Since female students value more the quality of the interpersonal relations, it is important to take care of the academic context that welcomes them, especially those who need to create a new network of friends and social support. Regarding students' vocational choices, we notice that the University has greater influence on students than the course, specially what concerns male students. This aspect requires more attention from the course directors and 1st year professors, since students need to be motivated for the course that they are attending and explore alternatives for their professional careers. Special attention must be given to male students, in order to increase their academic competencies to promote engagement, self-regulated learning and better achievements. As in Portugal a large percentage of students are not attending a first option degree, it is important to invite people from companies to develop Seminars and workshops in order to promote motivation and career developments in the engineering field.

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