

Engineering, a course of men

Does the inversion of this trend remain?

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Abstract— Commonly, there are more men than women seeking engineering courses, even though, with some common exclusions as for health related engineering courses.

Recently, Higher Education in Portugal has faced deep changes, particularly regarding the number of students, the growth of the educational network and the courses' curricular structure. There is an association with the increase in the number of women attending Portuguese Higher Education Institutions and the vast augmentation in the number of students.

To investigate whether these changes have also changed the preferences of women/men in engineering courses, options and admissions, from 2010 to 2014, in fifteen engineering courses of a Portuguese University, were studied and the conclusions of that work published [1].

In this paper we revisited that work and extended it with data from 2015/2016 and 2016/2017 and we studied, for each course, the number of applicants and the number of students placed (by gender), the application option and the average grades of the admitted applicants.

As a result of this analysis we verify that in courses with male predominance, the female gender increased significantly, unlike what happens in the other two courses (female predominance), where the values remain almost constant.

Keywords—Gender; Engineering; Higher Education.

I. INTRODUCTION

After the Bologna process was put in practice, there was an effort to unify the degrees and education levels among European institutions to facilitate the recognition of degrees, likewise the mobility between various countries and institutions. Consequently, it was determined to design courses leading to an academic degree in three different cycles of studies: a Bachelor's degree was granted with the 1st cycle of studies; the 2nd cycle of studies granted a master's degree; and a doctorate's degree was granted with the 3rd cycle of studies [2,3,4].

Portuguese higher education is organized in a binary system that integrates university education and polytechnic education and has a structure based on 4 cycles: a cycle of short-term studies that does not confer an academic degree and three

cycles of studies leading to degrees BSc, master and PhD as it can be seen in figure 1.

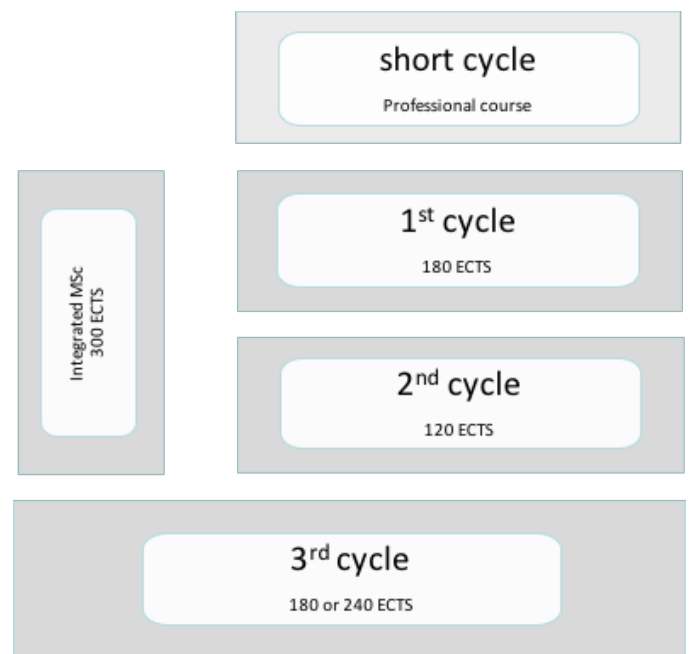


Fig. 1. The 4 cycles structure.

Before the implementation of the Bologna process, at best five years were needed to attain a Bachelor's degree. After its implementation and European evenness, most engineering courses were changed to integrated cycles of studies, where the bachelor's and the master's degree are combined, preserving the obligation of a five years training period [5,6,7,8].

To perceive if the gender still is a determinant factor, relatively to opting for a course, a study of the national admission and entrance application in 14 higher education engineering courses, from 2015 to 2016, was made, as the period from 2010 to 2014 was already done.

The study had as object of analysis data referring the admission and entrance applications, in a public higher education institution, registrations and admissions from 2015/2016 to 2016/2017 were studied.

The most usual entrance form is presently the national admission and entrance application [9]. It was only studied the 1st phase of each admission application, as it is just possible to do a possible comparison of the offer in this phase, based at the vacancies and the demand of applicants [9,10].

II. HIGHER EDUCATION: WOMEN IN STEAM COURSES

Although women graduate more than men, in most of the fields, in the fields of manufacturing and construction engineering the opposite occurs, as it can be seen in table I [11]. The existence of "typical" female fields of study, as well as "typical" male fields of study exists for centuries and it is predominant in Portugal, showing the usual European Union pattern of distribution.

The most popular fields of studies for women are Health and Welfare (79,4%) and Teaching, Training and education science (79%). Fields like Engineering, manufacturing and construction present in the EU more than 60% of male graduates.

TABLE I. TERTIARY EDUCATION GRADUATES BY SEX, 2014 (SHARE OF GRADUATES IN THE RESPECTIVE FIELD OF EDUCATION - %)

		EU	Portugal
Total	Men	42.1	40.7
	Women	57.9	59.3
Social sciences, business & law	Men	39.3	38.2
	Women	60.7	61.8
Engineering, manuf. & construction	Men	72.8	67.4
	Women	27.2	32.6
Health and welfare	Men	25.3	21.0
	Women	74.7	79.0
Humanities & arts	Men	32.8	39.4
	Women	67.2	60.6
Science, mathematics & computing	Men	57.6	43.1
	Women	42.4	56.9
Education	Men	19.7	20.6
	Women	80.3	79.4

As science and engineering have become more pervasive in society, women's participation rates in these fields have not seen a proportionate increase [12].

The education field is divided in several areas, namely the STEAM ones (Science, Engineering, Manufacturing and Construction; Math's and Informatics) and the others areas Education; Humanities and Arts; Social Science, Business and Law; Agriculture; Health and welfare; and Services as seen in table I [13].

As the focus of this study are 14 engineering courses, including Computer Engineering, we will evidence data concerning all the STEAM fields

III. METHODOLOGY, INSTRUMENTS AND PROCEDURES

As in the original study [1], the data used in this one was all the students enrolled in 14 Engineering Courses of a Portuguese public Higher Education Institution, as well as the number of applicants to these courses, but now concerning the academic years from 2010/2011 to 2016/2017.

The aim of this study is to determine whether the gender influences the students' choice of the course in the Engineering field. Consequently we analyzed the number of applicants and admitted students, as well as the Demand Satisfaction Index (DSI) for each one of the courses implicated in this study. The analyzed 23530 applicants, of which 16303 are male and 7227 are female. In the case of the 4146 admitted students, 2829 are male and 1317 are female. The DSI (Demand Satisfaction Index) incidence of the period 2016/2017 was also analyzed.

The ratio between the number of applicants in the 1st option and the number of existing vacancies per pair institution/ course, in the 1st phase of the national competition for higher education access is named DSI [1].

In order to ensure the design, implementation and coordination of Higher Education policies, there is a central Service of the Ministry of Education and Science (MEC), named Portuguese Higher Education General Directorate (DGES) whose mission is among others to collect data from Portuguese Higher Education Institutions [14].

The data used in this paper was obtained from DGES. From these files we used, the admission phase the number of application's options and its corresponding percentage, the gender of applicants and admitted students, the average grades of admitted students and the origin of applicants and admitted students.

Finally, a statistical study was carried out using the number of applicants and admitted students, crosschecking the analysis with the DSI, by gender and school year.

IV. RESULTS ANALYSIS

The data obtained from the files was analyzed and the results are shown in table 1 – the percentages of applicants and admitted students by gender; in table 2 the results obtained from the DSI; and in table 3 - Applicants and admitted students in the analyzed courses.

By analyzing the data presented in table 1, the new data (2015-2017) shows that there is a stabilization in growth of the percentage of female applicants and admitted female students in the last two years ending the growth shown between 2010-2015 [1]. Regarding female applications, we notice that in the last two years the fluctuation range was maintained between 28,4% and 33, 2%; while the percentage of female admitted students fluctuates between 29, 6% and 33%.

Naturally, applications and admissions among male students present the same stabilization.

TABLE II. APPLICANTS AND ADMITTED STUDENTS BY GENDER (M/F) (%).

School Year	Applicants		Admitted	
	M	F	M	F
2010/2011	72%	28%	70%	30%
2011/2012	71%	29%	71%	29%
2012/2013	69%	31%	68%	33%
2013/2014	69%	31%	69%	31%
2014/2015	67%	33%	67%	33%
2015/2016	70%	30%	69%	31%
2016/2017	67%	33%	67%	33%

Table 2 shows the DSI number for each one of the 14 courses analyzed from 2010/2011 to 2014/2015 [1] and the new data from 2015-2016.

TABLE III. DSI FOR THE 14 COURSES ANALYSED.

Course	10/11	11/12	12/13	13/14	14/15	15/16	16/17
MIEB	1,13	0,56	0,8	0,42	0,32	0,28	0,46
MIEBIOM	1,5	1,48	1,32	1,26	1,44	0,97	1,17
MIEC	1,04	0,56	0,16	0,04	0,06	0,18	0,20
MIEEIC	1,54	1	0,78	0,44	0,36	0,49	0,57
MIEF	-	-	-	0,53	0,37	0,64	0,92
MIEGI	1,13	1,28	1,25	0,91	1,32	1,78	1,94
MIEGSI	0,82	0,4	0,94	0,8	0,65	1,37	0,97
MIEGSI-PL	0,25	0,12	0,07	0,03	0,02	0,07	0,23
MIEI	1	1,2	1,26	1,68	1,29	2,63	1,96
MIEMAT	0,37	0,33	0,33	0,19	0,09	0,36	0,77
MIEMec	1,6	1,7	1,08	0,88	0,56	0,91	1,19
MIEPOL	0,53	0,43	0,29	0,06	0,19	0,47	0,41
MIETI	0,5	0,77	0,23	0,23	0,17	0,11	0,26
MIET	0	0	-	-	-	0,60	1,50

In the previous study [1] we used the DSI factor as criteria to choose the courses to be analyzed, using the extremities DSI values (above 1 or below 0,5) in all considered years. Using this criteria, we found the following courses:

DSI above 1

Integrated Master's in Informatics Engineering (LEI/MIEI)

Integrated Master's in Biomedical Engineering (MIEBIOM)

DSI below 0,5

Integrated Master's in Management and Information Systems (evening timetable) (LTSI/MIEGSI (PL))

Integrated Master's in Materials Engineering (MIEMat)

Integrated Master's in Textile Engineering (evening timetable) (MIET (PL)). In this paper the last course was not analyzed due to its closure,

In order to compare the data from the previous study [1] we analyzed the percentages of applicants (table 3) and admitted students (table 4) by gender in the four courses in analysis.

TABLE IV. APPLICANTS

		10/11	11/12	12/13	13/14	14/15	15/16	16/17
MIEBIOM	M	39%	37%	41%	33%	32%	35%	30%
	F	61%	63%	59%	67%	68%	65%	70%
MIEGSI-PL	M	91%	86%	82%	87%	77%	72%	81%
	F	9%	14%	18%	13%	23%	28%	19%
MIEI	M	91%	84%	89%	86%	85%	83%	84%
	F	9%	12%	11%	14%	15%	17%	16%
MIEMAT	M	63%	67%	62%	63%	54%	54%	55%
	F	34%	33%	38%	37%	46%	46%	45%

We notice that in the two last years, the percentage of female applicants remained almost the same for MIEBIOM (and MIEI and increased in MIEGSI-PL and MIEMAT. For the admitted female it remained almost the same for MIEBIOM and MIEMAT and increased in MIEGSI-PL and MIEGI.

Analyzing the graphs (figure 2) it is verified that the values of female applicants, regarding courses related to Information and Communication Technology (ICT) e.g. MEI and MIEGSI-PL, present lower percentages (above 30%) than those related to the area of health and technology (45-70%).

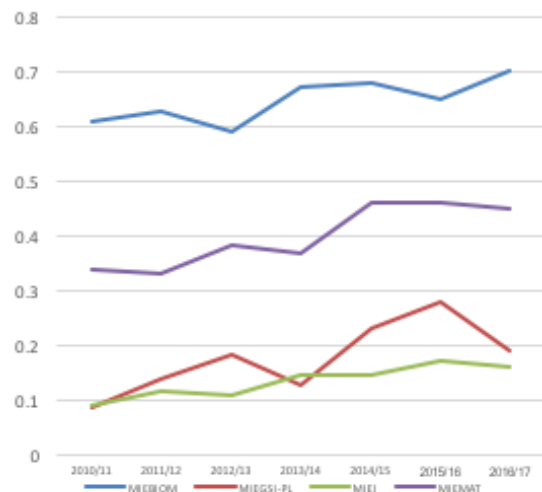


Fig. 2. Applicants.

In the course of MIEGSI-PL, there was a great increase in demand, although in the following year a small decrease.

The other course in the ICT area also showed a slight increase, from 9% in 2010 to 16% in 2017.

TABLE V. ADMITTED STUDENTS.

		10/11	11/12	12/13	13/14	14/15	15/16	16/17
MIEBIOM	M	45%	28%	54%	31%	27%	42%	35%
	F	60%	72%	46%	69%	73%	58%	65%
MIEGSI-PL	M	100%	86%	90%	87%	75%	76%	83%
	F	0%	14%	10%	13%	25%	24%	17%
MIEI	M	90%	89%	87%	91%	89%	85%	81%
	F	10%	11%	13%	9%	11%	15%	19%
MIEMAT	M	60%	70%	61%	50%	50%	50%	59%
	F	40%	30%	39%	50%	50%	50%	41%

It is interesting to note, from the analyses of table IV and V, that the percentage of admitted female students at MIEI (the most male predominance course) is superior than the percentage of female applicants. This shows the influence of better academic performance of the students.

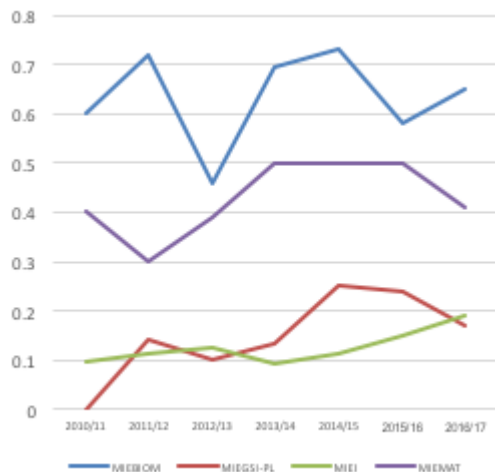


Fig. 3. Admitted Students.

Concerning admitted students (figure 3) there is a similar tendency to those existing in the applicants although with a great increase in the areas.

V. CONCLUSIONS

As it happened in the previous study, it is verified that there are great differences regarding the percentage of women enrolled among the analyzed courses.

We can state that we have three types of behaviors, one of them has a female predominance, with values reaching almost 70% (MIEBIOM). Another that is found to have values

between 30% and 45% related to the area of technology (MIEMAT) and finally the courses related to ICT, which have a lower percentage of women, varying the figures between 9% and 16%.

As result of this study we confirm that the percentage of the female gender students, comparing with previous studies, has increased, both in terms of applications and admissions in engineering courses in ICT areas, remaining almost the same in the other areas.

An increase in female gender of almost 2% of the number of applicants in the last two years, and 10% since the start of the study in 2010.

In this two last years of analysis, we verify that in courses with male predominance the female gender increased significantly, unlike what happens in the other two courses (female predominance), where the values remain almost constant.

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