

Women in Engineering Education in Turkey

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Introduction

The enrolment of women in engineering education is much lower than that of men in the whole world [1, 2, 3]. The socio-economic status influences positively the tendency to follow and complete more scientific courses [4]. Although women enrolment in engineering is also expected to be positively correlated to the development level of the country, this is not generally verified. Turkey is one of the countries where the enrolment of women in engineering education (22.7%) is higher than in most of the developed countries [5, 6, 7]. There are several reasons to that: engineering profession is still an attractive one in terms of social status; engineers are employed in a large spectrum and not only in their own field; top management positions are generally occupied by engineers. This is why boys as well as girls continue to prefer engineering departments to other fields of study. This explains why the enrolment rate in engineering in Turkey is not decreasing, as it is the case in most of the developed western countries. Yet the enrolment of women in engineering education is almost half of the overall women enrolment in higher education in Turkey which is 42.6%.

Kennedy and Parks [8] stated that the reasons of low female participation in engineering education are the existence of traditional barriers to women being equally represented in the physical sciences compared to their fraction of the total population. This statement is also valid for Turkey in addition to the other factors influencing women enrolment in engineering education.

The role of women in the Turkish society began changing rapidly with the proclamation of the Republic in 1923. This new period abolished the barriers applied to women, permitting them to participate in the labor force as an equal partner. This is the basic characteristic distinguishing Turkey from the rest of the Islamic countries. Turkish women obtained the right to vote in 1934, before some other European countries. The uniformisation of the education system contributed principally to the changing role of the women in the society. The first two women engineers in Turkey Melek Erbuğ and Sabiha Ecebilgen were the symbol of this change. They were graduated from the Engineering School in 1933 (Yüksek Mühendislik Mektebi which is actually Istanbul Technical University-ITU). Up to 1950, a few women engineer per year were graduated from ITU. In total 23 women were graduated at that period. Then the numbers of women graduated from ITU begin increasing, attaining 35 in 1960, 60 in 1971 and 104 in 1978 that are the first

graduates who were placed in ITU with the first general entrance exam of 1974. Women engineers graduating from ITU increased rapidly, reaching 525 in 2003 [9]. As many other universities joined ITU in graduating female engineers since 1933, the total figures are much higher for Turkey as a whole. The historical data were obtained from ITU archives and thus can not be compared to the other universities for which this type of data is not public.

Nevertheless, according to the press release of the Turkish Chamber of Engineers and Architects on March 8th, 2003, only one sixth of the engineers and architects registered to 23 chambers are female [10]. It is much lower than the women enrolment in engineering education and one of the main reasons is the discriminating condition in the working life. The New Labor Law adopted in 2003, aims to solve this problem by prohibiting the employers against gender discrimination (Art.5).

Paradoxically, at the same time with the New Labor Law, there are serious signals of gender discrimination in the professional life. This means that equal legal opportunities do not guarantee equal rights in reality. This is why research on gender issue is important to determine the reasons of discrimination and discuss ways of overcoming them.

The purpose of this paper is to examine the factors influencing the female participation in engineering education in Turkey as a developing country, as well as the reasons; in order to contribute to the research on gender issue.

Methodology

Recognizing that factors affecting the female enrolment in engineering education can only be sufficiently scrutinized through a series of researches, we decided to limit this paper with a pilot study. The aim of this pilot is to gather preliminary data on the reasons of female participation in engineering education. This preliminary part will provide us the opportunity to conduct a larger one in order to be able to make general conclusions for the country as a whole.

After an overview of the existing literature on the subject, an in-depth interview was carried out with the freshman students attending a course given by one of the authors in an engineering department of Istanbul Technical University. This interview helped to design a questionnaire including open and closed end questions.

The questionnaire is divided in three parts. The first part aims to collect data about the perception of the students with regard to their department's gendered distribution and their university choice ranking. The second part aimed to obtain the reasons of their choice of studying in an engineering department as well as try to know if they wish to exercise the profession of engineer after graduation. The third and last part was about the socio-economic profile of the students.

In order to proceed rapidly, to attain a large group of students and to form a databank, the questionnaire was transferred to a web address (<http://160.75.55.86/muhendislik/index2.html>). This address was sent to all the students of the authors' university, together with a short explanation about the aim of the research. A reminder was sent one week later.

The choice of ITU for conducting the preliminary research is that, founded in 1773, it is the oldest technical university, so that engineering education is identified by ITU in the Turkish society. At the same time, ITU succeeded to continuously improve the quality of its education and research [11]. Facts that are reflected in the motto used by the present rector, Gülsün Sağlamer: “pioneer through the ages”. This statement is verified in education by the fact that 12 departments got substantial equivalency from ABET (Accreditation Board of Engineering and Technology), 8 others being in the process; and in research by the fact that ITU is the one of the top two Turkish universities in SCI publications. This is why the behavior of ITU students can be representative of Turkish engineering community.

Studies in “women in engineering” are generally conducted with female students [1,3].or women engineers [12,7]. However this paper aims to study the place of women in engineering education in Turkey by questioning if there is any difference between the behavior of male and female students when they choose the field of study. The place of women in the professional life is largely determined by men, especially in underdeveloped and developing countries. Therefore it is of great importance to differentiate the attitudes of men and women. This paper will contribute to the existing literature in this field by this different approach.

Generally, studies conducted with students are limited to one or few engineering departments. For example, Baryeh, Squire and Mogotsi [1] conducted their research with 108 students from two engineering programs. Yet, we did not put any limitation of this kind in this survey since our aim is to gather preliminary data for a larger research. After the three weeks period we have determined for collecting the data, only 386 answers were obtained. The main reason of this low return is that ITU students prefer using their external e-mail addresses and not the ones provided by the university. This limitation will have to be overcome in the following part of the survey. This will give us the opportunity to review the questionnaire, to close the open-end questions and reach a larger group of students.

Results of the Survey

Replying Students’ Characteristics

The replying students’ distribution represents approximately the actual student distribution of the university. This is valid both for departmental and yearly distribution. A large proportion of replying students are male (75 girls representing 19.4% versus 311 boys representing 80.6%). The average percentage female participation of ITU’s engineering departments is 24% and 76% respectively, according to university statistics office [13,14]. The overall female participation in Turkish higher education is 42%, the rate being much lower (23%) in engineering departments’ [6]. It should be noticed that ITU female students’ percentage is almost equal to Turkish female participation rate in engineering education, thus it is another argument, supporting ITU choice for representing the whole country.

Replying students’ 41.2% are actually studying in a department which was among the top three on their list of preferences in the university entrance exam (explained later). There is a significant relationship between the gender and the existence of engineering departments in their higher preferences (Pearson Chi-Square= 13.209, df=1, p=0.000, Cramer’s V=0.185). According

to this correlation, more than half of the female students (54.7%) had departments other than engineering in their higher preferences whereas this percentage is much lower in the case of male students (32.2%) (Table 1).

Table 1. Replying Students' Characteristics

Variables	Female (75)		Male (311)		Total (386)	
	F	%	F	%	F	%
Preference ranking in the university entrance exam						
1. First	9	12.0	44	14.1	53	13.7
2. Second or third	28	37.3	78	25.1	106	27.5
3. Fourth or following	38	50.7	189	60.8	227	58.8
Those having departments other than engineering in their higher preferences in the university entrance exam	41	54.7	100	32.2	141	36.5
Those having only engineering departments in higher preferences in the university entrance exam	34	45.3	211	67.8	245	63.5

Importance of Gender in the Choice of Profession

There is a significant difference between male and female students with regard to their conviction of the importance of gender in the choice of profession (Pearson Chi-Square =12.176, df = 1, p = 0.000, Phi = 0.178). Almost half of male students (44.7%) are convinced that gender is important in the choice of profession, whereas only one fifth of female students (22.7%) think it is important (Table 2).

The students were also asked why they think gender is important in the choice of profession. The content analysis of the answers to this open-end question shows that the first factor is “the belief that some professions necessitate some physical capabilities”. The other factors are “specific working conditions of some professions”, “cultural assumptions for some professions being preferred by males and some others by females” and “the belief that the interest areas of males and females are different”. Almost half of the male students (40.6%) thinking gender is important in the choice of profession give the “physical capabilities” as the main reason. The other three reasons follow this first one almost with equal percentages. It is interesting to notice that female students thinking gender is important in the choice of profession give as the main reason the “specific working conditions of some professions” (41.2%). This is followed by the factor we call “cultural assumptions for some professions being preferred by males and some others by females” and which includes the assumption that women could not succeed in some professions due to their social and family responsibilities. The physical capabilities are only expressed in the third place by female students (Table 2).

The students were also asked about the gender appropriateness of their department. Although only 43.5% answered to this question, there is a significant difference between the answers of girls and boys. While 65% of the girls having answered to the question stated that their engineering field is appropriate both for women and men, only 39.2% of the boys think the same way (Table 3).

Table 2. Importance of Gender in the Choice of Profession

Variables	Female		Male		Total	
	F	%	F	%	F	%
"Gender is important in the choice of profession"						
0. Not believe	58	77.3	172	55.3	230	59.6
1. Believe	17	22.7	139	44.7	156	40.4
Total	75		311		386	
Factors affecting the importance of gender in the choice of profession						
1. Some professions necessitate some physical capabilities	4	23.5	56	40.6	60	38.7
2. Cultural assumptions for some professions being preferred by males and some others by females	5	29.4	26	18.8	31	20.0
3. Specific working conditions of some professions	7	41.2	33	23.9	40	25.8
4. The interest areas of males and females are different	1	5.9	23	16.7	24	15.5
- No answer	-	-	1	-	1	-
Total	17		139		156	

Those who stated that their engineering field is appropriate only for men or women were asked why they think the other sex had chosen this field, as an open-end question. Female students who answered that the department where they are studying is more appropriate for men explained their presence in the department with the fact that "their entrance grades were high enough". While the reasons given by male students have a larger diversity, the first reason is still the same with the girls. It is interesting to notice that boys thinking their departments are inappropriate for girls give as a second reason that they believe the choice was made by mistake.

Table 3. Gender Appropriateness of the Student's Department

Variables	Female		Male		Total	
	F	%	F	%	F	%
The student's department gender appropriateness						
1. Appropriate for women	1	5.0	5	3.4	6	3.6
2. Appropriate for men	6	30.0	85	57.4	91	54.2
3. Appropriate both for women and men	13	65.0	58	39.2	71	42.2
Total of answering students	75		311		386	
The reason of the choice by the other sex						
1. Their entrance grades were high enough	5	83.3	28	33.3	33	36.7
2. The choice was made by mistake	-	-	14	16.7	14	15.6
3. The carrier opportunities of the profession	-	-	9	10.7	9	10.0
4. Their interest in the field	1	16.7	12	14.3	13	14.4
5. For transferring to another department	-	-	4	4.8	4	4.4
6. With the family or friends influence	-	-	6	7.1	6	6.7
7. Do not know	-	-	11	13.1	11	12.2
- No answer	1		6		7	
Total of answering students	6		84		90	
Total of students who should answer	7		90		97	

Factors Affecting the Choice of Engineering as a Profession

Three groups of questions were asked to evaluate the impact of factors on the students' choice of engineering as a profession: i) Interest for engineering, ii) Leading people iii) University entrance exam.

i) Interest for Engineering

In order to evaluate the interest of students to engineering profession, two statements were offered to be answered on 7 point Likert Scale (1: Do not agree, 7: Totally agree).

1. I was attracted in engineering since my early childhood.
2. I wanted to become an engineer due to my interest in math and science courses.

The gendered distribution of the students agreeing with the statement "I was attracted in engineering since my early childhood" is significant according to the results of t-test students (t-test= -2,542, p=0,011). While the girls' average was 4.49 over 7 for this statement, boys agreed by 5.12 over 7. There is no significant relation between the importance given to gender in the choice of profession and the answers to this statement. The relation between the answers of those who want to work as an engineer after graduation (to be discussed later) and those who agree with this statement is significant. While the average of agreeing with this statement is quite low among those who do not want to work as an engineer (3.91 over 7), it is much higher (5.10 over 7) for those who will work as an engineer (t-test= -3.540, p=0.000).

The gendered distribution of the students agreeing with the statement "I wanted to become an engineer due to my interest in math and science courses" is not significant according to the results of t-test. There is no significant relationship between the importance given to gender in the choice of profession and agreeing with this statement. Students agree by 5.43 over 7 with this statement. Conversely the relationship between the students wanting to work as an engineer and their agreeing with this statement is significant (t-test= -2.755, p=0.006). Those who do not want to work as an engineer agreed by only 4.69 over 7 while those wanting to work as an engineer agreed by 5.50.

ii) Leading People

In many studies, it is reported that students' decisions are largely affected by the leading people in their environment who influence their choice of profession. Especially girls' who decide to follow engineering studies are largely influenced by the people in their close environment [1]. This is why we wanted to look if there is any influence of the environment on the students' choice of engineering as a profession. A list of people who might affect the students was offered, asking them to tick people who influenced them while they were preparing the choice list after receiving the results of the university entrance exam. Multiple ticks were possible. This list of probable influencing people was based on the findings of previous literature.

There is a significant difference about the persons affecting the students' engineering choice with regard to gendered distribution. While the gendered distribution of people affecting the girls'

decision is almost equal, it is clear that most of the influencing people for the boys were men. Only 14% of the boys answered that there were women affecting their choice of profession (Table 4). Those results show that women have great role on female students' choosing to become engineer.

Another important result is the influence of relatives on the students' engineering choice both on boys and girls, the influence being stronger for the latter. This is verified also in some other country [15]. The second group of people influencing the students' preferences is teachers at the supporting school. The influence of supporting school teachers is 16% on girls and 22% on boys. Results of some surveys in different countries show that high school teachers have influence on the university or profession choice [15]. It seems that in Turkey, this role is fulfilled by supporting school teachers. The first reason is that the private supporting school success depends on their students' placement in highly ranked departments, which means high entry grades in the university entrance exam. The second is that private supporting schools are largely distributed all over the country and generally a majority of high school students go there. This fact reduced the perceived responsibility of high school teachers in guiding their students towards a profession that is suitable to their aspirations and skills.

Table 4. People Influencing Students' Choice of Profession

Variables	Female (75)		Male (311)		Total (386)	
	F	%	F	%	F	%
Leading People						
1. Mother	7		9		16	
2. Father	9		34		43	
3. Elder brother	2		17		19	
4. Elder sister	6		6		12	
5. Aunt / Cousin (women)	-		11		1	
6. Uncle / Cousin (men)	4		18		22	
7. Friend (women)	3		7		10	
8. Friend (men)	2		21		23	
9. Mentor at the supporting school* (women)	4		9		13	
10. Mentor at the supporting school (men)	1		34		35	
11. Teacher at the supporting school (women)	1		4		5	
12. Teacher at the supporting school (men)	6		21		27	
13. Mentor at the high school (women)	1		5		6	
14. Mentor at the high school (men)	-		4		4	
15. Teacher at the high school (women)	4		1		5	
16. Teacher at the high school (men)	2		8		10	
Gendered distribution of the leading people						
1. Women	26	0.35	42	0.14	68	0.18
2. Men	26	0.35	157	0.51	183	0.47
Groups of leading people						
1. Family (Mother / father / brothers-sisters / close relatives)	28	0.37	85	0.27	113	0.29
2. Teachers at the supporting school	12	0.16	68	0.22	80	0.21
3. High school teachers	7	0.09	18	0.06	25	0.06
4. Friends	5	0.06	28	0.09	33	0.09

*Supporting schools in Turkey are private education institutions founded for preparing the students to the university entrance exam. Students go to those schools in parallel with high school, generally during week-ends and holidays.

Students actually enrolled in engineering departments differ by gender with regard to the existence of female engineers in their close environment. While 80% of the girls told they know a women engineer, this rate is only 64% among the boys. This can be interpreted as women engineers positively influencing girls for heading towards engineering departments. There is no gender difference concerning where the students met these female or male engineers: they both mostly stated that the engineers they know are either their “parents’ friends” or “people met during professional training activities”.

Table 5. Students Having Engineers in their Close Environment

Variables	Female (75)		Male (311)		Total (386)	
	F	%	F	%	F	%
Students having female engineers in their close environment						
0. Have not	15	20.0	112	36.0	127	32.9
1. Have	60	80.0	199	64.0	259	67.1
Female engineers of the close environment are						
1. Mother	2	2.7	8	2.6	10	2.6
2. Elder sister	4	5.3	13	4.2	17	4.4
3. Aunt / Cousin	16	21.3	41	13.2	57	14.8
4. Parents’ friends	33	44.0	92	29.6	125	32.4
5. People met during professional training activities	32	42.7	105	33.8	137	35.5
6. Other	10	13.3	30	9.6	40	10.4
Students having male engineers in their close environment						
0. Have not	5	6.7	13	4.2	18	4.7
1. Have	70	93.3	298	95.8	368	95.3
Male engineers of the close environment are						
1. Father	18	24.0	54	17.4	72	18.7
2. Elder brother	2	2.7	27	8.9	29	7.5
3. Uncle / Cousin	21	28.0	102	32.8	123	31.9
4. Parents’ friends	35	46.7	130	41.8	165	42.7
5. People met during professional training activities	33	44.0	130	41.8	163	42.2
6. Other	7	9.3	30	9.6	37	9.6

iii) University Entrance Exam

The last factor affecting the students’ choice of engineering as a profession is that “their university entrance exam results enabled them” to include this engineering department in their list of preferences (39%). There is no difference of behavior between girls and boys with regard to this factor. At that point, the Turkish admission system to higher education must be explained in order to give the possibility of better understanding this factor.

In Turkey, admission to higher education is centralized and based on nation-wide examination administrated by the Student Selection and Placement Center (ÖSYM) every year. The examination, named the Student Selection Examination (ÖSS), consists of verbal and quantitative parts. Candidates with scores between 105 and 120 points are offered a restricted choice of higher education programs. Placement of the candidate is based upon the composite

score calculated by taking into account the score of the entrance examination as well as the high school grade-point average, normalized nationally using the success of the classmates of the candidate in the entrance examination and also using a factor which depends on the high school type and the program of the candidate. After students receive the results of the exam, they are placed by the central placement in the higher education programs highest on their list of preferences, as is compatible with their scores. The final selection and placement of students in higher education institutions is dependent on the composite scores of the candidates (raised by the amount of the special credit mentioned above, if it applies), on the personal preferences they have listed, and on the quotas and prerequisites of the higher education programs. The central placement procedure in the higher education programs admitting students on the results of the examination is carried out through an iterative computing routine. Each candidate can be placed in one program only [16].

Planning to Work as an Engineer after Graduation

Most of the students (both boys and girls) say they plan to work as engineers after graduation. Half of the students not planning to work as an engineer give the fact that “they could not like and adopt this profession during their studies” as the reason to it. This is another negative effect of the university entrance exam pushing the students to make their preference list based on their grades and not on their aspirations and/or skills.

The second reason of the girls not wishing to work as engineers is their intention of following a university career. Among the replying students to this question 50% of the girls stated their wish to follow a university career while it is only 3.3% among the boys. This resulted is supported by the findings of previous research in Turkey [17]. The increase of female participation in graduate studies faculty and researchers is another proof to that behavior. Sağlamer [18,19] gives 32.4% for 1993-94 and 36.7% for 2001-2002.

Table 6. Planning to Work as an Engineer

Variables	Female (75)		Male (311)		Total (386)	
	F	%	F	%	F	%
Students planning to work as an engineer after graduation						
0. Do not plan	6	8.0	29	9.3	35	9.1
1. Plan	69	92.0	282	90.7	351	90.0
Reasons of not planning to work as an engineer						
1. Do not like the profession	2	33.3	16	53.3	18	50.0
2. Want to follow a university career	3	50.0	1	3.3	4	11.1
3. Limits of finding a job	-	-	3	10.0	3	8.3
4. The low level of salary	-	-	4	13.3	4	11.1
5. Wanting to continue the family activity	1	16.7	6	20.0	7	19.4

Conclusion

The findings of this survey show some important characteristics of Turkish society. The first one is that male students believe by 44.7% (only 22.7% for girls) that gender is important while deciding about profession. The reason they give is “the belief that some engineering fields

necessitate some physical capabilities”. Whereas the reason the girls give is “specific working conditions of some engineering fields”.

One of the main factors found out to affect the choice of engineering as a profession, is the interest in engineering. Boys have greater interest in engineering than girls as in any other country. It is due to the role given to men in the society and in the family. After studying 1125 textbooks used in primary education since 1928, Gümüšoğlu found out that books of twenties and thirties were by far less discriminating than actual ones [20]. This finding shows the importance of reshaping the education system in order to eliminate gender discriminating factors. A good example is the New Labor Law of 2003 banning gender discrimination in the labor market. There is a strong urge to surmount the society’s prejudices and pre-determined roles attributed to men and women by increasing general education.

Another factor is the role of leading people: boys are influenced mostly by men whereas girls reported being equally influenced by men and women while deciding about their profession. It is supported by the fact that girls know more women engineers than boys. Thus, in the process of deciding about profession, women engineers responsibility must be increased in order to increase the number of girls wishing to become engineer.

One may ask if there is a need to increase female engineers in Turkey. Any developing country’s only chance to rapidly increase its income and become a welfare state is by beginning to produce technology, “especially in the knowledge era”. This can only be reached through the increase of qualified labor in technology, thus engineers. The positive contribution of the increase of women engineers in that process is not only their own production but also their potential to change the society’s prejudices by educating their children without a gender bias.

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