



A Comparison Study of Higher Education Graduates of Germany and Turkey

Erol YUCEL^{1,*} , Serpil EROL² 

¹Gazi University, Graduate School of Natural and Applied Sciences, 06560, Ankara, Turkey

²Gazi University, Faculty of Industrial Engineering, 06560, Ankara, Turkey

Highlights

- This paper focuses on higher education graduates of Germany and Turkey, especially on engineering.
- A data-driven educational decision support system (E-DSS) has been developed and used in the study.
- Engineering field of education is dominated by male graduates in both countries.

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Abstract

This research focused on higher education graduates in Germany and Turkey on all fields of education, especially engineering programs in terms of all education levels and gender. The study has provided situational awareness in general on all fields of education, levels of education and gender, but on the “Engineering, manufacturing and construction” field in detail. In the research, many important findings are identified. Turkey’s ED7 (Master’s or equivalent level) and ED8 (Doctoral or equivalent level) graduate numbers and ratios are significantly lower than Germany when compared to the ED6 level. The research also revealed us that the graduation ratios of ED6 (Bachelor’s or equivalent level) and ED7 among female engineers in Germany are close to each other, indicating that female engineers in Germany are more likely to hold a master’s degree after undergraduate education. Among these findings, the most important finding is; while the gender ratio of higher education graduates in Germany at all education levels is almost equal between male and female students, this ratio has started to increase in favor of female graduates in Turkey. This situation developed differently among graduates of engineering programs. While engineering graduates in Germany had a fixed ratio of approximately 80.5% male and 19.5% female graduates between 2014 and 2019. In Turkey, this ratio is improving in favor of female graduates from 32.8% in 2014 to 34.9% in 2019. In this research, it is concluded that the higher education intelligence needs to be top priority for higher education officials.

1. INTRODUCTION

The scope of higher education is defined by UNESCO International Standard Classification of Education (ISCED) 2011 as education programs at the short-cycle tertiary education, bachelor’s, master’s and doctoral or equivalent levels [1]. Higher education institutions are expected to fulfill duties such as raising qualified workforce for all segments of society, producing science and technology, enlightening the society, leading social change and developments. For this reason, higher education has become a symbol of reputation for countries [2].

Higher education is also important to support not only the local and national, but global development efforts as well [3-4] in diverse ways. Highly qualified manpower is one of the most important factors in the development of every country. The most important element that creates this power is higher education graduates. Higher education graduates are very important as they constitute the main source of the country's strategic human capital.

Higher education institutions have a very important role in creating the necessary strategic human capital for the current and developing needs of the society. These institutions are also institutions where scientific research is carried out in the development of humanity and the results obtained from scientific research are reflected to the society. The main purpose of higher education is to provide time and space for individuals

*Corresponding author, e-mail: erol.yucel@gazi.edu.tr

to learn new things, discover who they are and what they want to be, and, increasingly, gain a profession to ensure a secure future.

Today, the functions of universities have begun to change in the face of rapidly changing and increasing knowledge. In addition, the education given at the associate and undergraduate level was insufficient to meet the needs of the society. The desired high-qualified manpower has now begun to be trained at the postgraduate level. While it was considered privileged to have a bachelor's degree in the past, now graduate or doctoral education provides privileges to the individual [5].

New empirical and conceptual insights based on the open-ended online surveys analysis of participants' response concluding that two dimensions of university contribution were established—the instrumental and the holistic/humanistic. At the instrumental level, universities are expected to equip individuals with subject-specific and generic skills and knowledge, and credentials enabling them to work in professions and occupations. Most participants of this study argued that only by providing high-quality higher education targeted the national labour market, can universities address global and national challenges [6].

Postgraduate education; it is a training program that trains a highly specialized manpower with a higher level of knowledge and effectiveness than undergraduate education by working in-depth in a field [7]. However, considering everyone who has completed graduate education as the scientist of the future does not seem right in the face of developments in the world. Just as the university needs the manpower to do high-quality research, the industry also needs trained manpower. Accelerating the development process necessitates scientific research in both the private and public sectors [8].

The increase in the number of graduates at the undergraduate education level directs individuals to be equipped with more advanced education levels and different qualifications. In this sense, postgraduate education can be seen as an investment that an individual makes to increase his or her future income and social status [9].

Improvement of higher education, especially postgraduate education in Turkey has strategic importance to increase highly qualified manpower which is needed in the development of the country, to follow and direct scientific and technological developments, to transform them into high-tech services and products that can meet the needs at national and international level, to provide more qualified education at associate and undergraduate level, finally to increase the number and quality of researchers and academicians. For these reasons, the decisions made by the administrators and managers in higher education have very important effects in the long run for the country.

Since higher education is one of the most important elements directly related to the development of every country and focused on raising internationally competitive work force, along with mass education, it is of strategic importance for the relevant administrators to examine the situational awareness in higher education and know the trends. To support higher education management decisions, higher education decision-makers need to understand not only the trends nationally and internationally related to higher education graduates in terms of all fields of education, education levels and gender, but also the trends on other important topics such as enrolments, entrants, and mobility, etc. This research is focused on the higher education graduates of Germany and Turkey in terms of all fields of education, especially in engineering programs, education levels and gender. But, other topics related to higher education graduates will be researched later on.

There are datasets available on national and international levels for higher education decision support, but they usually contain raw data and are not compatible with each other in terms of metadata. To overcome these issues, a data-driven educational decision support system (E-DSS) has been developed to include the education administrative data provided by the statistical office of the European Union (EUROSTAT) from 2013 onwards.

This study is divided into three sections. In the first part, the international organizations that manage the annual data collection and the data they cover are presented and the International Standard Classification

of Education (ISCED), which categorizes education statistics, is explained. Then, higher education graduates of Germany and Turkey at each education level and field of education are compared in general and later by the engineering, manufacturing and construction field, as well. Subsequently, the same analysis is performed by gender. In the last section, conclusions and suggestions for further studies are presented.

2. MATERIALS AND METHOD

The E-DSS needs comparable secondary data to monitor or benchmark the progress of the national education systems, including inputs and outputs, nationally or internationally across countries. This data need is met by the EUROSTAT education administrative data for the research.

2.1. International Organizations

Three international organizations are administering the annual data collection and the standards on international statistics on education and training. These are the United Nations Educational, Scientific, and Cultural Organization Institute for Statistics (UNESCO-UIS), the Organization for Economic Co-operation and Development (OECD), and the statistical office of the European Union (EUROSTAT). These international organizations collect annual data on enrollments and entrants, student mobility, education personnel, education finance, and language learning including participation ratios at different levels of education, shares of pupils and students by programme orientation and enrollments in public and private institutions, tertiary education graduates, degree mobile students enrolled and graduates, foreign language learning, expenditure on education per student and relative GDP, etc.[1].

2.2. International Standard Classification of Education (ISCED)

In the 1970s, UNESCO developed ISCED to categorize and report education statistics both nationally and internationally [1]. ISCED was revised in 1997 and later in 2011. ISCED is the reference international classification for researchers and education managers to organise education programmes and related qualifications by levels and fields.

The revision in 2011 concentrated primarily on changes to the levels of education programs (ISCED-P) with nine levels of education from level 0 to level 8 as presented in Table 1. In the current ISCED-P 2011, the tertiary education has more resolution in terms of education levels since ISCED 1997 classification covered short-cycle tertiary education, bachelor's, and master's or equivalent levels in a single level as ED5.

Table 1. Comparison of ISCED 1997 and ISCED-P 2011 education levels

ISCED 1997	ISCED-P 2011	Explanation (ISCED-P 2011)	Aggregated levels
ISCED 0 (ED0)	ISCED 0 (ED0)	Early childhood education	Low education
ISCED 1 (ED1)	ISCED 1 (ED1)	Primary education	
ISCED 2 (ED2)	ISCED 2 (ED2)	Lower secondary education	
ISCED 3 (ED3)	ISCED 3 (ED3)	Upper secondary education	Medium education
ISCED 4 (ED4)	ISCED 4 (ED4)	Post-secondary non-tertiary	
ISCED 5 (ED5)	ISCED 5 (ED5)	Short-cycle tertiary education	High education
	ISCED 6 (ED6)	Bachelor's or equivalent level	
	ISCED 7 (ED7)	Master's or equivalent level	
ISCED 6 (ED6)	ISCED 8 (ED8)	Doctoral or equivalent level	

ISCED revised in 2013 once more. The 2013 revision focused on the fields of education and training (ISCED-F). In ISCED-F-2013, all the education and training fields are categorized into 10 broad fields as shown in Table 2. Later, each broad field is divided into narrow fields, which are further explained by detailed fields.

Table 2. ISCED-F 2013 broad fields of education and training

Code	Broad Fields of Education and Training
F01	Education
F02	Arts and humanities
F03	Social sciences, journalism and information
F04	Business, administration and law
F05	Natural sciences, mathematics and statistics
F06	Information and Communication Technologies
F07	Engineering, manufacturing and construction
F08	Agriculture, forestry, fisheries and veterinary
F09	Health and welfare
F10	Services

Since the narrow and detailed list for all the broad fields is very long, this list is filtered to show all the narrow and detailed fields only for the F07 engineering, manufacturing and construction broad field in Table 3.

Table 3. ISCED-F 2013 F07 engineering, manufacturing, and construction fields

ISCED-F-13 Code	Fields		
	Broad	Narrow	Detailed
F07	Engineering, Manufacturing and Construction		
F070		Engineering, manufacturing and construction not further defined	
F071		Engineering and engineering trades	
F0710			Engineering and engineering trades not further defined
F0711			Chemical engineering and processes
F0712			Environmental protection technology
F0713			Electricity and energy
F0714			Electronics and automation
F0715			Mechanics and metal trades
F0716			Motor vehicles, ships and aircraft
F0719			Engineering and engineering trades not elsewhere classified
F072		Manufacturing and processing	
F0720			Manufacturing and processing not further defined
F0721			Food processing
F0722			Materials (glass, paper, plastic and wood)
F0723			Textiles (clothes, footwear and leather)
F0724			Mining and extraction
F0729			Manufacturing and processing not elsewhere classified
F073		Architecture and construction	
F0730			Architecture and construction not further defined
F0731			Architecture and town planning
F0732			Building and civil engineering
F078		Inter-disciplinary programmes and qualifications involving the F07 field	
F079		Engineering, manufacturing and construction not elsewhere classified	

2.3. Research Data

The research data cover the information about the tertiary graduates of Germany and Turkey in the table “Educ_uoe_grad02 graduates by education level, program orientation, gender and field of education” between 2014 and 2019 [10].

The research data used in this study starts from 2014, since the ISCED-F-2013 data for 2013 are not provided for Turkey. The ISCED-P 1997 data are still available but is not included in this study since they do not specifically provide higher education data for bachelor's and master's levels separately. Even though tertiary education covers ED5 (Short-cycle tertiary education) as well, ED5 is not included in the research data since Germany excludes vocational academies. The latest research data belong to 2019 and the tertiary term covers ED6, ED7 and ED8 data in the research.

2.4. Analysis of All Tertiary Graduates of Germany and Turkey

The analysis is conducted first for all the broad fields of education and then for F07 engineering, manufacturing, and construction Broad Field.

2.4.1. Analysis of all broad fields of education (ISCED-F-2013)

Tertiary education graduate ratios of Germany and Turkey in each education level are presented in Figure 1. Out of all tertiary education graduates in 2019, 60.88% of students in Germany, and 80.73% of students in Turkey have ED6 bachelor's level or equivalent degrees. For the ED7 master's level and ED8 doctoral level degrees, the ratios are increasing in Turkey, but still much lower than the ratios of Germany. For the ED8 doctoral level in Germany, the graduation ratio decreased from 5.39% in 2014 to 4.46% in 2019, but is still much higher than Turkey's ratios, which are 1.01% in 2014 and 1.39% in 2019. Figure 1 emphasizes visually that there are significant differences in graduate ratios of each education level between Germany and Turkey.

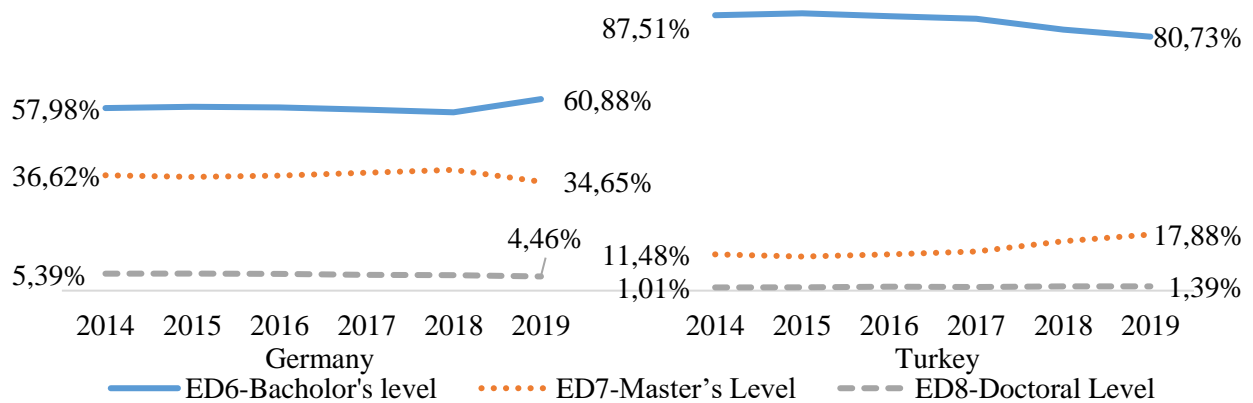


Figure 1. Education level graduation ratios for Germany and Turkey

In Table 4, for each education level, the number of graduates for Germany is stable in general, but for Turkey, is increasing every year. In 2019, 642.504 students in Germany, and 580.520 students in Turkey are graduated from tertiary education establishments.

Table 4. Tertiary graduates numbers and ratios of Germany and Turkey based on education levels

Country	Year	Number of Graduates				Ratios (%)		
		ED6	ED7	ED8	Total	ED6	ED7	ED8
Germany	Average	330.100	207.036	28.593	565.730	58.35	36.60	5.05
	2014	302.398	190.999	28.127	521.524	57.98	36.62	5.39
	2015	317.899	196.650	29.218	543.767	58.46	36.16	5.37
	2016	323.242	202.929	29.299	555.470	58.19	36.53	5.27
	2017	326.477	212.665	28.397	567.539	57.53	37.47	5.00
	2018	319.414	216.329	27.837	563.580	56.68	38.38	4.94
	2019	391.172	222.647	28.685	642.504	60.88	34.65	4.46
Turkey	Average	434.857	68.691	6.200	509.749	85.31	13.48	1.22
	2014	389.746	51.133	4.511	445.390	87.51	11.48	1.01
	2015	447.294	54.983	5.192	507.469	88.14	10.83	1.02
	2016	424.659	56.077	6.052	486.788	87.24	11.52	1.24
	2017	439.765	63.125	6.045	508.935	86.41	12.40	1.19
	2018	439.042	83.020	7.332	529.394	82.93	15.68	1.38
	2019	468.640	103.811	8.069	580.520	80.73	17.88	1.39

2019 tertiary graduate numbers of Germany and Turkey are listed in Table 5 by fields of education and training (ISCED-F-2013) according to education levels (ED6, ED7, ED8) with the first rank highlighted for each education level. F04 business, administration and law broad field of education has the highest number of graduates for both countries in ED6, ED7, and in total. For ED8, the highest number of graduates in Germany is registered in F09 Health and Welfare broad field (8,169 graduates-28.5% of all 2019 ED8 graduates) while F07 engineering, manufacturing, and construction broad field (1,518 graduates-18.8% of all 2019 ED8 graduates) in Turkey.

Table 5. 2019 graduate numbers–rank and ratio of every field of education in each education level in parenthesis (First rank highlighted)

ISCED-F-2013	ISCED-P-2011-Germany				ISCED-P-2011-Turkey			
	ED6	ED7	ED8	Total	ED6	ED7	ED8	Total
F01. Education	42,255 (3-10.8%)	20,198 (5-9.1%)	471 (9-1.6%)	62,924 (4-9.8%)	53,395 (5-11.4%)	7,806 (6-7.5%)	812 (5-10.1%)	62,013 (5-10.7%)
F02. Arts and humanities	26,955 (4-6.9%)	35,837 (3-16.1%)	2,152 (5-7.5%)	64,944 (3-10.1%)	66,266 (3-14.1%)	10,996 (4-10.6%)	1,288 (2-16.0%)	78,550 (3-10.7%)
F03. Social sciences, journalism and information	25,291 (5-6.5%)	17,754 (7-8.0%)	1,611 (6-5.6%)	44,656 (7-7.0%)	63,670 (4-13.6%)	8,412 (5-8.1%)	717 (7-8.9%)	72,799 (4-12.5%)
F04. Business, administration and law	109,762 (1-28.1%)	46,975 (1-21.1%)	2,468 (4-8.6%)	159,205 (1-24.8%)	135,478 (1-28.9%)	23,530 (1-22.7%)	1,185 (4-14.7%)	160,193 (1-27.6%)
F05. Natural sciences, math. and statistics	19,096 (7-4.9%)	25,056 (4-11.3%)	8,078 (2-28.2%)	52,230 (5-8.1%)	15,391 (8-3.3%)	6,694 (8-6.4%)	1,223 (3-15.2%)	23,308 (8-4.0%)
F06. Information Communication Technologies	18,221 (8-4.7%)	10,260 (8-4.6%)	1,032 (7-3.6%)	29,513 (8-4.6%)	2,653 (10-0.6%)	977 (10-0.9%)	43 (10-0.5%)	3,673 (10-0.6%)
F07. Engineering, manufacturing, and construction	108,882 (2-27.8%)	42,730 (2-19.2%)	3,790 (3-13.2%)	155,402 (2-24.2%)	73,288 (2-15.6%)	12,157 (3-11.7%)	1,518 (1-18.8%)	86,963 (2-15.0%)

F08. Agriculture, forestry, fisheries and veterinary	6,943 (10-1.8%)	3,260 (9-1.5%)	798 (8-2.8%)	11,001 (10-1.7%)	4,682 (9-1.0%)	5,083 (9-4.9%)	367 (8-4.5%)	10,132 (9-1.7%)
F09. Health and welfare	19,511 (6-5.0%)	18,135 (6-8.1%)	8,169 (1-28.5%)	45,815 (6-7.1%)	34,574 (6-7.4%)	20,520 (2-19.8%)	746 (6-9.2%)	55,840 (6-9.6%)
F10. Services	14,256 (9-3.6%)	2,442 (10-1.1%)	116 (10-0.4%)	16,814 (9-2.6%)	19,243 (7-4.1%)	7,636 (7-7.4%)	170 (9-2.1%)	27,049 (7-4.7%)
Total	391,172	222,647	28,685	642,504	468,640	103,811	8,069	580,520

In Table 4, tertiary education graduation ratios are presented by ISCED-P-2011 education levels, covering all ISCED-F-2013 education and training fields. In Table 6, these ratios are calculated according to each field of education and training by education level. High ratios in ED6 mean fewer ED7 and ED8 graduates in those fields of education. Some ED7 ratios are higher than their respective ED6 ratios, as seen in the F02 Arts and Humanities field of education in Germany, because some ED6 graduates of other fields of education are choosing this field for their master's degree level education but not for their respective fields of education. In doctoral or equivalent levels, F05 natural sciences, mathematics, and statistics and F09 health and welfare fields have nearly one-third of the all doctoral-level students in Germany; this ratio is 33.3% in Germany, but only 5.5% in Turkey.

Table 6. 2019 graduate ratios by education levels (First rank highlighted)

ISCED-F-2013	Germany (%)			Turkey (%)		
	ED6	ED7	ED8	ED6	ED7	ED8
F01. Education	67.2	32.1	0.7	86.1	12.6	1.3
F02. Arts and humanities	41.5	55.2	3.3	84.4	14.0	1.6
F03. Social sciences, journalism, and information	56.6	39.8	3.6	87.5	11.6	1.0
F04. Business, administration, and law	68.9	29.5	1.6	84.6	14.7	0.7
F05. Natural sciences, math. and statistics	36.6	48.0	15.5	66.0	28.7	5.2
F06. Information and Communication Technologies	61.7	34.8	3.5	72.2	26.6	1.2
F07. Engineering, manufacturing, and construction	70.1	27.5	2.4	84.3	14.0	1.7
F08. Agriculture, forestry, fisheries and veterinary	63.1	29.6	7.3	46.2	50.2	3.6
F09. Health and welfare	42.6	39.6	17.8	61.9	36.7	1.3
F10. Services	84.8	14.5	0.7	71.1	28.2	0.6
Total	60.9	34.7	4.5	80.7	17.9	1.4

2.4.2. Analysis for F07 engineering, manufacturing, and construction broad field

In Table 7, 2019 graduate numbers are presented for every narrow (highlighted black) and detailed field (not highlighted) of the F07 engineering, manufacturing and construction broad field of education. Among German higher education graduates, there was a remarkable variability in the distribution of tertiary graduates in this field. For example, in the F071 Engineering and its trades narrow field, Germany has 50,081 graduates in ED6; 14,253 graduates in ED7; and 1,358 graduates in ED8; while Turkey has 41,040, 6,688, and 892 respectively.

By analyzing Table 7 for number of graduates and Table 8 for graduate ratios in each educational level, it is concluded that among the narrow fields of Germany's F07 engineering, manufacturing and construction broad field of education, the number of graduates in the F078 Interdisciplinary programs was second with 35,004 graduates (32.1%) after F078 on the ED6, first with 16,903 graduates (39.6%) on the ED7, and first with 1,686 graduates (44.5%) on the ED8. This situation shows that interdisciplinary programs are given great importance among F07 engineering, manufacturing and construction programs in Germany. But, in Turkey, F071 engineering and its trades narrow field has the majority of graduates in every education level. F078 inter-disciplinary programmes has the most graduates after F073 architecture and construction field.

F0722 Materials detailed field has the lowest number of graduates in all F07 detailed fields in Turkey at every education level. Also, Germany does not have any ED8 graduates in the F0723 Textiles detailed field.

Table 7. 2019 graduates of F07 engineering, manufacturing and construction field by education levels

ISCED-F-2013	ISCED-P-2011 - Germany				ISCED-P-2011 - Turkey			
	ED6	ED7	ED8	Total	ED6	ED7	ED8	Total
F07 Eng., manufacturing, and const.	108,882	42,730	3,790	155,402	73,288	12,157	1,518	86,963
F071 Engineering and its trades	50,081	14,253	1,358	65,692	41,040	6,688	892	48,620
F0711 Chemical eng. and processes	3,731	1,841	241	5,813	1,817	571	79	2,467
F0712 Environmental protection tech.	1,258	1,222	54	2,534	2,407	578	66	3,051
F0713 Electricity and energy	4,291	1,477	35	5,803	2,090	532	55	2,677
F0714 Electronics and automation	14,612	6,417	833	21,862	19,848	2,929	392	23,169
F0715 Mechanics and metal trades	16,052	945	67	17,064	12,472	1,740	260	14,472
F0716 Motor vehicles, ships, aircraft	10,137	2,351	128	12,616	2,406	338	40	2,784
F072 Manufacturing and processing	6,898	1,736	213	8,847	5,077	1,162	169	6,408
F0721 Food processing	1,544	347	28	1,919	3,609	771	109	4,489
F0722 Materials	3,712	1,004	174	4,890	19	47	4	70
F0723 Textiles	727	151	0	878	621	160	23	804
F0724 Mining and extraction	915	234	11	1,160	828	184	33	1,045
F073 Architecture and construction	16,899	9,838	533	27,270	19,270	3,001	269	22,540
F0731 Architecture and town planning	6,262	5,145	183	11,590	8,356	1,418	118	9,892
F0732 Building and civil engineering	10,637	4,693	350	15,680	10,914	1,583	151	12,648
F078 Inter-disciplinary programmes	35,004	16,903	1,686	53,593	7,901	1,306	188	9,395

In Table 8, 2019 graduate ratios for every F07 engineering, manufacturing and construction broad, narrow, and detailed field are presented by education levels. In Figure 1, the ratios for all fields of education in terms of education levels for Germany are 60.88% in ED6, 34.65% in ED7 and 4.46% in ED8, but in F07, these ratios for Germany are 70.1%, 27.5% and 2.4% respectively. This would imply that in Germany, ED6 engineering graduates are not pursuing ED7 and ED8 degrees in their fields as much as other fields of education graduates. In Turkey, F07 graduates have a 3.88% lower ratio in ED7 than its ratio for all the fields of education and a 0.31% lower ratio in ED8 in general.

Table 8. 2019 graduate ratios in F07 engineering, manufacturing and construction field by education levels

ISCED-F-2013	Germany (%)			Turkey (%)		
	ED6	ED7	ED8	ED6	ED7	ED8
F07 Engineering, Manufacturing, Construction	70.1	27.5	2.4	84.3	14.0	1.7
F071 Engineering and engineering trades	76.2	21.7	2.1	84.4	13.8	1.8
F0711 Chemical engineering and processes	64.2	31.7	4.1	73.7	23.1	3.2
F0712 Environmental protection technology	49.6	48.2	2.1	78.9	18.9	2.2
F0713 Electricity and energy	73.9	25.5	0.6	78.1	19.9	2.1
F0714 Electronics and automation	66.8	29.4	3.8	85.7	12.6	1.7
F0715 Mechanics and metal trades	94.1	5.5	0.4	86.2	12.0	1.8
F0716 Motor vehicles, ships and aircraft	80.4	18.6	1.0	86.4	12.1	1.4
F072 Manufacturing and processing	78.0	19.6	2.4	79.2	18.1	2.6
F0721 Food processing	80.5	18.1	1.5	80.4	17.2	2.4
F0722 Materials (glass, paper, plastic and wood)	75.9	20.5	3.6	27.1	67.1	5.7
F0723 Textiles (clothes, footwear and leather)	82.8	17.2	0.0	77.2	19.9	2.9
F0724 Mining and extraction	78.9	20.2	0.9	79.2	17.6	3.2
F073 Architecture and construction	62.0	36.1	2.0	85.5	13.3	1.2
F0731 Architecture and town planning	54.0	44.4	1.6	84.5	14.3	1.2
F0732 Building and civil engineering	67.8	29.9	2.2	86.3	12.5	1.2
F078 Inter-disciplinary programs	65.3	31.5	3.1	84.1	13.9	2.0

In Table 9, 2019 graduate ratios for every F07 engineering, manufacturing and construction broad, narrow, and detailed field are presented in each education level. The share of total graduates in the F071 engineering and engineering trades narrow field was relatively low in Germany (42.3%), while a much higher share was registered in Turkey (55.9%). Similarly, the share of graduates in the F072 manufacturing and processing narrow field is relatively low in Germany (5.7%), while it was relatively high in Turkey (7.4%) and the same situation was seen for the F073 architecture and construction narrow field as well; 17.5% in Germany, 25.9% in Turkey. However, in the F078 inter-disciplinary programmes and qualifications field involving the F07 engineering, manufacturing and construction field, the situation changes drastically in favor of Germany with 34.5% and with only Turkey 10.8%.

Table 9. 2019 graduate ratios of F07 engineering, manufacturing and construction field's narrow and detailed fields

ISCED-F-2013	Germany (%)				Turkey (%)			
	ED6	ED7	ED8	Total	ED6	ED7	ED8	Total
F071 Engineering and its trades	46.0	33.4	35.8	42.3	56.0	55.0	58.8	55.9
F0711 Chemical engineering and processes	7.4	12.9	17.7	8.8	4.4	8.5	8.9	5.1
F0712 Environmental protection technology	2.5	8.6	4.0	3.9	5.9	8.6	7.4	6.3
F0713 Electricity and energy	8.6	10.4	2.6	8.8	5.1	8.0	6.2	5.5
F0714 Electronics and automation	29.2	45.0	61.3	33.3	48.4	43.8	43.9	47.7
F0715 Mechanics and metal trades	32.1	6.6	4.9	26.0	30.4	26.0	29.1	29.8
F0716 Motor vehicles, ships and aircraft	20.2	16.5	9.4	19.2	5.9	5.1	4.5	5.7
F072 Manufacturing and processing	6.3	4.1	5.6	5.7	6.9	9.6	11.1	7.4
F0721 Food processing	22.4	20.0	13.1	21.7	71.1	66.4	64.5	70.1
F0722 Materials (glass, paper, plastic and wood)	53.8	57.8	81.7	55.3	0.4	4.0	2.4	1.1
F0723 Textiles (clothes, footwear and leather)	10.5	8.7	0.0	9.9	12.2	13.8	13.6	12.5
F0724 Mining and extraction	13.3	13.5	5.2	13.1	16.3	15.8	19.5	16.3
F073 Architecture and construction	15.5	23.0	14.1	17.5	26.3	24.7	17.7	25.9
F0731 Architecture and town planning	37.1	52.3	34.3	42.5	43.4	47.3	43.9	43.9
F0732 Building and civil engineering	62.9	47.7	65.7	57.5	56.6	52.7	56.1	56.1
F078 Inter-disciplinary programs	32.1	39.6	44.5	34.5	10.8	10.7	12.4	10.8

Figure 2 shows each narrow field's graduate ratios for F07 engineering, Manufacturing, and Construction broad field. In Turkey, F071 Engineering and its trades narrow field has the highest ratio for each education level. In Germany, this field has the first place in ED6, but the second place in ED7 and ED8, while F078 Inter-disciplinary programmes field has the first place in ED7 and ED8.

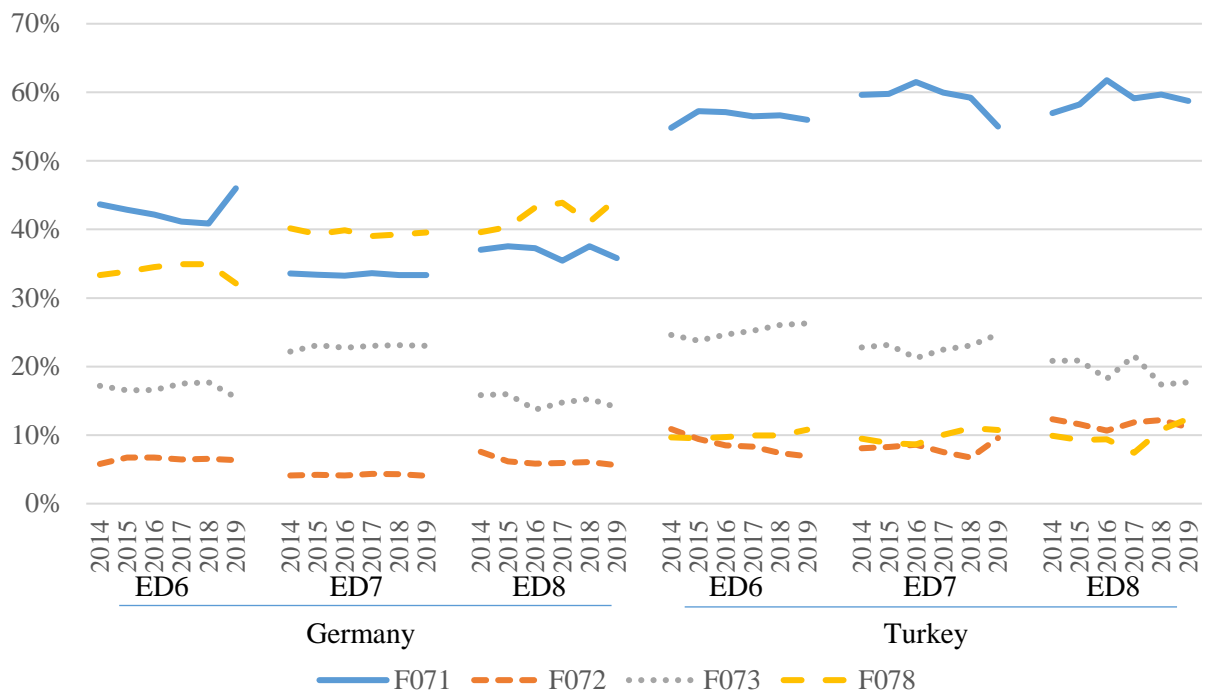


Figure 2. Education level graduation ratios for Germany and Turkey in each F07 narrow fields

2.5. Gender Analysis of All Tertiary Graduates of Germany and Turkey

The analysis for all tertiary graduates of Germany and Turkey is conducted in two dimensions in terms of gender: first for all the broad fields of education and then for F07 engineering, manufacturing, and construction broad field.

2.5.1. Analysis of all broad fields of education (ISCED-F-2013) by gender

In education statistics, one of the main indicators is the gender ratio. In Figure 3, all tertiary graduates of both countries are presented between 2014 and 2019 in terms of gender. In Germany, the ratio of male graduates is higher than the ratio of female graduates for the first time in 2019 between 2014 and 2019. However, in Turkey, the ratio of female graduates is higher than the ratio of male graduates since 2017 and the trend seems to improve in favor of female graduates.

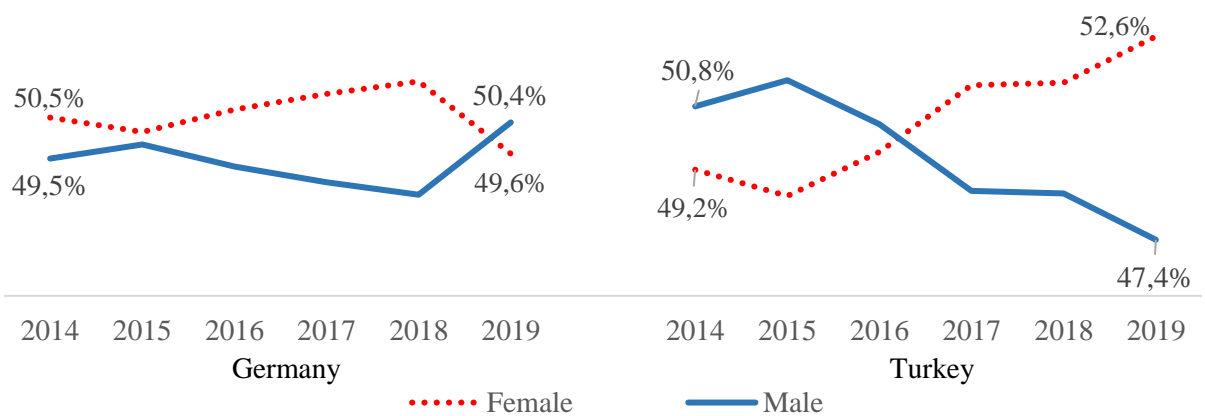


Figure 3. The ratio of tertiary graduates in terms of gender

In Table 10, the female graduate ratios and the numbers of tertiary female graduates for all fields of education and education levels are presented. Despite the fact that the number of female graduates increases every year at every education level in Germany, the ratio of women among all graduates seems to be stable in general. In Turkey, the situation has developed differently over the years. The ratio of female graduates among all

graduates increased from 50% to 53.1% at ED6 level, from 43.5% to 50.6% at ED7 level, and decreased from 47.7% to 46.5% at ED8 level.

Table 10. Ratios and the numbers of female graduates for all fields of education and education levels

	Year	Germany				Turkey			
		ED6	ED7	ED8	Total	ED6	ED7	ED8	Total
Ratios (%)	2014	48.6	54.3	45.5	50.5	50.0	43.5	47.7	49.2
	2015	48.4	53.8	44.7	50.2	49.0	45.3	46.1	48.5
	2016	49.7	53.2	45.2	50.7	50.1	46.5	46.3	49.7
	2017	50.8	52.4	44.8	51.1	52.2	45.8	49.0	51.3
	2018	51.2	52.6	45.2	51.4	52.6	45.2	46.8	51.4
	2019	47.8	53.4	45.4	49.6	53.1	50.6	46.5	52.6
	All Years	49.4	53.3	45.1	50.6	51.2	46.6	47.0	50.5
Numbers of female graduates	2014	146,899	103,771	12,784	263,454	194,732	22,230	2,153	219,115
	2015	153,873	105,817	13,052	272,742	218,987	24,910	2,394	246,291
	2016	160,613	107,879	13,247	281,739	212,838	26,051	2,803	241,692
	2017	165,891	111,508	12,711	290,110	229,437	28,891	2,960	261,288
	2018	163,419	113,886	12,577	289,882	231,150	37,538	3,435	272,123
	2019	186,840	118,838	13,037	318,715	248,902	52,571	3,751	305,224
	All Years	977,535	661,699	77,408	1,716,642	1,336,046	192,191	17,496	1,545,733

The visual analysis of Table 10 is shown in Figure 4. As can be seen in Table 8, while the ratio of female graduates to total graduates in Germany seems stable for all years, an upward trend is observed especially at ED6 and ED7 levels in Turkey, and a stable trend at ED8 level.

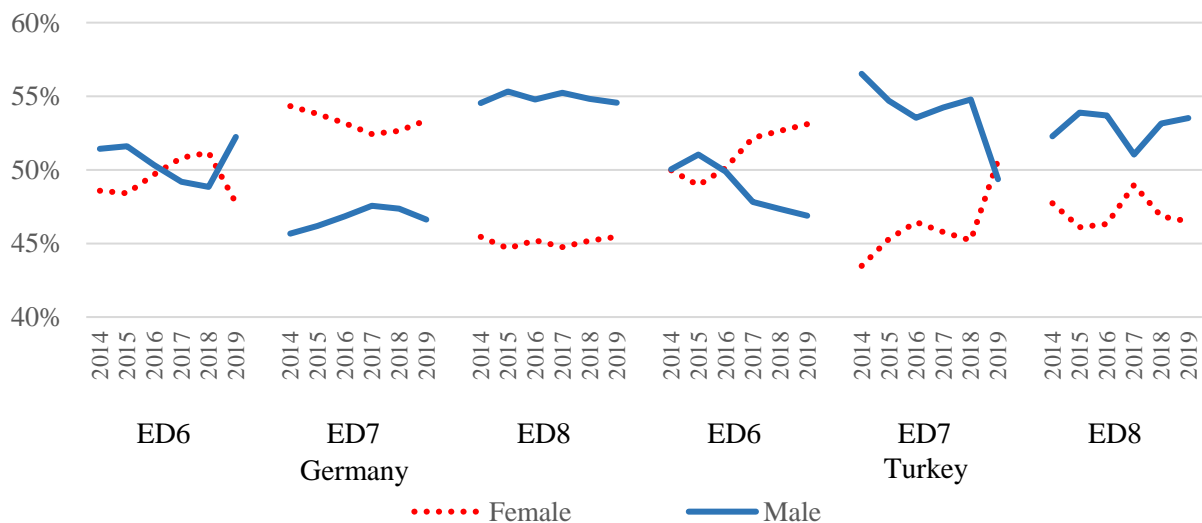


Figure 4. The ratios and numbers of tertiary graduates in terms of gender for each education level

2.5.2. Analysis for F07 engineering, manufacturing, and construction broad field by gender

In Figure 5, the gender ratios of F07 engineering, manufacturing, and construction field graduates are presented with the ratios of all fields of education. The F07 engineering, manufacturing, and construction graduates' gender ratios in Germany are quite stable and male engineering graduates have around a 60% difference between the female and male ratios for all years. But in Turkey, this ratio is improving in favor of female graduates from 34.4% in 2014 to 30.2% in 2019. Female graduates have lower representation in the engineering field for both countries compared to the total tertiary graduates.

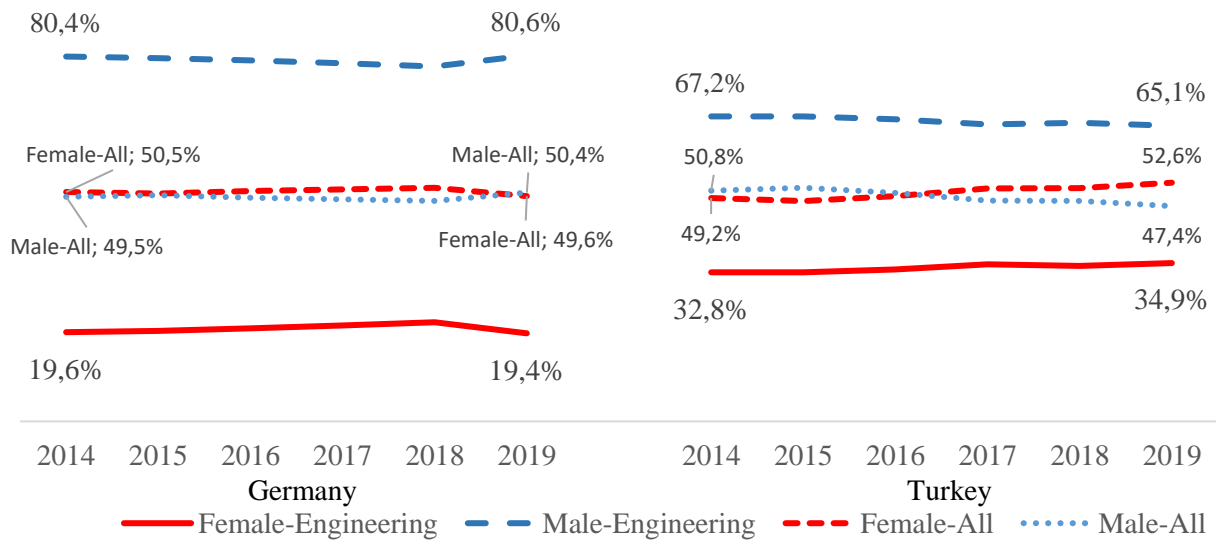


Figure 5. The ratios of tertiary graduates in terms of gender

In Figure 6, the gender ratios of F07 engineering, manufacturing, and construction field graduates for each education level are presented. In both countries, there is a male dominance for all education levels throughout the years. The ratios in Figure 7 for Germany also seem generally stable while in Turkey there is a gradually decreasing gender gap. When the ratios are examined, it is seen that Turkey have ratios that are almost twice as good as Germany. In fact, the rate of female graduates at the ED7 level has reached to 41.1%.

American Physical Society provided the number of female doctoral graduate ratios between 1966 and 2018 [11]. The data for the year 2018 is used for comparison with Germany and Turkey. In the USA, in all fields female ED8 level graduates have 50.3% in 2018, while Germany has 45.2% and Turkey has 46.8% the same year. But, for the engineering field in 2018, the female graduate ratios for the USA and Germany are 24.3% and 20.2% respectively, but 35.2% for Turkey.

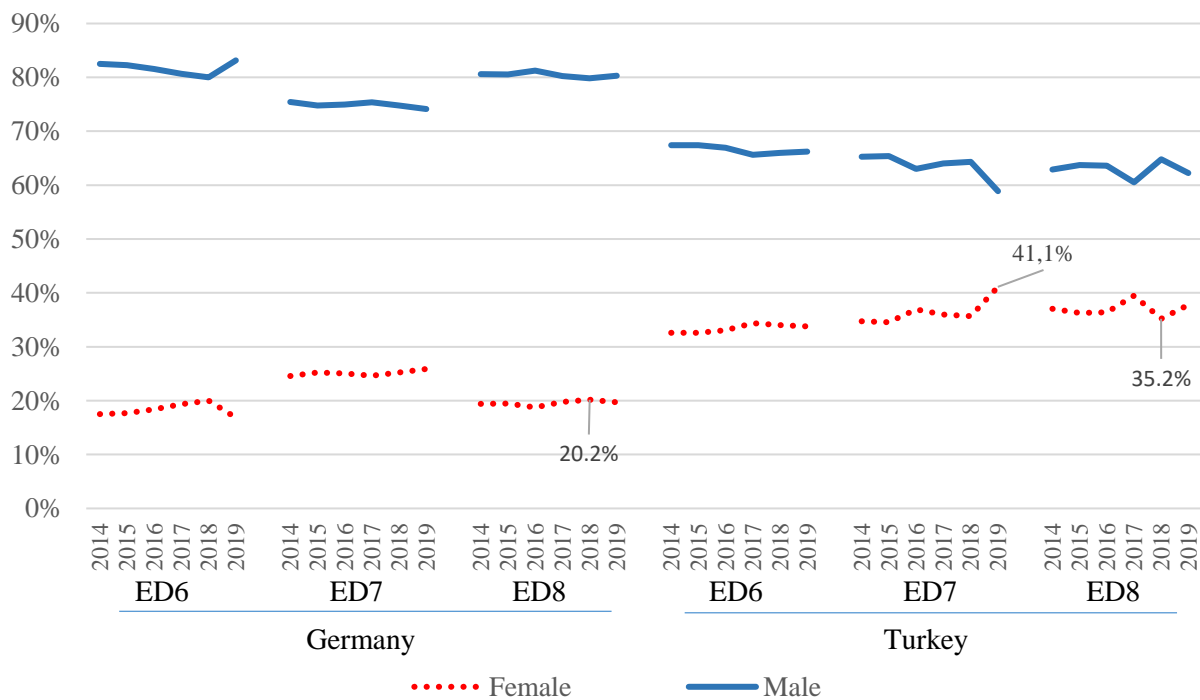


Figure 6. The ratios of F07 graduates in terms of gender for each education level

In Table 11, the female graduate ratios and numbers for the F07 engineering, manufacturing, and construction field female graduates for each education level are presented. In 2019, 30,143 women in Germany and 30,326 women in Turkey graduated from higher education engineering programs. With these graduate numbers in F07, female graduates had a rate of 19.4% and 34.9% in Turkey. Although the number of total female graduates in engineering seems almost equal for both countries in 2019; the number of ED7 level female graduates is 11,052 for Germany and 4,999 for Turkey in that year.

Table 11. 2019 female graduate ratios and numbers of tertiary graduates for F07 field

Data Type	Year	ISCED-P-2011-Germany				ISCED-P-2011-Turkey			
		ED6	ED7	ED8	Total	ED6	ED7	ED8	Total
Ratios (%)	2014	17.5	24.6	19.4	19.6	32.6	34.8	37.1	32.8
	2015	17.7	25.2	19.4	20.0	32.6	34.6	36.3	32.8
	2016	18.4	25.1	18.7	20.5	33.0	37.0	36.4	33.4
	2017	19.3	24.6	19.8	21.1	34.4	36.0	39.5	34.6
	2018	20.0	25.2	20.2	21.8	34.0	35.7	35.2	34.2
	2019	16.8	25.9	19.7	19.4	33.8	41.1	37.7	34.9
	All Years	18.2	25.1	19.5	20.4	33.5	37.2	37.0	33.9
Number	2014	13,284	8,011	623	21,918	14,244	1,542	274	16,060
	2015	14,573	8,986	728	24,287	16,933	1,818	339	19,090
	2016	14,910	9,515	695	25,120	19,542	2,142	396	22,080
	2017	15,080	10,137	743	25,960	22,558	2,335	452	25,345
	2018	14,983	10,653	728	26,364	23,626	3,099	500	27,225
	2019	18,345	11,052	746	30,143	24,754	4,999	573	30,326
	All Years	91,175	58,354	4,263	153,792	121,657	15,935	2,534	140,126

In Figure 7, the education level ratios of F07 graduates for each country are presented visually by gender. In both countries, the ratios of ED7 female graduates are higher than the ratios of ED7 male graduates. While the rate of ED7 female graduates with higher education degrees in Turkey was 9.6% in 2014, this ratio increased to 16.5% in 2019, and this ratios increased from 8.8% to 12.6% for male graduates, respectively.

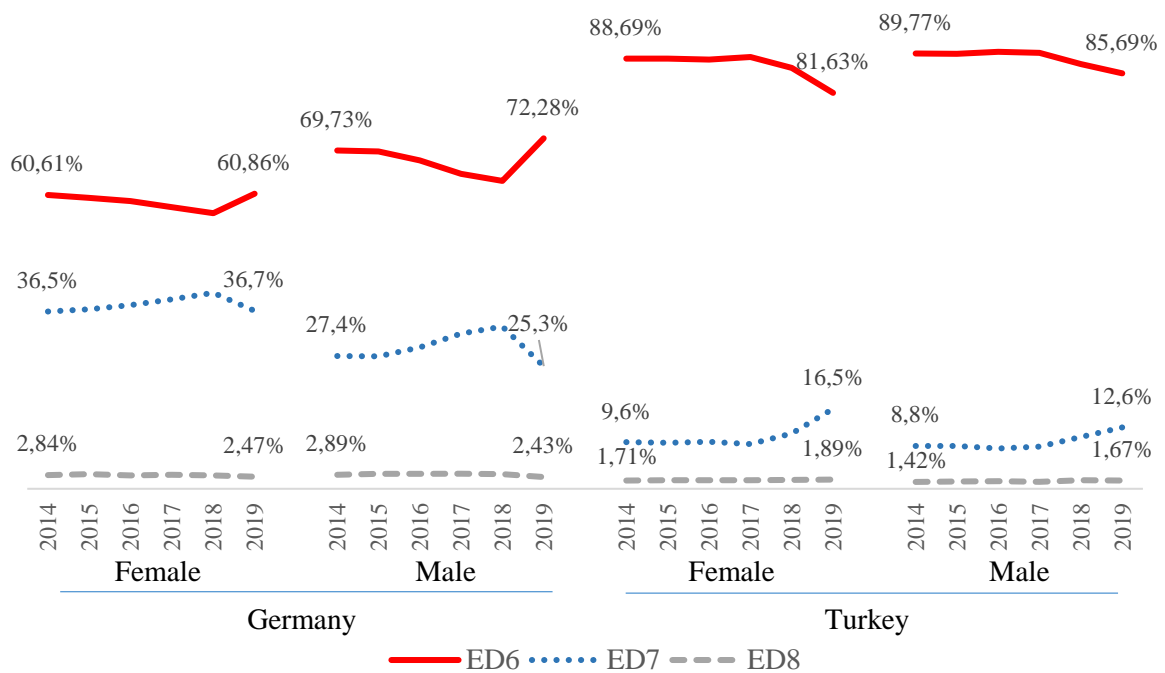


Figure 7. F07 engineering, manufacturing and construction field graduate ratios by education levels and gender

In Table 12, the education level ratios and number of female graduates for each country have been presented per year. In Germany, the female graduate ratios for each education level for all years are as follows: 59.28% of ED6, 37.94% of ED7, and 2.77% of ED8; while Turkey has 86.82%, 11.37%, and 1.81% respectively.

Table 12. F07 engineering, manufacturing and construction field's number and ratios of female graduates by the education levels

Data Type	Year	ISCED-P-2011-Germany				ISCED-P-2011-Turkey			
		ED6	ED7	ED8	Total	ED6	ED7	ED8	Total
Ratios (%)	2014	60.61	36.55	2.84	19.6	88.69	9.60	1.71	88.69
	2015	60.00	37.00	3.00	20.0	88.70	9.52	1.78	88.70
	2016	59.36	37.88	2.77	20.5	88.51	9.70	1.79	88.51
	2017	58.09	39.05	2.86	21.1	89.00	9.21	1.78	89.00
	2018	56.83	40.41	2.76	21.8	86.78	11.38	1.84	86.78
	2019	60.86	36.67	2.47	19.4	81.63	16.48	1.89	81.63
	All Years	59.28	37.94	2.77	20.4	86.82	11.37	1.81	86.82

3. RESULTS AND DISCUSSION

In this study, higher education graduates of Germany and Turkey were compared in terms of education levels and gender by all education levels fields and engineering fields separately.

First, the results of the analysis of all broad fields of education will be discussed. The number of graduate ratios for all education levels (ED6, ED7, ED8) in terms of are almost stable for Germany, except for 2019, which has 71,758 more graduates (391.172 graduates in 2019, 319.414 graduates in 2018) compared to the previous year, a 22.47% increase in ED6 Bachelor's level. This spike has caused the ED7 and ED8 ratios to decrease in 2019, while the numbers of graduates were stable between 2014 and 2018. In average of all years between 2014 and 2019, 58.35% of tertiary education students in Germany graduated from ED6 bachelor's level, 36.60% from ED7 master's level and 5.05% from ED8 doctoral level programmes. This shows us that there are 207,036 ED7 graduates and 28,593 ED8 graduates in all tertiary programs in Germany, compared to an average of 330,100 ED6 graduates every year. Since the tertiary education aims learning at a high level of complexity and specialization, Germany's tertiary graduates seem to be focused more to increase their academic and/or professional knowledge, skills and competences after ED6 level education.

In Turkey, 85.31% of tertiary education students graduated from ED6 bachelor's level, 13.48% from ED7 master's level and 1.22% from ED8 doctoral level programmes as an average between 2014 and 2019. This shows us that there are 68,691 ED7 graduates and 6,200 ED8 graduates in all tertiary programs in Turkey, compared to an average of 434,857 ED6 graduates every year. The ratio of ED6 bachelor's level graduates among all tertiary education graduates is decreasing, however, this ratio is still far below that of Germany.

The tertiary education graduates of 2019 are analyzed later by the ISCED-F-2013 fields of education as well. Among these fields, the F04 Business, administration and law field has the highest number of graduates in ED6, ED7 and total in both countries. For ED8 doctoral level, the highest number of graduates belongs to F09 health and welfare field of education in Germany, and F07 engineering, manufacturing, and construction field in Turkey.

Later, 2019 graduate ratios by ISCED-P-2011 education levels analyzed and the analysis has indicated several interesting results. The statistics explain the distribution of ED6, ED7 and ED8 graduate ratios among each field of education. For example, in Germany, F02 arts and humanities field of education produced 43,910 ED6 graduates in 2019 while having 71,674 ED7 graduates in the same year. Among all fields of education, the F02 arts and humanities field of education ranked first with the highest ratio (55.2%) at ED7 education level in 2019. This means that this field is in high demand at ED7 level not only in its own field, but also in other fields as well. On the other hand, the F10 services field of education was the

field with the lowest ratio of graduates in ED7 and ED8 with 14.5% in ED7 and 0.7% in ED8. At ED8 doctoral level, the highest ratio belongs to F09 health and welfare field of education. The fact that Germany has the lowest ratio among all the fields of education in F01 education field at the ED8 level is an issue that needs to be examined further. In addition, the fact that F05 and F08 fields at the ED8 level are above 15% indicates that Germany focuses and tries to deepen on these two fields more than other fields of education at strategic level.

In Turkey, 2019 graduate ratios by ISCED-P-2011 education levels show that the highest ratio in ED6 level belongs to F03 social sciences, journalism, and information with 87.5%. This means that in this field of education there is not much interest for ED7 and ED8 level degrees. The F08 agriculture, forestry, fisheries and veterinary field of education has the highest ratio (50.2%) in ED7 level and surpassed the ED6 level ratio as well. At ED8 doctoral level the highest ratio belongs to F05 natural sciences, mathematics and statistics field of education. In these statistics, it emerges as a necessity to promote higher education policies to increase the number of ED7 and ED8 graduates in Turkey.

In this research, after analyzing all the fields of educations by education levels, F07 engineering, manufacturing and construction field, all narrow and detailed fields' graduate numbers and ratios are presented by education levels between 2014 and 2019. F073 architecture and construction narrow field graduates generally have a higher ED7 ratio (36.1% in Germany, but 13.3% in Turkey) than other narrow fields. Within total graduates, in F078 inter-disciplinary programmes and qualifications involving engineering, manufacturing and construction field, the situation changes drastically in favor of Germany with 34.5% and Turkey with 10.8%. This shows that graduates of tertiary education engineering programs in Germany significantly prefer interdisciplinary programs compared to the ones in Turkey.

The analysis of education fields and education levels repeated again in terms of gender. The gender analysis of all tertiary graduates in Germany and Turkey shows that although the number of female graduates among all tertiary education graduates in Germany was higher than the number of male graduates until 2019, for the first time in 2019, the ratio of male graduates (50.4%) exceeded the ratio of female graduates (49.6%). However, a reverse situation has emerged in Turkey, the ratio of female graduates increased every year reaching 52.6% in 2019 and this ratio has high probability to continue to increase in the following years.

When this case is examined in terms of education levels, it is seen that the ratio increased in favor of male graduates at the ED6 level in Germany in 2019, however, the dominance of female graduates at the ED7 level and the male graduates at the ED8 level is stable. In Turkey, except for ED8, there is a dominance of female graduates at ED6 (53.1%-2019) and ED7 (50.6%-2019) education levels. At the ED8 level, the dominance of male graduates (53.5%-2019) continues to be stable. The increasing number of female graduates at the ED6 level in Turkey will gradually increase female dominance at the ED7 level in the future; this may lead to an improvement in the ratio of female graduates to the ratio of male graduates at the ED8 level as well.

In this study, we specifically examined the gender gap in the F07 field for all education levels. We have seen that there is an almost constant rate of 80% male and 20% female graduates over the years in Germany. However, it has been observed that these rates for Turkey have improved every year in favor of female graduates and reached the rate of 34.9% for female graduates and 65.1% for male graduates in 2019.

When we examine the female-to-male ratios according to the education levels in the F07, it is revealed that the ratios in every education level in Germany are stable over the years, although the female-to-male ratio at the ED7 level is lower than the ED6. The absence of this improvement in ED8 should be investigated in more detail. For Turkey, it has been determined that the ratio at the ED7 level has increased significantly in favor of female graduates in 2019 and is stable at the ED8 level.

Finally, when the graduates are analyzed in terms of gender by education levels, it is observed that female graduates have higher ratios than the ratios of male graduates in ED7 and ED8 levels in both countries. In 2019, 36.7% of female graduates receive ED7 level degree, while the same statistics is 25.3% for male

graduates in Germany. In Turkey, this statistics for the same year is 16.5% for female graduates and 12.6% for male graduates.

4. CONCLUSION

As a result of the study, we have found that Turkey's ED7 and ED8 graduate numbers are significantly lower than Germany's graduate numbers. Turkey needs more ED7 and ED8 level graduates. Most of the ED6 graduates do not follow further education levels. The ratios of education levels (ED6, ED7, ED8) in terms of graduate numbers are almost stable for Germany and relatively higher in ED7 and ED8 levels than Turkey. Since tertiary education aims for learning at a high level of complexity and specialization, Germany's tertiary graduates aim to increase their academic and/or professional knowledge, skills and competences.

The higher education administrators should consider providing solutions to improve Turkey's ED7 and ED8 number of graduates. The ratio of ED6 bachelor's level graduates among all tertiary education graduates is decreasing, however, this ratio is still far below that of Germany. In order for Turkey to catch up with Germany's higher education ratios at ED7 and ED8 levels, the number of ED7 master's level students will need to double, and the number of ED8 doctoral level students will have to at least triple. Therefore, higher education administrators in Turkey will need to make significant changes in their education policies.

In ED6, ED7 and in total number of graduates, the highest number of graduates are registered in F04 business, administration and law field in both countries. In ED8, the highest number of graduates in Germany are registered in F09 health and welfare field and in F07 engineering, manufacturing and construction field in Turkey.

According to the ratios of graduates based on ISCED-P-2011 education levels, in Germany, F01 education and F10 services fields of education has a 0.7% ratio in ED8 doctoral level. Especially for the education field, this ratio is much lower than ED8 level average (4.5%) and needs to be increased. In the F09 health and welfare field of education, the ratios are higher in ED7 (39.6%) and ED8 (17.8%). The human capital for F09 health and welfare field in Germany seems to be higher than any other field of education and Germany would advance and create innovative solutions in this field.

The ratios and graduate numbers by education levels for each narrow and detailed fields of education for F07 engineering, manufacturing, construction field are provided. This information pointed out that Germany mostly has F07 graduates educated in F078 interdisciplinary programmes in all education levels. Turkey has lower ratios in this narrow field. This issue needs to be addressed in detail by the Turkish higher education officials.

According to gender, the ratio of higher education female graduates in both countries between 2014 and 2019 is 50.6 for Germany and 50.5 for Turkey on average. However, contrary to Germany, the ratio of female graduates in Turkey has been on a continuous increase trend over the years. Interesting results are obtained when this statistic is decomposed into educational levels. It is seen that the ratio of graduates increased in favor of male graduates at the ED6 level in Germany in 2019, however, the dominance of female graduates at the ED7 level and the male graduates at the ED8 level is stable. In Turkey, with the exception of ED8, there is a dominance of female graduates at ED6 and ED7 education levels. At the ED8 level, the prevalence of male graduates in general continues to be stable. The increasing number of female graduates of ED6 level in Turkey will gradually improve female dominance at ED7 and ED8 levels.

In the field of F07, while there was a flat rate of 19.5% in female graduates in Germany over the years, this rate increased from 32.8% in 2014 to 34.9% in 2019 in Turkey. While there is almost a constant rate of female graduates at every education level in Germany (18.2% ED6, 25.1 ED7 and 19.5 ED8), these rates in Turkey are 33.5%, 37.2% and 37.0%, respectively, worth to note that at ED6 and ED7 levels, these ratios are increasing in favor of female graduates, even reaching 41.1% in 2019 at the ED7 level.

When the distribution of female graduates in the field of F07 at ED6, ED7 and ED8 education levels is examined, it has been determined that female graduates have higher ratios in ED7 and ED8 levels than male graduates.

In this research, it is concluded that the higher education intelligence needs to be top priority for higher education officials because there are plenty of hidden information and knowledge in the current official international organizations' datasets about higher education. For this reason, an education decision support system needs to be established not only for the higher education but for all the education levels as well.

In future studies, a comparison and analysis of higher education data for all European countries is planned.

CONFLICTS OF INTEREST

No conflict of interest was declared by the authors.

REFERENCES

- [1] [Http://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-isced-2011-en.pdf](http://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-isced-2011-en.pdf). Access date: 30.03.2021
- [2] Kaya, Y.K., "İnsan yetiştirme düzenimiz", Ankara, Bilim Yayınları, (1989).
- [3] Boni, A., Walker, M., "Universities and Global Human Development: Theoretical and empirical insights for social change", London, Routledge, (2016).
- [4] Oketch, M., McCowan, T., Schendel, R., "The Impact of Tertiary education on development: A rigorous literature review", London, DFID, (2014).
- [5] Güven, A., Tunç, B., "Lisansüstü öğretim öğrencilerinin akademik sorunları (Ankara Üniversitesi Eğitim Bilimleri Enstitüsü örneği)", Milli Eğitim, 35(173): 157-172, (2007).
- [6] Chankseliani, M., Qoraboyev, I., Gimranova, D., "Higher education contributing to local, national, and global development: new empirical and conceptual insights", Higher Education, 81(1): 109-127, (2021).
- [7] Çakar, Ö., "Fen Bilimleri Alanında Bilim Adamı Yetiştirme: Lisansüstü Eğitim", TÜBA Bilimsel Toplantı Serileri: 7, 65-75, (1997).
- [8] Alhas, A., "Lisansüstü eğitim yapmakta olan Milli Eğitim Bakanlığı öğretmenlerinin lisansüstü eğitime bakış açıları (Ankara ili örneği)", Basılmamış Yüksek Lisans Tezi, Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara, (2006).
- [9] Bülbül, T., "Ankara Üniversitesi Eğitim Bilimleri Fakültesinde görev yapan öğretim üyelerinin lisansüstü öğretime öğrenci seçme sürecine ilişkin görüşleri", Ankara University Journal of Faculty of Educational Sciences (JFES), 36(1): 167-174, (2003).
- [10] https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=educ_uoe_grad02. Access date: 30.03.2021
- [11] [Https://www.aps.org/programs/education/statistics/fraction-phd.cfm](https://www.aps.org/programs/education/statistics/fraction-phd.cfm). Access date: 12.12.2021