Gender Issues in Engineering Education
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Abstract
Female students are a minority in most technical universities in the EU, and some efforts have been made in an attempt to increase the participation of women in engineering. The growing need for IT professionals is one of the main reasons of social interest in attracting more girls to this field. This article provides a comparison of gender-related differences, as well as approaches for improving male-to-female ratio and resolving gender-related problems in engineering education. The article also presents some results of the project "Strengthening women’s position in the labor market", funded by the EU and implemented by the Faculty of Electrical Engineering in Osijek. The main objective of the project is to increase the employability of women in the Osijek-Baranja County by motivating more female students to enroll in some of the technical studies.

1. Introduction
In the last decades, a lot of effort has been made in the EU in order to increase the participation of women in STEM (Science, Technology, Engineering and Mathematics) fields. This is defined in the Lisbon strategy and Work programme on the follow-up of the objectives of education and training system in Europe 2002 (Official Journal C 142/01 of 14.06.2002) Objective 1.4. Increasing the interest in mathematics, science and technology from an early age and Improving gender balance among people learning mathematics, science and technology. According to the EUROSTAT report on EU education and training systems between 2000 and 2009, during that period the gender imbalance was not reduced.

Special attention (not only in the EU) is given to reducing the gender gap in the Information and Communication Technologies (ICT) sector. Under the Europe 2020 Strategy and Digital Agenda for Europe, [2], Pillar VI "Enhancing digital literacy, skills and inclusions" brings Action 60 Increasing of women in the ICT workforce. The most important step is to increase the interest of female primary- and high-school students in technical skills and knowledge and consequently their interest to enroll in some of the technical studies.

This article deals with the gender-related problems in engineering education and different approaches for resolving these problems. We present our research on the attitudes of high-school students about experimental work in primary- and high-school curricula as a motivational element for attracting young people to technical professions. In addition, we present results of the project "Strengthening women’s position in the labor market", conducted at the Faculty of Electrical Engineering in Osijek.

2. Women role in the engineering
It is a well-known fact that relatively more women than men follow tertiary level programs (55.7 % in 2009 for the EU27 according the Eurostat [1]). However, there are "typically" female fields of education: in
2012, 79.5% of all students in education and training field and 75.4% of all students in health and welfare were female (Eurostat data for EU28, [3]). In addition, the rate of women in engineering, manufacturing and construction fields is 26.9% for EU28, and differs across the Europe (18.6% in Germany, 22.2% in Hungary, 29.9% in Croatia).

Despite lots of actions taken to increase the percentage of women in the Information and Communication Technologies (ICT) sector, there is still a gender gap in Europe. According to the study Women Active in the ICT Sector, [4], only 2.9% of women with a bachelor degree hold a degree in ICT, compared to 9.5% men.

Women’s active participation in the ICT sector is essential for Europe's long-term growth and economic sustainability. By raising the percentage of women who work in ICT for approximately 50%, the additional earnings for the European GDP each year would be around 9 billion EUR [5]. According to [6], the number of jobs in ICT that could be created in Europe by 2015 could be as high as 864 000. At the same time the number of ICT graduates at universities is insufficient; it even decreases, which may jeopardize ICT job growth potential. The only way to improve this trend is to strengthen education in science, technology, engineering and mathematics, especially for women.

Several problems prevent women from fully participating in engineering. Even in the 21st century, cultural traditions and stereotypes about the women’s role in society are still strong. In addition, the socio-psychological factors such as lack of self-confidence as well as negative attitudes towards competition and risk taking pull back women from the engineering and its top positions. Male domination in the field, difficulties to reconcile private and professional life, and a lack of role models are the critical obstacles, which women are facing in technical professions.

Research presented in [7] reveals some interesting findings about the differences between male and female engineers. For example, women experience a rapid loss of confidence upon requiring engineering degrees. One of the reasons is that on arrival at the university female students begin to feel anxious to some extent as they chose a career that counters the gender norm. Another, widely acknowledged, issue is that it is often assumed that students have some practical skills and compared to male engineering students fewer women engineering students arrive to universities with them.

3. Best practices

The Vienna University of Technology (TUW) has recognized the problems women face studying or later working as teachers and researchers at that institution and has constituted an Office for Gender Competence. The Office is a service institution that aims to work towards achieving the goal of ensuring suitable development opportunities for men’s and women’s careers at the TUW and to remove or reconcile existing disadvantages for women, [8]. Since 2005, it has conducted several projects, which aimed at the promotion of women. Target groups of those projects were divergent; from 10-year-old students up to female university professors, Project fFORTE WIT - Women in
Technology (2008-2012) is a part of fFORTE, a joint initiative of the Council of Research and Technology Development and the Austrian Federal Ministries of Science and Research, for Transport, Innovation and Technology, and of Economy and Employment. This project provided the package of measures for improving girl’s and women's access to technology and supported women in their scientific careers in technology. [9]. Project Gender in die Lehre (2005-2007) is the first project in Austria, which has dealt comprehensively with the relationship between gender, social gender and two selected fields of study Electrical Engineering and Technical Physics. The aim was to raise awareness of the aforementioned issues as well as to develop concrete recommendations for the implementation of solutions into teaching. Another project, TU!MentorING (2008-2010) was aimed to young female scientist and gave them the opportunity to develop mentoring relationships with professors from the TUW.

Faculty of Informatics and Information Technologies in Bratislava started in 2013 with the project AJ TY V IT (You too in IT), which aims at female students from primary and secondary schools. The project aims to attract young girls in IT and programming.

An international initiative Girls in ICT Days started by the ITU (International Telecommunication Union) Resolution 70, [10], “aims to create a global environment that empowers and encourages girls and young women to consider careers in the growing field of information and communication technologies (ICTs)”. International Girls in ICT Day is celebrated on the 4th Thursday in April.

It is worthwhile to mention that the largest engineers association the Institute for Electrical and Electronic Engineers (IEEE) has formed in 1994 IEEE Women in Engineering, which became the largest international professional organization dedicated to promoting women engineers and scientist.

4. Project "Strengthening position of women in the labor market"

According to the report of the Central Bureau of Statistics in Croatia in 2009, women accounted for only 15.9% of people who graduated in the field of computing, 15.3% in engineering and 34.2% in architecture and construction. These numbers coincide with the statistics of female students at technical faculties of the Josip Juraj Strossmayer University in Osijek, where female students make around 30% of freshmen at the Faculty of Civil Engineering in Osijek (FCE) and only 10% at the Faculty of Electrical Engineering in Osijek (FEE). It is obvious that the only way to increase the number of female engineers is to raise the percentage of female freshmen at technical faculties. The idea of the project "Strengthening women’s position in the labour market" is to increase the interest of female high-school students in technical skills and knowledge through a series of lectures and technical workshops. The European Social Fund under the Operational Programme Human Resources Development funds the project for the period from 1st November 2013 to 30th June 2015.

At the beginning of the project, the project team made a survey among 220 high-
school students and 162 freshmen at the Faculty of Electrical Engineering in Osijek and the Faculty of Civil Engineering in Osijek (56% of respondents were male and 44% were female). High-school student’s distribution per chosen faculty is given in Figure 1. It can be seen that more students (both male and female) from the mathematical grammar school than from the general grammar school selected some of the technical faculties for their future study.

Furthermore, we examined student’s attitudes on practical work in schools, teaching methods, the importance of mathematics and physics, as well as the difference between male and female student’s approach to practical exercises. Figure 2 shows the estimate of the frequency of the group/individual practical work of students in primary and secondary schools. The average grade for primary school is 2.5 and for secondary school is 2.2, where 2 means that students rarely have practical work. To compensate this deficiency in pre-tertiary education, as a part of the project "Strengthening women’s position in the labour market", we have prepared four types of technical workshops that are offered to high-school female students: Basic Technical Skills, Basics of Electronics, Communications and Multimedia, and Simulation of Work in Testing Laboratory. The purpose of these workshops is to give an opportunity to a large group of female students to get an insight into the world of engineering and laboratory work as well as to try out some practical exercises. This will help them to see what their preferences and abilities are and whether they want to continue their education in a technical field. In addition, workshops give students some knowledge and skills important for their future adult life and improve their self-esteem.

119 girls participated in 13 workshops, which were organized to May 2015. In a survey we conducted, 52.9 % of these girls said they would try to get into some of the technical faculties. Also 77.3 % of girls said that workshops they attended helped them in the choice of future profession.

![Figure 1](image)

**Figure 1** Distribution of all secondary students per gender, per chosen faculty (1st choice) TehF- Technical faculty, PMF – Faculty of Science, MedF – Faculty of Medicine, BioTechF- Faculty of Food Technology and Biotechnology, DHF – Humanities and Social faculty
4. Conclusions
The gender related issues in both engineering education and engineering workplaces are identified and addressed in numerous projects and initiatives all over the world. The motivation of young girls to proceed with their education at technical faculties as well as the mentoring of women during their study and in their engineer and scientific careers are important activities that can make a difference. Moreover, teachers at faculties should be aware of the problems girls face, especially at the beginning of the study, and adjust teaching approaches taking into account subtle differences between genders.

Literature