

# Barriers, Role Models, and Diversity – Women in IT

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**Abstract.** Despite the growing need for IT professionals all around Europe, women are still severely underrepresented in IT-related fields. According to Eurostat, female IT specialists constitute only 16.5% of the workforce in the EU28 countries. Gender imbalance, however, is conspicuous already in higher education: only 23% of students majoring in IT are women. The reasons why girls are reluctant to consider a career in IT are complex. Based on the analysis of recent literature review papers about young women's barriers, we can differentiate four basic obstacles that keep girls from IT: social, educational, self-efficacy, and labour market factors. In order to overcome these obstacles, the necessary tools are the presence of role models, the promotion of diverse IT paths, and inclusive teaching environments. The present paper aims to introduce a study conducted within the settings of a non-degree, tertiary Computer Science program, with the usual scarcity of female students and a high dropout rate. As part of their program, students also need to attend an interdisciplinary course, in which they are exposed to an inclusive teaching environment, the presentations of role models, and diverse career paths. Before, during, and after the course, students were asked to reflect on the issues of barriers, diversity, and role models, which were analysed in a quantitative and qualitative manner. As a follow up, female graduates of the program, already working as software developers, were surveyed about the same questions, in order to explore what women who do end up in IT careers share.

**Keywords:** gender, women, barriers, IT, IT education, role models

## 1. Introduction

One of the biggest winners of the COVID pandemic was the IT sector, as tech companies such as Zoom, Google, and Amazon have gained unprecedented profits over 2020. [1,2] The continuous and rapid growth of the IT industry was obvious even before the pandemic: the IT sector had already been struggling with a significant shortage of qualified workforce both internationally [3,4] and specifically in Hungary. [5] In the past years, however, the demand for IT specialists has doubled. According to a recent study done by the Association of Hungarian Informatics, Telecommunication, and Electronics Professionals, in the next two years 44,000 IT professionals could be employed in Hungary [6]. The supply, though, is expected to lag behind, at about 18,000 professionals. Currently 9,000 tech jobs remain unfilled, and with the rapidly growing demand, the gap is bound to significantly increase [6]. Changes are necessary so that our global need for IT professionals can be met.

Despite the growing need for IT professionals all around Europe, women are still severely underrepresented in IT-related fields. According to Eurostat, female IT specialists constitute only 16.5% of the workforce in the EU28 countries [7]. Gender imbalance, however, is conspicuous already in higher education: only 23% of students majoring in IT are women [8].

According to the literature, we can differentiate four basic obstacles that keep girls from IT: social, self-efficacy, educational, and labour market factors. In order to overcome obstacles such as gender stereotypes linking IT to masculinity, girls' low self-efficacy due to such stereotypes and consecutive computer anxiety, the necessary tools are the presence of role models, the promotion of diverse IT paths, and inclusive teaching environments.

The present paper aims to introduce a study conducted within the settings of a non-degree, tertiary Computer Science program, with the usual scarcity of female students and a high dropout rate. As part of their program, students also need to attend an interdisciplinary course, in which they are exposed to an inclusive teaching environment, the presentations of role models, and diverse career paths. Before, during, and after the course, students were asked to reflect on the issues of barriers,

Central-European Journal of New Technologies in Research, Education and Practice

Volume 3, Number 3, 2021.

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## 2. Literature Review

In order to find out what the latest research has revealed about what keeps women from the IT field, a dozen review papers, published in the past two years, were selected. [9,10,11,12,13,14] After examining these recent papers, each dedicated to review the latest literature about young women's barriers, we can differentiate four basic obstacles that account for girls' scarcity in IT: social, self-efficacy, educational, and labour market factors.

The most fundamental obstacle that girls face is gender stereotyping, that is, a binary world view that divides the social world into feminine vs. masculine domains and characteristics [15] connecting IT, and generally, STEM<sup>1</sup> to masculinity. [9,10,11,12,13,14] Gender-based social stereotypes can affect how young women's closest environment relates to their career interests, such as their families. It is especially fathers' and male siblings' attitudes that were shown to influence girls' choices. [11] How the media portray the IT field and the IT professional matters as well: typically, it is still the antisocial, male geek that is normalised in the media [10,12], thus discouraging girls from considering IT.

As a direct consequence of gender stereotyping, girls tend to have low self-efficacy in STEM and specifically IT. [9,10,11,12,13,14] They perceive their analytical skills to be worse than they are and worse than boys'. It is also because of this that computer anxiety can develop in girls. [11] The perceived lack of success, then, deters young women from choosing IT as a study and career path.

Many girls encounter IT in schools for the first time, apart from using tech for personal communicational purposes. Both teachers' attitudes and the learning environments influence what kind of IT-experiences young women gain. [9,10,11,12,13,14] A number of STEM teachers reported to have, and act on, stereotypes connected to gender [16], which discourages girls from STEM fields. Male-dominated classes and male-oriented topics can also lead girls into not seeing the benefits and interests IT can offer, hence making them stay away [10,12].

Finally, another chief factor that poses as an obstacle for a larger involvement of women in IT has to do the labour market. [9,10,11,12,13,14] When in school, young women have scarce knowledge about the diversity and reality of careers in IT. Probably due to lack of resources and the rapid growth of the IT industry, schools often fail to provide adequate information about what it really means to work in the tech sector. [12] Without being clear on what areas and activities IT involves, and what kind of skills they require, young women rely on the deficient info media portrays about IT and the IT professional, which most often does not coincide with how they seem themselves (and what they think society expects of them).

Due to the complex nature of barriers young women face, interventions are needed in order to foster girls' interest in IT. We need to put emphasis on providing them role models, to make them see it is an open field for them. [10,12] Role models can also help in promoting the diversity of IT careers. As for their learning environments, girls need to be exposed to IT in inclusive classes

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<sup>1</sup> STEM = Science Technology Engineering Mathematics

employing teaching methods that actively work on overcoming gender stereotypes and promoting diversity.

### 3. Research

#### 3.1. Background

In order to test the above theories within the Hungarian context, a case study was done over the course of the 2020-2021 academic year. Students, enrolled in a recently launched Computer Science (later on referred to as “CS”) program at the Faculty of Informatics, Eötvös Loránd University, were the subjects of the analysis.

On average, 50-70 students get admitted to this program, launched just in 2018, but enrolment numbers have been steadily growing year after year since its start. Despite the growing popularity of the program, a significant gender imbalance and a large dropout rate clearly call for amends: only about 20% of its students are female and only about 10% end up graduating at the end of the second year.

As opposed to the bachelor’s level equivalent of this CS program, this one is a non-degree program which is pronouncedly “practice-oriented” (see program site<sup>2</sup>). Students spend their last term as interns at IT companies, and as opposed to BSc-students, those enrolled to this program also have the chance to attend, free of charge, communication training such as professional English language courses.

This interdisciplinary training, managed by the author, was designed specifically in accordance with the above literature, to reflect on gender-positivity, diversity, and inclusiveness within IT, specifically through the introduction of role models. Both with the teaching methods and the study materials, the course was aimed to improve students’ co-operational and social skills, while promoting diversity, in order to make them better language users, and also better programmers.

Regarding the contents of the course, they were put together primarily to demonstrate the human side, the social context, and the diversity of IT to students who are interested but may not yet be deeply experienced in the field. The course was divided into two parts (that is, academic terms) in a way that the materials did not only connect to but also derived from one another. While the first part was supposed to build the foundations of the coursework, the second was meant to elaborate on and deepen the concepts and the skills.

All the communication, skills development, and analytic activities of the course were based on eight, high-quality, English-language TED3-talks covering a specific IT topic [see more in 17]. The speakers were selected with an eye for diversity. First, so they can represent and present different subtopics within IT, such as computer vision, machine learning, face recognition, ethical hacking, and data visualisation, showcasing the wide options within the field. Second, the identity of the speakers was also meant to be a testament of difference and inclusion. Regarding their ethnicity and nationality, the speakers are not at all homogenous; in addition, religion and sexual orientation

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<sup>2</sup> <https://www.inf.elte.hu/content/programtervezo-informatikus-fejleszto-felsooktatasi-szakkepzes-budapest-es-szombathelyen.t.1442?m=256>

<sup>3</sup> TED = Technology Education Design

appear as a matter of choice as well. Most importantly, as far as gender is concerned, it was a very conscious decision to include a fair number of women among the presenters (see Figure 1).



Figure 1: The TED presenters as IT role models

### 3.2. Methods

At the beginning, in the middle, and at the very end of the coursework, students were asked to do written self-reflection tasks related to the course material. Both in graded and ungraded frameworks, they were prompted to share their opinions on concepts such as role models, motivation, obstacles, and the IT field itself. Students' replies were collected (in the period between September 2020 and May 2021) and analysed (in the period between May 2021 and August 2021), in search of common narratives.

As a follow-up to the above one-year-long study, female graduates of the program were also asked in a survey (between May 2021 and August 2021) about their experiences with role models, motivation, obstacles, and the IT field. In addition, they were also asked what they think made them successful, given that both as women and as graduates of a CS program they were exceptional.

### 3.3. Findings

In order to keep track of students' views about role models in IT, they were asked at the very start of their CS studies, during the course (in the middle of term 1, at the end of term 1, and in the middle of term2), and at the very end of the course, that is, at the end of their first year in the program, to reflect on questions related to motivation and inspiring characters.

At the beginning of their CS studies, the large majority of students replied they do not have relatable role models in IT. Most of the students who did report to have a role model mentioned someone who is well known from (not only tech-savvy) news, such as Elon Musk, Bill Gates, or Jeff Bezos. Students, therefore, demonstrated to have superficial exposure to the field, and practically no role models, when they start their studies.

However, when asked, during the different stages of the course, to reflect on the IT professionals they were being exposed to in the TED talks, the majority of students reported to be inspired by them “for figuring out their ways,” “working in fields they love” or “helping to make society better”. Some students even confessed to wanting to work in similar fields as the speakers, such as animation.

At the end of the course and their first year, students were once again asked the same explicit question regarding whether they have role models in IT as at the very start. The overall response rate was only slightly better than at the beginning: the majority of students still felt they do not have “role models” in IT.

Students were also prompted about what they perceive to be their main barriers on the IT field. The most frequent replies were laziness, a not necessarily discipline-specific obstacle, and that they do not know what they are doing here or in the future. Students felt the IT field was unclear to them, just as their place in it. At the end of the course, there were less replies that questioned how IT was related to the real world but uncertainties about their place remained. Some of the female students underlined gender as an obstacle and at the end of the course several of them brought up the female IT experts from the TED talks, both as reminders of the problem and as counterexamples.

As a follow-up to the study conducted during the course, the alumnae of the class of 2019 and class of 2020 were also interviewed. Each of the five female graduates of the program got hired by the IT company, affiliated with the program, where they did their internships. Both as women in IT and as graduates of the CS program, they were exceptional, so their input promised to shed some light of the narrative of the successful path-takers. When reflecting on motivation for the field and role models, their responses were not too unlike the ones still at the beginning of their IT paths: even these women, already working in IT, reported not to have role models when growing up or attending school. Some of them, though, did mention that having started work, now they could name some people who inspire them. As for barriers, several of them seemed to be more aware of gender as an obstacle, in family circles, among acquaintances, and even in school. Several of them, however, mentioned that at their workplace they do not feel anymore that gender matter; in fact, they have supportive environments and colleagues. When asked what they attribute their success to, they said that they were interested in IT, they disregarded gender stereotypes, and they have a work environment that actively promotes women in IT.

#### 4. Conclusion

The findings of the study reveal that even students who are interested enough to give IT a shot by enrolling to a CS program have superficial knowledge about the field. Only a few of them have immersed themselves enough in the domain to be inspired, or be able to name, specific people in the field who are personally relatable. According to Gibson’s career theory, however, the presence of a role model or mentor is essential for success. [18]

Even when students are exposed, for multiple months, to stories and works of people who are more relatable than tech giants such as Elon Musk or Bill Gates, they failed to label them as “role models”. Perhaps the exposure was still not deep enough; the IT experts, as TED speakers, were still too unapproachable for students; or the concept of a “role model” in their native language (Hungarian “példakép”) is simply too abstract for students to categorize a “mentor figure” into it.

As a consequence, it might be more effective to expose novice students, not just to established IT experts, but also to higher-level fellow students or alumnae who can serve as approachable mentors for them, giving inspiration and guidance. Stout et al.'s Stereotype Inoculation Model, that is, the concept to connect in-group mentors, has proven to enhance women's self-concept in STEM, positive attitudes and motivation to pursue STEM careers. [19]

Having relatable mentors could help women overcome some of the main barriers mentioned in their feedback. On the one hand, it can facilitate a better awareness of the IT field and necessary skills through the experiencing sharing process. On the other hand, the presence of female mentors can contribute to lessen another recurring problem, which was gender imbalance. Focusing on what the surveyed alumnae named to be their keys to success, we can conclude that environments that actively promote gender balance can foster women's better involvement and retention. Next to peer mentoring, it also seems vital to create environments that clearly look out for women, not just in rhetoric but also in practice.

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**About this document****Published in:**

CENTRAL-EUROPEAN JOURNAL OF  
NEW TECHNOLOGIES IN RESEARCH,  
EDUCATION AND PRACTICE

Volume 3, Number 3. 2021.

ISSN: 2676-9425 (online)

**DOI:**

10.36427/CEJNTREP.2.2.2582

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