Women Motivations Applying for Science, Technology, Engineering and Mathematics Education and Workplaces in Hungary

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Abstract: Women are significantly underrepresented in the STEM (science, technology, engineering and mathematics) fields in Hungary in higher education and, as follows, in the related workplaces. The aim of the research described herein was to explore the sources of motivation of the women who choose to pursue STEM-related higher education. A further aim was to investigate their employment history and examine their opportunities on the labor market. This analysis of the conditions of women's career choices helps understand the reasons for the low share of women in the related subjects and highlights the critical factors behind their commitment to STEM. In-depth interviews were conducted with women who have studied and may work in the related fields. Narrative analysis was used to interpret the results and provide insight into the factors underlying and working situations of the STEM-related decisions of women. Determinant factors included positive impressions of the field in women's lives, such as childhood experiences, and emotionally engaging work experience. The findings suggest that STEM-related issues should be embedded favorably into children's education. State support for STEM-related higher education also has an impact on commitment in this field. Employment-related difficulties which are liable to occur are very similar to those with other fresh graduate students, and include a lack of vision, long-term work experience, appropriate English-language skills, and understanding the content of job advertisements and their requirements.

Keywords: STEM, higher education, labor market, women studies

1 Introduction

Women are underrepresented in the STEM- (Science, Technology, Engineering and Mathematics) related fields in the EU, including in Hungary. Increasing the share of women in STEM jobs would create notable benefits, especially in terms of women's employment and the related economic growth which is facilitated by enhanced productivity (George et al. 2001, Xie et al. 2015, de Sanfeliu et al. 2016). Such a target is thus also shared by the European Union.

In this paper we highlight the different motivations of women that influence their educational and work choices. A further, related research question was also addressed: why do women choose STEM-related professions? The job-searching circumstances and the situation of women in the workplace are also explored. Regarding the main research question (why are women motivated to choose a STEM-related field of education), a model is constructed which enables deeper understanding of the results.

2 Women in STEM-related education

STEM fields are components of the foundation of scientific, technological and economic growth, and consequently have a determining impact on the path of future development. The greater the representation of a social stratum in these fields, the larger its recognition and share of the related wealth compared to less well represented social groups. The proportion of women in STEM fields has been low in Europe, and only in recent decades have changes occurred. International experience (see Friedmann, 2018) shows that whether due to a shortage of workforce or better understanding of the need to dismantle the invisible social barriers, the engagement of women in STEM fields has increased, and the number of women in related fields of education and workforce is proving women's abilities and confuting traditional stereotypes about women.

In Hungary there are more women in higher education than men, which may be due to the difference in their socialization, learning methods, and personal qualities. Table 1. shows that higher education is characterized by severe horizontal segregation: the majority of fields are dominated by either female or male students. In spite of the larger proportion of women in higher education, they are in a minority in STEM fields, particularly in academic IT and engineering programs which are a particularly good path to careers with a high salary. Friedmann (2018) assumes that wages and the ability to balance job and family are the most important factors that foster women's participation in STEM-related workplaces. The proportion of women and men is nonetheless quite balanced in the fields of science more generally.

Table 1. Proportion of female/male students in bachelors- and masters-level higher education by subject in Hungary (school year 2017/2018)

	Share of female students	Share of male students	Share of students as percentage in all sciences
Education	79,5%	20,5%	11,2%
Arts	62,4%	37,6%	2,7%
Humanities	63,7%	36,3%	5,8%
Social sciences	63,4%	36,6%	8,3%
Business and management	56,4%	43,6%	16,4%
Law	61,2%	38,8%	4,8%
Sciences	49,6%	50,4%	3,1%
IT	14,6%	85,4%	7,5%
Engineering	24,2%	75,8%	15,8%
Agronomy and animal health	49,1%	50,9%	3,7%
Health and social sector	67,4%	32,6%	11,7%
Services	54,0%	46,0%	6,0%
Not classified according to training area	53,2%	46,8%	3,1%
Total	52,8%	47,2%	100,0%

Note: STEM fields are highlighted in blue.

Source: Hungarian Statistical Office (2018). The spreadsheet was compiled by HSO following a personal request.

The share of men in IT and engineering is 5.8 (3.1) times higher than that of women. Even though these figures reflect a considerable degree of segregation, the gap has slightly diminished since 2008 when the related figures were 6.6 and 4.3. The small proportion of female students in STEM fields has been defined as a problem in many societies and is linked to stereotypes among teachers, students and other members of society and to the lack of self-esteem of girls (Szekeres et al., 2012).

STEM skills are associated with knowledge-driven growth and productivity gains in high-tech sectors, thus they are critical to boosting jobs and economic growth. Employment in STEM occupations in the EU is estimated to increase by 12.1 % by 2025, much higher than the increase expected in other occupations (3.8%) (EC, 2015).

Beblavy et al. (2013) conducted research in five European countries, including Hungary, and found that both females and males view entry into STEM fields as having a high initial cost, but that only males tend to obtain significant returns

after graduation. The authors claim that this fact might explain why women show less interest in STEM fields, and suggest that an important step towards increasing female interest in STEM fields might be to examine the reasons for smaller post-graduation payback. Related to this finding, a European study concluded that many students do not bear in mind the fact that STEM fields of study can lead to jobs that deal with a range of global challenges, including food security, water resources and environmental protection, which are essential to sustainable development. The research claims that more focus on promoting STEM through campaigns which mention this factor could attract more women to STEM careers because women tend to be more value-driven than men in their choice of studies, thus tend to prefer professions which are perceived to create value for society (EC, 2015).

Although numerous measures have been taken to redress the imbalance between men and women both at the EU level and in Member States, the participation rates of women in STEM fields have not increased considerably. Experiences so far have shown that successful initiatives are comprised of a number of measures such as networking, enhancing the visibility of women experts, promoting the achievements of successful women in research, and offering women career support.

3 Research Method and Aim

The aim of the in-depth interviews was to explore the preferences and the difficulties of women who have graduated from STEM-related fields in order to better understanding their situation, thereby contributing to the development of a tool-kit that creates better employment opportunities for women. The main target of the study was thus to obtain information which will assist in the creation of tools and educational methods that can sustain women's employment and integration into the labor market in the field of informatics and technical sciences.

In our qualitative, exploratory study we interviewed women in two waves in 2018. During the first stage, a phone-based, semi-structured in-depth interview was conducted followed by a further eight online, structured interviews. After this, some novel issues were identified which supported the second stage of research. This involved interviewing a further three women with a STEM background. In total, the choices and experiences of twelve respondents were explored.

Initially, face-to-face inquiries seemed to be the most appropriate method for the research because sensitive issues can arise in connection with this topic. We also believed that this approach would enable us to more accurately explore the attitudes and motivations behind decision making. However, interviewees were often not personally available.

Open interview questions were sent to respondents via e-mail. The importance of the first semi-structured interview was that we obtained experience from the pilot interview that could be used to refine the structure of the guide and the questions.

According to Malhotra (2010), interviews are appropriate for use when sensitive topics and questions are involved. Individual interviews provide respondents with the opportunity to answer questions but also to avoid the discussion of sensitive issues in a group setting.

At the beginning of the online interviews respondents were reassured about the anonymity of the process and their right to opt out of answering overly sensitive questions. They were also told that there were no "wrong answers" in order to encourage them to express themselves freely. The research was open, because we informed participants about the aims of the study.

Interviews were analyzed using content analysis, involving the use of narratives to depict the situation and to report interviewees' points of view. A model was built to draw attention to the main factors which determine women's choices.

3.1 Data

In order to meet research targets, the sample members were recruited according to two criteria: respondents had to be women with STEM-related educational experience. The sample is illustrated in Table 1. Most respondents were young adults (25-30 years old), thus part of Generation Y. Three interviewees belonged to Generation X, and were thus born before the widespread use of the internet. The Y generation is characterized by having less personal contact because they rely on internet-mediated relationships and use social media platforms and related devices (Hidvegi and Kelemen-Erdos, 2016, Kolnhofer-Derecskei and Reicher, 2016). The educational qualifications of the sample ranged from bachelor degrees to PhDs. Most of them had changed their field of interest compared to their original STEM qualification.

Interviewees were predominantly technical managers, but other experts were also represented in the sample: a light industry engineer, an environmental manager, an electronic engineer, a mechanical and safety engineer, a physicist and a clinical chemist. Two interviewees also had other degrees (one as a sports trainer, and the other an electronic engineer). The respondents had mainly earned their degrees from full-time courses, although two of them had attended correspondence courses; further, one interviewee had studied at an evening course as well as a full-time course.

All interviewees had working experience and most of them had a job at the time of the interview, although one respondent was at home on maternity leave, and another was unemployed.

Table 2: Sample description

	Year of birth	Faculty	Educational level	Type of Education	Profession
I1	1993	Technical manager	BSc, graduate	Full-time	Global customer full sales specialist
I2	1967	Light industry engineer	BSc, graduate	Correspondent	Account manager
I3	1989	IT engineer	BSc, graduate	Full-time + evening course	Software tester
I4	1989	Environmental engineer	BSc, graduate	Correspondent	Receptionist
I5	1990	Technical manager business development	MSc, graduate	Full-time	Financial controller
I6	1992	Technical manager	BSc, graduated	Full-time	Costume designer assistant
I7	1993	Electronic engineer	BSc graduate	Full-time	Production optimizer engineer
I8	1992	Technical manager	BSc, graduated	Full-time	Project manager
I9	1988	Technical engineer	BSc, graduated	Full-time	Marketing and selling
I10	1988	Mechanical and safety engineer	MSc, graduated	Full-time	Tool designer; automation engineer
I11	1978	Physicist	PhD	Full-time	Post-doctoral researcher
I12	1982	Clinical chemist	PhD	Full-time	Assistant lecturer

Source: Authors' construction

4 Results

First, the motivation of women for STEM education is explored. After this, job searching circumstances and methods are highlighted, emphasizing the problems which STEM job-seekers encounter. Finally, the situation of women in the workplace is described.

4.1 Motivation for Women's STEM education

The types of motivation for women's choice of STEM education can be classified into two groups (Figure 1). Some women are dedicated to STEM-related professions, while others were "forced" to be STEM students; in the latter case, financial issues played a prominent role.

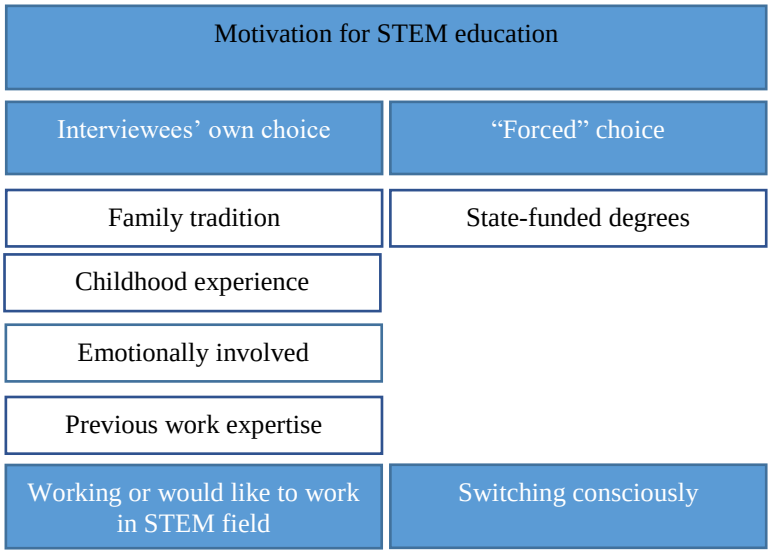

Figure 1: Model of Women's Motivation for Engagement in STEM
Source: Authors' construction based on interviews

Six interviewees stated that they had been really emotionally involved in STEM since their childhood because they liked the related subjects, such as mathematics, physics, chemistry, biology and informatics: *"I have been engaged with computer science since I was 11 years old and interested in it."* (I3); *"I am a kind of study-loving student who likes to go to classes, be responsible for tasks, and participate in industrial site visits. I am active in the lab. I love to solve technological problems with instruments."* (I10*); "I have always been interested in technical sciences and, before applying for a degree, I looked into the curriculum and I found that most of the subjects (biology, chemistry, and physics) used to be my favorites in primary school."* (I4); *"Even in elementary school and later in grammar school it was easy with chemistry and biology to get good results, so it was obvious for me to choose this degree program."* (I12); *"I was always involved in a technical profession, and my salary is also good as an engineer."* (I7); Others had experienced the enthusiasm of family members about technical matters: *"My mother was a 'do everything yourself' type."* (I6). Another respondent applied for a degree in a STEM field because of her previous work expertise: *"I worked in the*

printing industry for several years…After earning my degree, I continued to work for the same company." (I2).

Two of the interviewees did not want to choose a degree from the STEM field originally but they did so because of the Hungarian educational system (in the case of degrees in subjects such as economics, places are self-financing or candidates should have very high admission scores, but in the case of STEM subjects almost the minimum level of points is enough for being accepted on a state-funded course).

One interviewee who had experience with STEM in the family reported that *"The university was very difficult…I would choose another type of education which suited me better if I had the possibility now."* (I11).

There are also notable differences concerning the respondents' evaluations of the proportion of women in STEM fields. Some of them do not notice many differences related to sex, while others have another point of view: *"I do not know anything about female engineers, because I didn't see one either as a trainee, or now."* (I7); *"We are too few."* (I10).

4.2 Job-Searching Circumstances

Job-searching relies on informal and formal sources. Among the younger respondents, the most frequently used methods of job-seeking are job fairs, acquaintances, and social media such as LinkedIn and other job advertising portals. Older respondents reported using noticeboards at universities and personal relationships. Personal contacts can significantly contribute to success with obtaining positions (e.g. recommendations of a teammate or a lecturer, or even a relationship based on an interaction that occurred during the writing of a thesis, as the interviewees noted). Another important route is taking part in company trainee programs, after which respondents continued working at the same places.

Respondents mentioned the very diverse but specifically gendered issues they encountered while job-seeking: *"I have the same opportunities at the workplace as men."* (I1). I6 mentioned that she felt that men are preferred for jobs in technical engineering: *"No job placement is possible (for a woman)."* (I5). *"… characterized by sexism … Girls are not encouraged in primary school to be open to these (STEM) studies. So there are only a few women who apply for such university degrees, graduate from them, and stay in the field"* (I10). I9 noted the widespread perception that: *"The place of women is at home […] Men are always preferred.".*

Most respondents had not any serious problems with finding a job, although this took them a range of time – from one day to a few weeks, two months, and as much as half a year.

The main obstacles (Figure 2.) were a lack of long-term work experience as a career starter (I3, I6) or a lack of knowledge of English (I1); however, in the latter case the interviewee had the chance to improve her skills after admission to the workplace. Furthermore, I7 stressed the importance of language knowledge (she was looking for a job in Germany where knowledge of German was required). A further difficulty was that *"I could not decide what I wanted to do."* (I5).

Other problems were related to job-seeking more generally, including:

- understanding job advertisements – a lack of practical knowledge about terminology and understanding which skills and capabilities were required;
- the fact that employers do not understand the needs of the new generation;
- realizing that a jobseeker will not be called in for a job interview if she does not have the required certificates, even though she has the appropriate competences.

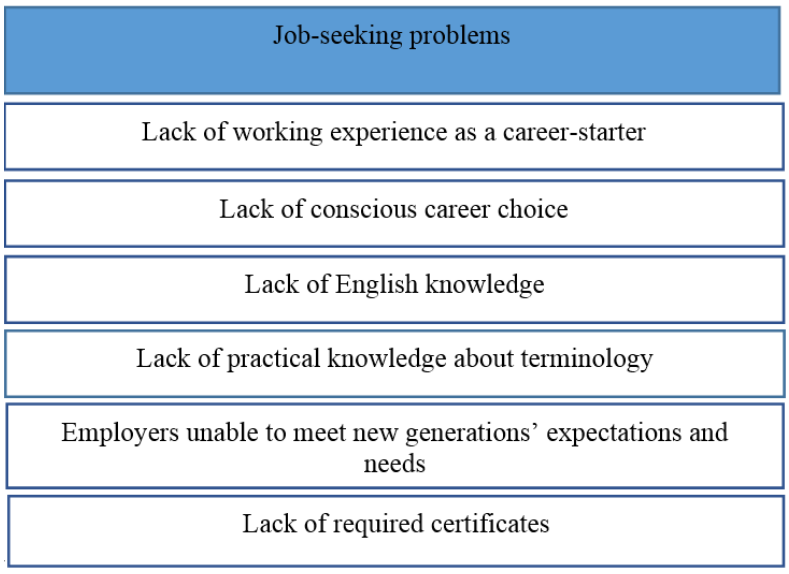

Figure 2: Problems Encountered by STEM Job-seekers
Source: Authors' construction based on interviews

4.3 The Situation of Women in STEM Workplaces

More respondents are satisfied with their jobs, like their professions, and did not mention any problems related to their workplaces. *"I would not call them problems but rather challenges; in every situation you have to find the right*

solution for your work." (I2); *"There is such a lack of workforce that I have very good opportunities (and will also in the future)."* (I7).

Women may face difficulties in the case of demands for hard physical work (e.g. moving products), but an interviewee states that (I6) "*Personally, I never felt the disadvantage of being a woman. This incorporates the fact that I have some great bosses […] Overload affects all of us. It is difficult to put a researcher's life into the frame [….] Flexible working hours means that if an experiment lasts until 10 pm, we will be in the lab or if there is a deadline, we'll work until dawn after the children are put to bed. This often generates frustration and creates sleep deprivation."* (I12). Moreover *"…being undervalued, aggression, humiliation, and lack of communication…"* (I6) and stress (I5) can arise. I9 reported that *"Internal conflict and a lack of team spirit are the main problems."* at her workplace. However, I6 explained that she had faced more serious problems in the film industry, such as are represented by the '#metoo' campaign in Hollywood which involves the struggle for the equality of women actors. A further problem is that *"A masculine attitude is more appreciated […] most disadvantages lead back to feminine characteristics."* (I11). Inequality occurs in the form of unequal salaries in the same field. A more serious and general problem is that salaries sometimes do not provide enough to live on.

Among the "dream jobs" of respondents are chief financial officer, entrepreneur and NASA researcher, but one interviewee claimed that she was satisfied, saying "*The dream job for me is the one I have now."* (I2), while other respondents would like to have the same job as now with better conditions: *"Project manager at my current job."* (I7); *"Software tester (or test manager) with greater responsibility and a higher salary."* (I10); *"I always wanted to start an enterprise. I like start-ups."* (I9). *"I would like a job that is exciting, meets my interest, and where I can continually improve my knowledge. It should give me the opportunity to travel a lot, and I should get appreciation for my work, and it should involve a harmonious working environment where I can also appreciate my colleagues and my employees."* (I6). I4 likes her job although she had wanted to establish herself in a STEM job but could not. In the future she would prefer a STEM job with flexi-time work.

"I like my work, but I feel 'unsocialized'… People have low emotional intelligence, and a low threshold for stimuli and motivation […] I would like to be an entrepreneur; I can't imagine anything else in the long term." (I10). Others prefer to work in a team: *"Where you can work in a well-organized team, coordinating the strengths of different people in the community for the sake of success."* (I11).

All respondents reported that they could return to their workplace if they had a baby. *"Everyone at my workplace can work one day a week at home, and with permission even two days. A colleague (who has children) works twice a week at*

home, and sometimes starts early and goes home earlier […] so, this will also be the right place for me with a baby." (I1).

Conclusion

The research method we have employed is inappropriate for drawing overall conclusions but the results highlight the main problems which women face in STEM fields, and provide information that helps improve their opportunity to be integrated into the labor market.

The decision to opt for an education and work in the field of STEM appears to be deeply rooted in individual socialization experiences. Positive childhood experiences can contribute to the creation of positive attitudes towards technical and information sciences, and may result in engagement with STEM.

Women with experience in STEM claim that they face problems similar to those of men. However, many problems are related to conflict management and teamwork, and could be improved by training.

In order to better integrate women into the field of STEM, it is necessary to overcome both stereotypes and prejudices. However, if knowledge obtained in the STEM field is coupled with the wider personal competencies that facilitate individual careers, STEM may represent a promising opportunity to integrate women and thereby bridge differences.

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