Pedagogical Strategies for Female Students in IT Disciplines to Promote Gender Equality: the Case of Five European Universities

Elisabeth T. Pereira*[1], Ana Vukičević[2], Frane Urem[2] and Diogo Gomes[3]
[1]Research Unit in Governance, Competitiveness, and Politic Policies (GOVCOPP) and Department of Economics, Management, Industrial Engineering and Tourism (DEGEIT), University of Aveiro, Campus Universitário de Santiago, Portugal
[2]Department of Applied Sciences, Šibenik University of Applied Sciences, Šibenik, Croatia
[3]Department of Electronics, Telecommunications and Informatics (DETI), University of Aveiro, Campus Universitário de Santiago, Portugal

melisa@ua.pt
ana_u@vus.hr
frane@vus.hr
dgomes@ua.pt

**corresponding author*

Abstract: Once Female students in Informatics and Technology (IT) and Computer Science degrees at European higher education institutions, in the 21st century, represent a smaller percentage compared with male students, this paper investigates the main reasons that may explain this fact, as well as presents new pedagogical strategies for female students in IT courses. These strategies derive from understanding stereotypes, perceptions, cultural implications, and propositions for inclusive IT education; and are relevant for supporting IT students' equality and success. Further, good lecturing in general together with positive reinforcement with students lays a crucial foundation for supporting all students in IT. The present research was developed in five European universities: Croatia, Italy, Slovakia, Poland, and Portugal. Starting from a literature review on the topic was developed a questionnaire that was applied to a sample of IT students in these five universities. The results were analyzed to define some new pedagogical strategies. These allowed us to conclude about the main reasons for the decision of female students to choose to study IT programs and higher education institutions develop pedagogical strategies more adequate and more attractive to female students, as well as to contribute to increased employability and successful integration in the labor market.

Keywords: Female Students, HEIs, IT, STEM, Gender Equality, Strategies, CodeIn.

1. Introduction

The need for Information Technology (IT) and Computing Science education is recognized as being of central relevance for meeting current social and economic challenges, as well as for developing a scientifically, mathematically, and technologically literate citizenry. In many countries, however, there are gender differences in the participation and achievement of women in IT and Science, Technology, Engineering, and Mathematics (STEM) education and careers.

This paper is part of the European project Cloud cOmputing for Digital Education Innovation (*CodeIn*) and aims to investigate the best pedagogical strategies for female students in IT disciplines in European higher education institutions (HEI), considering the students from five European universities: University of Aveiro (Portugal), Šibenik University of Applied Science (Croatia), LUISS University (Italy), Technological University of Lodz (Poland), Technologic University of Zilina (Slovakia). Based on this sample is studied the current situation through the application of a questionnaire and, based on the obtained results, are described new pedagogical strategies for female students in IT disciplines through understanding stereotypes, perceptions, and cultural implications, and also through suggestions for inclusive IT education.

This paper is organized as follows. After this introduction, section 2 presents the literature review of female IT students, centered on the framework of female IT and STEM students, the gender differences, the importance of understanding stereotypes of female students in IT; and the most common issues in STEM education and gender differences in IT. Section 3 defines the methodology. Section 4 exposes and discusses the obtained results of the survey on pedagogical strategies for teaching female students that were run among HEI students on different levels of study distance learning in the five European countries. And, finally, Section 5 summarizes the conclusions, limitations, and future research.

2. Literature Review

2.1 Framework in Female IT and Computer Science Students

The framework to support female IT and STEM students' research can be based on several models. Yates and Plagnol (2022) state the model of Cheryan et al. (2017), which is based on three elements, that combine fields unappealing for women: i) the masculine culture, ii) the lack of early exposure for women, and iii) women's lack of belief in their ability to succeed. However, this model does not aim to offer a comprehensive overview of the experiences of women in these fields, and there are some aspects of women's experiences in STEM that are not considered in the framework. According to Ayre et al. (2023) and Fouad et al. (2011), the framework does not cover the experiences of some sexism, microaggressions, and sexual harassment that women in STEM fields report as well not refer to women's struggle to see how to best manage their careers within STEM fields (Yates & Skinner, 2021).

2.1.1 The Domination of Masculine Culture

A stereotyped society and "gendered organizations" (Acker, 1990) have contributed to a better understanding of female's experiences in STEM organizations and the barriers they face to career progression (Yates & Skinner, 2021). The term "gendered organization" refers to organizational cultures that purpose to be fair and meritocratic, assuming that all employees are apprehended to the same standards and given the same opportunities, but, in reality, it favours men, establishing standards and opportunities that are better suited to men.

A 'gendered classroom' extends this notion, referring to a classroom that is assumed to be gender-neutral but which is tailored to male students (Yates & Skinner, 2021). The existing literature suggests that this concept of the gendered classroom can be applied to STEM education as useful to understand the experiences of female students.

Considering that female students are more motivated by communal goals and males by agentic goals, a pedagogical style and a learning environment appealing to agentic learners positively discriminate the male students (Bakan, 1966; Eagly et al., 2000; Riegle-Crumb et al., 2019). The ones motivated by communal goals are drawn to supportive relationships and collaboration and want to see a pro-social purpose to their activities. Those motivated by agentic goals are encouraged by competition, appreciate autonomy and independence, and are motivated to learn for their interests. Females tend to choose more communal learning environments (Brotman & Moore, 2008), characterized by supportive relationships (Meyers-Levy & Loken, 2015; Tamres et al., 2002), with clear guidance from tutors (Aylor, 2003; Frymier & Houser, 2000; Menekse et al., 2020), and where the curricula are more significative (Giannakos et al., 2017). These common needs, more often related to females, may not always be well seen in the typical IT classroom.

STEM careers have been related to several goals (Diekman et al., 2010) and learning core skills, which represent specific targets within the technology industry (Zander et al., 2012). IT and computer courses tend to be correlated with specific goals related to autonomy, independence, and self-directed learning (McCartney et al., 2016; Thomas, 2013). On the other side, competitiveness is prevalent in STEM Education and in IT classrooms, where students demonstrate it through long hours of intense work (Hirshfeld, 2010, 2015; Sallee, 2011).

Research developed in the United States exploring the environment of IT and computer science classrooms adds weight to the idea that these provide limited support for communal learners. Barker and Garvin-Doxas (2004) in an observation study classroom found evidence of an impersonal and protected environment, as well as the establishment of informal hierarchies which led to a competitive behavior from the students. They identified certain types of discourse that stuck the development of a supportive and collaborative culture within the classroom originating a strongly defensive climate with a low level of trust and where students did not feel safe to incur mistakes, with the fear of being humiliated. According to Barker and Garvin-Doxas (2004), Östberg (2003), and Barker (2016), one important factor that may contribute to an inhospitable environment for females in IT classroom comes from stereotypes: female may feel that they are different from their own and the perceptions of a typical IT expert, and this can impact on their feelings of IT field belonging and their choices.

For Yates and Plagnol (2021), based on Beyer (2008, 2014) and Cheryan et al., (2009), the stereotypical computer and IT scientists and experts are usually male, clever, and obsessed with coding and informatics. These stereotypes are held by girls, boys, parents, teachers, and employers (Dickhäuser & Meyer, 2006; Vekiri, 2013), are deep-rooted from an early age (Master et al., 2017), and could make females feel that they will not fit in or

be successful in the field of technology. The stereotypes in these areas may reflect negatively on performance and have been shown to impact levels of interest in some STEM subjects like engineering, IT, and science and on girls' study choices at high school (Yates & Plangol, 2021).

2.1.2 Early Exposure to the Subject Fields of STEM and IT

The second element of Cheryan et al.'s (2017) model is the lack of early exposure to STEAM fields. Many children become familiar with computers through games they play as children, but much of games are characterized by their repetitive shooting, loud noises, and violent graphics, which are in large part aimed at and played by boys (Hartmann & Klimmt, 2006; Dele-Ajayi et al, 2018).

Recent evidence indicates that boys and girls spend similar amounts of time on screens throughout their adolescence, but the way they engage with technology is different: boys spend significantly more time playing video games and girls spend more time interacting with their friends on social media sites (Mullan, 2018). These differences have been shown to have an impact on their career decisions, with computer gaming being a significant positive predictor of interest and confidence in studying IT and computer science (Sevin & DeCamp, 2016). Girls who have a certain degree of early exposure develop more computer self-efficacy (Master et al., 2017) and IT interest, and have more positive stereotypes associated with technology jobs (Cheryan et al., 2013). Some studies show evidence that early exposure plays a crucial role, with the countries that have more compulsory STEM coursework also having a better gender balance in STEM jobs (Charles et al, 2017).

2.1.3 Gender Differences in Self-Efficacy

The third element of the model of Cheryan et al. (2013) explains that female under-representation in STEM fields is based on their lower levels of computer self-efficacy. According to Gürer and Camp (2002), this is due to the lack of confidence in their ability to accomplish computer-related tasks is the most influential factor in the under-representation of women in IT and computer science. This difference results from women not believing in their abilities (Beyer, 2008) and men overestimating theirs (Bench et al., 2015). Women's lack of belief in their abilities has an impact on their career plans (Beyer, 2014; Dempsey et al., 2015; Rosson et al., 2011), expectations of success in the technology industry (Appianing & Van Eck, 2015), in the development of occupational identity (Carlone & Johnson, 2007; Dempsey et al., 2015), intention to study IT at school (Sáinz & Eccles, 2012), and interest in the IT and computer science fields (Margolis et al., 2000).

2.2 Most Common Issues in STEM Education

In the last decade, several studies investigated particular variables involving students' attitudes toward STEM education (Lane et al., 2022). Falk et al. (2017) concluded that females have lower interest levels in STEM compared to males, which is based on social inclusion factors as a particular reason for lower interest. Means et al. (2021), according to Lane et al (2022), state a relationship between attendance at an inclusive STEM high school or academic and motivational outcomes, based on the fact that students with prior academic achievement in inclusive STEM high schools lead the development of STEM interests and motivations. This allowed the authors to conclude that the students who attended an inclusive STEM high school compared with non-STEM schools will denote high interest in undertaking a graduate degree and a career in a STEM field. These studies highlight the need to focus on strategies to increase the social identification of young students in STEM to a better gender balance and to increase interest in STEM fields (Lane et al, 2022).

2.3 Gender Differences in IT Studies

The study by Blažev et al (2017) applied to Croatian high schools shows that students, male and female, who had previous success in STEM fields are more likely to hold stereotypical beliefs about STEM. Several factors have been proposed to positively impact stereotypical beliefs, such as the presence of girls in a classroom (Gunderson et al., 2012; Riegle-Crumb et al., 2017). Riegle-Crumb et al. (2017) stated that the presence of females in high school classes had a positive impact in reducing male peers' stereotypical beliefs. On the other side, Blažev et al (2017) concluded that the presence of female teachers had a similar impact.

In contrast, Gunderson et al. (2012) noted that gender stereotypes about female's mathematics abilities are developed, rather than improved, by teachers. Exposure to role models is many times promoted as a way of overcoming negative female stereotypical beliefs about STEM. The findings of Gladstone and Cimpian's (2021) systematic literature review focus on four recommendations for maximizing the effectiveness of role models in STEM for motivating students, considering different gender and ethnic: i) show models as competent and

successful, avoiding extreme levels of success that could instead be segregating; ii) present models as being significantly similar to students; iii) prioritize exposure to role models from groups traditionally underrepresented in STEM; iv) portray the success of the models as being achievable. For their part, Luo et al. (2021) state that primary school students' stereotypical beliefs about STEM careers can negatively influence STEM self-efficacy and career-related outcome expectations; which suggests that measures focusing on STEM career aspirations need to target STEM stereotypes, self-efficacy, and outcome expectations.

3. Data and Methodology

Based on the topics presented in the literature review in the previous section, a questionnaire was designed and applied to the students, female and male, from four different levels of study: undergraduate, graduate, post-graduate, and post-doctoral students; of the five partner's HEI: University of Aveiro (Portugal), Šibenik University of Applied Science (Croatia), LUISS University (Italy), Technological University of Lodz (Poland), Technologic University of Zilina (Slovakia). The purpose of the survey is to identify and support new pedagogical strategies for teaching to increase female students' active participation in STEM and IT courses, gender equality in an IT career graduation, and contribute to women's engagement in the digital economy.

The research was conducted among female and male students of IT degrees of the five European universities of the project, during September and October of 2023, through an electronic survey sent by email with the answers received directly in the online *Forms* platform. The questionnaire was sent to 502 students and answered a total of 107 valid answers, from 74% of male and 26% of female students.

The questionnaire comprised thirteen questions focused on the issues related to pedagogical gender strategies for teaching IT students in HEIs, in addition to personal questions to students about the study cycle level and gender. The questionnaire's questions and answers are presented in Table 1. An ANOVA test to analyse the significative differences between female and male responses was applied and is also presented in Table 1.

4. Results and Discussion

This section exposes and discusses the obtained results of the survey on pedagogical strategy for teaching female students that were run among HEI students on different levels of study distance learning coming from five different European countries.

4.1 The Results of the Survey

The following paragraphs describe the results of the survey on pedagogical strategy for teaching female students in IT applied to higher education students in five different European countries. The respondents came from five different EU countries: Croatia (18%), Italy (26%), Poland (28%), Portugal (14%) and Slovakia (2%). The questionnaire contained 13 different statements, listed below. Respondents could express their degree of agreement/disagreement with each statement according to the scale: Strongly disagree; Disagree; Neither agree nor disagree; Agree; Strongly Agree.

107 students answered the questionnaire, characterized, according to the IT level of studies (Q2) by 57% Undergraduate (1st cycle), 31% Graduate (2nd cycle), 7% Post-Graduate Studies (Ph.D. or 3rd cycle), and 3% Post-Doctoral studies. Of the total number of students, 26% were female and 74% male.

The questions 3 to 12 and the obtained answers are presented in Table 1.

Table 2.1: Obtained answers to Questions 3 to 12

Question	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Gender Sign.Diffs (ANOVA)
Q3: Using mixed-ability, collaborative rather than competitive group work as the preferred teaching method	3%	7%	24%	42%	22%	**
Q4: Providing diverse historical and contemporary female role model in IT and their work (guest speakers, class materials) is highly motivational	4%	5%	28%	38%	25%	**
Q5: Using gender is inclusive language when discussing occupational roles	10%	8%	28%	41%	11%	*
Q6. Using gender-inclusive teaching material will	14%	9%	29%	37%	9%	**

Question	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Gender Sign.Diffs (ANOVA)
help challenge potential stereotypes about females in IT						
Q7: Offering non-integrated curricular courses (summer school, workshops, seminars) and out-of-contact hours (online training, seminars) will encourage female students to participate more in IT programs with peers	5%	6%	28%	44%	15%	**
Q8: Teaching female students by offering workshops can strengthen their IT performance and participation	5%	3%	24%	43%	22%	*
Q9: Teachers should stay well informed of good local programs and events, contests, and other learning opportunities to promote	5%	1%	1%	53%	40%	**
Q10: Developing greater competence and confidence, as well as enthusiasm for teachers' own IT knowledge and skills is crucial for the teaching process	2%	1%	10%	50%	37%	
Q11: The High Educational Institution teachers need to grow professionally by learning more about gender issues in IT disciplines	5%	8%	24%	39%	21%	*
Q12: Students feel well prepared about the obtained skills at the High Educational Institution to develop an equal career in the labor market	3%	11%	29%	43%	12%	

Gender differences significant level: *** p<0,01; **p<0,05; *p<0,1

In question 13, the students were questioned about their opinion about the main obstacles for female students in IT. The majority identified as main obstacles and Figure 1.

- Gender bias, discrimination in the workplace, a lack of female role models,
- STEM studies are difficult for the majority of people,
- Male peers are perceived as more skilled,
- Lack of female followers,
- Prejudices - IT is thought of as a male job area,
- That it is a male-dominated field,
- Stereotypes about women, that they're more emotional than logical.

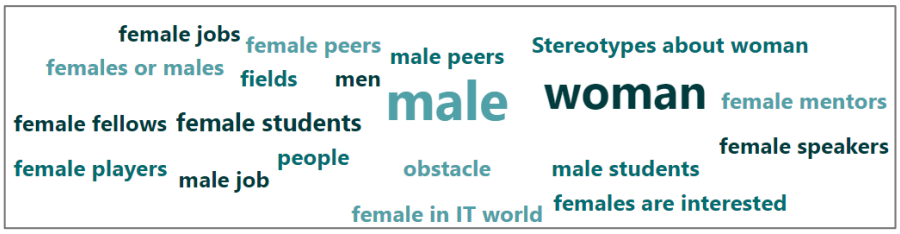

Figure 1: Main words that emerged from obstacles answers identified (Source: Forms.Office)

4.2 Main Findings From the Survey

Based on Table 1, the significative gender differences in answers focus on questions 3, 4, 6, 7 and 9. The significative gender differences, in question 3, about the use of mixed-ability, collaborative rather than competitive group work as the preferred teaching method are according to the model of Cheryan et al. (2013) and with the conclusions of Bakan (1966); Eagly et al.,(2000), Riegle-Crumb et al. (2019), Meyers-Levy and Loken (2015), Tamres et al. (2002), that stated for the female motivation by communal goals drawn by supportive relationships and collaboration with pro-social purposes Communal learning environments), once male is motivated by agentic goals encouraged by competition, autonomy, and independence, guided by their learning interests.

From question 4, one can conclude that historical and contemporary female role models in IT and their work are relevant, which is confirmed by the answers and more significant to female students. When discussing occupational roles, in questions 5, 6, and 9, the use of gender–inclusive language is preferred among the majority of students, as well as the fact that teachers should stay well informed of good local programs and events,

contests, and other learning opportunities to promote. The fact that teachers show developing greater competence and confidence, as well as enthusiasm for teachers' own IT knowledge and skills is relevant and females and males are both in accordance as well as they are in accordance that is crucial the teaching involvement in the learning process to students feel well prepared about the obtained skills at the HEI to develop an equal career in the labour market.

Most of the surveyed students believe that the main obstacles are the belief that IT is still perceived as a male-dominated field, together with the fact there are not enough female followers or female role models in IT.

Another finding from the survey is that offering non-integrated curricular courses (summer school, workshops, seminars) and out-of-contact hours (online training, seminars) will encourage female students to participate more in IT programs with peers.

The answers are according to the literature review statements but with significant answers from students. With allows the development of some new strategies to attract girls to study IT and science computers and to promote and improve teaching and learning in good classroom environments as well as to empower female careers in these technological fields.

5. Conclusions

Through this paper, we have shown the major research findings concerning pedagogical strategies for female students in IT strategies. Moreover, by conducting research among female students we were able to recommend a way for educators to support and encourage females in IT and computer science disciplines. While these strategies are especially relevant for supporting females in IT, many are also important approaches for males and to promote gender equality in STEM, IT, and computer science degrees, classrooms and careers. Further, good lecturing, in general, together with positive reinforcement on stereotypes, gender and culture equality, an early exposition of students to STEM fields are of crucial foundation for supporting all students in IT. Educators need to continue to grow professionally by widening their knowledge about gender issues in IT disciplines and learning the tools how to address issues effectively. So, new strategies can do the future difference contributing to decreasing gender differences and increasing the number of female students in universities IT and computer science degrees and academic programs, like:

- Use mixed-ability, collaborative, and competitive group work as teaching methods;
- Provide and promote diverse historical and contemporary female role models in IT and their work (guest speakers, class materials) is highly motivational
- Use gender-inclusive language in teaching material and gender-inclusive environments in classrooms;
- Offer non-integrated curricular courses (summer Schools, workshops, seminars) and out-of-contact hours (online training, seminars) to promote and integrate female students in IT programs with peers and to strengthen their IT performance and participation;
- Promote and support teachers with information about good local programs and events, contests, and other learning opportunities;
- Promote tools (innovation programs) for the teachers to grow professionally by learning and teaching as well as to the development of competencies, confidence, and enthusiasm for teaching IT knowledge and skills and about gender equality issues on student curricula and future careers.

The present study has some limitations concerning general applications, once the findings are based on a questionnaire applied to five specific European universities.

For future research, is suggested a quantitative analysis of the data collected through the questionnaire complemented by interviews with some focus groups of the students of the five HEIs.

Acknowledgments

This study was, in part, financially supported by the Research Unit on Governance, Competitiveness and Public Policies (UIDB/04058/2020) + (UIDP/04058/2020), funded by national funds through FCT—Fundação para a Ciência e a Tecnologia.

This study was, in part, financially supported by ERASMUS+ project Cloud cOmputing for Digital Education Innovation CodeIn), Key Action 2, and Strategic Partnerships [2020-1-HR01-KA226-HE-094713].

References

funded by national funds through FCT—Fundação para a Ciência e a Tecnologia. ERASMUS+ project GreenTex,
Acker, J. (1990). Hierarchies, jobs, bodies: A theory of gendered organizations. Gender & Society, 4(2),139–158.
Ayre, M., Mills, J., & Gill, J. (2013). "Yes, I do belong": The women who stay in engineering. Engineering Studies, 5 (3), 216-232.
Bakan, D. (1966). The duality of human existence: An essay on psychology and religion. Chicago: Rand McNally.
Barker, L. J. & Aspray, W. (2006). The state of research on girls and IT. In Cohoon, J.M. & Aspray, W (Eds.). Women and Information Technology: Research on Underrepresentation, Cambridge, Massachusetts Institute of Technology Press, 354.
Baker, M. (2016), "Women graduates and the workplace: continuing challenges for academic women", Studies in Higher Education, 41 (5), 887-900.
Barker, L. J., & Aspray, W. (2006). The state of research on girls and IT. In J. M. Cohoon, & W. Aspray(Eds.), Women and information technology: Research on underrepresentation (pp. 3–54). Cambridge: The MIT Press.
Barker, L. J., & Garvin-Doxas, K. (2004). Making visible the behaviors that influence learning environment: A qualitative exploration of computer science classrooms. Computer Science Education, 4(2), 119–145.
Barker, L. J., McDowell, C., & Kalahar, K. (2009). Exploring factors that influence computer science introductory course students to persist in the major. ACM SIGCSE Bulletin, 41, 282–286. Cambridge, MA: MIT Press.
Barker, L. J., O'Neill, M., & Kazim, N. (2014). Framing classroom climate for student learning and
retention in computer science. In Proceedings of the 45th ACM Technical Symposium on Computer Science Education (pp. 319–324).
Beyer, S. (1999). Gender differences in the accuracy of grade expectancies and evaluations. Sex Roles, 41(3/4), 279–296.
Beyer, S. (2008). Predictors of female and male computer science students' grades. Journal of Women and Minorities in Science and Engineering, 14(4), 377–409.
Beyer, S. (2014). Why are women underrepresented in computer science? Gender differences in stereotypes, self-efficacy, values, and interests and predictors of future CS course-taking and grades. Computer Science Education, 24(2–3), 153–192.
Brotman, J. S., & Moore, F. M. (2008). Girls and science: A review of four themes in the science education literature. Journal of Research in Science Teaching, 45(9), 971–1002.
Bers, M., Flannery, L., Kazakoff, E., & Sullivan, A. (2014). Computational thinking and tinkering: Exploration of an early childhood robotics curriculum. Computers and Education 72, 145–157.
Beekhuyzen, J. & Dorries, R. (2008). Tech Girls are Chic! (Not Just Geek!). tech2morrow, Brisbane. Bell, D. A. & White, S. S. (2014). Gender Diversity in Silicon Valley: A Comparison of Silicon Valley Public Companies and Large Public Companies. Fenwick & West LLP.
Bell, D. A. & White, S. S. (2014). Gender Diversity in Silicon Valley: A Comparison of Silicon Valley Public Companies and Large Public Companies. Fenwick & West LLP.
Bers, M., Flannery, L., Kazakoff, E., & Sullivan, A. (2014). Computational thinking and tinkering: Exploration of an early childhood robotics curriculum. Computers and Education, 72, 145–157.
Blažev, M., Karabegović, M., Burušić, J., and Selimbegović, L. (2017). Predicting gender-STEM stereotyped beliefs among boys and girls from prior school achievement and interest in STEM school subjects. Soc. Psychol. Educ. 20, 831–847.
Beyer, S. (2016). Women in CS: Deterrents. Encyclopedia of Computer Science and Technology Edition: 2ndChapter: Women in CS: Deterrents, Publisher: CRC Group Editors: P. A. Laplante.
Box, S. (2018). Digital transformation must focus on women and girls. Policy Options Politiques, Retrieved 20th October, 2023, from http://policyoptions.irpp.org/magazines/november-2018/digital-transformation-must-focus-women-girls/
Buskens, I. & Webb, A. (2014). Women and ICT in Africa and the Middle East: Changing Selves, Changing Societies. In Zed Books.
Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. Journal of Research in Science Teaching, 44(8), 1187– 1218.
Carter, L. (2006). Why students with an apparent aptitude for computer science don't choose to major in computer science? Proceedings of the 37th SIGCSE Technical Symposium on Computer Science Education, 27–31.
Cheryan, S., Plaut, V. C., Davies, P. G., & Steele, C. M. (2009). Ambient belonging: How stereotypical cues impact gender participation in computer science. Journal of Personality and Social Psychology, 97(6), 1045–1060.
Cheryan, S., Plaut, V. C., Handron, C., & Hudso, L. (2013). The stereotypical computer scientist: Gendered media representations as a barrier to inclusion for women. Springer Science & Business Media, 69(1-2), 58–71.
Cheryan, S., Siy, J. O., Vichayapai, M., Drury, B. J., & Kim, S. (2011). Do female and male role models who embody STEM stereotypes hinder women's anticipated success in STEM? , Social Psychological and Personality Science, 2(6), 656–664.
Cheryan, S., Plaut, V., Davies, P., & Steele, C. (2009). Ambient belonging: How stereotypical cues impact gender participation in computer science. Journal of Personality and Social Psychology, 97(6), 1045–1060.
Cheryan, S., Siy, J. O., Vichayapai, M., Drury, B. J., & Kim, S. (2011). Do female and male role models who embody STEM stereotypes hinder women's anticipated success in STEM? Social Psychological and Personality Science, 2(6), 656–664.

Cheryan, S., Plaut, V. C., Handron, C., & Hudson, L. (2013). The stereotypical computer scientist: Gendered media representations as a barrier to inclusion for women. Sex Roles, 69(1–2), 58–71.

Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender-balanced than others? Psychological Bulletin, 143(1), 1–35.

Ciobanu, C. (2018). Eastern Europe, is heaven for women in tech. News Mavens, Central & Eastern Europe. Retrieved 19th November 2023 from https://newsmavens.com/news/aha-moments/1326/eastern-europe-heaven-for-women-in-tech.

Clarke-Midura, J., Allan, V., & Close, K. (2016). Investigating the Role of Being a Mentor as a Way of Increasing Interest in CS. Proceedings of the 47th ACM Technical Symposium on Computing Science Education, 297–302.

Dele-Ajayi, O., Emembolu, I., Peers, M., Shimwell, J., & Strachan, B. (2018). Exploring Digital Careers, Stereotypes and Diversity with Young People through Game Design and Implementation, in 2018 IEEE Global Engineering Education Conference (EDUCON) IEEE.

Dickhäuser, O., & Meyer, W.-U. (2006). Gender differences in young children's math ability attributions. Psychology Science, 48(1), 3–16.

Diekman, A. B., Brown, E. R., Johnston, A. M., & Clark, E. K. (2010). Seeking congruity between goals and roles: A new look at why women opt out of science, technology, engineering, and mathematics careers. Psychological Science, 21(8), 1051–1057.

European Statistics Eurostat (2023), Digitalisation in Europe, from https://ec.europa.eu/eurostat/web/interactive-publications/digitalisation-2023, Accessed in 6 November 2023.

European Statistics Eurostat (2019). Hard-to-fill ICT vacancies: how countries compare, Retrieved September 21, 2019, from https://ec.europa.eu/eurostat/de/web/products-eurostat-news/-/DDN-20190327-1 European Statistics Eurostat (2019b). ICT specialists are predominantly male, Retrieved from https://ec.europa.eu/eurostat/de/web/products-eurostat-news/-/DDN-20190513-1

European Statistics Eurostat (2018a) Women in science and technology,https://ec.europa.eu/eurostat/web/products-eurostat-news/-/EDN-20180210-1?inheritRedirect=true.

European Statistics Eurostat (2018b). Girls and women under-represented in ICT, Retrieved in 19th November from https://ec.europa.eu/eurostat/de/web/products-eurostat-news/-/EDN-20180425-1

Falk N. A., Rottinghaus P. J., Casanova T. N., Borgen F. H., Betz N. E. (2017). Expanding women's participation in STEM: insights from parallel measures of self-efficacy and interests. J. Career Assess. 25, 571–584.

Fouad, N., Fitzpatrick, M., & Liu, J. P. (2011). Persistence of women in engineering careers: A qualitative study of current and former female engineers. Journal of Women and Minorities in Science and Engineering, 17(1), 69–96.

Gabay-Egozi, L., Shavit, Y., & Yaish, M. (2015). Gender Differences in Fields of Study: The Role of Significant Others and Rational Choice Motivations. European Sociological Review. 31(3), 284–297.

Giannakos, M. N., Pappas, I. O., Jaccheri, L., & Sampson, D. G. (2017). Understanding student retention in computer science education: The role of environment, gains, barriers, and usefulness. Education and Information Technologies, 22(5), 2365–2382.

Lane, C., Kaya-Capocci, S., Kelly, R., O'Connell, T. & Goos, M (2022), Fascinating or dull? Female students' attitudes towards STEM subjects and careers, Front Psychol. 13: 959972.

Lockwood, P. (2006). "Someone Like Me Can Be Successful": Do College Students Need Same-Gender Role Models? Psychology of Women Quarterly, 30(1), 36–46.

Khan, N. Z. & Luxton-Reilly, A. (2016). Is computing for social good the solution to closing the gender gap in computer science? Proceedings of the Australasian Computer Science Week Multiconference, Paper 17, 1–5.

Ko, A. J. & Davis, K. (2017). Computing Mentorship in a Software Boomtown: Relationships to Adolescent Interest and Beliefs. Proceedings of the 2017 ACM Conference on International Computing Education Research, 236–244.

Margolis, J., & Fisher, A. (2002). Unlocking the clubhouse: Women in computing. Boston: MIT Press.

Margolis, J., Fisher, A., & Miller, F. (2000). The anatomy of interest: Women in undergraduate comp Margolis J. & Fisher, A. (2003). Unlocking the clubhouse: Women in computing. MIT Press, Cambridge, MA. Master, A., Sapna, C., & Meltzoff, A. N. (2016). Computing Whether She Belongs: Stereotypes Undermine Girls' Interest and Sense of Belonging in Computer Science. Journal of Educational Psychology, 108(3), 424–437.

Master, A., Cheryan, S., Moscatelli, A., & Meltzoff, A. N. (2017). Programming experience promotes higher STEM motivation among first-grade girls. Journal of Experimental Child Psychology, 160, 92–106.

Master, A., Sapna, C., & Meltzoff, A. N. (2016). Computing Whether She Belongs: Stereotypes Undermine Girls' Interest and Sense of Belonging in Computer Science. Journal of Educational Psychology, 108(3), 424–437.

Meyers-Levy, J., & Loken, B. (2015). Revisiting gender differences: What we know and what lies ahead. Journal of Consumer Psychology, 25(1), 129–149.

Mullan, K. (2018). Technology and children's screen-based activities in the UK: The story of the millennium so far. Child Indicators Research, 11(6), 1781–1800.

Oates-Indruchová, L. (2020). Censorship in Czech and Hungarian Academic Publishing, 1969-89: Snakes and Ladders. London: Bloomsbury Academic.

Oliver, T. (2017). An In-Depth Look At The Gender Gap in the Tech Industry. Retrieved 19th November, 2023, from https://www.technicallycompatible.com/an-in-depth-look-at-the-gender-gap-in-the-tech-industry/

Ong, P. (2016). Tides are turning in favour of women in tech. Here's why. Tech in Asia, Retrieved 19th November, 2023, from https://www.techinasia.com/talk/programming-brighter-future-women-tech

Ripley, A. (2017). Boys Are Not Defective. The Atlantic, Retrieved on 19th November, 2023, from https://www.theatlantic.com/education/archive/2017/09/boys-are-not-defective/540204/

Sanders, J. (2005). Gender and technology in education: what the research tells us. Proceedings of the international symposium on Women and ICT: Creating Global Transformation. (CWIT '05), Claudia Morrell and Jo Sanders (Eds.). 6.

Semmens, R., Piech, C., & Friend, M. (2015). Who Are You? We Really Wanna Know... Especially If You Think You'reLike a Computer Scientist. Proceedings of the Third Conference on GenderIT (GenderIT '15), 40 – 43.

Sevin, R., & DeCamp, W. (2016). From playing to programming: The effect of video game play on confidence with computers and an interest in computer science. Sociological Research Online, 21(3), 14–23.

Spieler, B; Oates-Induchovà, L.; and Slany, W. (2020) Female Teenagers in Computer Science Education: Understanding Stereotypes, Negative Impacts, and Positive Motivation. Journal of Women and Minorities in Science and Engineering. 26 (5), 473-510.

Stoet, G. & Geary, D. C. (2018). The Gender-Equality Paradox in Science, Technology, Engineering, and Mathematics Education, Psychological Science. 29(4), 581–593.

Unfried, A., Da Faber, M., Stanhope, D. S., & Wiebe, E. (2015). The Development and Validation of a Measure of Student Attitudes Toward Science, Technology, Engineering, and Math (S-STEM). Journal of Psychoeducational Assessment, 33(7), 622–639.

Vichayapai, M., Drury, B. J., & Kim, S. (2011). Do female and male role models who embody STEM stereotypes hinder women's anticipated success in STEM?, Social Psychological and Personality Science, 2(6), 656–664.

Wing, J. (2006). Computational thinking. Communications of the ACM, 49(3), 33–35.

World Economic Forum Statistics (2023), This is the state of digitalization in Europe in 2023 – Eurostat report, Retrieved 19th October, 2023, from https://www.weforum.org/agenda/2023/09/digitalization-europe-eurostat-report/#:~:text=More%20than%209%20million%20people%20in%20EU%20member,skewed%2C%20with%2081%25%20male%20compared%20to%2019%25%20female.

Yates, J., & Skinner, S. (2021). How do female engineers conceptualise career advancement in engineering: a template analysis. Career Development International, 26 (5).

Yates, K. Plagnol, a.C. (2022). Female computer science students: A qualitative exploration of women experiences studying computer science at university in the UK. Education and Information Technologies, 3080-3105.

Young, D. M., Rudman, L. A., Buettner, H. M., & McLean, M. C. (2013). The Influence of Female Role Models on Women's Implicit Science Cognitions. Psychology of Women Quarterly, 37(3), 283–292.

Zagami, J., Boden, M., Keane, T., Moreton, B., & Schulz, K. (2015). Girls and computing: Female participation in computing in schools. Australian Educational Computing, 30(2), 1–14.