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WOMEN'S BUMPY ROAD IN STEM CAREERS

WHERE ARE WE? WHY SO FEW? AND WHAT TO DO?

SEHAM AHMAD ALJAAFREH[1]

PROF. DR. YÜCEL SAYILAR[2]

ABSTRACT

Women, in general, suffer from barriers in social and professional life that hinder their progress more than their male counterparts, especially in the fields of science, technology, mathematics and engineering (STEM). Researchers over the past decades have investigated these barriers from various perspectives. The purpose of this review paper is to discuss these barriers more comprehensively and systematically. The paper is organized into three main sections. First, the paper explores the current education and workforce representation of women in the science, technology, engineering, and mathematics landscape, and then, the paper details the barriers women face during education and work stages and societal barriers as well. Finally, we provide appropriate suggestions and highlight successful practices to overcome such barriers in woman's STEM career paths. The information has been elaborated on and classified throughout reviewing the literature, national and global reports and statistics.

Keywords: *STEM Career, STEM Education, Career Barriers, Gender Discrimination.*

[1] Uludağ University, Business Administration, Organization management, Ph.D. Student sehamjaafreh@ymail.com, Orcid No 0000-0002-1361-2394

[2] Uludağ University, Business Administration, Organization management, y.sayilar@uludag.edu.tr , Orcid No 0000-0001-6226-0324

Sorumlu yazar / Corresponding Author: Seham ALJAAFREH **e-posta:** sehamjaafreh2014@gmail.com
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INTRODUCTION

The gender gap in workforce and economic participation continues to create a considerable buzz across the globe. Many scholars have invested their interest and efforts in exploring and addressing various issues in this domain. One of the most prominent contemporary research issues in this context is the gender gap in science, technology, engineering, and mathematics (STEM) disciplines. Most of the previous studies, if not all, stated that the gender gap in STEM is mostly in favor of males, which specifically means males outnumber females in science, technology, engineering, and mathematics disciplines in terms of education (Blackburn, 2017; Cimpian et al., 2020), and economic participation (World Economic Forum Report, 2019), This scant representation may be due to several forms of gender discrimination - both explicit and implicit - that women in STEM face at all stages of their career life.

Researchers over the past decades have investigated barriers that may hinder women from pursuing STEM careers from various perspectives. During our review of the literature, we found a lack of comprehensive studies that exposes all forms of discrimination that women face during their STEM career path, starting from the stage of early education To the stage at which the woman may choose to leave the job. Besides, the barriers that women face in STEM are complex and intertwined and include conceptual and temporal confusion between the different stages of emergence (before choosing to study STEM, during education, pre-employment, during work, and persistent societal obstacles, etc.). This requires a comprehensive review of all inhibiting factors at each stage of a woman's career growth in STEM and the sites of intersection between them. Accordingly, one contribution of this study is that we served to define, organize and classify several related factors that may influence women's STEM career path negatively, with those factors falling under three primary categories: 1) gender discrimination in STEM education, 2) social norms and gender bias 3) gender discrimination in STEM workforce. These three main factors act as barriers during different stages of career development process. It is worth noting that these factors differ in their nature and impact depending on social and cultural backgrounds,

This paper is organized into three main sections. First, we explore the current educational and economic representation of women in the science, technology, engineering, and mathematics landscape, and then, we detail the main issue, including the barriers women face during education and work stages and societal barriers as well. Finally, we provide recommendations for community members, policymakers and practitioners.

1. CURRENT LANDSCAPE OF WOMEN IN STEM

2.1 Women in STEM Education

STEM acronym is still wide and there is no clear definition of the disciplines that fall under STEM umbrella; therefore, we considered that a glimpse of the term, its origin, and its development in education should be given before proceeding to discuss the current status of STEM educatıon. Interest in STEM education began roughly since the 1990s, As the US National Science Foundation (NSF) included engineering and technology, along with science and mathematics, in undergraduate and K-12 school education (NSF, 1998). Earlier, the acronym SMET had been used when referring to the main disciplines in science, technology, engineering, and mathematics, and all knowledge and skills included under these disciplines. But in 2001, the words were rearranged to form the acronym STEM. Since then, STEM education curricula have been used in many countries outside the United States until this acronym has become universally popular. NSF published a list of approved disciplines which considered under the umbrella of STEM, and the list includes core fields (e.g., physics, biology, chemistry, engineering, technology, and mathematics) and also includes subspecialties in social sciences and economics (Li et al., 2020).

Findings of cross-cultural comparative studies (e.g., TIMSS: Trends in the Study of International Mathematics and Science, and PISA: a Program for International Student Assessment, a triennial assessment of knowledge and skills at the age of 15) have helped researchers and educators understand how students' cognitive and emotional learning achievement can vary according to several factors such as gender, age, and country (Chiu & Duit, 2011). PISA 2018 suggests that gender differences are generally small in mathematics and science achievements , Boys outperformed girls by just five points in mathematics, and girls outperformed boys in science by just two scoring points on average across OECD countries (OCED, 2018), Despite the similar achievements of students of both sexes in the fields of science and mathematics, However, this does not mean that girls and boys will go at the same rate to higher education and work in these fields in the future , studies shows that males are more likely to choose these fields to study at the higher education stage, as Amongst the students assessed by PISA, only 1% of girls reported that they want to pursue an ICT-related career, compared with 8% of boys who so reported , furthermore, More than one in four boys stated that they expected to work as an engineer or science professional when they were 30 years old, but less than one in six girls reported this on average across OECD countries (OCED, 2019). However, statistics indicate a significant improvement in the number of women choosing to enroll in STEM majors, but the increase is not sufficient to fill the

gap. Because the number of men is also increasing in a high manner, in fact, the increase caused by men is much faster than women (NSF, 2018),

Globally, statistics show indications of gender inequality manifestations highlighted by the numbers in information technology and engineering. This paper reviews the recent data on the representation of undergraduate women in STEM fields across several countries and economies (see table 1). Looking at the table below, we find that women are mostly well represented in natural and physical sciences except for the United States by 19.3% and Japan by 27.9%, which is lower than the general average for the rest of the regions. Nevertheless, in all the countries and economies reviewed, women are significantly underrepresented in the fields of technology and engineering. India is an exception when it comes to engineering, as the representation of women compared to men almost exceeds 50.0%.

It is important to emphasize that the numbers that represent women in the education stage do not necessarily mean that they are compatible with representation in the labor market. Not all female graduates work in the same specialty, maybe due to lack of opportunities, moving to another field, or their inability to overcome the obstacles they faced during the transitions between education and the labor market. Women who have challenged educational difficulties and started to work in STEM professions are facing several difficulties in this male-dominated work environment with high levels of discrimination (Funk & Parker, 2018).

Table 1: Representation Of Undergraduate Women In STEM Fields Across Several Countries And Economies In 2018

Region	Natural And Physics Sciences	ITRelated Fields	Engineering-Related Fields	Source
USA	19.3%,	18.7 %	20.9 %	National Science Foundation "Advance: Organization change for gender equity in STEM academic professions.". (2019b).
Australia	53.6%	18.0%,	17.2%	Australian Government, Department of Education, Skills and Employment "Completion Count by Course Level by Field of Education by Gender by Year, uCube "(2020)
India	54.1%	31.4%	54.1%	Government of India, Ministry of Human Resource Development, "Table 35: Out-Turn/Pass-Out at Under Graduate Level in Major Disciplines/Subjects (Based on Actual Response)," All India Survey on Higher Education 2018-19 (MHRD India, 2018).
Japan	27.9%	35.0 %	15.4%	Government of Japan, Gender Equality Bureau Cabinet Office, "Chapter 5: Education and Research Fields," *Women and Men in Japan* (2020).
Canada	56.9%	28.0%	20.2%	Statistics Canada, "Table 37-10-0163-02: Proportion of Male and Female Postsecondary Enrolments, by International Standard Classification of Education, Institution Type, Classification of Instructional Programs, STEM and BHASE Groupings, Status of Student in Canada and Age Group," (2020).
European Union	54.8%	19.8%	26.7%	Eurostat, "HRST by Category, Sex and Age," *Eurostat Database* (2020).
France	53.7%	15.4%	25.4%	
Germany	46.1%	19.6%	20.0%	
Netherlands	45.2%	10.3%	21.9%	
Sweden	58.6%	33.8%	35.9%	

Sorumlu yazar / Corresponding Author: Seham ALJAAFREH **e-posta:** sehamjaafreh2014@gmail.com
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Switzerland	41.0%	8.9%	13.7%

2.2 Women In STEM Labor Market

STEM careers have become among the most sought-after professions nowadays (Madgavkar et al., 2019), as the global economy is in high demand for engineering and technology skills to keep pace with the rapid economic development (Lund et al., 2019). wherefore, developed countries have focused on improving STEM awareness, not only to increase literacy in these fields but also to develop the workforce of scientists and engineers and diversity and inclusion strategies working on enhancing the contribution of underrepresented groups (such as women and immigrants) in STEM careers. However, the gender gap in these areas still exists.

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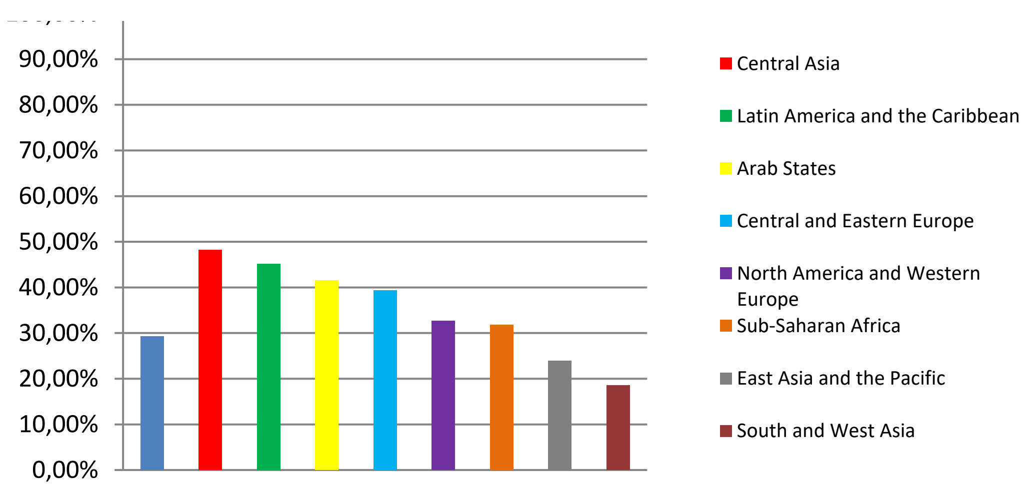
Women constitute half of the labor market. Nevertheless, the percentage of women working in STEM does not exceed 28% (World Economic Forum Report, 2019). Women consisted approximately 29.3% of the scientific research and development S&D workforce in 2016 (see figure1)(UNESCO,2019)

Figure 1: The Regional Averages For The Share Of Female Researchers (Based On Available Data Only) For 2016



Source: UNESCO, 'Women in science', Fact Sheet No. 55 June 2019.

According to Eurostat for European statistics, the number of female scientists and engineers reached more than 3.6 million, an estimated 41.0% compared to 59.0% for men in 2019 (see Eurostat, 2020).

Women are not just underrepresented in functional careers. But also, they do not fairly exist in leadership and senior management positions. Female CEOS and board members are underrepresented across all fields. but the situation is worse in STEM fields. However, in the information technology industry, boards of technology companies are making progress, the proportion of women in board director positions has increased from 14.8% in 2018 to 17.9% (Emelianova & Milhomem, 2019), But the gap still exists in In many other sectors (see Table 2)

Table 2: Percentage Of Women On Boards By Industry (2019)

Communication services	20.20%
Consumer discretionary	22.10%
Consumer staples	21.40%
Energy	18.50%
Financials	22.20%
Healthcare	21.60%
Industrials	20.20%
Information technology	17.90%
Materials	17.90%
Real estate	18.10%
Utilities	19.40%
Global	**20.60%**

Source: Credit Suisse Research, CS Gender 3000, The changing face of companies, 2019

2. BARRIERS TO PURSUING STEM CAREERS

In the past, it was prevalent that biological and innate factors are the most important reasons for the limited presence of women in STEM fields, which is not subject to change (Bleier & Engle, 1987), but scholars proved that it does not depend only on innate and biological characteristics, but there are external factors in the surrounding environment, such as social and cultural factors that play a significant role in the scene (Ceci et al., 2014). These factors deepen over time and become barriers to female enrollment in majors associated with these fields at the university. These factors also make females unwilling to work in the aforementioned fields and if they enter, they will quickly withdraw.

3.1 Socio-cultural Barriers

The disparity in STEM fields may arise from socio-cultural factors represented by gender roles, values, lifestyle and stereotypes (Ceci et al., 2014). It is worth noting that social and cultural factors are not limited to a time. It depends on the prevailing social and cultural contexts rather than age. Accordingly, this section discusses the factors stemming from the social and cultural contexts that women may be exposed to during all stages of career development (at school, university, and workplace).

3.1.1 Stereotypes and Social Norms

Stereotypes exemplify the association of certain traits with members of a group (for example, women do not succeed as scientists, men are more tech-savvy, and women are not suitable for leadership positions), and these stereotypes operate either overtly or implicitly in the unconscious mind and often Be negative traits (Gawronski & Bodenhausen, 2006; Greenwald et al., 1998, 2002; Smyth & Nosek, 2015),

People across their lifespan perceive certain roles to be more or less appropriate for their gender (Martin & Halverson, 2016), It is possible that stereotypes about what someone in STEM fields

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should look like and how he/she should behave can lead to ignoring individual's competence and potential, for example, It is often thought that a typical scientist or in a STEM profession, is male. Therefore, women in science fields may not fit individuals' perceptions of what a scientist should be, and thus she may be overlooked. The role compatibility theory of prejudices states that a perceived conflict between gender and a particular role or job can lead to negative evaluations. Negative stereotypes about women's quantitative abilities can lead people to undervalue their work or discourage those women from continuing into science, technology, engineering, and mathematics (STEM) fields. (Good et al., 2010; Miyake et al., 2010) , In a study carried out in Turkey, it was found that when choosing a university department, girls are given more attention to the relevance of this specialty to their gender role as female (Korkut-owen et al., 2012).

The prevailing perception reinforces an implicit notion that women are less qualified in the scientific fields and are more appropriate for caregiving fields (Ecklund, Lincoln, & Tansey, 2012; Saucerman & Vasquez, 2014, Ceci vd., 2014), and the difficult and abstract scientific disciplines are seen as a traditionally male domain (Ecklund et al., 2012). Stereotypes about males motivate boys at early ages to acquire applied skills and focus on activities that emphasize problem-solving skills, finance, information technology, and mathematics. This encourages them to advance in STEM fields in the future (Alawi & Al Mubarak, 2019). The stereotypes about females lead them to focus on family formation and management, also on activities related to personal relationships, which limit their orientation and participation in the future in areas such as mathematics and engineering, and they choose courses related to humanities, caring or teaching (Benitez-Herrera et al., 2019).

Many consider stereotypes not only a logical form of choosing a course, a university major, or even a hiring decision, but much more. Studies have shown that stereotypes also have a fundamental role in perception, performance, and important decisions without awareness, which is the implicit effect (Charlesworth & Banaji, 2019; Smyth & Nosek, 2015). This implicit perception of STEM environments as environments that represent power, status, self-strength, and competitiveness (Diekman et al., 2011) prevents women from approaching these areas because they feel that they are unable to compete in a male-dominant domain. Also, in academia, the belief that brilliance is more important than dedication to success, and males are naturally brilliant than women, makes women feel that they are not suitable for STEM academic work (Morgan, 2019)

One study found that there is a direct relationship between the underrepresentation of women in fields such as science and mathematics and the belief that success in these fields depends on genius and innate talents due to stereotypes claiming that women do not have these talents (Litson et al., 2021). Hence, stereotypical ideologies regarding gender roles represent a factor in seeing women as ineffective and do not possess the necessary ingredients for success as scientists (Carli et al., 2016).

As mentioned before, social norms and stereotypes about gender are not limited to Time, and they may begin to play a significant role at the early education stage, driven by expectations about the "role of women" (Carlana, 2019), or during the work stages, women may choose to withdraw from STEM in order to achieve a match between their innate biological characteristics and the social and cultural barriers they face, as women believe that their gender identity conflicts with the nature of STEM careers and that their success will be weak (Diekman et al., 2010).

3.1.2 Sexual Harassment

Sexual harassment is more frequent in areas where males outnumber females and dominate the profession (Kim et al., 2016). In male-dominated environments, harassment, inappropriate comments, and microaggressions abound (Barthelemy et al., 2016), and since there are more men than women in the fields of science, technology, engineering, and mathematics, we expect that women in STEM fields are more likely to be exposed to sexual harassment. Verbal and physical harassment is a phenomenon that women are exposed to even in educational institutions and workplaces. One study found that undergraduate female physicists are more likely to experience sexual harassment than other females in other disciplines (Aycock et al., 2019).

Women are not only affected by their own experiences but also by the experiences of others. According to social cognitive career theory, individuals are affected by the experiences of those around them from family, friends, and acquaintances, which form a set of expectations for the future that affect their current decisions (Sheu & Phrasavath, 2019). If a woman anticipates that she may not be safe in a job, she may not put this job among her career options, and this is supported by a study in Germany that shows that job security is an influencing factor in the career selection process (Wüst & Leko Šimić, 2017), unsafety workplace is one of the reasons for the low number of women applying to STEM jobs.

3.2 Education Stage Barriers

3.2.1 Gender Bias In ClassRooms

After the Industrial Revolution, the gender gap in education has shrunk to a huge extent, and this has made a big difference, as about half of the economic growth in OECD countries over the past five decades has been due to higher educational attainment, especially among women, However, there is still a gender gap in STEM education (OCED, 2019). This gap shows early in the middle school stage, as the number of males who aspire to work in professions related to science and engineering is twice the number of females at that stage (Legewie & A. DiPrete, 2012). One of the reasons for this is that some teachers themselves hold biased beliefs about girls and boys in the fields of science and mathematics. A study found that teachers believe that male students 'success in mathematics stems from their personal factors but that girls' success is due to other factors such as perseverance and diligence (Fennema et al., 1990). This undermines girl's self-confidence and makes her doubt her ability to succeed, which negatively affects her future orientations and career options. Implicit stereotypes not only lie within the school, but parents' expectations of girls also drive them away from science, technology, engineering, and mathematics fields (Dasgupta & Stout, 2014). Even if girls choose to enroll in specializations related to STEM fields in higher education, they may face obstacles that lead them to leave or change specializations. Studies show that females are more likely to drop out or move away from higher education in STEM majors (Wu & Uttal, 2020; Shaw & Stanton, 2012). Scholars called this phenomenon “The leaked pipeline “. Leaked pipeline among females in STEM sciences occurs when moving from middle school to high school (Legewie & A. DiPrete, 2012) and from high school to college (Shaw & Stanton, 2012). For example, in USA, girls' interest in computers and coding reduces from 66% to merely 4% between the ages of six to eighteen, according to “ Girls Who Code (2019)” report. Therefore, these transitional stages must be given special attention when designing orientation and mentoring programs.

3.2.2 Absence Of Female Role Models

Many women were growing up when there was a complete absence of female role models to support their desire to enroll in STEM fields; Children are exposed daily to false information, especially in media, and medıa diminished the role of women to be limited in caring and forming a family. Also, many visual media present women as sexy, over-emotional, or victims (Kitzinger et al., 2008). For example, in family films, men are portrayed 14 times more in STEM professions than women (Kong et al., 2020). The noticeable absence of positive role models for STEM makes it difficult for children at that stage to imagine a woman as a scientist, engineer, or programmer.

Scholars supposed that students' observation of same-sex role models enhanced their learning process and behaviors, which lead to similar behaviors and aspirations, counter stereotypical role models influences aspirations and career choices among students (Olsson & Martiny, 2018). Furthermore, It has been proven that students' meeting with male and female scientists has a positive effect on them, as students may consider them as role models, which motivates them to perform better (Adedokun et al., 2012). A recent study conducted on a group of female students before and after the role model intervention found that having a role model has an important positive role in enjoying mathematics and the increasing feeling of the importance of this field, and also enhancing the confidence and expectations to succeed (González-Pérez et al., 2020).

3.3 Work Stage Barriers

Over the past decades, women have made remarkable progress in their qualifications and activity rate (Dabla-Norris & Kochhar, 2019), which has led to positive progress in women's representation in the labor market and economic participation (Lundberg & Stearns, 2019). However, women continue to experience discrimination in the workforce, facing vertical and horizontal bias, and occupational segregation before and during engaging in the workplace (Bettio & Verashchagina, 2009). In this section, we review the forms of discrimination that women exposed to in the workplace

3.3.1 Access To Vocations

Many studies have investigated gender discrimination in the labor market (e.g. Riach & Rich, 2006, Kübler, Schmid, & Stüber, 2018, Azmat & Petrongolo, 2014). Women have difficulty in reaching jobs in general and science, engineering, technology, and mathematics professions in particular. Several experimental studies have shown that women are less likely to be employed, and if they get a job, they get a lower salary than men with the same qualifications. (Milkman et al., 2015; Reuben et al., 2014),

In a field study examining gender bias in employment criteria, two resumes for a man and woman with different qualifications were sent to 1372 job offers and two other resumes with a difference in parenthood status (with or without children), A bias in favor of men is observed, the extent of bias decreases when women have higher qualifications, and increases when women have children (González et al., 2019), another study shows that online ads of STEM professions target men more than women. These ads were explicitly intended to be gender-neutral in their delivery (Lambrecht & Tucker, 2019). In another study, email requests were sent out to meet with professors in doctoral programs at the 260 top US universities. It was impossible to determine whether any particular individual in this study was experiencing discrimination since each participant saw only one of the applications from only one graduate student. The researchers found, however, evidence of discrimination against ethnic minorities and women compared to Caucasian men (Milkman et al., 2012).

Social impediments to women's accession and advancement in STEM fields do not stem from only man's bias against women; women's bias against women also exists. Studies showed that prejudice does not depend on gender. A study was conducted on faculty members of a science college in two universities interested in scientific development and research, where they were asked to evaluate students' applications for employment in a laboratory manager position. The study revealed various forms of hidden bias against women. Despite identical CVs, the female candidates were seen as less likely to be hired than the male candidates. Female candidates have been offered approximately 88% of the male candidate's salary. female candidates were seen as less worthy of mentoring than the male candidate; Both male and female faculty evaluators were more inclined to select, compensate, and mentor male candidates generously; The extent of the differential evaluation was mediated by the perception of greater proficiency in male candidates. (Moss-Racusin et al., 2012),

3.3.2 Gender Pay Gap

Women earn 15% less than men on average in OECD countries and 20% less among higher-paid workers (OCED, 2018, 2019). furthermore, female scientists do not receive fair compensation compared to their male counterparts (Blau & Kahn, 2017), in the United States, women in science and engineering jobs earn $ 20,000 less than men annually and receive approximately 79% of what men earn for the same work (NSF, 2018),

Although STEM occupations are considered high-paying professions, women are paid less than their male co-workers (Funk & Parker, 2018). The pay gap exists in all sectors, but it is wider in STEM professions when women enter traditionally male-dominated fields (perhaps to earn a higher salary), they feel disappointed by unequal compensation compared to male coworkers with the same qualification, and the wage gap forces women to abandon these professions because they do not feel fair by the financial rewards systems, where previous studies have shown that financial rewards have a significant impact on young people's choice of career (Wüst & Leko Šimić, 2017).

3.3.3 Performance Evaluation and Promotion Bias

Bias against women within the workplace promotes an unsupportive work environment, in which women feel a lack of belonging and isolation, and these reasons may push them to leave work (Hewlett et al., 2008). Bias in the workplace appears in several forms, the most important of which is discrimination in performance evaluation and promotion opportunities.

Females are often considered less competent than males even if the job indicators are identical (Dasgupta & Stout, 2014). Wenneras and Wold (1997) examined scores provided by the Swedish Performance Indicators Review Committee for postdoctoral grant applicants and found that even when male and female performance indicators were identical, female indicators were assessed as less competent, which reduces their chances of getting the overall grant (Wenneras & Wold, 1997).

Unfair evaluation minimizes opportunities for promotion and advancement to higher job levels. McKinsey (2020) reported that men are promoted 30% more than women (McKinsey, 2020). Stereotypes also play a role in the low likelihood of promotion, stereotypes about women in the field of science, and the less the committee is convinced that there are implicit barriers preventing women from advancing, the less likely ıs the committee will promote women (Régner et al., 2019). Bias in evaluation and promotion opportunities is one of the reasons that lead women to quit their jobs and thus to ع underrepresentation of women in higher-paying and higher-ranking jobs such as STEM jobs.

3.3.4 Family-Work conflict

Women are leaving STEM careers at higher rates than men, especially among working mothers (Frank, 2019). They work at low-paying part-time jobs to be able to do household duties. Moreover, women who take extended maternity leave are more likely to receive low pay and have less chance of promotion (Cech & Blair-Loy, 2019). This is because working women still perform all household chores in addition to work tasks; The dilemma is even more difficult in STEM careers.

Hewlett and her colleagues found that 39% of women in science, technology, and engineering fields have left their jobs due to work pressures and the inability to balance work and private life (Hewlett et al., 2008). Another scholar stated that women who have children and work in the technical field, such as engineering and computers, are more likely to leave their jobs than their male peers or female peers without children (Cha, 2013). Another study carried out in Turkey found that playing multiple roles such as the mother, wife and working woman can negatively affect the career commitment of working women (Otluoğlu1 & Akdoğanli, 2019).

The concerns experienced by women in trying to reconcile work and family obligations negatively affect the feeling of belonging and intentions of commitment at work. Moreover, women in fields such as engineering work in an environment that is typically recognized as male jobs, not for women, and the women's task is family care, which makes internal conflict more intense (Singh et al., 2018).

3. RECOMMENDED SOLUTİONS AND STRATEGİES

In order to bridge the gender gap in science, technology, engineering, and mathematics in both education and work stages, every institution interested in these fields, whether in the education or the labor market, must address the implicit and overt obstacles that women and girls face in In STEM career path (Charlesworth& Banaji, 2019; Corbett & Hill, 2015; Valantine, Collins, & Verma, 2015). Besides, practical steps must be taken, clear policies are drawn up, and targeted programs designed to enable more women in STEM in terms of quantity and quality. In this section, the paper suggests possible solutions for education and work stages and also presents a set of practical, tested strategies that have proven their worth in changing perceptions of prejudice and stereotypes that may hinder women's progress in STEM.

4.1 Education Life level

4.1.1 Reform Stereotypes by Promoting and Celebrating Female Role Models

As mentioned before, in the second section of this paper, stereotypes begin to crystallize in students' minds at early ages through what they capture in terms of information and perceptions about the role of women and men and their capabilities. Therefore, we believe that early education initiatives aimed at shattering gender stereotypes in science are more effective with elementary school students and even pre-kindergarten students. These stereotypes can be reformed by establishing diverse role models to promote women's roles in STEM fields. Presenting non-traditional role models, which is what scholars call "counterstereotype exposure," plays a major role in In modifying past beliefs, raising the level of self-efficacy and the feeling of ability to succeed in STEM fields and increasing the likelihood of choosing these disciplines (González-Pérez et al., 2020). There is positive empirical evidence of the effectiveness of this approach. For example, Hermann (2016) examined the impact of role model intervention on Students' attitudes, and female students were emailed as role models, in which she normalized concerns about belonging, provided examples of overcoming hardships, and stimulated perseverance. Participants showed higher signs, less failure, and less withdrawal (Herrmann et al., 2016). Another study found that female students in 9th and 10th grades perform better in science when the images in their textbooks include counter-stereotypes of female scientists. Accordingly, we suggest conducting awareness-raising workshops for faculty members in science, technology, engineering and mathematics majors and drawing their attention to the impact of gender discrimination in the classroom on students' future career intentions, as well as awareness within the family by teaching children that females and males differ in biological structure, but have the same rights and duties in the community. Also, facilitates students' confrontation with female role models during the educational process. This enhances the girl’s self-confidence and contributes to correcting false stereotypes about gender roles and female capabilities by using media to promote a positive image of women in STEM .

4.1.2 Develop Effective Extracurricular STEM Programs

Extracurricular programs can make progress in attracting women to STEM majors, In the United States, several programs have been developed to support girls ın STEM fields, such as “Girls who code” for supporting girls in computer science, and the “ First “ program for Inspiration and Recognition of Science and Technology (Kong et al., 2020), These programs can be emulated and transferred to other countries. Inclusion of girls in non-curricular programs and activities related to science, technology, and mathematics can enhance their self-efficacy and normalize the idea of their presence in these environments.

4.2 Work-life Level

4.2.1 Combat Implicit Bias In Hiring, Evaluation Systems

The stereotypes ingrained in people's minds may lead to the formation of implicit bias and subjective judgment in core practices at the workplace, such as recruitment and promotion. Studies have suggested practical strategies to break the implicit bias and generate fair, objective decisions regarding women in workplace. The 'breaking habits ' strategy has proven effective in fostering the desire for change and reducing racial and gender bias (Carnes et al., 2015; Charlesworth & Banaji, 2019; Devine et al., 2017; Forscher et al., 2017) The implicit bias is similar to the negative habits that are inherent in the individual, and he or she practices without awareness, accordingly, this strategy suggests educating individuals about the forms of implicit bias within them and its effect on their behavior, their attitudes and the decisions they make, Forscher and his colleagues examined behavioral changes of a random cluster sample of faculty members from 92 STEM departments after offering them "Breaking Habits" workshop on stereotypes in STEM fields. Participants demonstrated positive awareness, resulting in decisions and actions to reduce gender bias. Breaking Habits approach has been shown to be effective in raising awareness, increasing affiliation (Forscher et al., 2017), and promoting positive practices such as fair employment in many organizations (Devine et al., 2017).

Another study used an evidence-based intervention technique, in which participants were confronted with objective and personal evidence of showing a gender bias in the evaluations. The study showed some effectiveness in perceiving bias, but in the participants were negative feelings of guilt, defense attitude, and anxiety about the future (Paluck, Green, & Green, 2019; Parker, Monteith, Moss-Racusin, & Van Camp, 2018). The combination of strategies, synchronized with the Awareness approach, shows progress in addressing gender disparities in STEM (Charlesworth & Banaji, 2019).

In this context, we also suggest providing workshops for employers on the importance of achieving difference and integration in the workplace and the ability of women to bring benefits and creativity to the organization. Adding to this, the application of blind employment policies that rely only on qualifications and competence and do not consider gender can greatly contribute to reducing bias in hiring functions (Meena, 2016).

4.2.2 Implement Mentorship and Targeted Training Programs

Effective mentoring programs have an important role in countering the increasing stress and lack of self-confidence that women may be exposed to because of the obstacles and pressures they experience in the STEM work environment. These programs provide mutual psychological and emotional support as well as understanding and guidance on a more personal level (Dawson et al., 2015; Primé et al., 2015). Effective mentoring also helps in identifying and correcting weaknesses, enhancing strengths, increasing self-efficacy, and making more rational decisions during the career development process (Paglis et al., 2006). In this context, we suggest providıng more vocational training and professional nebtorıngprograms for women in non-traditional fields like programming and coding and celebrating success stories to encourage others to take a step and engage in these fields

4.2.3 Reform Laws on Gender Discrimination Concerning Wages and Maternity Leave

Gender-based discrimination is illegal around the world, yet discrimination in pay and maternity leave still exists (Kong et al., 2020), which requires effective implementation of labor laws that guarantee women's rights to fair compensation and maternity leave by establishing specific definitions of gender discrimination forms to reduce confusion ın legal accountability, Accurate definitions in the law can help employers and institutions understand, and reduce practices of gender discrimination that occur consciously or unconsciously by themselves or others in their organization.

Regarding equal pay, positive steps are being taken in many countries. For example, In the UK, large companies must publish financial wage data in detail, such as the mean and average hourly wages, bonuses, and other rewards, by gender (Kong et al., 2020). Pay transparency and concerns about accountability have a major role in reducing manipulation and discrimination practices.

The same is valid for the maternity leave issue, as developing flexible work arrangements can enhance a healthy work-life balance and deliver benefits for women, employers, and organizations. To achieve this, many countries have encouraged employers to provide paid parental leave to female employees. OCED (2019) report stated that 24 countries in the OECD provide paid maternity leave (OCED, 2019). Facilitating maternity leave procedures could push more women to join the labor market, as well as reduce the phenomenon of leaving work resulting from the struggle between work and life that working women experience.

4.2.4 Promote Encouraging and Safe Workplace Culture

An insecure work environment in which there is a risk of women experiencing physical and verbal harassment is considered a repulsive environment. These practices can push women to refrain from applying for male-dominated jobs or quit work if they have already or are expected to be exposed to such experiences (Kim et al., 2016). Accordıgly, Public health professionals should make an intervention to reduce harassment practices in the workplace and facilitate reporting channels that a woman can use if she is exposed to any type of harassment, which constitutes a deterrent that reduces the likelihood of this phenomenon in general. Also, more efforts must be made to increase societal awareness of the consequences of this phenomenon on all personal, institutional and societal levels.

4. CONCLUSION

Promoting the inclusive and meaningful participation of women and ensuring equal access to opportunities in STEM fields is not only essential to closing the work gap and supporting economic growth, it also leads to more inclusive, innovative and prosperous societies. It is important for societies to realize the vital role women play in these areas and to work on removing the regulatory barriers and legal and political restrictions that keep women on the margins. The best approach to finding solutions is to look at the issue with a more holistic view in terms of scope and time dimension by starting to amend the misconceptions and stereotypes prevailing about the roles of men and women in society and encouraging girls to engage in what is considered an unconventional field for them as well as providing a safe and polarized educational environment that motivates girls to continue and pursue STEM careers in the future.

In the context of the labor market, the parties that should contribute to supporting women are many, including governments, business owners, employers, policy-makers, decision-makers, society and women themselves. It is important to reformulate laws and policies that include a barrier to the development of women and design programs to develop and refine the capabilities of women and raise their efficiency in the fields of STEM, it is important to explore and exchange successful practices and experiences in different countries of the world, that the intensification of efforts of all professional bodies can achieve the desired goals.

We hope this review will contribute to the continued progress in studies of STEM careers progression at the national and transnational levels by encouraging researchers to bridge the gap and reach a deeper understanding of the problem that enables us to find solutions and transfer successful practices and policies.

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