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EMPOWERING DIVERSITY: POLICIES FOR GENDER EQUALITY IN STEM EDUCATION AND WORKFORCE PROGRESSION IN NORTH MACEDONIA

Fatime Hasani Reka PhD (c)
Faculty of Contemporary Social Sciences,
South East European University,
Tetovo, North Macedonia
f.hasani@seeu.edu.mk

Memet Memeti, Full Professor
Faculty of Contemporary Social Sciences,
South East European University,
Tetovo, North Macedonia
m.memeti@seeu.edu.mk

ABSTRACT

The enduring global issue of women's underrepresentation in science, technology, engineering, and mathematics (STEM) fields carries significant implications for both societal advancement and economic growth. Despite the rise in women's enrollment in higher education, the persistent gender pay gap can be attributed in part to their limited presence in STEM domains, which tend to offer higher-paying career prospects. This study scrutinizes the impact of national policies on gender imbalances in STEM, focusing on the case of North Macedonia. It assesses existing measures and programs while proposing recommendations to foster gender parity in STEM both national and local scales. Employing a mixed research methodology, the study incorporates desktop research,

statistical analysis of gender distribution in STEM fields, policy evaluations of national frameworks, and primary data collection through interviews and surveys.

Keywords: gender mainstreaming, gender equality, STEM, gender gap, affirmative action, gender policies

INTRODUCTION

The global underrepresentation of girls and women in STEM fields, encompassing science, technology, engineering, and mathematics, is a pervasive issue *(Burke & Mattis, 2007)*. STEM professions are expanding and exerting a considerable influence on the economy, offering opportunities for narrowing the gender pay gap and enhancing economic resilience in future labor markets. Prioritizing the STEM sector to align with global market trends and promote women's empowerment in the workforce is critical for advancing gender equality. Thus, achieving a balance of genders in STEM (science, technology, engineering, and mathematics) fields is imperative in many developed nations. The growing integration of technology into daily life highlights the significance of gender parity in STEM, as it correlates with economic development. Despite the increasing demand for STEM in academia and in practice involvement of women remains disproportionately low in North Macedonia. In addition, the absence of sex-disaggregated data per field complicates the assessment of women's status in STEM. Moreover, different studies exemplify that gender stereotypes persist in the job market, exacerbating the low participation of women. This disparity in job selection results in unequal earnings and economic vulnerability. Empowering women in STEM will not only contribute to the economic development of the country but also foster greater gender equality. Moreover, women in the Republic of North Macedonia continue to encounter gender-based violence, stereotypes, and discrimination in various aspects of life, including the labor market (*The Kvinna Till Kvinna Foundation, 2023*), political engagement, and decision-making processes.

DESIGN OF THE STUDY

This paper's methodology involved several research methods. Firstly, we gathered desktop and statistical data to analyze the representation of women and men in STEM fields in the Republic of North Macedonia. We conducted a thorough policy analysis of all relevant action plans, frameworks, and national documents pertaining to Women in STEM. To identify existing

initiatives, mechanisms, and programs at the regional level, we conducted primary data gathering through surveys. We engaged with various stakeholders who promote women in STEM, including regional and international organizations, women's and business associations, and women's rights groups. This study employs a mixed methods approach to comprehensively investigate gender disparity within STEM fields. The research design combines quantitative analysis of existing datasets with qualitative insights gathered through surveys and interviews. This approach allows for triangulation of data sources, enhancing the validity and reliability of the findings.

Limitations, while efforts will be made to obtain a representative sample, the study's findings may be influenced by sample bias inherent in survey and interview-based research. Cultural and contextual factors not captured by the data may influence gender dynamics within specific STEM disciplines.

WOMEN'S PARTICIPATION IN STEM IN NORTH MACEDONIA

Despite North Macedonia's relatively favorable ranking in the Global Gender Gap Index, the Gender Gap 2022 report by the World Economic Forum suggests that gender parity is still distant, with an estimated 99.5 years required to bridge the gap. North Macedonia's Gender Equality Index in 2022 revealed a 5.4-point gap from the European average, indicating the need for significant improvements in gender equality (*EIGE, 2023*)

Table: Ranking of Western Balkan Economies in the Gender Gap Report

Western Balkans Economy	Rank and score
Albania	Ranked 17; score 0.791
Bosnia and Herzegovina	Ranked 86; score 0.698
North Macedonia	Ranked 73; score 0.711
Kosovo*[1*]	Does not appear on the rank list of WEF in 2023
Montenegro	Ranked 71; score 0.710
Serbia	Ranked 38; score 0.760

Source: World Economic Forum, Gender Gap Report 2023, available online

North Macedonia still lags behind the EU average by 3.5 points, but the gap has decreased from the previous measurements. The country is making slow progress in alignment with EU member states, signaling a need for significant improvements in policies and practices for gender equality. North Macedonia shows the largest gaps with the EU in the domains of Money and Time, while it scores higher in the domain of Power. Legislation and policy changes have been observed in North Macedonia, including the drafting of a new Law on Gender Equality and the adoption of the new Strategy for Gender Equality 2022-2027. Progress has been noted in areas such as labor market regulations, education reforms promoting equality, and laws addressing discrimination and violence against women. Despite advancements in legal and strategic frameworks, challenges remain in the consistent implementation of gender equality measures, primarily due to financial constraints, inadequate monitoring systems, and issues related to accountability and prioritization at the institutional level (*Gender Index,2023*).

The initial measurement in 2015, as well as subsequent assessments of the Gender Equality Index in the realm of Knowledge, underscores the imperative for substantial enhancements. This includes specifically narrowing the disparities among men and women in education. Efforts are particularly

[1*] This designation is without prejudice to positions on status and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo* declaration of independence

crucial in diminishing educational segregation by field between genders and fostering increased involvement of women in educational domains linked to natural sciences, technology, and engineering. While gender-based educational choices remain prevalent, there has been a notable increase in women's enrollment in STEM fields over the past decade. This has led to a reduction in the difference in enrollment rates between genders decreasing from 5.6 percentage points in 2013 to 3.8 percentage points in 2020 (*Eurostat, 2022*). Besides the job-market-driven aspects in STEM fields, the implementation of positive measures in recent years, such as awareness campaigns and scholarships for women in STEM fields, has also played a role in narrowing the difference in gender representation (*Official Gazette of the Republic of North Macedonia, No. 170/2022*). An area of concern is the low enrollment of female students in STEM faculties in the Republic of North Macedonia, with only 15.69% of women compared to 25.72% of men (*Regional Cooperation Council, 2020*). Furthermore, around 70% of women in STEM fields tend to drop out due to various factors such as prejudice, unequal distribution of family responsibilities, income inequality, family care duties, and discrimination. Those who do graduate often leave the field later in their careers (*Shen, Ao.,2024*).

In contrast, the ICT field has seen steady growth in the last few decades, offering more job opportunities compared to the less developed engineering sector. This growth can be attributed to various programs aimed at encouraging girls and women to pursue careers in ICT. These programs promote the ICT industry as a stable and attractive employer with global applicability.

Data shows that women's enrollment and graduation rates in engineering are nearly equal. However, there is a gender gap in science (more women compared to men) and technology where more men are enrolled compared to women.

Table: Involvement of Men and Women in Higher Education STEM Programs

Tertiary STEM education	Science	W	M	Technology	W	M	Engineering	W	M	Math	W	M
Enrolled in academic 2019/2020	11665	7849	3816	9147	3735	5412	3467	1502	1965	1833	1211	622
Enrolled in academic 2022/2023	11934	7931	4003	9271	3811	5460	3214	1449	1765	1824	1201	623

Source: (State Statistics Office: Enrolled Students at Higher Vocational Schools and Faculties in the Republic of North Macedonia in the 2022/2023 Academic Year (First Cycle of Studies), n.d.)

The employment data reveals that women often pursue careers as math teachers, leading to their higher representation in math-related fields. This trend is also noticeable in the science fields, where the teaching profession influences gender balance. In contrast, women are significantly underrepresented in technology-related fields, highlighting a substantial gender gap.

Data exemplifies the concerning trend of high unemployment rates (18.5%) among tertiary-educated women of reproductive age. This suggests either a discriminatory labor market or prevailing gender roles influencing employers' decisions. The data also underscores a significant gender gap in employment, with women often gravitating towards public sector jobs perceived as secure but lower paying. This disparity is reflected in an 18% overall gender pay gap, with the industry sector showing a 32% gap favoring men due to their higher representation while the public sector exhibits a 6.90% gap favoring men (*World Bank,2018*, *Trends in Labor Markets in FYR Macedonia*).

Table: Labor Market Data Disaggregated by Sex

Labor market	Women		Men	
Activity rate	44,3%		69,3%	
Employed	Private	Public	Private	Public
	74,2%	25,8%	85,8%	14,3%
Unemployed	21,8%		22,7%	
Pay gap	Industry		Public	
18%	32%		6.9%	

Source: (State Statistical Office - Publication: Gender Equality Index for North Macedonia 2023 - Measuring Gender Equality, n.d.)

Another challenge faced by women in the STEM sector is the existence of a "glass ceiling," where men predominantly hold executive positions while women are limited to operational roles. This gender disparity is also evident in the business sector, where women occupy less than 30% of leadership positions on company boards and are underrepresented in entrepreneurship, with women making up only half the representation of men *(RCC 2020).*

Table: Gender Disaggregation of Leadership in Business

Leadership	Women	Men
Representation in private companies' boards (*Latkovic, Marija & Topuzovska Latkovikj, Marija, 2019)*	33%	67%
Representation in public companies' boards *(IDSCS, 2023)*	29%	71%

Source: Latkovic, Marija & Topuzovska Latkovikj, Marija, 2019; IDSCS, 2023

Despite North Macedonia having a substantial number of female researchers (89% of all researchers are women), there is noticeable gender segregation in research and development (R&D). Specifically, engineering and technology fields have twice as many male researchers compared to female researchers. Conversely, in agricultural and medical sciences, there are twice as many female researchers as male researchers, and in the natural sciences, the female population outnumbers males by a factor of three.

Table: Participation of men and women in research and development

STEM Research and Development *(State Statistics Office - Publication: Research And Development, n.d.)*	**NS**	**W**	**M**		**W**	**M**	**MS**	**W**	**M**	**AS**	**W**	**M**
Research and Development	510	370	140	246	90	152	96	72	24	104	70	34
%		73%	38%		37%	62%		75%	25%		67%	33%

Source: (State Statistics Office - Publication: Research and Development, n.d.)

Legend: AS- Agricultural Science; NS- natural sciences; MS- Medical Science; M-men; W- women.

The STEM sector in local companies, particularly in production roles, often lacks attractiveness for women due to inadequate accommodation of their needs. This results in women predominantly occupying administrative positions rather than engaging in production activities. However, there has been a recent shift towards greater integration of women in manufacturing roles, particularly in firms situated in industrial and technological areas. In sectors such as electro-industry and ICT, companies have provided intensive training to women, either due to a shortage of skilled labor or the high mobility of male-trained personnel. For instance, Rade Končar has trained women from the textile industry to become machine operators (*RCC, 2020*).

Over the past decade, there has been significant foreign investment in the Republic of North Macedonia, leading to the establishment of technological and industrial zones. These investments have provided employment opportunities for women with engineering backgrounds or those previously not working in engineering. The international companies operating in these zones offer

career advancement, continuous learning opportunities, and safety nets that align with women's interests and characteristics.

ENFORCEABLE LEGISLATION IN STEM AND EFFICIENT POLICIES

In North Macedonia, several laws prohibit sex-based discrimination (*European Institute for Gender Equality*, 2024). Article 9 of the Constitution ensures that all citizens have equal opportunities regardless of their gender. The enactment of the Law on Equal Opportunities for Men and Women in 2006 and the subsequent Law on Equal Opportunities in 2012 *(Official Gazette of RM no. 20/2015)* defined responsibilities for entities to ensure gender equality through affirmative measures. Legal mechanisms were established against discrimination on various grounds, with the Anti-Discrimination Law *(Official Gazette of the Republic of North Macedonia No.50 / 2010)* serving as a tool against the double discrimination often faced by women *(Gender Equality Strategy 2020-2025*). The Labor Law also plays a vital role in achieving greater gender equality *(Official Gazette of RM no. 74/2015)* by guaranteeing equal access to the labor market and prohibiting bias in employment and indirect prejudice in the workplace(*ibid).*

However, most STEM jobs in North Macedonia are in the gig economy, requiring new forms of work to be regulated by Labor relations. The current legal framework does not recognize these new forms of employment and their application to the labor market *(CRPM,2018)*. Although the current Education Strategy for 2018-2025 (*North Macedonia. Education Strategy for 2018-2025 And Action Plan*, n.d.) has established educational goals for women in STEM, it does not address the needs and interests required to overcome the educational gender gap. Gender parity is only mentioned in one of the aims of the strategy, without specific policies, apparatuses, and instruments to achieve it as a separate strategic goal. While the strategy includes revising textbooks to be gender-sensitive, it does not analyze women's status in STEM nor set specific goals for increasing their participation in these academic areas.

To bridge the gap between the labor market and unemployment by enhancing skills, the Employment Agency Service (EAS) of North Macedonia launched calls for IT courses for unemployed young people. However, this initiative is not gender-sensitive, as it does not take into account the distinct requirements of women and men. The Law on Scientific Research is crucial for increasing women's participation in scientific research *(Official Gazette of RM no. 46/2008),* with one of its aims being women's equality in science *(Law on Scientific Research Activity, Art. 4*

Official Gazette of RM no. 46/2008). Despite an increase in women inventors between 2005 and 2016, gender differences in patent inventions indicate severe underrepresentation of women. This underrepresentation is more pronounced in innovation (patent inventions) than in research (scientific publications) *(Directorate-General for Research and Innovation, 2019)*. This is partly due to the lack of technological development parks, which do not provide an enabling environment for ambitious women, often leading them to emigrate. There has been a positive development in directing financial support for innovation through the Fund for Innovation and Technological Development for enterprises owned and led by women *(МКД.МК, n.d.)*. The most recent call for proposals to address the COVID-19 health and economic crisis focuses predominantly on women, with extra consideration given to businesses owned or overseen by women and those registered in underdeveloped areas *(FITR.MKD.n.d.)* As a result, 56% of accepted applications are from women entrepreneurs *(Stojanova,2020)*.

EFFECTIVE STRATEGIES FOR PROMOTING WOMEN IN STEM

The EU, foreign embassies, and international donors primarily finance programs promoting women in STEM in North Macedonia, with a particular focus on IT over other STEM fields. The "Digi Girls" program, part of the Microsoft Initiative "YourSpark," has had a significant impact in the field of ICT (*RCC,2020*), Launched worldwide, including in Tetovo and Skopje - North Macedonia in 2018, the program targets to inspire girls to learn coding, programming, and develop innovative ideas in the IT sector (Смартпортал, 2019). To foster interest in coding and careers in ICT among high school students, the City of Skopje, in collaboration with CRPM 2014, organized the 'Hour of Code' event. In 2019, fifteen high school girls from North Macedonia took part in the Women in Science (WiSci) Girls STEAM Camp in Pristina, Kosovo. WiSci Camps is a joint initiative involving the US Department of State, Girl Up, Intel, Google, and other groups with the goal of addressing the imbalance in gender representation in STEAM(Science, Technology, Engineering, Arts & Design, and Mathematics) The camp united 100 adolescent girls from Kosovo, Albania, Serbia, North Macedonia, Montenegro, and the United States to reside and study collectively for a fortnight (*15 High-school Girls From North. . . - U.S. Embassy North Macedonia | Facebook*, n.d.).

It must be noted that nowadays, numerous IT schools are making IT education more available. However, they lack an approach based on gender and disproportionately more significant numbers

of boys enrolling than girls. Similarly, some companies provide extracurricular STEM programs for kids, contributing to the popularization of STEM fields, albeit with less impact on girls. The peer influence among young women to meager in dance lessons similar to their peers and parents' gender insensitivity affects this situation. A more encouraging trend is seen in "math" schools like Brain-to-brain and Little Genius, which tend to attract more girls compared to IT and robotics schools. Numerous initiatives are supporting and educating young girls and women in STEM, resulting in an increasing number of women pursuing careers in STEM. However, the advocacy for women in STEM by local organizations is still in its nascent phases.

WAY FORWARD TO ADDRESS GENDER IN STEM

Gender equality is a fundamental human right, crucial for sustainable development as outlined in the 2030 Agenda. Science, technology, and engineering play pivotal roles in sustainable development. The agenda emphasizes the commitment to "leave no one behind," with a central focus on gender equality. Achieving this requires national statistical systems to meticulously collect and analyze data disaggregated by various factors, including sex, age, income, location, disability, race, and ethnicity. The EU requires North Macedonia to adapt its science, technology, and innovation policies to align with future needs. To achieve gender equality in STEM, change-makers must influence policy development and actively implement gender-sensitive measures.

To identify change agents and their potential connections for enhancing policy influence in North Macedonia's STEM fields, we surveyed activists and professionals. The dominant perception among respondents was that the limited involvement of women in STEM puts them at a disadvantage, especially as STEM fields are considered jobs of the future with increasing demand and better salaries. Increasing women's involvement in STEM would empower them and help narrow the gender pay gap. To promote the schooling, hiring, retention, assistance, and progression of women in STEM, we propose establishing a regional network. The network would focus on campaigns highlighting women exemplars in STEM, offering networking prospects for policymakers and STEM professionals, and developing mentoring initiatives to encourage more women to enter STEM careers.

A network provides an efficient method of empowering women in STEM, enhancing their self-assurance, and assisting in their career development. The priority initiatives within the network, as

identified in our research, comprise a scholarship program for young women in STEM and a regional mentorship and internship matching initiative.

CONCLUSIONS

Decision-makers in the country ought to foster increased engagement from all pertinent actors, whether public or private, to enhance women's engagement in STEM disciplines and bolster their professional paths.

The lack of gender-sensitive data is a serious impediment to any policy initiative based on needs analysis and evidence. In this manner, standardizing data collection and having sex-disaggregated data available will aid policy development and financial support.

Affirmative measures, such as scholarships for girls in STEM, should be implemented until gender parity is achieved. Establishing a Network of Women in STEM for regional cooperation can promote role models, facilitate knowledge exchange, and encourage mentorship initiatives. Campaigns challenging stereotypes and providing gender equality training to career counselors are essential.

Tailored policy reforms and targeted STEM initiatives are effective in addressing the gender gap. Gender mainstreaming in education, science, and technology policies is crucial for compliance with European accession commitments.

Continuous monitoring and evaluation from a gender perspective is necessary. Promoting gender mainstreaming in STEM education and raising awareness among businesses and academia will contribute to sustained efforts for gender equality.

Civil Society Organizations (CSOs) play a significant role in promoting women in STEM and creating better job opportunities.

Regional initiatives with financial instruments and capacity building are essential to address the gender gap. Supporting cooperation in STEM through policy initiatives and funding schemes is vital. Mentorship programs with successful women role models and internship opportunities can further encourage participation in STEM fields.

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